LARIMER COUNTY | COMMUNITY DEVELOPMENT

P.O. Box 1190, Fort Collins, Colorado 80522-1190, 970.498.7683, Larimer.org

MEMORANDUM

To: Larimer County Board of County

Commissioners From: Development Staff

Date: September 1, 2020

RE: Northern Water documents to be added to the record / Citizen Comments for File #20-ZONE2657

Attached to this memo please find the following information received by staff since publication of the August 31st Hearing Addendum:

1. Northern Water documents to be added to the record.
    a. 2016 Colorado Water Plan
    b. 2019 Colorado Water Plan Update
    c. 2017 Letter of Support from Governor Hickenlooper
    d. Water Secure Handout (we have provided this in the past to the planning commission)
    e. Letter on the 287 realignment

2. Public comments received after the August 31st hearing through 12:00 p.m. on September 1st in the form of email strings.

LARIMER COUNTY

CPW 2016



2015


COLLABORATING ON COLORADO'S WATER FUTURE


COLORADO'S WATER PLAN







2015

COLORADO'S WATER PLAN

Colorado's Water Plan Leadership Team

Colorado's Governor, the Board Members of the Colorado Water Conservation Board (CWCB), and other staff involved in the development of the plan standing on the state map of Colorado located in the History Colorado Center. Photo taken by Matt Nager in October, 2015.

Individuals standing in the center of the state map near the continental divide, beginning left to right:

James Eklund, Director, Colorado Water Conservation Board; Governor John W. Hickenlooper; John Stulp, Special Policy Advisor to the Governor for Water and Chairman of the Interbasin Compact Committee.

CWCB Board Members standing near their basins on the state map, beginning in the south central region, clockwise:

Travis Smith, Rio Grande Basin Representative; John McClow, Gunnison Basin Representative; Russell George, Colorado Basin Representative; Jay Gallagher, Yampa/White/Green Basin Representative; Ty Wattenberg, North Platte Basin Representative; Diane Hoppe, South Platte Basin Representative; Patricia Wells, Metro Basin Representative; Alan Hamel, Arkansas Basin Representative. Not pictured: April Montgomery, Southwest Basin Representative.

Individuals standing along the state lines, beginning from the southwestern corner (individuals are CWCB staff members, unless otherwise identified):

Don West , Kaylea Moore, Ben Wade, Stephanie DiBettito, Jodie Tavares, Lauren Ris (Assistant Director for Water, Colorado Department of Natural Resources), Kevin Reidy, Brent Newman, Tom Browning, Linda Bassi, Kate McIntire, Rebecca Mitchell, Jacob Bornstein, Dick Wolfe (State Engineer, Colorado Division of Water Resources), Mike King (Executive Director, Colorado Department of Natural Resources), Don Brown (Commissioner of Agriculture, Colorado Department of Agriculture), Kevin Houck, Ted Kowalski, Robert Randall (Deputy Director, Colorado Department of Natural Resources), Kirk Russell, Taryn Finnessey, Doug Mahan, Carolyn Fritz, Sam May, Michelle Garrison, Jonathan Hernandez, Suzanne Sellers, Emily LoDolce, Mara MacKillop.

"We embark on Colorado's first water plan written by Coloradans, for Coloradans."

Acknowledgements

Governor Hickenlooper's May 2013 executive order to create Colorado's first water plan was a monumental task in a tight timeframe given Colorado's water history. Over two years later with the final plan in hand, we would like to express our sincere gratitude to the thousands of individuals and hundreds of organizations that helped us build Colorado's Water Plan. Your passion for water in Colorado is at once both humbling and energizing!

The hallmark of Colorado's Water Plan is collaboration. It would not be possible without the participants in the basin roundtables, and the Interbasin Compact Committee, the PEPO Workgroup of the IBCC, and the Water Investment Funding Committee. The hours you volunteered to spend in community centers, candidly discussing water issues, and the hard work you put into mapping out your basin's water needs and solutions are the heartbeat of Colorado's Water Plan.

Thank you to numerous members of our sister state agencies: the Office of the State Engineer, the Colorado Department of Public Health and Environment's (CDPHE) Water Quality Control Division and Commission, the Colorado Attorney General's Office, the Water Court Committee of the Colorado Supreme Court, the Colorado Water Resources and Power Development Authority, Colorado Parks and Wildlife, the State Land Board, the Colorado Department of Agriculture, the Colorado Energy Office, the Department of Local Affairs, and our neighbors in the Department of Natural Resources' (DNR) Executive Director's Office. We are proud to serve Colorado alongside each of you.

Thank you to those who took time out of their busy schedules to submit comments on Colorado's Water Plan. We received over 30,000 comments from individuals, organizations, and agencies during development of the plan. Thank you to members of the Colorado General Assembly's Water Resources Review Committee who traveled across the state to solicit additional public comments through the Senate Bill 14-115 hearings. Each comment was reviewed and your thoughtful recommendations helped shape the final plan.

Thank you to Colorado Water Conservation Board (CWCB) Director James Eklund and all of the current Board members for providing the leadership necessary to draft the plan. Current CWCB Board members include Bob Broscheid, Don Brown, Cynthia Coffman, Jay Gallagher, Russell George (Vice-Chair), Alan Hamel, Diane Hoppe (Chair), Mike King, John McClow, April Montgomery, Travis Smith, John Stulp, Ty Wattenberg, Patricia Wells, and Dick Wolfe.

Thank you to Colorado Water Conservation Board staff and partners who authored sections of the plan. Section authors were Tamara Allen (CDPHE), Linda Bassi, Jacob Bornstein, Tom Browning, Lindsay Cox, Tim Feehan, Taryn Finnessy, Craig Godbout, Ted Kowalski, Kate McIntire, Steve Miller, Rebecca Mitchell, Andy Moore, Brent Newman, Kevin Reidy, Lauren Ris (DNR), Nicole Rowan (CDPHE), and Chris Sturm. Our review team was Josh Boissevain, Meg Dickey-Griffith, Stephanie DiBetitto, Allison Franz, Carolyn Fritz, Linda Lidov (Highland PR), Mara MacKillop, Britton Marchese (HDR), Bill McDonald (Consultant), Luke Rein, Erik Skeie, Dardoh Sowe (DNR), and Ben Wade.

Finally, special thanks goes to Gene Malowany, of Malowany Associates, who provided Creative Direction for the plan, the team at Atomic20, who assisted with layout and formatting of the plan, and Matt Nager, of Matt Nager Photography, who took photographs statewide to help tell the water plan story visually.

Table of Contents

Acronyms and Abbreviations

CHAPTER 1

IBIP	Basin Implementation Plan	**IBCC**	Interbasin Compact Committee
CWCB	Colorado Water Conservation Board	**SWSI**	Statewide Water Supply Imitative

CHAPTER 2

BLM	U.S. Bureau of Land Management	**DWR**	Colorado Division of Water Resources
BOR	U.S. Bureau of Reclamation	**EPA**	Environmental Protection Agency
CCP	Compact Compliance Pipeline	**ESA**	Endangered Species Act
CDPHE	Colorado Department of Public Health and Environment	**FERC**	Federal Energy Regulatory Commission
CDSS	Colorado's Decision Support System	**FLPMA**	Federal Land Policy and Management Act
CEQ	Council on Environmental Quality	**IBCC**	Interbasin Compact Committee
Corps	U.S. Army Corps of Engineers	**MOU**	Memorandum of Understanding
CPW	Colorado Parks and Wildlife	**NEPA**	National Environmental Policy Act
CWA	Clean Water Act	**NPS**	U.S. National Park Service
CWCB	Colorado Water Conservation Board	**RRCA**	Republican River Compact Administration
WQCD	Colorado Water Quality Control Division	**SWSI**	Statewide Water Supply Initiative
DLG	Division of Local Governments	**USFS**	U.S. Forest Service
DNR	Department of Natural Resources	**USFWS**	U.S. Fish and Wildlife Services
DOLA	Department of Local Affairs		

CHAPTER 3

ALP	Animas-La Plata	**IPP**	Identified Projects and Processes
BIP	Basin Implementation Plan	**M&I**	municipal and industrial
BLM	U.S. Bureau of Land Management	**PRRIP**	Platte River Recovery Implementation Program
BOR	U.S. Bureau of Reclamation	**SWSI**	Statewide Water Supply Imitative
CWCB	Colorado Water Conservation Board	**USFS**	U.S. Forest Service
ESA	Endangered Species Act		

CHAPTER 4

BOR	Bureau of Reclamation	**CWCB**	Colorado Water Conservation Board

CHAPTER 5

BIP	Basin Implementation Plan	**CWCB**	Colorado Water Conservation Board
CDPHE	Colorado Department of Public Health and Environment	**EPACT**	Energy Policy Act
GDP	gross domestic product	**SWSI**	Statewide Water Supply Initiative
IPP	Identified Projects and Processes	**WQCC**	Water Quality Control Commission
M&I	municipal and industrial		

Acronyms and Abbreviations

CHAPTER 6

AMI	Advanced Metering Infrastructure
ARR	aquifer recharge and recovery
ASR	aquifer storage and recharge
ATM	Alternative Transfer Method
BIP	Basin Implementation Plan
BLM	Bureau of Land Management
CDA	Colorado Department of Agriculture
CDPHE	Colorado Deparment of Public Health and Evironment
CDSS	Colorado's Decision Support Systems
CIR	crop irrigation requirement
CPW	Colorado Parks and Wildlife
CRCA	Colorado River Cooperative Agreement
CRCT	Colorado River cutthroat trout
CU	consumptive use
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
DNR	Department of Natural Resources
DORA	Department of Regulatory Agencies
DPR	direct portable reuse
DRCOG	Denver Regional Council of Governments
DWR	Division of Water Resources
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EQIP	Environmental Quality Incentives Program
ET	evapotranspiration
COGCC	Colorado Oil and Gas Conservation Commission
GIS	geographic information system
GPCD	gallons per capita per day
IBCC	Interbasin Compact Committee
IPP	Identified Projects and Processes
IPR	indirect portable reuse
ISA	interruptible service agreements
IWM	irrigation water management
IWSA	interruptible water supply agreement
LULA	Land Use Leadership Alliance Training
M&I	municipal and industrial
MGD	million gallons per day
MW	megawatts
MWh	megawatt per hour
ORV	Outstandingly Remarkable Values
P&M	projects and methods
PBO	Programmatic Biological opinion
PLT	Project Leadership Teams
PSOP	Preferred Storage Option Plan
PUC	Public Utilities Commission
RBF	river bank filtration
RICD	recreational in-channel diversions
RO	reverse osmosis
SECWCD	Southeastern Colorado Water Conservancy District
SMP	stream management plan
SSI	self-supplied industrial
SWSI	Statewide Water Supply Imitative
TMD	transmountain diversion
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WEGP	Water Efficiency Grant Program
WFET	Watershed Flow Evaluation Tool
WISE	Water Infrastructure and Supply Efficiency
WQCC	Water Quality Control Commission
WQCD	Water Quality Control Division
WSRA	Water Supply Reserve Account
ZLD	zero liquid discharge

CHAPTER 7

BIP	Basin Implementation Plan
CDOT	Colorado Department of Transportation
CWCB	Colorado Water Conservation Board
WQCD	Colorado Water Quality Control Division

Acronyms and Abbreviations

CHAPTER 8

BIP	Basin Implementation Plan
BOR	Bureau of Reclamation
CRCA	Colorado River Cooperative Agreement
CRWCD	Colorado River Water Conservation District
CWCB	Colorado Water Conservation Board
IBCC	Interbasin Compact Committee
SWSI	Statewide Water Supply Imitative
TMD	transmountain diversion
WISE	Water Infrastructure and Supply Efficiency

CHAPTER 9

AG	Attorney General
ATM	Alternative Transfer Method
Authority	Water Resources and Power Development Authority
BIP	Basin Implementation Plan
BLM	Bureau of Land Management
BMP	best management practices
BOR	Bureau of Reclamation
CAWS	Collaborative Approach to Water Supply Permit Evaluation
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CFWE	Colorado Foundation for Water Education
CJRP	Colorado Joint Review Process
Corps	U.S. Army Corps of Engineers
CPW	Colorado Parks and Wildlife
CRSP	Colorado River Storage Project
CRWAS	Colorado River Water Availability Study
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
DNR	department of natural resources
DOC	Department of Corrections
DORA	Department of Regulatory Affairs
DWR	Division of Water Resources
EIS	Environmental Impact Statement
ESA	Endangered Species Act
EPA	U.S. Environmental Protection Agency
EPAT	Extreme Precipitation Analysis Tool
FERC	Federal Energy Regulatory Commission
FWS	U.S. Fish and Wildlife Service
IBCC	Interbasin Compact Committee
WRA	Western Resource Advocates
WRBP	Water Revenue Bond Program
IPP	Identified Projects and Processes
IT	Information Technology
LEDPA	Least Environmentally Damaging Practicable Alternative
M&I	Municipal and Industrial
MOA	memorandum of agreement
MOU	Memorandums of Understanding
NCWCD	Northern Colorado Water Conservancy District
NEPA	National Environmental Policy Act
NGO	nongovernmental organizations
NRCS	Natural Resources Conservation Service
P&I	principal and interest
P3	Public-Private Partnerships
PEPO	Public Education, Participation, and Outreach
ROD	Record of Decision
SDS	Southern Delivery System
SLB	Colorado State Land Board
SMWSA	South Metro Water Supply Authority
SWIFT	State Water Implementation Fund for Texas
SWIRFT	State Water Implementation Revenue Fund for Texas
SWSI	Statewide Water Supply Initiative
TU	Trout Unlimited
USFS	U.S. Forest Service
WEGP	Water Efficiency Grant Program
WET	Water Education for Teachers
WIFIA	Water Infrastructure Finance and Innovation Authority
WISE	Water Infrastructure and Supply Efficiency
WPCRF	Water Pollution Control Revolving Fund
WQCD	Colorado Water Quality Control Division
WRRC	Water Resources Review Committee
WSRA	Water Supply Reserve Account

Acronyms and Abbreviations

CHAPTER 10

AGO	Colorado Attorney General's Office	**DNR**	Department of Natural Resources
ATMs	Alternative Transfer Methods	**DOLA**	Colorado Deparment of Local Affairs
BIPs	Basin Implementation Plans	**DWR**	Colorado Division of Water Resources
BRTs	Basin Roundtables	**IBCC**	Interbasin Compact Committee
CDA	Colorado Department of Agriculture	**NEPA**	The National Environmental Policy Act
CDPHE	Colorado Department of Public Health and Environment	**NRCS**	Natural Resources Conservation Service
COIN	Colorado Innovation Network	**SWSI**	Statewide Water Supply Initiative
CPW	Colorado Parks and Wildlife	**WRRC**	Water Resources Review Committee
CSU	Colorado State University	**WSRA**	Water Supply Reserve Account
CWAPA	Colorado Water and Power Authority		
CWCB	Colorado Water Conservation Board		

CHAPTER 11

BIP	Basin Implementation Plan	**IBCC**	Interbasin Compact Committee
CWCB	Colorado Water Conservation Board		

STOCK PHOTO CREDITS

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Chapter 3

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Chapter 6

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Wildflowers on mountain stream, Adventure Photo/iStock by Getty Images
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Chapter 9

State capitol dome, Joseph Sohm/shutterstock
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COLORADO'S WATER PLAN

EXECUTIVE SUMMARY

People love Colorado.

Our iconic mountains, rivers, minerals, plains, communities, forests, snow, wildlife, and wilderness have drawn people by the millions to our centennial state. Our population has ballooned from 1 million in 1930 to over 5 million today, and could nearly double by 2050. Sustaining this growth requires water. While we grow at this pace, how do we preserve what we love about our state?

Colorado's Water Plan has answers.

This plan is a roadmap that leads to a productive economy, vibrant and sustainable cities, productive agriculture, a strong environment, and a robust recreation industry. It sets forth the measurable objectives, goals, and actions by which Colorado will address its projected future water needs and measure its progress—all built on our shared values. Just as it was created, this plan will be implemented by working collaboratively with the basin roundtables, local governments, water providers, other stakeholders, and the general public. It includes a set of policies and actions that all Coloradans and their elected officials can support and help implement.

Meeting by the hundreds in small-town community centers and big-city water utilities, Coloradans have undertaken the largest civic engagement process in our state's history. We have faced our water challenges head-on and focused on solutions. Just as our forbearers created sound and functional water law and policy, we now take up the torch of innovation as a headwaters state ready to again lead the way on water.

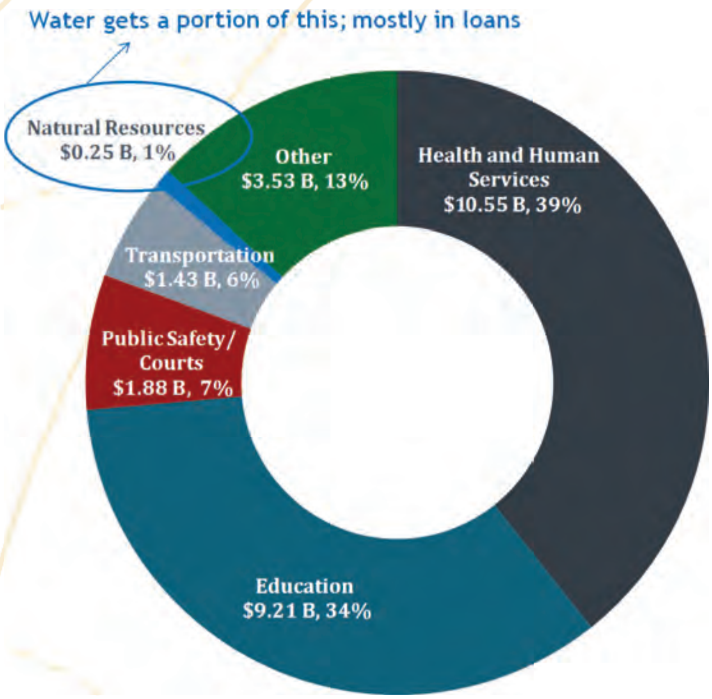
Introduction: Collaborating on Colorado's Water Future

1

Never before has Colorado experienced this type of momentum regarding water issues. We are galvanized by our challenges: drought, wildfire, flooding, climate change, and unprecedented growth. And we are energized by our capability: hundreds of meetings, thousands of participants, tens of thousands of comments, and the political will of our Governor and our General Assembly. If we are wise stewards of our water resources, Colorado has enough water to meet our state's future needs. The following are actions we can, and will, take immediately:

- The State will safeguard Colorado's water by proactively protecting our interstate water interests. We will also continue to apply and strengthen the doctrine of prior appropriation. This requires us to recognize that water rights are property rights whose owners are free to respond to the economics of the marketplace and to continue to work within our local control structure. Moreover, we strengthen the doctrine of prior appropriation when we evaluate and improve upon the water law and policy we have built on its foundation.
- The State will continue to stress that every water conversation begins with conservation and must include water storage. When we lower demand (conservation) and increase supply (storage), we close the supply-demand gap.
- The State will investigate options to raise additional revenue to support implementation of this plan. Only one-tenth of 1 percent of the state's budget goes toward natural resources, including loans for water projects. While we estimate $20 billion in financial need in the areas of water supply, water infrastructure, recreation, and the environment over the next 30 years, water providers have plans in place to meet much of this need. Because our water is too important to fail, the State will continue to work with water users and stakeholders to ensure financing options are available for water projects.

FIGURE ES-1 2015 COLORADO STATE BUDGET



- The State will examine and use its water-rights portfolio to ensure alignment with Colorado's water values. State agencies will coordinate their uses of water to achieve multiple benefits, including environmental flows, irrigation important to wildlife habitat, and compact compliance. Like the Rio Grande Cooperative Project and the Animas-La Plata Project, the State will encourage projects that enhance the environment, provide recreation, increase supplies, and meet compact compliance. Like the Chatfield Reallocation Project, the State will continue to pursue and support projects that can creatively move water through various uses and through shared facilities.
- The State will increase efficiency and effectiveness in water project permitting while properly mitigating negative environmental impacts. It will achieve this by front-loading the State's role in the permitting process and establishing a path to State support of water projects without being pre-decisional.
- The State will continue to strengthen water outreach, education, and public engagement to equip Coloradans with the necessary information to make informed water choices. Colorado's Water Plan has generated momentum on Colorado water as a worthy statewide issue: Over 30,000 comments from across the state, and input from over 150 diverse entities, helped shape the plan. We will leverage this momentum to both educate a wider band of our population on water and tap Coloradans for good ideas and discussion.

This is the beginning of the next phase in Colorado water policy, where collaboration and innovation come together with hard work to meet and implement the objectives, goals, and actions set forth in Colorado's Water Plan. The CWCB will continue the dialogue moving forward, and will strive for transparency along the way—this document lays the foundation for this discussion. The chapters of the plan consist of the following content:

Chapter 1 provides background on how we got to where we are today and explains the need for Colorado's Water Plan.

Chapters 2 through 5 focus on the foundational elements that guide Colorado's water management; our strategies and actions will build upon those elements going forward. Core elements include descriptions of Colorado's legal structure and critical facts about supply and demand.

Chapters 6 through 9 discuss the dynamic strategy we need to put into place to meet Colorado's future water needs, including goals and actions. Chapters 6 through 8 focus on ways in which we can meet our water needs and prepare for an uncertain future.

Chapter 9 addresses increased funding opportunities, more efficient and effective permitting, and enhanced education for citizens.

Chapters 10 and 11 further detail strategies and recommendations for implementation as well as future updates to the plan.

Colorado's Water Plan discusses values, objectives, goals, and actions throughout. These are defined as follows:

TABLE ES-1 KEY TERMS AND DEFINITIONS

Terms	Definitions
Value	An overarching tenet that guides how Colorado's Water Plan will work to shape Colorado's water future.
Measurable Objective	A result or benchmark expected to be achieved from the implementation of Colorado's Water Plan.
Goal	A purpose toward which Colorado's Water Plan is directed.
Action	A necessary step to achieve the measurable objectives and goals, and ultimately to maintain Colorado's water values.

Colorado Water Law & Our Basins

The legal and institutional system that governs the use and allocation of water in Colorado has three foundational elements: interstate compacts and equitable apportionment decrees, Colorado water law, and local control. Colorado's Water Plan is premised on these elements.

At the headwaters of the Continental Divide, all of Colorado's major rivers flow downstream to eighteen states and Mexico. As Colorado and its downstream neighbors developed over time, disputes arose among states over the allocation of interstate stream waters. Following early U.S. Supreme Court litigation, Colorado negotiated nine formal agreements with downstream states. These interstate water compacts are federal law, state law, and legally binding contracts among the signatory states.

Colorado water law, rooted in the doctrine of prior appropriation, commands widespread respect—not because of its longevity (older water law exists), or its rigidity (it has undergone significant change over the years), and certainly not due to its clarity. Our water law is respected because it works. First, it stipulates that water rights are property rights that can be bought and sold by willing parties and that can be transferred to new users. Second, it provides certainty among competing water uses by telling us which rights have priority. Third, it has accommodated Colorado values as they developed over time: when our mining and agricultural economies grew, when our municipalities on both sides of the Continental Divide grew, when we recognized the connection between groundwater and surface water, when we recognized the need for water for the environment, when we experienced energy booms and busts, and now, when growing demands for water threaten to eclipse diminishing supplies.

A network of water providers, public utilities, ditch and reservoir companies, individual water rights owners, and special districts deliver Colorado's water. Each river basin in Colorado faces unique challenges that demand custom solutions. So, who better than local water users and stakeholders to tackle these challenges? Municipal, county, and district officials make day-to-day decisions about topics ranging from water to emergency response. Colorado's Water Plan recognizes this structure as an asset—and local control allows us to effectively respond to our water challenges. Communities in each of eight basins developed regional plans, called Basin Implementation Plans, which now allow a comprehensive view of water statewide. But this approach also requires heightened collaboration among state and local entities on water issues. To this end, the CWCB has engaged the Colorado Municipal League, Colorado Counties, Inc., and the Special District Association of Colorado to embark on a new era of collaboration between state and local government on water and land use issues.

Supply & Demand

Seventy to 80 percent of Colorado's water falls west of the Continental Divide, while 80 to 90 percent of our population resides east of it. Twenty-four tunnels and ditches move an annual average of 500,000 acre-feet from the western slope to the eastern slope. Our average precipitation yields 14 million acre-feet of water annually in Colorado.

Over 5 million acre-feet of water is consumed annually through agriculture, municipal, industrial uses—though we've reduced our consumption in certain areas by 20 percent since the 2002 drought. States downstream of us are legally entitled to water as determined by our nine interstate compacts and two equitable apportionment decrees from the U.S. Supreme Court.

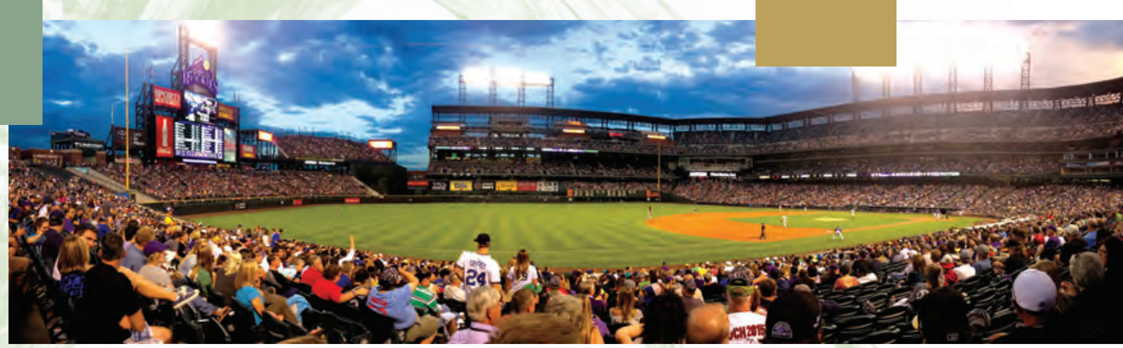
Since projections suggest wide variability in future precipitation,[1] Colorado faces the possibility of a significant water supply shortfall within the next few decades, even with aggressive conservation and new water projects.[2] Our legal and physical constraints open a gap between projected supply and demand in each basin. Colorado's Water Plan sets an objective to close this gap by 2030, while also addressing the effects of a changing climate on our water resources.

Managing Our Water

6+7

Chapters 6 and 7 establish action steps to help Colorado respond to its water challenges. These chapters delineate ways in which Colorado can advance conservation, reuse, alternative agricultural transfers, and multipurpose and collaborative projects while protecting the health of rivers, streams, and watersheds.

Chapter 6 opens with scenario planning, which provides the framework for how Colorado will address its water future, no matter what water supply and demand challenges we may face. Scenario planning also indicates what Colorado needs to first accomplish in the short term, and the rest of Chapter 6 explores specific approaches to meet our water needs. Chapter 7 examines factors beyond supply and demand—such as natural hazards, watershed health, and water quality—that affect water availability.



The Colorado Way Forward

8+9

Colorado's Water Plan focuses on collaboration. The basin roundtables not only provide grassroots insight into each river basin's challenges and solutions, but are a mechanism to resolve conflicts between basins. *Why does it matter if we get along?* Because our water challenges are great and demand our united focus. Because other governments watch Colorado's water positions closely. Because discordant infighting weakens Colorado's position in interstate and international arenas, invites unnecessary federal intervention in our water affairs, and dulls our responsiveness. It's undeniable: our water challenges necessitate that we pull together as one, innovate, and become more agile.

Fortunately, we are positioned to be better collaborators as a result of a recent paradigm shift in Colorado water. Indeed, this shift helped galvanize Colorado's Water Plan. Over the past decade, historically adversarial views have shifted toward: [1] the benefits of collaborating on win-win projects that benefit all parties; [2] putting money to work solving problems instead of escalating litigation; and [3] capitalizing on the regional connections that tie Colorado together economically and hydrologically—instead of ignoring those connections.

Colorado's Water Plan recognizes the historic nature of eastern slope-western slope relations. Never before has Colorado's footing been as firm on the issue of transmountain water as it is right now, as a result of this effort. Despite differences of opinion, the IBCC, basin roundtables, the CWCB directors, and numerous county commissioners reached consensus to support a conceptual framework, which sets out the fundamental principles the parties to a new transmountain diversion should expect to address. It presents seven principles to guide future negotiations between end users and basin-of-origin communities in the contemplation of any new transmountain diversion. The IBCC's diverse stakeholders thoroughly explored the difficult issues that would surround any new transmountain diversion. The CWCB will ensure that this conceptual framework is implemented by playing an active role in brokering agreements among parties on transmountain water. In this role, the State will promote eastern slope-western slope cooperation as well as consideration of interstate compacts in any transmountain diversion discussions.

This level of collaboration has already helped solve some of the most intractable issues in Colorado. Colorado's Water Plan aims to continue this practice to solve a growing funding need, a broken permitting system, and real risks in the Colorado River system. Education and outreach will be critical to ensuring that we understand the water challenges across Colorado, and that we are prepared to work together to find innovative solutions to address those challenges.

Measurable Objectives, Actions, and Future Updates

Colorado's Water Plan is not the end of our story; rather, it marks the beginning of a new chapter in Colorado water. Implementing this plan, and meeting its goals and objectives, will require Colorado innovation and hard work. Rather than guess about the direction of our state's water policy, we now have measurable objectives to achieve, and we can monitor our progress on these objectives in real time.

Chapter 10, which summarizes the objectives, goals, and actions in Chapters 6 through 9, focuses on the actions that are most critical to implementing Colorado's Water Plan in the near term. Chapter 11 confirms that the plan is a living document that will require updates on an ongoing basis. Additionally, the CWCB will monitor our progress and report to the governor and the Colorado General Assembly annually. Together, these chapters will help ensure that Colorado is responsive in addressing its immediate water challenges and is prepared to adapt to changing conditions. The measurable objectives on which we will gauge our progress and success are outlined on the following pages.

The children of several of the authors of Colorado's Water Plan, standing together at Clear Creek in Golden. They represent the importance of planning for a sustainable water future: Gizachew Mitchell, Taye Mitchell holding Emma Bornstein, Saba Mitchell holding Wrenna McIntire, Forest Eklund, Aidan Reidy, Maeve Reidy, Sierra Mitchell holding Clay McIntire, and Rowan Eklund.

"Failure is not an option."

—Gene Kranz, Apollo Mission Flight Director

Supply-Demand Gap

Colorado's Water Plan sets a measurable objective of reducing the projected 2050 municipal and industrial gap from as much as 560,000 acre-feet to zero acre-feet by 2030.

The success of Colorado's Water Plan will ultimately be measured by whether or not the municipal water supply-and-demand gap is closed, and the choices we make to close it. With increased efforts on conservation, storage, land use, alternative transfer methods, and reuse, Colorado can close its gap, balance its water values, and address the effects of climate change on water resources.

Conservation

Colorado's Water Plan sets a measurable objective to achieve 400,000 acre-feet of municipal and industrial water conservation by 2050.

Colorado must address projected gaps between future water needs and available water provisions from both the supply side and the demand side. Every acre-foot of conserved water used to meet new demands is an acre-foot of water that does not need to come from other existing uses.

Land Use

Colorado's Water Plan sets a measurable objective that by 2025, 75 percent of Coloradans will live in communities that have incorporated water-saving actions into land-use planning.

In order to reduce the amount of water needed for future generations of Coloradans and keep urban-adjacent agricultural lands in production, Colorado must support the growth of the next 5 million residents more strategically than the last 5 million. Colorado's Water Plan calls for a partnership among local water providers and Colorado's communities. This partnership aims to incorporate water-saving actions into local land-use planning. The CWCB will work with the Department of Local Affairs, local governments, water providers, Colorado Counties Inc., Colorado Municipal League, the Special District Association, councils of governments, and homebuilders (Colorado Association of Homebuilders) to examine and strengthen the tools they collectively possess to help Colorado reach this objective.

Agriculture

Colorado's Water Plan sets an objective that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production.

To achieve this objective, the State will work closely with the agricultural community, in the same collaborative manner that has produced agricultural transfer pilot projects, to share at least 50,000 acre-feet of agricultural water using voluntary alternative transfer methods by 2030.

Without a water plan, Colorado could lose up to 700,000 more acres of irrigated agricultural lands—that equals 20 percent of irrigated agricultural lands statewide and nearly 35 percent in Colorado's most productive basin, the South Platte. While the right to buy or sell water rights must not be infringed upon, Colorado's Water Plan describes market-competitive options to typical "buy-and-dry" transactions. Such alternative transfer methods can keep agriculturally dependent communities whole and continue agricultural production in most years, and if such arrangements can be made more permanent in nature, they will provide certainty to both municipal water providers and agricultural producers. Options include lease-fallowing agreements, deficit irrigation, water banking, interruptible supply agreements, rotational fallowing, water conservation programs, and water cooperatives. The State will encourage innovation and creativity by agricultural producers and research institutions to maximize the productivity of every drop of water.

Storage

Colorado's Water Plan sets a measurable objective of attaining 400,000 acre-feet of water storage in order to manage and share conserved water and the yield of IPPs by 2050. This objective equates to an 80 percent success rate for these planned projects.

As the state conserves, Colorado must also develop additional storage to meet growing needs and face the changing climate. Tomorrow's storage projects will increase the capacity of existing reservoirs, address a diverse set of needs, and involve more partners. New storage projects will be increasingly innovative, and will rely on technologies such as aquifer storage and recharge. In addition, water managers will need to be more agile in responding to changing conditions, so that storage can be more rapidly added to Colorado's water portfolio while maintaining strong environmental health. To do this, we must address a broken permitting system that currently produces uncertainty and fosters mistrust among all stakeholders.

Watershed Health, Environment, and Recreation

Colorado's Water Plan sets a measurable objective to cover 80 percent of the locally prioritized lists of rivers with stream management plans, and 80 percent of critical watersheds with watershed protection plans, all by 2030.

The environment and recreation are too critical to Colorado's brand not to have robust objectives; a strong Colorado environment is critical to the economy and way of life. In addition, the WQCC identified a strategic water quality objective to have fully supported classified uses—which may include drinking water, agriculture, recreation, aquatic life, and wetlands—of all of Colorado's waters by 2050. These plans will address a variety of concerns, including pre- and post-fire mitigation, forest mortality, water quality impairments, potential impacts of legacy mines, flood mitigation and recovery, aquatic and riparian habitat enhancement, and land use change.

Funding

Colorado's Water Plan sets an objective to sustainably fund its implementation. In order to support this objective, the State will investigate options to raise additional revenue in the amount of $100 million annually ($3 billion by 2050) starting in 2020.

Such funds could establish a repayment guarantee fund and green bond program focused on funding environmental and recreational projects. In addition, such funds could further support conservation, agricultural viability, alternative transfer methods, education and outreach, and other plan implementation priorities.

Colorado faces challenging fiscal conditions, not only for water infrastructure, but most other parts of the State budget. In order to address the water infrastructure fiscal need, the CWCB will explore creation of a repayment guarantee fund and green bond program with an initial investment of $50 million from the Severance Tax Perpetual Fund. A repayment guarantee fund could assist water providers in securing financing for regional multi-partner and multi-purpose projects by backing bonds so that all the partners can achieve financing. Issuance of green bonds could support large-scale environmental and recreational projects. These funds could be operated in a conjunctive manner. As water provider bonds were paid down, the guarantee fund could be reduced and could be used to pay green bonds. By doing so, an initial $50 million investment could leverage half a billion dollars of regional projects. Under a well-planned, phased approach, an additional $100 million per year might address all of the State-related funding needs described in Colorado's Water Plan, as further detailed in Section 9.2.

Education, Outreach, and Innovation

Colorado's Water Plan sets a measurable objective to significantly improve the level of public awareness and engagement regarding water issues statewide by 2020, as determined by water awareness surveys. Colorado's Water Plan also sets a measurable objective to engage Coloradans statewide on at least five key water challenges (identified by CWCB) that should be addressed by 2030.

Colorado's Water Plan will expand outreach and education efforts that engage the public to promote well-informed community discourse and decision making regarding balanced water solutions. This work will be collaborative and include state, local, and federal partners. As one component of this overall strategy, the CWCB will work with Colorado's innovation community, education and outreach experts, research institutions, and the Governor's Colorado Innovation Network (COIN) to address Colorado's water challenges with innovation and "outside-the-box" creativity.

COVER, OPENING PAGES AND EXECUTIVE SUMMARY - CAPTIONS AND CREDITS

Front Cover
Young patron at the Routt County Fair in Hayden, M. Nager
Riding the chairlift
Aerial photo of Ridgway, K. Grambley
Denver at night
Red barn at the Sakata Farm in Brighton, M. Nager
Uncompahgre River near Ouray
Playing soccer on a grassy field
Center pivot irrigation at Sakata Farm in Brighton, M. Nager
Birds take flight over the Yampa River on the Daughenbaugh Ranch, M. Nager
Wheat growing on the eastern plains
Little girl playing in the sprinkler
Rafting the Arkansas River near Buena Vista, M. Nager
Vicki Phelps and students on the San Miguel River, M. Nager
Cameo Call set of diversions, M. Nager

Back Cover
Crystal Mill, abandoned, near Carbondale
Sunset over Ridgway Reservoir
Columbine, Colorado's state flower
Ruddy duck (male) among water smartweed, near Walden, All Canada Photos / Alamy Stock Photo
Water droplet on leaf
Hayfield near Steamboat Springs, M. Nager
Boy playing in fountain in Aspen, Visions of America, LLC / Alamy Stock Photo
Woman flyfishing on the Arkansas River, H. Mark Weidman Photography / Alamy Stock Photo
Cows grazing
Mountain goat mother and kid atop Mount Evans with Rocky Mountains in background, Danita Delimont / Alamy Stock Photo
River flowing

Inside Back Cover
Works When I am 100 (Wrenna McIntire)
Photo: J. Johnson

Pages iv and v:
Aerial photo of Ridgway, K. Grambley

Executive Summary (beginning on page xvi):
Snowy trees

Chapter 2+3:
New dam built on Saint Vrain River near Longmont, CO after historic 2013 floods, M. Nager
Kids playing soccer on a grassy field
Crop rows, Sakata Family Farms, Brighton, M. Nager
Durango-Silverton Narrow Gauge Railroad

Chapter 4+5:
Denver Broncos helmet
Dallas Divide, San Juan Mountain Range, near Ridgway

Chapter 6+7:
Cameo Call set of diversions and Roller Dam, Colorado River, M. Nager
Coors Field, Denver, G. Malowany
Alberto Oscanoa of the Perilous Sheep Company, herds sheep in Routt National Forest, Colorado, M. Nager
Working the ditches at one of Harold Griffith's irrigated corn fields in Fort Morgan, M. Nager

Chapter 8+9:
Grand Lake, M. Nager
4H competition at the Routt County Fair in Hayden, M. Nager
Cows graze on Marsha Daughenbaugh's ranch near Steamboat Springs, M. Nager
Vicki Phelps teaches students as part of a Telluride Institute Watershed Education Project collaborative program with the Telluride Academy, in the San Miguel River Basin, M. Nager

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[2] Colorado Water Conservation Board (CWCB). *Statewide Water Supply Initiative 2010* (Denver 2011), Section 5-28.

Introduction: Collaborating on Colorado's Water Future

People love Colorado. Our state's population ballooned from 1 million in 1930 to more than 5 million today, and is projected to grow at even faster rates in the future. So how do we ensure that this population growth doesn't change what we know and love about our state—including our precious natural resources, and particularly, our water resources? When it comes to our water, Colorado's Water Plan has answers.


ORADO
COLORADO'S WATER PLAN HAS ANSWERS

One of the views at Sakata Family Farms in Brighton, Colorado. The farm produces more than 1,600 acres of vegetables each year. Photo: M. Nager.

This plan articulates collaborative, balanced water solutions to Colorado's water challenges. Equally important, it establishes the method by which we will continue to find solutions to those challenges into the future. This method is based in our grassroots basin roundtable structure and the geographic representation that forms the Colorado Water Conservation Board (CWCB).

If Colorado's water is managed strategically, our state has enough water to meet our needs well into the future. As is the case with other Western states, Colorado does not have enough water to meet historic and future uses in a balanced manner without a collaborative plan of action. Our principal water challenge lies not in the amount of water we're given, but in our management of what we have under Colorado's unique legal system, and given the diverse needs and values of citizens. Colorado's Water Plan offers a suite of actions for present and future Coloradans to measurably achieve this strategic balance.

Moving forward, the implementation of identified actions in this plan and the Basin Implementation Plans (BIPs) will decrease uncertainty and close identified supply gaps in a manner that encourages collaboration, innovation, and protection of Colorado's water values. State agencies and basin stakeholders must gain measurable progress on these identified actions, or the status quo will continue and uncertainty will increase unabated.

THE COLORADO WATER CONSERVATION BOARD

The CWCB is Colorado's water planning and policy agency and is responsible for stream, watershed, and lake protection; water conservation; flood mitigation; stream restoration; drought planning; water supply planning; and water project financing. The agency works to protect the state's water apportionments in collaboration with other Western states and federal agencies.[1]

We have used the real and looming "gap" between water supply and demand to catalyze action on water in Colorado. The challenges ahead are numerous, and the CWCB and stakeholders around the state have identified inherent difficulties and points of contention through our grassroots process:

- Establishing cooperative alternatives to the rapid removal of water from farms and ranches to supply urban growth.
- Implementing projects and methods that take into account potential multiple beneficiaries, potential multiple uses, and the effects on river systems on which all Coloradans rely.
- Replacing the continued mining of groundwater aquifers to supply municipal growth with renewable water resources and the implementation of collaborative projects and methods.
- Developing a statewide conservation ethic that recognizes the need to work within Colorado's naturally arid environment, increases the understanding of conservation practices, and reduces wasteful behavior.
- Improving regulatory processes for critical water storage projects to reduce project costs and time commitment while maintaining the integrity of permitting review.
- Establishing a plan with stakeholders and water managers statewide to finance the daunting cost of water infrastructure projects (municipal, industrial, and environmental).
- Strengthening state water management policies and tools to ensure state and local control - as opposed to federal intervention - over water management decisions.
- Allowing for efficient and effective water sharing by overcoming such hurdles as high transaction costs.
- Continuing to promote agility in Colorado water law and administrative practices, which have proven to be flexible enough to meet challenges presented by competing uses and increasing demands while protecting private property rights.
- Cooperating more efficiently across state agencies with different statutory mandates, so that regulatory and policy decisions are made in a more adaptive manner.

Boating on Grand Lake, Colorado's largest natural lake, near Rainbow Bridge. Photo: M. Nager.

If we do nothing, these challenges demonstrate the uncertain future we will hand down to our children and grandchildren. It is a future without a value-based strategy. Colorado's Water Plan offers an alternate path. This path will not solve all our problems, and it will not be easy. It will require the continued hard work and effort of Coloradans both inside and outside of the water profession, as well as measurable progress made on items identified in the Critical Action Plan.

This strategic plan is the first of its kind for Colorado: a plan by Coloradans, for Coloradans. Colorado's Water Plan is designed to be dynamic so that it can evolve as Colorado grows and transforms. While the plan reflects the most current water data available, the CWCB will update the plan as data, needs, and projections change.

Colorado's Water Plan is rooted in a thoughtful, strategic approach initiated by Governor John Hickenlooper. In May 2013, Governor Hickenlooper issued Executive Order D 2013-05, which directed the CWCB to prepare a water plan for Colorado (see Appendix A). The order directed the CWCB to:

A. Create a water policy that reflects Colorado's water values.

B. Work with the Governor's Office to complete the final plan no later than December 10, 2015.

C. Align state support of projects, studies, funding, and other efforts to Colorado's Water Plan to the greatest extent possible.

D. Align the state's role in water project permitting and review processes with the water values, and streamline the state's role in the approval and regulatory processes regarding water projects.

E. Utilize the Interbasin Compact Committee (IBCC) and the basin roundtables in drafting Colorado's Water Plan, as well as review and build upon discussions and points of consensus that have emerged as part of the IBCC and basin roundtable processes to capitalize on the momentum generated by these grassroots efforts.

F. Work with its sister agencies and other relevant state agencies as needed.

G. Reaffirm the Colorado Constitution's recognition of priority of appropriation while offering recommendations to the governor for legislation that will improve coordination, streamline processes, and align state efforts.

Colorado's Water Values

This plan acts as a foundation for Colorado to honor the State's core water values. The CWCB developed these water values, set out in Governor Hickenlooper's executive order, by assessing the grassroots work the IBCC and the basin roundtables conducted.

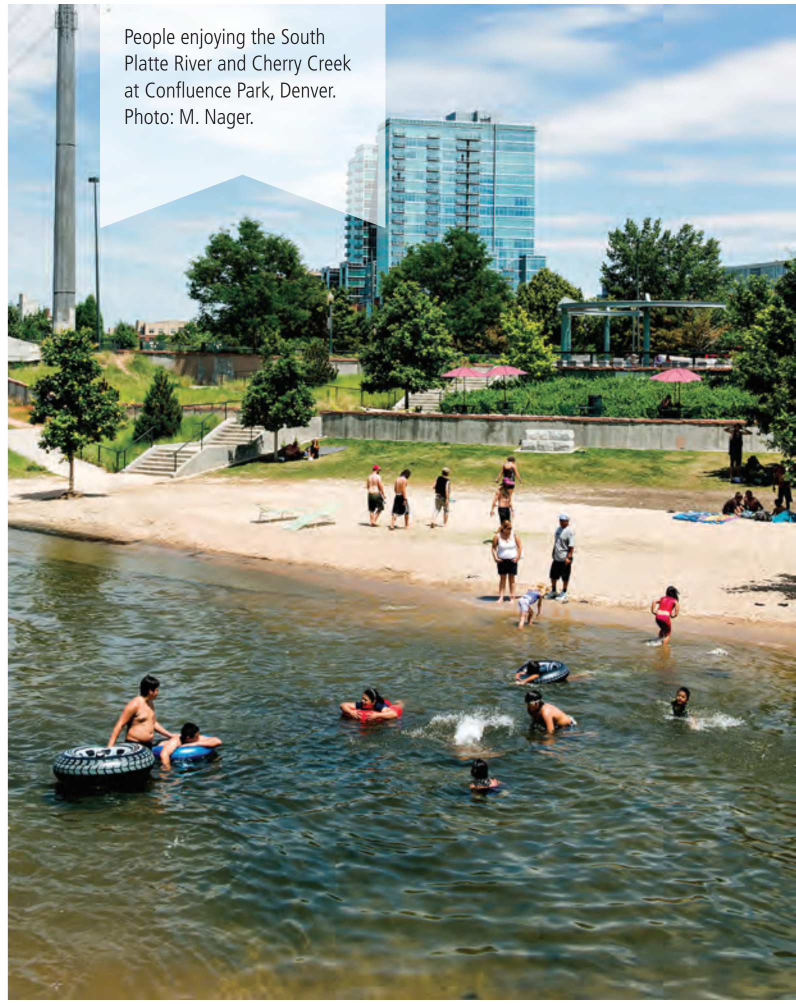
COLORADO'S WATER VALUES[2]

- A productive economy that supports vibrant and sustainable cities, viable and productive agriculture, and a robust skiing, recreation, and tourism industry;
- Efficient and effective water infrastructure promoting smart land use; and
- A strong environment that includes healthy watersheds, rivers and streams, and wildlife.

Our History of Collaboration

The year 2015 marks more than a decade of unprecedented efforts to engage diverse stakeholders and develop water planning information, serving as the foundation of Colorado's Water Plan. Over the course of the past decade, Coloradans from all sectors of the economy and all corners of the state have identified the need for a focused plan for the future.[3]

CWCB established the roots of the water plan when Colorado experienced extreme drought in 2002 and 2003. When some municipalities were mere weeks away from running out of water, it became apparent that there was need for a comprehensive analysis of Colorado's water needs. That realization sparked the Statewide Water Supply Initiative (SWSI).[4] Today, the CWCB leads the SWSI, conducting an ongoing analysis of Colorado's water resources, and in providing key technical data and information that are used to guide decision-making. The SWSI also takes different climate variability scenarios into account. As a result of the SWSI and other technical work performed by the agency, Colorado has more information today than ever before about available water supplies and agricultural, environmental, recreational, and community water needs.



People enjoying the South Platte River and Cherry Creek at Confluence Park, Denver. Photo: M. Nager.

Vineyards in the Grand Valley, near Palisade. The valley is a major fruit growing region, with a large number of orchards including wine grapes and peaches. Photo: M. Nager.

In 2005, Colorado leaders recognized the need to depoliticize water issues for the good of the entire state. The General Assembly passed, and Governor Bill Owens signed, House Bill 1177, which created 10 essential stakeholder engagement bodies. These bodies included the IBCC and nine basin roundtables.[5] The 27 members of the IBCC represent every basin and take into account nearly every water perspective in Colorado. The IBCC agrees that steps must be taken in the near future to avoid undesirable consequences that would result from a growing water gap.[6]

In 2014, each basin roundtable developed a draft Basin Implementation Plan (BIP) that examined each basin area's future water needs and provided strategies for addressing those needs. The basin roundtables brought together representatives from the business community, local government, and water users, as well as stakeholders representing the environment, agriculture, recreation, and various industries. Providers from each of Colorado's major river basins and the Denver metro area began mapping out each basin's needs. The grassroots approach of the basin roundtables and the IBCC (which engaged hundreds of stakeholders across diverse sectors and regions) enabled citizens in each basin to share their vision for Colorado's water future. This "produced informed discussions, provided a forum for building consensus, and generated momentum."[7] The last decade has focused on actively engaging communities through concerted public involvement, and on developing balanced, locally driven, collaborative water management solutions. Those solutions form the building blocks of this water plan.

Why Do We Need a Water Plan?

Many people regard Colorado as one of the best locations in which to live, work, and play.[8] As a result, more and more people and businesses are moving to Colorado and staying. Even with a robust conservation ethic, this growth will increase demand for water. At the same time, we as a state have witnessed sustained and systemic drought on a scale never before recorded by humans. This gap between water supply and our increased demand for water results in the possibility of a significant shortfall within the next few decades, even with aggressive conservation and additional water projects.[9] To complicate matters further, precipitation patterns and amounts have recently shown their ability to swing and vary wildly. For example, in 2013, Colorado suffered from systemic drought and deadly flooding simultaneously.[10]

The Historic Arkansas Riverwalk of Pueblo, a riverfront promenade with family-oriented activities and events including boat rides and concerts.

These are the big water challenges facing Colorado:

- **Growing water supply gap:** The gap between municipal water supply and demand is growing, and water conservation and the completion of proposed water projects are likely insufficient to address projected 2050 shortfalls that could total more than 500,000 acre-feet statewide.[11]
- **Agricultural dry-up:** The purchase and permanent transfer of agricultural water rights is causing irrigated agriculture to disappear. At the current rate of transfer, there will be a major reduction in Colorado's agricultural lands in the future. This could affect Colorado's economy and food security. In addition, rural communities could suffer along with agriculture if enough agricultural business goes away.[12]
- **Critical environmental concerns:** A key component of Colorado's brand is its natural environment. We must address water quality, watershed health, and ecosystem resilience in light of water demands and a changing climate. An increasing number of fish species in Colorado are at risk of becoming endangered because of habitat loss. This risk has the potential to increase if agricultural, municipal, and industrial water needs are set up to clash with environmental and recreational water needs.[13]
- **Variable climatic conditions:** Climate change and its associated effects make it more difficult to meet Colorado's future water needs because of diminishing supplies, increased demand for water, and potential big swings in precipitation patterns and amounts of precipitation in the future. Chapters 4 and 5 discuss this phenomenon at length.[14]
- **Inefficient regulatory process:** Colorado requires a more efficient regulatory process if we as a state are to effectively respond to our water challenges. By encouraging up-front collaboration and resource prioritization, Colorado can do its part to move multi-partner and multipurpose projects forward more quickly.
- **Increasing funding needs:** Colorado faces a financial gap in addressing future environmental, recreational, agricultural, and communal needs. Without adequate investment, Colorado cannot effectively address the challenges described above.

The Gunnison River flowing through the Black Canyon of the Gunnison National Park near Montrose. The Gunnison River is managed for a range of needs.
Photo: M. Nager.

Winter river flowing on Telluride's Valley Floor. A conservation easement protects 560 acres of open space in perpetuity.

Colorado's Water Plan as a Roadmap

This plan is focused on achieving the right balance of water resource management strategies. It recognizes that water is important for all sectors and regions in Colorado, and greatly affects Coloradans' livelihoods.

Water connects Colorado. While the majority of our precipitation falls west of the Continental Divide, the majority of our state's people reside to the east. Through a vast infrastructure, we move water from the west to the east in large quantities every year. Western slope ranchers finish their cattle on the eastern slope, and process and distribute them there. The people who live in the eastern slope consume western slope peaches and wine. The western slope offers world–class recreational opportunities, and Front Range families are the largest users of these recreational opportunities and own many of the second homes in western slope communities. The Front Range is the economic hub of Colorado, accounting for almost 75 percent of the state's gross domestic product.[15] Water is one of our most critical, contentious, and shared resources, but because we are all connected, Colorado's success depends on the ability of all regions to work collaboratively to solve challenges.

This plan takes into account Colorado's history, legal system, policy structure (which includes local, state, and federal laws, institutions, and players), and institutional arrangements that influence decisions about Colorado's water resources. Colorado's Water Plan affirms the private ownership of water rights under the state's prior appropriation system. Furthermore, this plan supports the authorities and responsibilities of local governments and water providers established by state law. It recognizes the limited statutory role of state agencies in decisions regarding the allocation and reallocation of water to various beneficial uses, and the overlay of federal regulatory and permitting processes that pervade water resources management decisions in Colorado. Thus, the plan advocates for cooperation among parties so that no one governmental agency, water provider, or private party is compelled to go it alone and make unilateral decisions.

This plan is a framework to guide future decision-making and to address water challenges with a collaborative, balanced, and solutions-oriented approach. The State recognizes that Coloradans have accomplished innovative and creative work—and acknowledges that there is still much work to do.

Although moving beyond the status quo can be both difficult and complex, it is our responsibility as Coloradans to come together to find compromises and opportunities to ensure that our state remains a vibrant place to live, work, and play for future generations.

The Goal

Colorado is composed of vibrant and sustainable cities, viable and productive agriculture, a robust recreation and tourism industry, and a thriving natural environment. The goals of the Colorado Water Plan are to meet the water supply gap, defend Colorado's compact entitlements, improve regulatory processes, and explore financial incentives—all while honoring Colorado's water values and ensuring that the state's most valuable resource is protected and available for generations to come.

Chapters 2 through 5 focus on the foundational elements that guide Colorado's water management. These include descriptions of Colorado's legal structure and critical facts about supply and demand.

Chapters 6 through 11 establish action steps to help Colorado respond to future challenges. These sections show how Colorado can advance conservation, reuse, alternative agricultural transfers, and multipurpose and collaborative projects while protecting the health of rivers, streams, and watersheds. Building on successful agreements between eastern and western slopes, Chapter 8 charts a collaborative path forward for discussion regarding transmountain water from the western slope. Chapter 9 addresses increased funding opportunities, more efficient and effective permitting, and enhanced education for citizens. Chapter 10 pulls together the measurable objectives and critical actions found in Chapters 6 through 9. Because the various factors affecting forecasts, hydrology, the economy, and the fields of science and technology will continue to be dynamic, Chapter 11 suggests ways to update the plan moving forward.

A LOOK AT HISTORY

Mural related to water, located in Colorado's State Capitol building.

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[15] "Water," Denver Metro Chamber of Commerce, last accessed July 26, 2015, http://www.denverchamber.org/policy_committees/water.aspx.

Colorado's Legal and Institutional Setting

Chapter 2 provides an overview of the regulatory framework that guides water management in Colorado. The doctrine of prior appropriation establishes much of the foundation of water law within the state. This chapter presents a brief explanation of this system along with an overview of how this resource is administered by state and federal agencies.

As a headwaters state, Colorado is subject to interstate agreements and international treaties regarding usage of water and obligations downstream. Section 2.2 of this chapter explains interstate compacts and equitable apportionment decrees as well as their effects on water availability within the state. Colorado also has the distinction of being a local control state, in which much of the planning and implementation authority rests at the local level. Section 2.3 reviews key features of the local control system and describes the importance of these processes to water management within the state.

When moving a water project or method forward in Colorado, interaction with regulatory agencies is necessary at the federal, state, and local levels. Section 2.4 briefly enumerates these agencies, their delegated jurisdictions, and the roles each plays in the approval and permitting processes. Finally, Section 2.5 of this chapter examines the issue of federal- and tribal-reserved water rights, as these types of water designations affect the management and decision making of entities within the state.

An understanding of this legal and institutional landscape is very important for water managers as they move forward in planning and implementation processes within Colorado. Moreover, in order to make our state's laws and policies better, we as Coloradans must understand where we stand and how we got here.

The cover of an 1874 issue of Harper's Weekly depicting two irrigators letting water into a sluiceway and the engineering needed to bring water from where it flows to where it is needed. This represents a foundational principle of Colorado water law. Courtesy of Justice Gregory Hobbs.

HARPER'S WEEKLY.
A JOURNAL OF CIVILIZATION.

Vol. XVIII.—No. 912.] NEW YORK, SATURDAY, JUNE 20, 1874. [WITH A SUPPLEMENT. PRICE TEN CENTS.

IRRIGATION IN COLORADO—LETTING WATER INTO A SIDE SLUICE-WAY.—[See Page 514.]

2.1 COLORADO WATER LAW AND ADMINISTRATION

The evolution and history of Colorado water law is as rich and complicated as the history of the West itself. From the San Luis People's Ditch (the oldest operational water right in Colorado, developed before the creation of the Colorado Territory) to the innovations of Aurora's Prairie Waters project, the result of this complex and varied history is the current massive body of law, legal precedent, rules, and regulations that governs this valuable resource.[1] To sufficiently plan for the opportunities and challenges apparent in Colorado's water future, we as Coloradans must understand the legal framework on which they rest.

Water users in Colorado's semi-arid climate require a flexible system that honors private water rights, provides reliable administration, and responds to changes in supply and demand. As the Colorado Supreme Court articulated in 2001, "The objective of the water law system is to guarantee security, assure reliability, and cultivate flexibility in the public and private use of this scarce and valuable resource."[2] Through ever-evolving case law, policies established by state and local government, and laws passed by the General Assembly, Coloradans are constantly working together to maintain this flexible and reliable system.

The Prior Appropriation System

The foundation of Colorado water law is the "prior appropriation system," which is a framework for establishing one water user's priority for use over that of another. This framework was necessary because of the arid nature of the Western United States, and because the riparian water laws of Europe and the Eastern United States would not have adequately protected older water rights from new uses when there were water shortages.[3]

Colorado established the prior appropriation doctrine, in large part, to protect gold mining claims, and it is not a coincidence that the basic tenets of the prior appropriation doctrine are similar to early mining laws.[4] Colorado was the first to formalize the prior appropriation system in a set of principles known as the "Colorado Doctrine," which the State adopted in the 1860s, even before Colorado obtained statehood in 1876.[5] Most Western states share this legal system in a pure or hybrid form.

The Colorado Constitution explains the heart of the prior appropriation system. It states: "The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using the water for the same purpose."[6] The simple distillation of this legal framework is "first in time, first in right."[7]

THE COLORADO DOCTRINE

All surface and groundwater in Colorado is a public resource for beneficial use by public agencies and private persons;

A water right is a right to use a portion of the public's water resources—a usufructuary right;

Water-rights owners may build facilities on the lands of others, either by agreement or with just compensation, to divert, extract, or move water from a stream or aquifer to its place of use; and

Water-rights owners may use streams and aquifers for the transportation and storage of water.

After constitutional establishment of the prior appropriation system, the Water Right Determination and Administration Act of 1969 ("The 1969 Act"), which applies to surface water and tributary groundwater,[8] further codified the procedure for adjudication and administration of water rights in Colorado. The 1969 Act specified that all water in the state intended for public use was subject to appropriation and administration to "maximize the beneficial use of all of the waters of the state."[9]

MAJOR ACCOMPLISHMENTS OF THE 1969 ACT[10]

- Integration of surface water and tributary groundwater into a unitary adjudication and administration system;
- Specialized water court jurisdiction and engineer administration on a watershed basis;
- Resumption of notice procedure for obtaining jurisdiction for adjudication of rights;
- Case-by-case decrees and appeals in the context of an ongoing and comprehensive adjudication;
- Authorization of augmentation plans to enable otherwise out-of-priority water use through the provision of replacement water;
- Effective rulemaking and enforcement authority by the Colorado Division of Water Resources and division engineers for the protection of state, federal, and interstate rights; and
- Explicit procedures for filing and pursuing applications and objections to applications for water rights, conditional water rights, changes of water rights, and augmentation plans.

Colorado allocates and administers water according to two general categories: (1) Surface water, which includes tributary groundwater, and (2) other groundwater. The first category is subject to Colorado's prior appropriation

JOE GALLEGOS

RIO GRANDE RIVER BASIN

Joe is a Costilla County Commissioner and still works on the land his family farmed five generations ago. His great grandfather helped dig the People's Ditch, which has the oldest water right in Colorado. Joe is pictured next to the People's Ditch.

The Colorado Water Plan is a great start to getting a grasp on the water and a direction when shortages or dispute take place but this plan cannot be written in stone; water, weather, and human situations are dynamic and therefore the plan must also be dynamic. The Plan must be consistently updated and have an ability to improvise for unforeseen occurrences. Like everyone else I worry about the future water supply, but with a plan and power of the community, shortages can be managed. Having a lifestyle that is totally dependent on water, my commitment to being involved in creating a future manageable water situation is part of that lifestyle.I am a fifth Generation rancher and farmer benefiting...

CONTINUED AT END OF CHAPTER

PROFILE

doctrine; Article XVI, Sections 5 and 6, of the Colorado Constitution and the 1969 Act generally govern it.[11] This category of water includes all natural stream water and all tributary groundwater, which is groundwater that is hydrologically connected to a surface stream. Colorado law presumes that all groundwater in Colorado is tributary unless law defines it otherwise, or facts prove it.[12]

A modified prior appropriation doctrine governs, and Colorado's Groundwater Management Act ("The Groundwater Act") partially governs, the second category.[13] This category includes groundwater that law or fact has found to be insignificantly hydrologically connected to a surface stream. This category of water encompasses many different types of water, including: (a) designated groundwater (within a designated groundwater basin);[14] (b) nontributary groundwater outside of designated groundwater basins;[15] (c) "not nontributary" groundwater;[16] (d) Denver Basin groundwater;[17] (e) geothermal groundwater;[18] (f) exempt groundwater;[19] and (g) other types of groundwater that may require a well permit from the Colorado Division of Water Resources (DWR),[20] or as determined by the Colorado Ground Water Commission.[21] For instance, the doctrine of prior appropriation does not apply to nontributary, Denver Basin, or designated groundwater. Such water is allocated as correlative rights generally based on overlying land ownership.[22] The Colorado Ground Water Commission (comprising 12 members, nine of whom are appointed by the governor and confirmed by the Senate) may determine and alter boundaries of designated groundwater basins and their subdivisions by geographic description; these boundaries are subject to statutory limitations.[23]

The vast majority of Colorado's water rights are subject to the prior appropriation system, which aligns water rights in order of appropriation and adjudication dates. This system can result in a situation in which a downstream water user that has a senior priority right, which the water court has adjudicated, may divert and use water before upstream users with less senior water rights (or junior rights) on the same stream. This becomes particularly vital during a time of water shortage when senior water rights are more highly valued. A "call" on a stream by a downstream senior water rights holder may cause an upstream user with junior rights to reduce diversions or curtail water usage completely; in that case, the calling downstream user may receive the quantity of water to which it is entitled. The DWR and division engineers are required to regulate such a call pursuant to state statute.[24]

"Beneficial use," defined as a reasonable level of use beyond which waste may occur,[25] serves as both the measure and the limit of water.[26] There are a number of important water law terms that require definition. Three very good existing glossaries are available online at Colorado State University Extension,[27] Denver Water,[28] and Colorado River Water Conservation District.[29]

The term "beneficial use" is used to both determine and administer water rights. In the early territorial days, beneficial use extended primarily to domestic and agricultural use. As the state's population has grown and water values have evolved, the definition of beneficial use has likewise evolved and expanded to include municipal, industrial, recreational, wildlife, and other uses.[30] Instream flow water rights are held exclusively by the CWCB. The purpose of instream flow water rights is to preserve or improve the environment to a reasonable degree, as codified in the statutory definition of beneficial use.[31] The General Assembly has recently amended the statutory definition to recognize in-channel uses for recreational purposes.[32]

Water Rights and Adjudication

The prior appropriation system today is a product of our constitutional, legislative, regulatory, and judicial processes. Colorado's seven water courts in each of the state's seven major watersheds issue decrees confirming water use rights.[33] Water rights may be confirmed for use on a direct flow basis, by storage, or by exchange.[34] With a direct-flow right, the water user directly applies the water from the stream or tributary aquifer for irrigation, domestic, industrial, or other uses. A user typically accomplishes a storage right by placing water into a vessel, such as a reservoir or a tank (or, under certain conditions, into an aquifer), for beneficial use at a later time. A user generally accomplishes an exchange by diverting water at an upstream location while providing a substitute supply of water at a downstream location; that supply must be suitable in quantity and quality to satisfy downstream senior priorities, and must not affect existing, intervening water uses within the exchange reach. Water court decrees generally quantify direct flow and exchange water rights in terms of flow, which is measured in cubic feet per second, while storage water rights are generally measured volumetrically in acre-feet.[35]

The People's Ditch holds the first adjudicated water rights in Colorado, dated in 1851. This is ten years prior to Colorado becoming a U.S. territory and 25 years before statehood. Photo: M. Nager.

Section 6 of Article XVI of the Colorado Constitution sets forth the right to appropriate as "the right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied."[36] In Colorado, a user appropriates a water right by demonstrating intent and taking steps to put water to beneficial use. A user makes that right absolute by storing or directly applying a specified amount of water for beneficial use.[37] A water user may then receive protection under the priority system by adjudicating that right through the water court process.[38] A user can also obtain a conditional water right by showing an intent to put water to beneficial use and proving that that user "can and will" put the water to beneficial use under Colorado's anti-speculation doctrine.[39] To avoid the requirement of further diligence applications, a user must exercise conditional right in priority, and a court must establish it as an absolute right by decree.

As the prior appropriation system has evolved, more adjudicated water rights exist than some river basins can satisfy in dry years. When this occurs, that basin is described as over-appropriated, meaning that there is limited opportunity to develop new junior water rights in that basin.[40] In over-appropriated basins, a user may create new water uses by changing existing water rights to the new uses, or by developing augmentation plans to increase the water supply.[41]

Changes of Water Rights

The right to use water in Colorado is usufructuary.[43] As such, it is limited to the amount of diversion, location of diversion, place of use, manner of use, and type of use a water court decree allows.[44] A user may convey a water right to another water user or, with appropriate water court or administrative approval, change it to another location of diversion, place of use, manner of use, or type of use, while still retaining its priority. However, changes in water rights are subject to terms and conditions that prevent injury to existing water rights.[45]

USUFRUCTUARY RIGHT

A civil law term referring to the right of enjoying a thing, the property of which is vested in another (in this case the State), and to draw from the same all of the profit, utility, and advantage which it may produce, providing it be without altering the substance of the thing.[41]

The engineering analysis in a change-of-water-right proceeding establishes the time, place, and amount of decreed and historical consumptive use, which serves as the volumetric limitation on any new consumptive use.[46] In addition to establishing historical consumptive use, an analysis must establish the timing, location, and amount of historical return flows (the non-consumed portion of the diversion). Return flows must be replaced in the stream so that water users senior to the date of the change may continue to enjoy stream conditions that were in place at the time of their appropriation.[47] A full analysis considering time, place, and amount of historical use on a stream is generally referred to as a "net stream depletion" analysis. Because the prior appropriation doctrine forbids the change of one water right to the injury of another (even a junior water right[48]), making such changes is a costly proposition that requires complex legal and engineering analyses.

The goal of the net stream depletion assessment, including historical beneficial consumptive use, is to ensure that future depletions or consumptive use do not exceed historic depletions or consumptive use. Maintaining flows after a change of water right ensures that water users that established their rights before the date of the change in use receive the water to which they are entitled, and do not suffer an injury to their water rights as a result of that change.[49]

Augmentation Plans

Colorado water law allows users to divert water out of priority if they replace any injurious depletions under what is called a "plan for augmentation."[50] A typical plan for augmentation allows a user with a junior water-rights holder to divert out of priority ("cutting in line," so to speak), as long as that junior water user can replace or remedy its injurious depletions to the user with senior calling water rights, and avoid injuring other water users in the process.[51] A common scenario is one in which a water user pumps a well out of priority and then replaces stream depletions with other senior surface water or nontributary groundwater. Under an augmentation plan, the replacement water must generally be available in the same quality and quantity. It also must be available at the same time, location, and amount as the stream depletions the out-of-priority pumping or diversions caused.[52] Permanent or long-term plans for augmentation and changes of water rights require water court approval, but the DWR has statutory authority to approve temporary, substitute water supply plans and interruptible water supply agreements for similar purposes.

State Administration of Water Rights

The DWR, a division of the Department of Natural Resources (DNR), administers water rights. Also referred to as the State Engineer's Office, the DWR evaluates well permits, inspects dams and wells, and oversees the work of field water commissioners who physically allocate the water and enforce compacts, water court decrees, and well permits.[53]

The DWR is headquartered in Denver and has seven field offices in each major river basin across the state. Every field office has a division engineer who serves as the lead and manages the administration of that particular water division.[55] Water commissioners, who work under the division engineer, not only monitor diversion structures and streams in the field for immediate administration of water rights, but also gather important data for use in water planning studies and decision-support systems.[56]

FIGURE 2.1-1 COLORADO'S WATER DIVISIONS[54]

The water commissioners also administer calls on the river system to ensure that the holder of a senior water right receives its entitlement. Other duties of the water commissioners and other DWR employees include regulating headgates, measuring devices, and administering and enforcing storage water rights, plans for augmentation, exchanges, and transmountain water diversions.[57] The DWR also oversees the well-permitting process for all types of groundwater.[58] The DWR requires well permits for extraction of tributary groundwater, designated groundwater, nontributary groundwater, Denver Basin groundwater, produced water from tributary coalbed methane wells, and geothermal groundwater.[59]

In its management of water records statewide, the DWR maintains decrees, permits, maps, historical streamflow and diversion measurements, real-time streamflow and major diversions, and groundwater levels. The DWR also maintains a repository of policy documents, planning materials, rules, and regulations.[60]

Rainbow over the lower Colorado River near Grand Junction. Photo: M. Nager.

The DWR collects water resources data and makes them available online through Colorado's Decision Support Systems (CDSS), a joint effort of the CWCB and the DWR.[61] The CDSS consists of data, mapping, and analytical tools and models to assist the State and stakeholders in water resources planning and management. The CDSS contains historical data and information about streamflow, diversions, climate, water rights, call records, well permits, aquifer properties and groundwater levels. The CDSS's analytical resources include an online map viewer, data processing and graphing tools, crop consumptive use models, and surface water and groundwater models. The CDSS map viewer is available here.[62]

The Colorado Ground Water Commission is responsible for adjudicating groundwater rights and issuing large-capacity well permits. Much of the groundwater located within the basin has been authorized as being in a designated groundwater basin. The Colorado Groundwater Commission has also established eight designated basins and 13 groundwater management districts within such basins. Groundwater management districts are local districts that have additional administrative authority.

Moving Forward

The evolution of Colorado water law through the courtroom and the legislative process presents both challenges and opportunities for Colorado's Water Plan. The institution of the prior appropriation system can be difficult to navigate because of the planning and costs associated with judicial and administrative approvals. Efforts are currently underway to simplify the process and support evolving water uses in Colorado. Alternatives, such as the Alternatives to Agricultural Transfer Grant Program, new legislation, water court rule changes, and ongoing studies and processes on water banking have helped increase the flexibility within this landscape, and demonstrate how well the complex Colorado water administration system can adjust.

Recent agreements between multiple stakeholders, such as the Colorado River Cooperative Agreement, between Denver Water and more than two dozen western slope entities,[63] and subsequent agreements with various entities, including the CWCB, illustrate the ability to work collaboratively and creatively within of Colorado's water administration system to achieve maximum use of the state's water resources for the greatest benefit.

2.2 INTERSTATE COMPACTS AND EQUITABLE APPORTIONMENT DECREES

Colorado is a headwaters state in which the major rivers flow to downstream states on both sides of the Continental Divide. As Colorado and other downstream states developed those rivers in the late 19th and early 20th centuries, disputes arose regarding the authority of one state to control the use of an interstate stream that originates in another state.[64] Initially, downstream states sought to resolve water disputes through litigation before the United States Supreme Court.[65]

TABLE 2.2-1 COLORADO'S INTERSTATE COMPACTS

Colorado River Compact	1922
La Plata River Compact	1922
South Platte River Compact	1923
Rio Grande River Compact	1938
Republican River Compact	1942
Upper Colorado River Compact	1948
Arkansas River Compact	1948
Costilla Creek Compact	1963
Animas-La Plata Compact	1969

The United States Supreme Court decided two cases that convinced Colorado water leaders that negotiated interstate water agreements were preferable to interstate litigation.[66] Colorado is party to nine formal interstate water agreements called "compacts." These compacts, in addition to water administration within Colorado, place limits on Colorado's ability to use all of the water supplies that originate within the state (see Table 2.2-1 and Table 2.2-2).

In the 1907 case of *Kansas v. Colorado,* which arose from the contention that water users in Colorado were depriving users in Kansas of their fair share of Arkansas River flows, the United States Supreme Court announced the doctrine of equitable apportionment.[67] This doctrine provides that the principle of "equality of right" should be applied when determining how states should share rivers to ensure that each state receives equal benefit.[68] The court dismissed Kansas' claim because it could not show sufficient injury from Colorado's diversions, but allowed Kansas to bring a new action in the event of a "material increase in the depletion of the waters of the Arkansas by Colorado."[69] *Kansas v. Colorado* left future disagreements about river use to the uncertain and expensive process of protracted, United States Supreme Court litigation. A similar dispute over Colorado's proposed diversions from the Laramie River, to the detriment of downstream senior appropriators in Wyoming, led to the case of *Wyoming v. Colorado.*[70] Resolving the dispute in Wyoming's favor, the Supreme Court ruled in 1922 that when two states each use the prior appropriation doctrine, the doctrine should be applied to determine relative priorities on an interstate basis.[71] As a result, this decision required junior water users in Colorado to honor senior water rights in Wyoming.[72]

TABLE 2.2-2 COLORADO'S INTERSTATE DECREES

Laramie River Decree	1957
North Platte Decree	2001

Greeley's Delph Carpenter, one of the attorneys representing Colorado in the Wyoming litigation, was a visionary who recognized that the law resulting from the *Kansas* and *Wyoming* decisions put Colorado's future at great risk.[73] Carpenter, an experienced irrigation litigator as well as a rancher and a former state senator, was appointed to be interstate streams commissioner in 1913.[74] As an attorney for Colorado, he worked on negotiations with Nebraska regarding the South Platte River.[75] During that time, he formulated the leading theory on rights and authorities for entering into interstate compacts, which guided the creation of the nine water compacts the State of Colorado ultimately signed.[76]

Historic map of the rivers in the southern Rocky Mountains.
Courtesy of Justice Gregory Hobbs.

MAP
Showing the Route pursued by the Exploring Expedition to
NEW MEXICO
AND THE
SOUTHERN ROCKY MOUNTAINS
made under the orders of
CAPTAIN J.C. FREMONT U.S. TOPOGRAPHICAL ENGINEERS
and conducted by
LIEUT. J.W. ABERT, assisted by LIEUT. W.G. PECK U.S.T.E.
during the year 1845
Notes
MISSOURI
MISSOURI RIVER
KANSAS RIVER
NEBRASKA OR PLATTE RIVER
N. Fork of the Platte
South Fork of the Platte R.
Pole Creek
SIOUX INDIANS
PAWNEE INDIANS
Republican Fork of the Kansas
ARAPAHOE AND CHEYENNE INDIANS
Smoky Hill Fork of the Kansas
Smoky Hill Fork
Grand Saline Fk.
Solomons Fork
Arkansas River
ARKANSAS RIVER
SALT PLAINS
Cimmaron R.
Beaver Creek
Red Fork of Arkansas
North Fork of Canadian
Neosho River
Verdigris C.
CANADIAN RIVER
COMANCHEE AND KIOWA INDIANS
EL LLANO ESTACADO
Sweet Water Mountains
Fort Laramie
Fort Leavenworth
Fort Gibson
Fort Smith
Bents Fort
Santa Fe
Taos
Rio Puerco

Carpenter became especially concerned about the Colorado River. California, a prior appropriation state, was growing rapidly.[77] Carpenter feared that without an agreed apportionment between the states, California farmers and municipalities would appropriate the river to the point that Colorado would not be able to provide for future development.[78] With a vision to protect Colorado, Carpenter became the principal force in the negotiation of the Colorado River Compact, and went on to negotiate additional compacts on behalf of Colorado.[79] Carpenter's model guided other negotiators of interstate water compacts, providing greater certainty to water users in all participating states.[a]

Interstate water compacts are formal agreements among participating states. The United States Constitution authorizes these compacts, and state legislatures and the United States Congress must ratify them for them to take effect. Under this framework, compacts are considered federal law, state law, and legally binding contracts among the signatory states. These compacts help the states negotiate, rather than litigate, over the management of interstate waters. As this chapter more fully describes, litigation still occurs regarding compact interpretation; however, that litigation tends to be more streamlined and efficient as a result of an existing water compact. The nine water compacts, along with two court decrees, are fundamental elements of Colorado's Water Plan because they dictate how states share water. The compacts also identify and delineate the rights and obligations that control the use and future development of every stream in Colorado.

Colorado's Interstate Compacts and Interstate Equitable Apportionment Decrees

Colorado River Compact

The Colorado River Compact is the foundation for a complicated body of law regarding use and management of the Colorado River. Together, the Colorado River Compact and the associated body of law are known as the "Law of the River."[b] Negotiators of the compact signed it on November 24, 1922, and the United States Congress approved it by passage of the Boulder Canyon Project Act in 1929.[80]

Generally, the compact divides the right to consume water for beneficial use from the Colorado River system among the Upper Basin states (Colorado, Utah, Wyoming, and New Mexico) and the Lower Basin states (California, Arizona, and Nevada).[81] Lee Ferry, Arizona marks the dividing point between the basins[82] (See Figure 2.2-1). The compact recognizes each basin's right to the beneficial consumptive use of 7.5 million acre-feet of water per year in perpetuity.[83] The Lower Basin states may increase their beneficial consumptive use by 1 million acre-feet per year.[84] The compact also obligates the Upper Division states to "not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75 million acre-feet zfor any period of 10 consecutive years."[85]

Anticipating a potential treaty between the United States and Mexico, the compact further specifies that the states are to address any obligation to deliver water to Mexico under a future treaty by using water in excess of the apportionments between the basins.[86] If no surplus exists, the Upper and Lower Basin states are to share equally in meeting any such deficiency.[87] In addition to the apportionment provisions, the Colorado River Compact asserts that the compact does not affect present, perfected rights, and recognizes the states' respective authority to regulate and control the appropriation, use, and distribution of water within their boundaries.[88] Present, perfected rights are defined as "perfected rights, as here defined, existing as of June 25, 1929, the effective date of the Boulder Canyon Act."[89] Complete text of the compact is available here.[90]

[a] Carpenter also negotiated the South Platte River Compact and the La Plata River Compact. Other negotiators of interstate water compacts include: Clifford H. Stone (Upper Colorado River Compact and original Costilla Creek Compact); M.C. Hinderlider (Rio Grande River Compact and Republican River Compact); J.E. Whitten (amended Costilla Creek Compact); Henry C. Vidal, Gail L. Ireland and Harry B. Mendenhall (Arkansas River Compact); and multiple negotiators (Animas-La Plata Compact).

[b] The "Law of the River" is a colloquial phrase that generally refers to the collective body of compacts, decrees, statutes, regulations, contracts, treaty, and other legal documents and agreements applicable to the allocation, appropriation, development, exportation, and management of the waters of the Colorado River.

FIGURE 2.2-1 THE COLORADO RIVER BASIN

Upper Colorado River Basin Compact

The Upper Colorado River Basin Compact divides the right to beneficial consumptive use of the Colorado River among the Upper Division states (Colorado, Wyoming, Utah, and New Mexico), plus Arizona, which receives an allocation based on the portion of the state that is located in the Upper Basin.[91] These five states signed the compact on October 11, 1948, and subsequently ratified it. Congress then ratified it in 1949.[92] The compact allocates the consumptive use as follows: Colorado, 51.75 percent; New Mexico, 11.25 percent; Utah, 23 percent; Wyoming, 14 percent; and Arizona, 50,000 acre-feet per year.[93] In addition to the allocation provisions, the compact outlines parameters for the Upper Division states to assure compliance with the flow obligation at Lee Ferry under the Colorado River Compact, and establishes a commission to implement and administer the compact.[94] Each of the four Upper Division states and the federal government may appoint a commissioner to the commission.[95]

The Upper Colorado River Basin Compact sets forth specific terms for apportioning, among the states, the use of interstate tributaries to the Colorado River. These interstate tributaries include the Yampa, San Juan, Little Snake, and Henry's Fork.[96] The compact also recognizes water use as decreed by the La Plata River Compact, and accounts for such uses as part of the Upper Colorado River Compact.[97] Complete text of the compact is available here.[98]

Arkansas River Compact

Recognizing the value of settling uncertainties associated with the equitable apportionment decree from *Kansas v. Colorado,* those two states signed the Arkansas River Compact on December 14, 1948, and Congress ratified it in 1949.[99] This compact does not impose any fixed-delivery obligation.[100] Instead, it protects water uses in existence in 1949, and limits future development in either Colorado or Kansas to the extent that it would cause any material depletion of usable state-line flow.[101] The compact also addresses the allocation of benefits from use of storage at John Martin Reservoir, whose construction was complete the same year the Congress approved the compact.[102] Specifically, the compact directs that John Martin Reservoir be operated for the benefit of both states, and provides specific terms for operation.[103] Based on the compact, storage periods are divided between winter (November 1 to March 31), when all inflows are stored, and summer (April 1 to October 31), when generally only large flood flows are stored.[104] The compact also establishes the Arkansas River Compact Administration, with designated roles and responsibilities.[105]

Based on its authority and obligations, the Arkansas River Compact Administration adopted the 1980 Operating Plan for John Martin Reservoir, substantially modifying the storage and release of water from the reservoir to improve the efficiency of water delivery to users in both states.[106] Recent litigation in *Kansas v. Colorado* provides more specific guidance for administration of the river, within the framework established in the compact and the operating plan.[107] Complete text of the compact is available here.[108]

Animas-La Plata Project Compact

Signed on June 7, 1969, this compact between Colorado and New Mexico informs the operation of the Animas-La Plata Project.[109] The compact recognizes New Mexico's right to divert and store water from the Animas and La Plata Rivers, for uses the federal reclamation Animas-La Plata Project describes, with the same priority as those diversions made under the same project for Colorado users.[110] The compact further clarifies that any of New Mexico's use of these waters counts toward that state's allocation under the Upper Colorado River Basin Compact.[111] Complete text of the compact is available here.[112]

La Plata River Compact

Following on the heels of the Colorado River Compact, New Mexico and Colorado signed the La Plata River Compact on November 27, 1922, and Congress approved it in 1925.[113] The La Plata River Compact designates the location and operation of two gages on the river and defines the calculation for determining La Plata River flows.[114] This compact allows both states unrestricted use of the river between December 1 and February 15 of each year.[115] During the rest of the year, the compact entitles each state to unrestricted water when the interstate gage station is greater than 100 cubic feet per second.[116] When the interstate gage station is less than 100 cubic feet per second, Colorado must deliver half of the mean flow measured at the Hesperus gage station to New Mexico.[117] Additionally, the compact allows for alternating periods of use between the two states during times of low flow, and specifies that it will not consider minor deviations from the required water deliveries to be a violation.[118] Complete text of the compact is available here.[119]

Republican River Compact

Colorado, Kansas, and Nebraska signed the Republican River Compact on December 31, 1942, and Congress ratified it in 1943.[120] The compact quantifies the average annual "Virgin Water Supply" (defined as water within the basin "undepleted by the activities of man") within the basin and its tributaries as 478,900 acre-feet of water per year.[121] For beneficial consumptive use each year, the compact allocates 54,100 acre-feet of water to Colorado, 190,300 acre-feet of water to Kansas, and 234,500 acre-feet of water to Nebraska.[122] In addition, the compact allocates the entire water supply originating in the basin downstream from the lowest crossing of the river at the Nebraska-Kansas state line for beneficial consumptive use in Kansas.[123] If the water supply of any sub basin varies by greater than 10 percent relative to the period of record used as a basis for the compact, the allocations also change by the same percentage.[124]

Rather than establishing principles for dispute resolution, the compact calls for each state to administer the compact through its respective water administration officials, and acknowledges that those officials may, by unanimous action, adopt rules and regulations consistent with the compact.[125] Consequently, in 1959 the states established the Republican River Compact Administration (RRCA).[126] Each year, by unanimous action, the three RRCA members compute the Virgin Water Supply within the basin and the beneficial consumptive use of each state.[127] Under the accounting procedures the RRCA established, Colorado's allocation for beneficial consumptive use in the Republican River sub-basins, under normal conditions, includes 10,000 acre-feet from the North Fork of the Republican, 15,400 acre-feet from the Arikaree River, 25,400 acre-feet from the South Fork of the Republican, and 3300 acre-feet from the Beaver Creek. Kansas and Nebraska may each consume 190,300 acre-feet and 234,500 acre-feet of water, respectively.[128]

Despite efforts to avoid litigation and promote interstate amiability through the Republican River Compact, the states have been involved in formal disputes regarding compact compliance and interpretation since 1999. Currently, the lack of consensus regarding accounting procedures and compact compliance has formed the basis of several non-binding arbitrations and litigation before the United States Supreme Court. Complete text of the compact is available here.[129]

Rio Grande River Compact

The Rio Grande Compact allocates beneficial use of water from the Rio Grande River among Colorado, New Mexico, and Texas. These states signed the Rio Grande Compact on March 18, 1938, and Congress approved it the following year.[130] The compact defines the boundaries of the Rio Grande River Basin and establishes the operation of six gage stations and recorders near reservoirs built after 1929.[131] It requires that Colorado deliver a certain amount of water at the New Mexico/ Colorado state line annually based on an index schedule, and includes provisions for New Mexico to deliver certain amounts to Elephant Butte Reservoir based on a similar, though separate, index schedule.[132] The compact assumes a normal release of 790,000 acre-feet from Elephant Butte to irrigate lands in southern New Mexico and Texas, and to provide water to Mexico consistent with the 1906 Treaty.[133] Additionally, the compact creates a system of water credits and debits, storage, spills, and releases from the Rio Grande Project at Elephant Butte, and places further restrictions on storage within Colorado and New Mexico.[134] The compact also establishes a commission for compact administration purposes. Colorado's state engineer serves as Colorado's commissioner.[135] Complete text of the compact is available here.[136]

South Platte River Compact

Colorado signed the South Platte River Compact shortly after the La Plata River Compact on April 27, 1923; however, Congress did not fully ratify the compact until 1926.[137] This compact allocates the waters of the South Platte River between Colorado and Nebraska.[138] It relies on the western boundary of Washington County to separate the upper and lower sections of the South Platte River within Colorado, and establishes a gage at Julesburg to measure flow.[139] The South Platte Compact provides Colorado unrestricted use of water in the lower section between October 15 and April 1 and includes several provisions relating to Nebraska's canals. Between April 1 and October 15, the compact stipulates that Colorado curtail diversions in the lower section by appropriators with decrees junior to June 14, 1897, when the mean flow (as measured at the Julesburg gage) is less than 120 cubic feet per second.[140] Like the La Plata Compact, the South Platte Compact specifies that minor irregularities in water delivery will not constitute a violation of the compact.[141] Complete text of the compact is available here.[142]

Amended Costilla Creek Compact

Colorado and New Mexico signed the Costilla Creek Compact on September 30, 1944, and amended the compact in 1963.[143] Congress ratified it in 1963. The Costilla Creek Compact is intended to establish integrated operations between Colorado and New Mexico for existing and prospective irrigation facilities, and to equalize the benefits of the water and its beneficial use between the two states.[144] The compact defines May 16 to September 30 as the irrigation season, designates October 1 to May 15 as the storage season, and prohibits direct-flow diversions during the storage season.[145] The compact further sets forth the amount of water to be delivered among the water users within both states, and provides for allocation of surplus flows and storage in reservoirs constructed after the compact took effect.[146] Costilla Creek flows downstream from where the water leaves the mountains make deliveries to water users in Colorado.[147] Moreover, the compact allocates 36.5 percent of the usable capacity of the Costilla Reservoir to Colorado, and 63.5 percent to New Mexico.[148] The 1963 amendment to the compact allows for a change in point-of-diversion for the Cerro Ditch, where delivery from Costilla Reservoir is made.[149] A commission comprising the state engineers for both Colorado and New Mexico oversees the compact.[150] Complete text of the compact is available here.[151]

Laramie River Decree

The decree in *Wyoming v. Colorado,* 353 United States 953 (1957), permits Colorado to divert 49,375 acre-feet of water per calendar year from the Laramie River and its tributaries, provided that Colorado diverts no more than 19,875 acre-feet per calendar year of that total amount outside of the Laramie River Basin.[152] Further, Colorado may divert no more than 1800 acre-feet after July 31 of each year for use within the basin. All waters diverted for use within the Laramie River Basin in Colorado are restricted to irrigation use on those lands the court designated at the time of the decree, while waters diverted for use outside of the basin are not subject to that restriction. The waters of Sand Creek are specifically excluded from the operation of this decree.[153] Complete text of the decree is available here.[154]

North Platte Decree

The amended decree in *Nebraska v. Wyoming,* 534 U.S. 40 (2001), equitably apportions water in the North Platte River among Colorado, Nebraska, and Wyoming.[155] The decree limits Colorado's diversion of water from the North Platte River in Jackson County for irrigation of no more than 145,000 acres during one irrigation season (May 1 to September 30), and limits storage to no more than 17,000 acre-feet of water for irrigation purposes between October 1 of any year and September 30 of the following year. The decree also limits total water exports from the North Platte River Basin in Colorado to no more than 60,000 acre-feet during any 10-year period. The decree does not affect or restrict the use or diversion of water for ordinary and usual domestic, municipal, orstock-watering purposes.[156] Complete text of the decree is available here.[157]

Other Institutional Interstate and Federal Agreements

To effectively manage water resources, Colorado has entered into many interstate agreements (rather than more formalized compacts) in addition to the compacts and interstate equitable apportionment decrees described above. Two such agreements are memoranda of understandings (MOUs) between Colorado and neighboring states; the MOUs involve Pot Creek in Utah and Sand Creek in Wyoming. This plan more fully describes these less-formally recognized interstate water agreements below.

In addition, Colorado is actively involved in interstate and federal water matters to protect the State's rights and interests in water resources. Recognizing that formal disagreements or disputes among states rise directly to the United States Supreme Court and inevitably result in expensive, protracted litigation, Colorado, the federal government, and downstream states have engaged in an unprecedented amount of cooperation and interstate consensus the last two decades about matters related to enforcement, interpretation, or implementation of the interstate compacts, or reconsideration of equitable apportionment decisions. The result of this cooperation is that interstate agreements have ultimately resolved many disputes. This plan further describes some of these cooperative arrangements below.

Pot Creek Agreement

Rather than using an interstate compact, Colorado and Utah used an MOU to define their relationship regarding Pot Creek.[158] Originating in the Uinta Mountains in Utah, Pot Creek flows for eight miles within Colorado before joining the Green River. The two states signed the Pot Creek MOU on April 1, 1958 and established an equitable and workable division of water. This MOU stipulates that both Colorado and Utah believed that a compact would eventually be necessary to appropriate water between the two states, but that in the meantime, the MOU would help develop a functioning system. One aspect of the Pot Creek MOU defines the parameters for appointing a water commissioner with the authority to administer water in both Colorado and Utah. The MOU also calls for a division of the expenses, with Utah bearing 80 percent of the costs and Colorado bearing 20 percent. Additionally, this MOU states that the states may not exercise direct flow diversions before May 1 of each year, and establishes a schedule of priorities for use in the two states.[159]

Sand Creek Agreement

Sand Creek originates in the Laramie Mountains of Colorado and flows into Wyoming, where it joins the Laramie River.[160] To equitably apportion Sand Creek, Colorado and Wyoming signed an MOU on March 13, 1939. The Sand Creek MOU allocates waters according to the priority water rights in Colorado and Wyoming, recognizing that Wyoming was entitled to 50.68 cubic feet per second before any Colorado diversions. This provision was later revised on August 7, 1997 to require Colorado to deliver 40 cubic feet per second over a seven-day period at the beginning of the irrigation season; after that period, Colorado was required to deliver 35 cubic feet per second. Finally, the Sand Creek MOU limits diversions of the Sand Creek Ditch and the Wilson Supply Ditch to amounts of water in excess of the water allocated to Wyoming.[161]

Colorado River Agreements

Within the Colorado River Basin in the last several decades, states have made extraordinary strides toward cooperation. For example, the Upper Colorado River Endangered Fish Recovery Program and the San Juan River Recovery Implementation Program enable Colorado to fully use its compact entitlements, while striving to support the recovery of endangered fish species. This plan further describes these programs.

In 2006, Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming also signed the Range-Wide Conservation Agreement and Strategy for Roundtail Chub, Bluehead Sucker, and Flannelmouth Sucker (the "Three Species Agreement").[162] Through a collaborative and cooperative interstate effort, the states created this agreement to expedite the implementation of conservation measures for the three species. Using coordinated, state-driven preventative measures, the Three Species Agreement seeks to minimize potential threats to the species that could result in a federal listing.[163]

In 2007, the states overcame substantial disagreement to collectively support the Bureau of Reclamation's (BOR's) Record of Decision on Interim Guidelines for Lower Basin Shortages and Coordinated Operation for Lake Powell and Lake Mead through 2026.[164] Among other things, these guidelines: 1) Set forth coordinated, operational protocols between Lakes Mead and Powell to allow the system to operate more efficiently during drought; 2) establish shortage guidelines in the lower basin; and 3) implement the "Intentionally Created Surplus" mechanism for banking water in Lake Mead.[165]

Continued cooperative efforts have helped lower-basin interests to use water more efficiently. Such efforts include the creation of the Intentionally Created Surplus, the pilot operation of the Yuma Desalting Plant, and the construction and operation of Brock Reservoir.

The states and the federal government have also continued to develop a working relationship with Mexico, resulting in Minutes 316-319 to the 1944 Water Treaty.[166] These minutes identify and implement voluntary options for creating a larger quantity of water in the system, enhancing environmental values, providing Mexico with access to storage in the United States, providing improved water management during drought in both countries, and establishing the foundation for developing and implementing cooperative projects that are mutually beneficial to both countries—and that are consistent with the 1944 Water Treaty and the Law of the River.

In response to the basin-wide drought that began in 2000, there has also been increased interstate activity in the field of weather modification. Weather modification, or cloud seeding, is designed to increase winter precipitation through aerial and ground-based techniques. The Colorado Basin states are pursuing winter cloud seeding efforts in Colorado, Wyoming, and Utah. Additionally, New Mexico helps fund Colorado's weather modification program in Southwest Colorado to increase runoff and flow in the Colorado River.[167]

Most recently, the Colorado River Basin states have turned their attention to: 1) Collaborating on drought contingency planning to protect certain reservoir thresholds in the event of continued drought conditions; 2) protecting power generation and instream natural resources, including endangered fish and other natural resources; and 3) ensuring the continued use and development of existing water supplies.

Platte River Agreements

On the South and North Platte Rivers, Colorado, Wyoming, and Nebraska are currently working with the Department of the Interior to collectively manage the rivers, with the dual goals of enabling endangered species recovery and protecting water development. The Platte River Recovery Implementation Program, established in 1997 and authorized by Congress in 2008, seeks to restore habitat, provide for increased streamflows, and encourage an adaptive management approach to river operations.[168] Chapter 6 further describes this program.

Republican River Agreements

Within the Republican River Basin, the State of Colorado continues to be involved with Colorado water users, as well as with water users in Nebraska and Kansas, to identify reasonable methods for future compact compliance by all parties. Colorado recently constructed the Compact Compliance Pipeline (CCP) to facilitate Colorado's ongoing and future compact compliance, while mitigating any negative effects of compact compliance on Colorado water users. Before the pipeline can become fully operational, Nebraska, Kansas, and Colorado must agree on how to account for the water under the compact. This includes negotiating, and in some instances arbitrating, appropriate changes to compact accounting procedures, and implementing new operations in the basin. Once the states reach a final agreement, water deliveries from the CCP will count toward Colorado's compact obligations to Nebraska and Kansas.

Rio Grande River Agreements

On the Rio Grande, the State continues to work on intrastate and interstate issues related to groundwater administration and compliance with the compact and the Endangered Species Act (ESA). The DWR is addressing groundwater issues in the San Luis Valley through the establishment of basin sub-districts and ongoing efforts to develop groundwater administration rules for the Rio Grande Basin in Colorado. Additionally, the State continues to work with the federal government and stakeholders to address survival and recovery efforts of endangered and threatened species in a manner that respects and complies with existing Colorado water rights, as well as with interstate compact rights and authorities. The State is also involved in an interstate lawsuit before the United States Supreme Court concerning groundwater pumping and usage between Texas and New Mexico below Elephant Butte Reservoir. Because interpretation and enforcement of the Rio Grande River Compact may form the basis for part of the controversy between Texas and New Mexico, Colorado, as a signatory to the compact, is a named party to the lawsuit.[169]

San Juan/Dolores River Agreements

In the San Juan/Dolores Basin, a major project was recently built to assist Colorado in meeting its compact obligations to New Mexico. The State worked with local stakeholders to construct Long Hollow Reservoir to both supplement the irrigation needs for the region and to assist in fulfilling compact requirements. This reservoir allocates 300 acre-feet of annual storage to be used for deliveries to New Mexico during summer low-flow months. In addition, the State worked with local governments, neighboring states, tribal interests, and the federal government to complete the Animas-La Plata Project. The water the CWCB purchased for this project will be important to Colorado in the future.

COLORADO'S LOCAL-CONTROL STRUCTURE

Colorado's local governments have considerable authority in making water development and management decisions. The state's 64 counties and 271 municipalities exercise a broad range of powers, which state law explicitly delegates to them, to address the needs of respective constituents.

Generally, counties have discretionary powers to provide services, including water and sewer, and to operate districts for irrigation and recreation, among other uses. Cities and towns have the ability to address the needs of their denser populations through self-government, including administrative, police, and financial powers. Furthermore, the State constitution authorizes municipalities and counties to adopt home-rule charters, which provide even greater autonomy and flexibility to address local problems.[170] Municipal home-rule is intended to ensure that cities can make decisions on expending funds, incurring debt, building and maintaining public facilities, and undertaking other activities to meet their needs. County home-rule charters are authorized to establish the organization and structure of county government, but do not provide the "functional" home-rule powers of municipal charters.[171]

Land- and Water-Use Planning Authority

State law also provides local governments with authority specific to land use and water planning. The Local Government Land Use Control Enabling Act broadly allows counties and municipalities to balance environmental protection with the need to provide for the planned and orderly use of land.[172] The act allows a local government to provide for the phased development of services and to regulate the location of activities and development that may cause substantial changes in population density. The act also requires a local government to make a determination about whether an applicant for larger developments (in excess of 50 units or single-family equivalents) has demonstrated that the proposed water supply is adequate to serve the proposed development.[173]

The act requires counties and municipalities to adopt master plans for the development of their jurisdictions; these plans which may include a water supply component.[174] State law encourages water efficiency and conservation through public project landscaping guidelines.[175]

Counties and municipalities have the authority to impose an impact fee as a condition of a development permit to pay for certain costs associated with growth. Counties and municipalities can only use these fees to offset the added burden of new development on existing infrastructure and capital improvements, and cannot use them for ongoing expenses and maintenance.[176] Nearly half of Colorado's cities have implemented impact fees, and the most commonly used fees are for water and sewer.[177] When the market can sustain the full price increase needed to cover the fee, the new development's residents typically bear the costs collectively through increased housing prices, and the developer pays the actual fee.[178]

In addition to providing a tool for offsetting burdens on existing infrastructure, state law allows a municipality to construct or authorize the construction of new waterworks, if voters approve. State law also authorizes the municipality to protect the waterworks and water supply from pollution for up to five miles above the point from which the water is taken.[179]

Finally, HB-74-1041 powers (further explained in Section 2.4) allow local governments, primarily counties, to identify, designate, and regulate 21 statutorily defined "areas and activities of state interest," including site selection, construction, or extensions of major new water and sewage treatment systems. This ensures that local governments can consider and mitigate the effects of new developments.[180]

Special Districts Overview

Colorado law allows voters to create many types of local special districts,[181] which are governing entities that oversee specific services, such as fire protection, water, and sewer. Special districts have the autonomy to solve local problems using local funds. Districts do this by dividing the costs of services among all property owners and residents. They are also able to finance larger infrastructure and public-facility projects, and repay these costs over time as development occurs and property values increase.[182] Several special districts are related to water use and water planning, including:

- **Water Districts:** Supply water for domestic and other public and private purposes by any available means and provide all necessary or proper reservoirs, treatment works, and facilities.[183]
- **Sanitation Districts:** Provide for storm or sanitary sewers, or both; flood and surface drainage; treatment and disposal works and facilities; solid waste disposal facilities or waste services; and all necessary or proper equipment.[184]
- **Water and Sanitation Districts:** Provide both water and wastewater services.[185]
- **Metropolitan Districts:** Provide two or more of a variety of services, including parks and recreation, wastewater, and water.[186]
- **Park and Recreation Districts:** Provide park or recreational facilities or programs.[187]
- **Irrigation Districts:** Provide for the irrigation of lands and the drainage work necessary to maintain irrigation in the district.[188]
- **Water Conservancy Districts and Water Conservation Districts:** Build and administer water projects, interface with federal agencies, and administer the repayment of project capital and operations and maintenance costs, as well as transmit information and coordinate efforts among agencies, political subdivisions, and private citizens and businesses concerning the conservation, protection, and development of Colorado's water resources.[189]
- **Urban Drainage and Flood Control:** Assist local governments with multi-jurisdictional drainage and flood control challenges and provide funding or levy property taxes to fund programs and projects.[190]
- **Groundwater Management Districts:** Adopt rules and regulations to help administer groundwater within the district.[191]

The Department of Local Affairs Overview

The Department of Local Affairs (DOLA) is responsible for supporting Colorado's local communities and augmenting local government capacity by providing training, technical, and financial assistance. The department's divisions serve several purposes, including provision of affordable housing, property tax assessment and collection, training for local government issues, and distribution of state and federal funds for community projects. Within the DOLA, the Division of Local Government (DLG) provides local governments with demographic data, technical assistance for local governments on common issues (such as budgeting and planning), technical resources, and financial assistance programs. Specifically within the DLG, the Community Development Office provides technical and financial assistance to local governments on land-use planning and general community development, including training for planners and planning commissioners. The DLG often funds county and municipal comprehensive plans and encourages water supply and conservation elements.

Houses dot the hillside above Grand Lake. Photo: M. Nager.

2.4 LOCAL, STATE, TRIBAL, AND FEDERAL WATER PLANNING, APPROVAL, AND PERMITTING

Those that wish to implement a water project in Colorado must have permits, licenses, contracts, certifications, or other approvals from numerous local, state, and federal governmental entities. Partnerships with and among these agencies at all levels of government are critical to ensure that the State can identify and address environmental issues in a timely and effective manner. This section provides an overview of the entities typically involved in permitting, and the State's role in planning.

Lake Nighthorse is part of the Animas La Plata Project and provides water for local communities including Durango and the Ute Mountain Ute Tribe. Photo: M. Nager.

Governmental Entities with Permitting, Licensing, Contract, and Certification Responsibilities

Typically, the following organizations are involved in the permitting process.

Local Entities:

- *Project proponents* include a wide array of water users and water providers including, but not limited to, local governments that run a utility, private water companies that act as a local utility, special districts, ditch companies, and regional water conservancy and conservation districts that sell water to local water providers. These entities are responsible for coordinating with state and federal permitting entities to successfully permit their water project.
- *Local governments* have jurisdiction and authority over parts of development projects, and can request mitigation for any effects resulting from proposed water projects because of their 1041 powers. Section 9.4 of Colorado's Water Plan details those powers.[192]

State Entities:

- *The CWCB* is a division within the Colorado DNR. The CWCB sets water policy and planning in Colorado and has a role regarding the review of mitigation plans.[193]
- *The Colorado Water Quality Control Division (WQCD)* is housed within the Colorado Department of Public Health and Environment (CDPHE). The agency reviews water quality certifications under Section 401 of the federal Clean Water Act (CWA).
- *The DWR* is housed in the Colorado DNR and is responsible for water administration. The DWR ensures that the water rights for a project can be administered.

- *The Colorado Attorney General's Office* is the legal authority regarding matters of law, including whether or not a particular project or agreement is legal under Colorado law.
- *Colorado Parks and Wildlife (CPW)* is a division within the Colorado DNR. CPW reviews state wildlife mitigation plans under Colorado's state statutes, known as 122.2 plans.[194]

Tribal Entities:

- The Southern Ute Indian Tribe and the Ute Mountain Ute Tribe are federally recognized tribal governments with responsibilities for the protection and use of water on the Southern Ute Indian Reservation and the Ute Mountain Ute Indian Reservation.
- The Ute Mountain Ute Tribe Environmental Programs Department is responsible for implementing tribal water-quality standards (including anti-degradation provisions under Section 303 of the CWA) and for federal permitting under Section 401 of the CWA for projects located on the Ute Mountain Ute Indian Reservation.
- The Southern Ute Indian Tribe Water Resources Division is a division of the Southern Ute Indian Tribe overseeing: 1) Water resources planning; 2) project implementation, including cooperative projects with non-Indian communities coordinating tribal actions in Colorado's water courts; and, 2) the Tribe's role in the cooperative and coordinated administration of the Tribe's water rights.

Federal Entities:

Federal entities have several roles that relate to water management issues in Colorado. As land managers, federal agencies provide land-use authorizations for water projects that occupy federal lands. Three federal agencies own substantial tracts of land in Colorado:

- *The U.S. Forest Service (USFS)* manages national forests and grasslands (see also Section 2.5).
- *The U.S. Bureau of Land Management (BLM)*.
- *The U.S. National Park Service (NPS)* manages national parks and monuments (see also Section 2.5).

In addition, federal agencies must comply with numerous federal laws in order to issue permits and other authorizations for any water projects. These include, for example, the Federal Land Policy and Management Act (FLPMA), the ESA, the Clean Water Act (CWA), and the Wild and Scenic Rivers Act. The existence of a federal nexus often triggers the need for consultation under Section 7 of the ESA. A water project is considered to have a federal nexus if it involves federal funding, federal permitting or licensing, use of federal lands, or a federal program. All significant federal actions also require compliance with the National Environmental Policy Act (NEPA). In addition to the land management responsibilities listed above, the following agencies can all act as lead agencies responsible for NEPA compliance and other federal authorizations; many of these agencies are responsible for compliance with land-use authorizations for water projects.

- *The Environmental Protection Agency (EPA)* comments on NEPA documents and reviews the United States Army Corps of Engineers' (Corps) Clean Water Act 404 permits.
- *The United States Army Corps of Engineers (Corps)* is responsible for 404-permitting, related to the placement of dredged or fill material in waters of the United States, including jurisdictional wetlands, under the CWA; it is also responsible for the approval of uses of the federally owned flood control and water supply facilities.

- *The United States Forest Service (USFS)* manages national forests and grasslands and has substantial land holdings in Colorado (Section 2.5 describes its role related to water rights). The USFS assumes the lead agency role under NEPA in certain situations.
- *The United States Fish and Wildlife Service (USFWS)* manages threatened and endangered species-recovery programs and regulates actions affecting threatened or endangered species listed under the ESA. This agency is responsible for determining whether a project exceeds the bounds of any programmatic biological opinions regarding further water development. In addition, under the Fish and Wildlife Coordination Act, federal agencies responsible for coordinating federal NEPA compliance must consult with the USFWS regarding a project's potential effects on threatened and endangered fish and wildlife species.
- *The BOR* is the agency that built, and now manages, several water supply and hydropower projects. In Colorado, these include Blue Mesa Reservoir and the Fryingpan-Arkansas Project, among other projects. The BOR is responsible for contracting water out of these federal projects, and these federally owned facilities.
- *The United States Bureau of Land Management (BLM)* is responsible for managing substantial public-land holdings within Colorado. The BLM assumes the lead agency role under NEPA in certain situations.
- *The United States National Park Service (NPS)* manages substantial land holdings within Colorado for national parks, monuments, recreation areas, and historic sites (see Section 2.5 for the NPS). The NPS assumes the lead agency role under NEPA in certain situations.
- *The Federal Energy Regulatory Commission (FERC)* is responsible for licensing non-federal hydropower projects.

Cooperating Agency Status

Federal agencies actively consider designation of cooperating agencies in the preparation of analyses and documentation NEPA requires, and they participate as cooperating agencies in other agencies' NEPA processes.[195] The Council on Environmental Quality (CEQ) regulations that address cooperating governing agencies specify that federal agencies responsible for preparing NEPA analyses and documentation do so "in cooperation with state and local governments" and other agencies with jurisdiction by law or special expertise.[196]

Stakeholder involvement is important in ensuring that decision-makers have the environmental information necessary to make informed and timely decisions. Cooperating agency status is a major component of agency stakeholder involvement in the NEPA process. The benefits of early cooperating agency participation in the preparation of NEPA analyses include: Disclosing relevant information early in the analytical process; applying available technical expertise and staff support; avoiding duplication with other federal, state, tribal, and local procedures; establishing a mechanism for addressing intergovernmental issues; and other benefits. On a case-by-case basis, Colorado participates as both a non-federal project sponsor and as a cooperating technical agency for water projects in the state.

Section 9.4 of this plan explores in greater detail the permitting process, along with potential permitting-process improvements.

State Planning

The CWCB is the primary state agency responsible for statewide water planning. Water planning determines the types of water projects and quantity of water needed to support Colorado's growing population in the future.[197] In 2005, the General Assembly created the basin roundtables and the IBCC, which are participants in the CWCB's statewide water planning efforts.[198]

The IBCC comprises two representatives from each basin roundtable, six governor appointees, and two appointees from the state legislature.[199] Their charge is to develop agreements among basins and to develop statewide policy issues.[200]

Both the basin roundtables and the IBCC provide critical input to the SWSI and to Colorado's Water Plan. The SWSI creates a technical foundation and a common technical platform that stakeholders and Colorado's Water Plan use and build upon. The report, which the SWSI periodically updates with the latest technical information, tracks Colorado's changing water supply and demand. In addition, the basin roundtables and the CWCB have developed a forum through which project proponents can find technical and financial support.[201] Other state agencies have a critical role in planning for other water-related aspects. For instance, CPW develops management plans for fish and other water-dependent species.[202] These planning efforts and the technical documentation supporting them often provide a baseline of information that is helpful in the permitting process.

CHAIRMAN MANUEL HEART

UTE MOUNTAIN UTE TRIBE SOUTHWEST RIVER BASIN

Manuel Heart is the current Chairman of the Ute Mountain Ute Tribe. He was sworn in for a three year term on November 1, 2013. Chairman Heart is pictured in front of Lake Nighthorse, the reservoir he worked to get approved.

My first and foremost hope for the future of water supply is to preserve and protect the 1868 Ute Mountain Ute water treaty settlement of the Animas La Plata project water and the McPhee reservoir for my Tribe. I also hope to help with a state water plan and look at upper and lower basin allocations and a water plan for the future.

I believe that in Colorado's Water Plan we must work toward partnerships for the future of water, but we as Ute Mountain Ute Tribe are also looking to work with the state of Colorado on a...

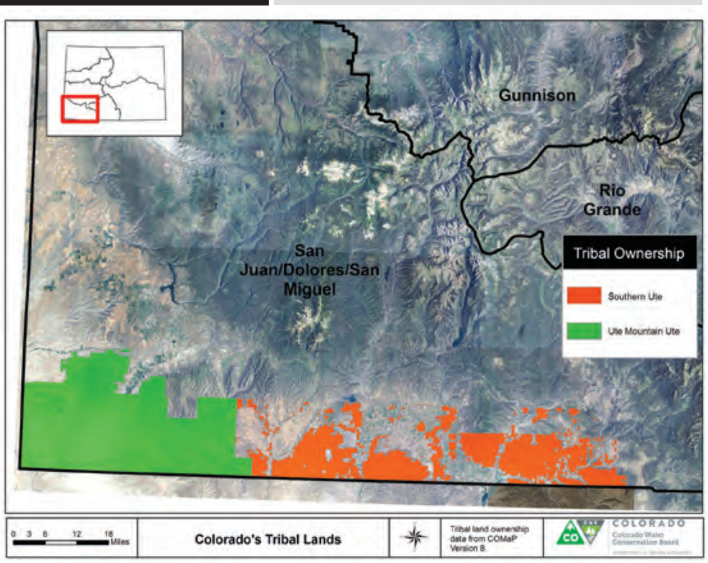
CONTINUED AT END OF CHAPTER

PROFILE

2.5 TRIBAL AND FEDERAL RESERVED WATER RIGHT ISSUES WITHIN COLORADO

In addition to the patchwork of local, state, and federal agencies involved in water planning (as Section 2.4 describes), many federal agencies and Native American tribes hold water rights that serve as part of the existing institutional setting for water planning. Colorado is home to a substantial amount of tribal and federally held lands. Of the 66,485,760 acres that form the State of Colorado, the federal government holds title to more than one-third—totaling 24,996,075 acres, including tribal lands.[203] Federal agencies with major,

FIGURE 2.5-1 COLORADO'S TRIBAL LANDS



federal-land holdings in Colorado include: the USFS, the BLM, the NPS, and the USFWS. In addition, two different Native American tribes have reservations located within Colorado borders. The Southern Ute Indian Tribe and the Ute Mountain Ute Tribe are both located in southwestern Colorado (and the Ute Mountain Ute Reservation also includes lands in northwestern New Mexico and in southeastern Utah). The Southern Ute Indian Tribe is governed by its Tribal Council, whose constitution was approved in 1936.[204] The Ute Mountain Ute Tribe is governed by its Tribal Council, whose constitution was approved in 1940.[205] Beyond the two tribes, only the USFS, the NPS, and the BLM have pursued substantial reserved water rights associated with their landholdings in Colorado.

The history of federal and tribal water rights as they relate to these land holdings in Colorado is unique and complicated. Any discussion of federal water rights must begin with a discussion of "the Winters Doctrine."[206] The Winters Doctrine, which the United States Supreme Court established in 1908, generally indicates that when the United States sets aside an Indian reservation, it also reserves a sufficient amount of water necessary to fulfill the purposes of the reservation, while establishing the priority date as the date of the reservation's formation.[207] The Winters Doctrine was a landmark case: it was the first time the federal government had deviated from the established convention that water law was purely a state matter.[208] The court subsequently expanded application of the Winters Doctrine beyond tribal reservations, also applying the doctrine to other "reserved" federal lands, such as USFS lands. These lands have been withdrawn from the public domain, and water is deemed either expressly or impliedly necessary to satisfy the primary purposes of the federal reservation.[209] This expanded version of the judicially created Winters Doctrine resulted in what is generally referred to as "federal reserved water rights."

Federal reserved rights differ from rights acquired under state law in that reserved rights typically, but not always, rest on the date a reservation was created—not when the water was first put to beneficial use—and cannot be lost through non-use. Moreover, before 1952, the United States avoided, and was not required to formally list, its federal claims to water, nor was it required to make those claims the subject of any decree or permit within the state water administration system. Rather, federal reserved water rights existed outside of (and separate from) the procedure for administering all other water rights within the states. Therefore, the federal reserved water rights complicated the ability of the state systems to avoid conflict and create a firm water supply through a comprehensive and cohesive water administration system.

As a direct response to this unintended ambiguity, Congress adopted the McCarran Amendment in 1952. The amendment rectified the fact that "the extent and priority of federal water rights, including federal reserved rights, were unknown and not subject to adjudication or determination in state courts."[210] To overcome this complication, the amendment provides a limited waiver of the United States' sovereign immunity for the purpose of including the United States (on its own behalf or on behalf of the tribes) in state stream adjudications and water administration suits.[211] Since then, Colorado has settled and adjudicated tribal reserved rights claims asserted on behalf of the Southern Ute Indian and Ute Mountain Ute Tribes in Colorado, as well as claims for federal reserved water rights by federal agencies throughout the state. The State and the tribes administer the reserved rights recognized by these proceedings in conjunction with state-based water rights.

Federal Agencies

Water rights held by the USFS, the USFWS, and the NPS have complicated histories.[212] Each agency has sought substantial federal reserved water rights in a variety of locations throughout the Western United States. In Colorado, the USFS has filed for reserved water rights in all seven water divisions. In Water Divisions 1 and 2, the water court denied and withdrew with prejudice the USFS claims for nonconsumptive reserved rights.[213] In Water Division 3, the USFS reached a stipulated decree settlement for both consumptive and nonconsumptive reserved rights in 2000.[214] Stemming from the Colorado Supreme Court decision in *U.S. v. Denver,* the USFS may not claim federal reserved water rights for instream flow purposes in Water Divisions 4, 5, or 6.[215] The USFS's applications for federal water rights are still pending in Water Division 7.[216]

The USFWS manages eight national wildlife refuges and two national fish hatcheries in Colorado. These facilities use water in compliance with water-rights decrees based on Colorado's system of prior appropriation. The NPS has obtained federal reserved water rights for Rocky Mountain National Park, Great Sand Dunes National Park, Colorado National Monument, the Black Canyon of the Gunnison National Park, and Mesa Verde National Park.[217] The federal government also maintains a wild and scenic river designation that includes a federal reserved water right for the upper reaches of the Cache La Poudre under the Wild and Scenic Rivers Act.[218]

Tribes

In 1895, the United States established the Southern Ute Indian Reservation in Southwest Colorado and the Ute Mountain Ute Reservation in the southwest corner of Colorado and northern New Mexico (later adding lands in southeastern Utah).[219] On behalf of the Southern Ute Tribe and Ute Mountain Ute Tribe, the United States filed claims to water in Southwest Colorado to resolve reserved rights claims for the two reservations in 1976. Through an enormous effort of the Ute Tribes, the State of Colorado, the United States, water districts, and local water users, all of the parties were able to resolve the tribal litigation claims in 11 river basins through negotiated settlement, resulting in the 1986 Colorado Ute Indian Water Rights Final Settlement Agreement.[220] In 1988, Congress passed the Colorado Ute Indian Water Settlement Act, approving the 1986 Settlement Agreement. The settlement set forth shared responsibilities for the administration of some of the tribal rights.[221] A critical component of the 1986 Settlement Agreement is the provision of water to the tribes from the Animas-La Plata Project, a participating project of the Colorado River Storage Project Act, which the Colorado River Basin Project Act authorized.[222]

In the early 1990s, complications concerning endangered species, water quality, and other issues prevented the full implementation of the 1986 Settlement Agreement as it related to the Animas and La Plata Rivers. For the second time, the parties forged a new compromise related to the down-sizing of the Animas-La Plata Project. Congress approved the modifications and amended the 1988 Settlement Act in December 2000.[223] The Ute Tribes, the State of Colorado, and the United States agreed to an institutional framework that establishes quantities of water rights, priorities of tribal rights, permitting requirements, conditions for changing water rights, conditions for leasing, and other terms. Most importantly, it recognizes the need for cooperative and coordinated administration of the tribes' reserved water rights under state and federal law.

A LOOK AT HISTORY

The two-year negotiation of the Colorado Ute Indian Water Rights Final Settlement Agreement was formally concluded at a signing ceremony on December 10, 1986, in the old Supreme Court Chambers, Colorado State Capitol.

source: J. William McDonald's personal collection [Bureau of Reclamation, photographer unknown].

caption: Thomas V. Cech, J William McDonald, Defened and Develop: *A Brief History of the Colorado Water Conservation Board's First 75 Years,* [Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

A LOOK AT HISTORY

Commission members signing the Rio Grande Compact in 1938, along with their legal and engineering advisors. This compact still guides water supply management between Colorado, New Mexico, Texas, and Mexico.

caption: Thomas V. Cech, J William McDonald, Defened and Develop: *A Brief History of the Colorado Water Conservation Board's First 75 Years,* [Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

JOE GALLEGOS, CONTINUED FROM PAGE, 2-4:
from the legacy of water battles that my forefathers endured. They left us a long record and appreciation for the miracles of water. So when misuse or pollution occurs on the ever "blood of the land," the issue becomes very personal.

I am 59 years old and have a college degree in Mechanical Engineering from CSU- Go Rams! Now I am presently a General Partner in the family business, Corpus A. Gallegos Ranches (Colorado Centennial Ranch). I have worked on the Ranch since 1986 when I returned from the oil business (worked five years in oil patch), to be back on the land, or should I say back with the water. My love for clean water drove me out of the oil industry to my family ranch in San Luis only to get involved in a major water battle with a mining company that involved many water quality issues. With personal and economic reasons to be immersed in water issues, I was appointed to be on the Costilla County Conservancy District in 1989. I was also the Mayordomo (ditchrider) for thirteen years for the San Luis Peoples Ditch (SLPD), known as an acequia. SLPD is the first and oldest established water right in the state but the SLPD acequia was established much earlier than Colorado's statehood. In 1851 pioneers like my Great grandfather, Dario Gallegos, dug the first recorded ditch to divert water from a creek to beneficially use the precious resource.

A satisfying and positive accomplishment of mine is having been involved and having the opportunity to testify in front of the Colorado Agricultural Committee in 2009 for the passage of House Bill HB09-1233, known as the Acequia Recognition Law. The newly enacted law speaks for itself as the acequias strive for a special place in Colorado Water Law.

CHAIRMAN MANUEL HEART, CONTINUED FROM PAGE 2-28:
government-to-government basis to help protect and preserve our treaty of 1868 and to our water rights as Ute Mountain Ute Tribe. In Colorado's Water Plan the State needs to look at our tribal lands for the Ute Mountain Ute Tribe.

Our land base totals around 600,000 acres and extends into three states: Colorado, New Mexico and Utah. Based on Colorado water law and the compacts between the two states, we cannot manage our water in the contiguous tribal lands as one by taking water across state lines, despite the fact that our lands were established before the states were recognized as states.

I've served on the Ute Mountain Ute tribal council since 1994 in various capacities. In addition to my current chairmanship, I've served as Vice Chairman, Treasurer and Secretary Custodian. I am also a board member on various committees Tribal, State, and National level, including for the Weminuche Construction Company, Brunot Hunting Commission, Blue Mountain Hospital Board, Animas La Plata Water Board, La Plata West water Board, Albuquerque Area Health Board, Colorado Commission of Indian Affairs, Utah Tribal Leaders, National Congress of American Indians, Native American Bank, and Council of Energy Resource Tribes.

I have been involved in water for the Ute Mountain Ute Tribe throughout my career on the Tribal Council. Just as his past Ute elders did, I advocate that water is life for everything in this world and we must protect it.

I started my Tribal Council career with the Animas La Plata project (ALP) in Southwestern Colorado where the tribal reservation is located. I started out lobbing Congress for the authorization of the project, taking many trips to Washington DC with tribal council from Ute Mountain Ute Tribe and

Southern Ute Indian Tribal Council and their non-Indian local water board partners from two states. I was there to witness Secretary Babbits signing ceremony of the authorization of the ALP project at the Interior Department in Washington DC.

I am married to my high school sweetheart Marie Heart, and have 6 children, 16 grandchildren, one great grandson, and many relatives from both sides of our family.

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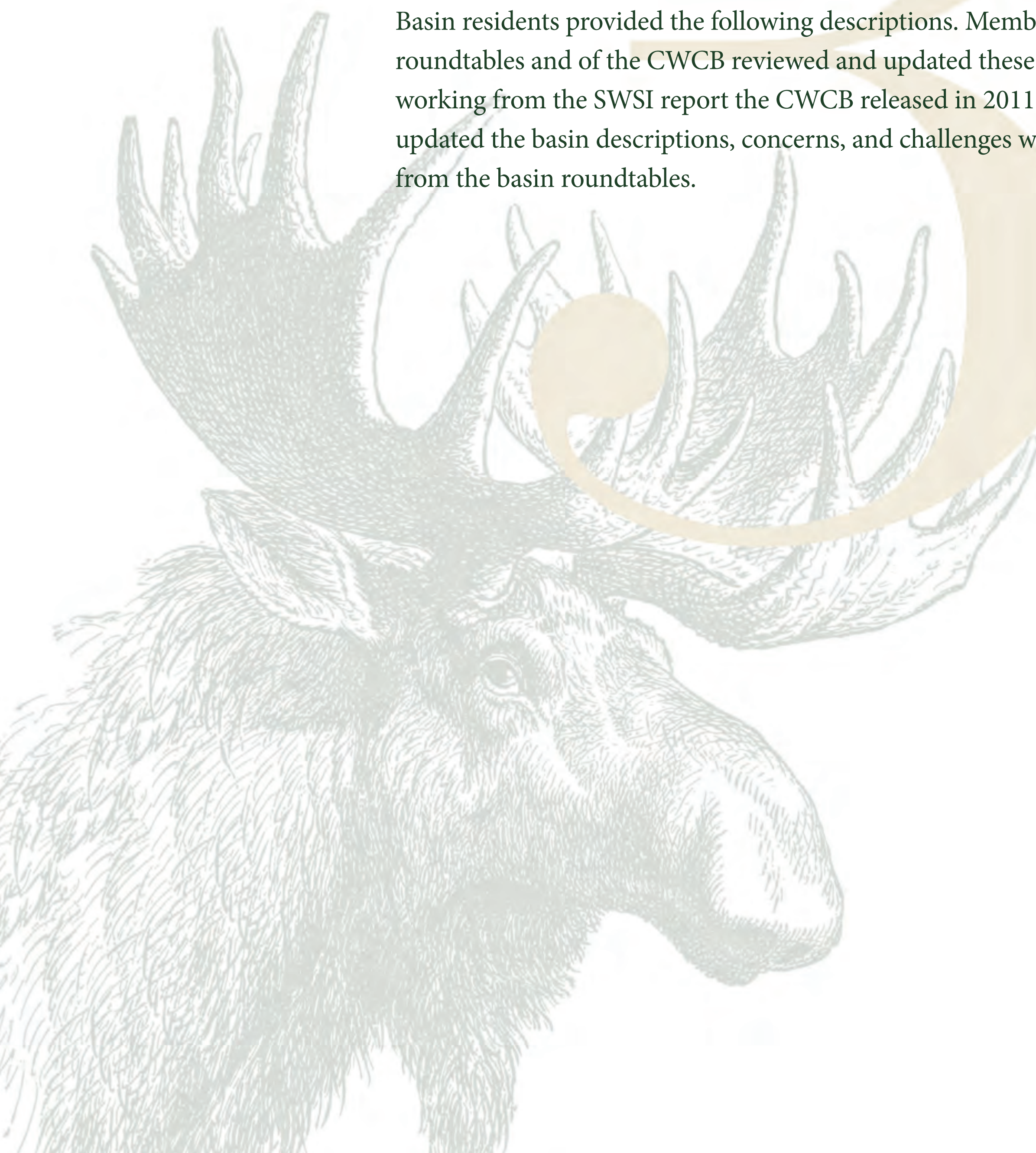
Overview of Each Basin

Chapter 3 examines the river basins in the context of the larger river systems they comprise. While Colorado is one state, each river basin is unique. An understanding and recognition of each basin's particular landscape, historical context, and current challenges provide the necessary basis to explore Colorado's complete water picture.

Basin residents provided the following descriptions. Members of the basin roundtables and of the CWCB reviewed and updated these descriptions, working from the SWSI report the CWCB released in 2011. The CWCB updated the basin descriptions, concerns, and challenges with recent feedback from the basin roundtables.



Green Mountain Reservoir near Kremmling is important for water management in the mainstem of the Colorado River. Photo: M. Nager.

Basin Descriptions and Challenges

Arkansas Basin

Basin Description: The Arkansas River originates in the central mountains of Colorado near Leadville, at an elevation of more than 14,000 feet. The river travels eastward through the southeastern part of Colorado toward the Kansas border, dropping more than 10,000 feet to an elevation of 3,340 feet at the Colorado-Kansas line. Several tributaries flow from the high southern mountains toward the mainstem of the Arkansas, and drainage from the higher plains to the north also contributes to the flows. The Arkansas River Basin is spatially the largest river basin in Colorado, covering slightly less than one-third of the state's land area (28,268 square miles, or 27 percent of the state's total surface area).

Rafting on the Upper Arkansas, Colorado's most popular river for rafting. Photo: M. Nager.

Grassland and forest cover approximately 67 percent and 13 percent of the basin, respectively. More than 20 percent of the land is publicly owned. A large amount of the grassland is devoted to agriculture, with one-third of agricultural lands requiring irrigation. Increasing urbanization is occurring throughout portions of the Arkansas River Basin, and over the last few years, persistent drought has heavily affected the basin.

The Arkansas River Compact of 1948 apportions the waters of the Arkansas River between Colorado and Kansas, while providing for the operation of John Martin Reservoir. The compact is "not intended to impede or prevent future beneficial development… as well as the improved or prolonged functioning of existing works: Provided, that the waters of the Arkansas river… shall not be materially depleted in usable quantity or availability…."[1] The primary tool for administering the Arkansas River Compact is the 1980 Operating Principles, which provide for storage accounts in John Martin Reservoir, and the release of water from those accounts for Colorado and Kansas water users.

Since the early 20th century, Colorado and Kansas have litigated claims concerning Arkansas River water; these claims ultimately led to the negotiation of the compact. In 1995, the United States Supreme Court found that Colorado had depleted stateline flows through the use of tributary groundwater, which violated the compact. As a result, the Colorado DWR developed well administration rules to bring Colorado into compliance with the compact, and Colorado compensated Kansas for damage claims, which totaled about $34 million. Recently, the DWR developed irrigation efficiency rules, which require augmentation for any upgrades to water delivery systems, such as drip irrigation or sprinkler systems.

Garden of the Gods, near Colorado Springs, is open to the public free of charge and a popular spot for visitors.

Basin Challenges: The Arkansas Basin will face several key opportunities and challenges pertaining to water management issues and needs over the next 40 years. These are as follows:

- All new uses require augmentation. Increasing irrigation efficiency, i.e. conversion from flood to center-pivot irrigation for labor and cost savings, will require 30,000-50,000 acre-feet of augmentation water in the coming years.
- Replacement of municipal water supplies that depend on the non-renewing Denver Basin aquifer and declining water levels in designated basins is becoming critical, exacerbated by continued growth in groundwater-dependent urban areas.
- Concerns over agricultural transfers and the effects on rural economies are substantial in the lower portion of the basin downstream of Pueblo Reservoir.
- Collaborative solutions, as demonstrated in Alternative Transfer Methods pilot projects, are needed to forestall or avoid loss of irrigated acreage in agriculture.
- As the most rafted river in the world, the Arkansas River Voluntary Flow Agreement provides a benchmark for cooperative integration of municipal, agricultural and recreational solutions in support of recreational boating and a gold medal fishery.
- Concerns over water quality include drinking water in the Lower Valley and the impact of fires and floods in the Fountain Creek watershed.
- Rural areas within the Arkansas Basin have identified water needs, but face challenges in marshalling resources to identify and implement solutions. Support from the Roundtable and CWCB is needed.
- The great majority of surface storage reservoirs in the Arkansas Basin were constructed between 1890 and 1930. Many of these facilities are in need of repair or restoration.
- Regional solutions are emerging, like the SECWCD Regional Water Conservation Plan, which can serve as a model for future regional initiatives to address the needs of the Arkansas Basin.

The Arkansas Basin Implementation Plan (BIP) identifies specific projects and methods for meeting the future water needs of the Arkansas Basin.

Snowshoeing near the Continental Divide.

Basins of the Colorado River System

The basins in the Colorado River system (including tributary basins) are more than one-third the size of the state's geographic area. Originating in the north central mountains, the main stem of the Colorado River flows southwesterly and is met at Grand Junction by the Gunnison River before flowing west into Utah. The Yampa River and the White River move westward across the northwest quadrant of the state to the Utah border where they join the Green River, another tributary of the Colorado. The San Miguel River and the Dolores River begin near the southwestern corner of Colorado and travel north along the western border into Utah. The San Juan River and its tributaries collect the water in the southernmost regions west of the Continental Divide and flow into New Mexico.

Less than 20 percent of the entire Colorado River Basin lies inside Colorado; however, approximately 75 percent of the water in the entire river basin originates in the state. In Colorado, transmountain diversions account for approximately 5 percent of the total water supply, or approximately 500,000 acre-feet per year. Most of these transbasin diversions move water from west to east, supplying water to the Front Range.

Mainstem Colorado River Basin

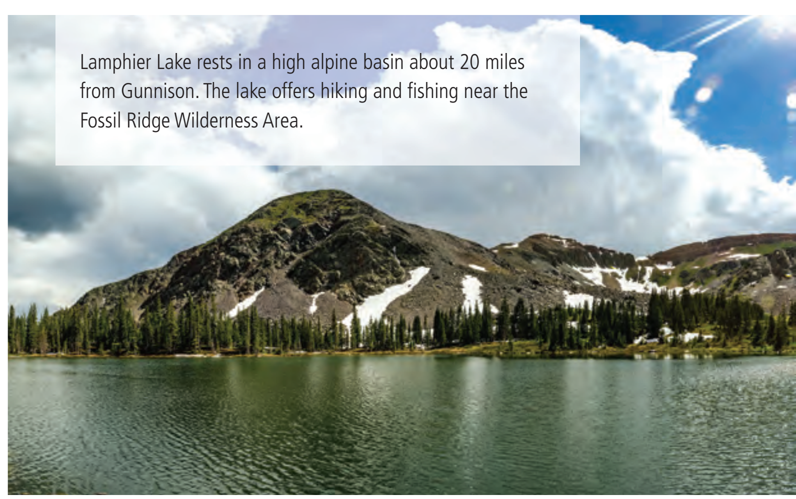
Basin Description: The Colorado River Basin in Colorado encompasses approximately 9,830 square miles. Elevations in the basin range from greater than 14,000 feet in the headwaters areas, to about 4,300 feet at the Colorado-Utah state line. The basin's mountainous upper reaches gradually give way to a series of canyons and gentler terrain as the river flows along the Interstate 70 corridor toward Grand Junction and the Utah border.

Snowpack in the elevations above 9,000 feet is an important water source for human use on both sides of the Continental Divide in Colorado. This water is also important for compliance with legal obligations, since as much as 70 percent of the river flows out of state.

A substantial portion of the basin is composed of federally owned land. Rangeland and forest are the predominant landscapes in the Upper Colorado River Basin, comprising about 85 percent of the area. Livestock grazing, recreation, timber harvesting, and gas drilling are the leading uses of the federal lands, and the basin also features active and inactive mines.

Basin Challenges: The Colorado River Basin will face several key challenges pertaining to water management issues and supply needs over the next 40 years, some of which are as follows:

- Recreational use and environmental conservation are major drivers in the basin and are important for economic health and quality of life. There is some concern that many of these areas are vulnerable for various reasons, and competition with other water needs is one of those concerns.
- Agriculture is important in the basin, especially in the lower basin (Grand Valley). However, despite the importance of agriculture, the continued expansion of communities causes agricultural lands to become urbanized, which could affect 20 percent of irrigated lands in the basin.
- The success of the Upper Colorado River Endangered Fish Recovery Program is vital to the future of the river. The program is designed to address the recovery needs of the endangered



Lamphier Lake rests in a high alpine basin about 20 miles from Gunnison. The lake offers hiking and fishing near the Fossil Ridge Wilderness Area.

fish in the Colorado River while protecting existing water uses and allowing for the future use of Colorado River water in compliance with interstate compacts, treaties, and applicable federal and state law.

- There is concern over a potential compact shortage during severe and sustained drought and the potential effects to in-basin supplies.
- The development of water rights associated with transbasin projects is a concern, and Colorado must consider the effect on in-basin supplies.
- Water quality is a concern, particularly related to selenium and salinity issues.

Gunnison River Basin

Basin Description: The Gunnison River Basin stretches across more than 8000 square miles of western Colorado, extending from the Continental Divide to the confluence of the Gunnison and Colorado Rivers near Grand Junction. The Gunnison River Basin is defined by the Elk Range to the north, the Sawatch Range to the east, the San Juan Mountains to the south, and the Uncompahgre Plateau to the southwest. Water traveling from the headwaters to Grand Junction experiences an elevation change of more than 9,500 feet.

The Gunnison River Basin is largely forested, with forest area covering approximately 52 percent of the total basin area. About 5.5 percent of the land in the basin is classified as planted or cultivated land and is primarily concentrated in the Uncompahgre River Valley between Montrose and Delta, with additional pockets near Gunnison and Hotchkiss.

Basin Challenges: Basin residents have identified several water management issues that will present challenges to Gunnison River Basin water users over the next 40 years. These issues include:

- Growth in the headwaters region will require additional water management strategies.
- Addressing agricultural water shortages in the upper portion of the basin is an important goal of the community. Lack of financial resources is an impediment.
- There is concern over possible future transbasin diversions and the potential effect this might have on existing uses within the basin.

Ice climbing at the annual Ouray Ice Festival happens in a natural gorge within walking distance of the City of Ouray. The park remains free and open for public use.

Young patron at the Demolition Derby and the 4H competition at the Routt County Fair in Hayden. Photo: M. Nager.

- The area between Ouray and Montrose is rapidly growing. Tourism is important in the headwaters areas, but agriculture is dominant in the Uncompahgre Valley. A rapid influx of retirees and growth in the Uncompahgre Valley may dramatically change the agricultural uses and other land uses in the area.

Yampa River, White River, and Green River Basins

Basin Description: The Yampa River, White River, and Green River Basins cover roughly 10,500 square miles in northwest Colorado and south-central Wyoming. The Continental Divide on the east defines, in part, the basin's boundaries. The elevation in the basin ranges from 12,200 feet at Mount Zirkel in the Park Range, to about 5,100 feet at the confluence of the Yampa and Green Rivers at Echo Park within Dinosaur National Monument. The basin contains diverse landforms, including steep mountain slopes, high plateaus, rolling hills, incised sandstone canyons, and broad alluvial valleys and floodplains.

Large portions of land in the basin are federally owned. Livestock, grazing, and recreation are the predominant land uses. Near the towns of Craig, Hayden, Steamboat Springs, Yampa, and Meeker, much of the land is dedicated to agricultural use, and the mountains are densely covered by forest. The valleys and plateaus are mostly covered by shrubland with some forested areas. The Steamboat Springs area, featuring a destination ski resort, is likely to experience continued and rapid population growth.

Basin Challenges: Within the Yampa River, White River, and Green River Basins, key water management issues for the next 40 years include:

- The emerging development of gas and oil shale resources is affecting water demand, for both direct production and the associated increase in municipal use.
- Agriculture, tourism, and recreation are vital components of this basin's economy. As the needs of communities and industry grow, competition among sectors could increase.
- Industrial uses, especially power production, are a major water use. Future energy development is less certain.
- While rapidly growing in some areas, particularly in the Yampa River/Steamboat Springs area, the basin as a whole is not developing as rapidly as other portions of the state. This has led to concern that the basin will not get a "fair share" of water use the Colorado River Compact affords to Colorado in the event of a compact call.
- Implementation of a successful Upper Colorado River Endangered Fish Recovery Program is vital to ensuring protection of existing and future water uses.
- Agricultural producers in the basin would like to increase the amount of irrigated land by 14,000 to 18,000 acres, but the lack of financial resources is an impediment.

Cattle cooling off in the Yampa River - on the Daughenbaugh Ranch. Photo: M. Nager.

Dolores River, San Juan River, and San Miguel River Basins

Basin Description: The San Juan River, Dolores River, and San Miguel River Basins are located in the southwest corner of Colorado and cover an area of approximately 10,169 square miles. The Upper San Juan River and its tributaries flow through two Native American reservations in the southern portion of the basin—the Ute Mountain Ute Reservation and the Southern Ute Indian Reservation. The Southwest Basin is a series of nine sub-basins, eight of which flow out of state before they join the San Juan River in New Mexico or the Colorado River in Utah. The Colorado River Compact, the Colorado Ute Indian Water Rights Settlement, and several BOR storage projects have shaped the water history of the Southwest Basin.

Basin Challenges: In addition to the three compacts governing water use across the broader Colorado River Basin, other compacts, settlements, and species-related issues are specific to the San Juan/Dolores/San Miguel region:

- ❖ The Colorado Ute Indian Water Rights Settlement Act of 1988 settled the reserved water-rights claims of the Southern Ute and Ute Mountain Ute Tribes concerning quantity, priority, and administration on all streams that cross the two tribes' reservations.
- ❖ The Dolores Project was integral to the Ute Mountain Ute portion of the Indian Water Rights Settlement. Construction of the Dolores Project proceeded in 1977 by order of the Secretary of Interior, because it provided potable water for the first time to the Ute Mountain Ute community of Towaoc and irrigation water for a highly productive, 7,600-acre tribal farm in exchange for subordinating senior tribal water rights claims that could have dried up the Mancos River Valley.
- ❖ Tribal water allocations out of the Animas-La Plata Project component of the settlement provided the tribes with a municipal and industrial (M&I) water source to supply and augment future depletions of the San Juan River system that are constrained by the San Juan Recovery Program for Endangered Native Fish. The Animas-La Plata Project also provided the City of Durango and surrounding areas with a long term M&I supply.
- ❖ The Southwest Basin includes numerous instream flow segments. Instream flows have served as a tool to balance valued agricultural uses with instream water to support recreational and environmental values, all of which combine to support the economic and aesthetic values that drive settlement and commerce in the Southwest Basin.
- ❖ The USFS and the BLM have extensive owner ship of land in the Southwest Basin. Most Southwest Basin headwaters originate on federal land. These federal agencies have worked with the CWCB Instream Flow Program to secure substantial flow protection at high elevations throughout the basin. As stream-flow protections have increasingly focused on lower elevation streams that are below stored water and communities, instream flow appropriations have become more complex and challenging.

Agriculture and ranching have, for many generations, prevailed in the lower elevations of La Plata, Montezuma, Dolores, San Miguel, and Montrose Counties. Tourism and recreation have become more established in the region as the Animas, Piedra, Dolores, and San Miguel Rivers offer both fishing and rafting opportunities along with flat-water recreation on the region's many reservoirs.

This multiple-basin area of the state is extremely diverse and is experiencing changing demographics:

- ❖ The Pagosa Springs-Bayfield-Durango corridor is rapidly growing while experiencing areas of localized water shortages. This area is transitioning from oil and gas, mining, and agricultural use to tourism and recreation use, and to a retirement or second-home area.
- ❖ The Cortez and Dove Creek area remains strongly agricultural, supplemented by energy production, but it is also seeing growth with an increase in retirees who are moving to the area.
- ❖ The San Miguel area shows a mix of recreation and tourism activities, along with a strong desire to maintain agriculture in the western part of the county.

As a result of numerous storage projects built primarily to supply irrigation water, water supply

The Bridal Veil Falls, near Telluride, is the tallest free falling waterfall in Colorado at 365 feet. The falls entice many people to hike, bike or four-wheel drive up the road.

Students studying the aquatic ecosystem along the San Miguel River near Placerville. Photo: M. Nager.

is available in the Southwest Basin. Several of these storage projects have been able to allocate or carve out small amounts of M&I water to supply domestic growth. Resulting revenues from M&I sales are being re-invested in delivery system efficiencies that will yield the water necessary to meet future M&I needs without diminishing agricultural deliveries. The remaining challenge is the development of sufficient infrastructure to deliver M&I water where it is needed. There is also a need for new storage to meet long-term supply requirements in the Pagosa Springs area, as well as in Montrose County.

The Southwest Basin Roundtable takes very seriously the need to make a strong commitment to balancing a vibrant agricultural sector with healthy streams to support environmental and recreational values. In keeping with this philosophy, the Southwest Basin is organizing a list of Identified Projects and Processes (IPPs) by sub-basin. By addressing agricultural, municipal, industrial, environmental, and recreational values and needs, the IPP approach is intended to reveal opportunities for multi-benefit projects that address water supply gaps.

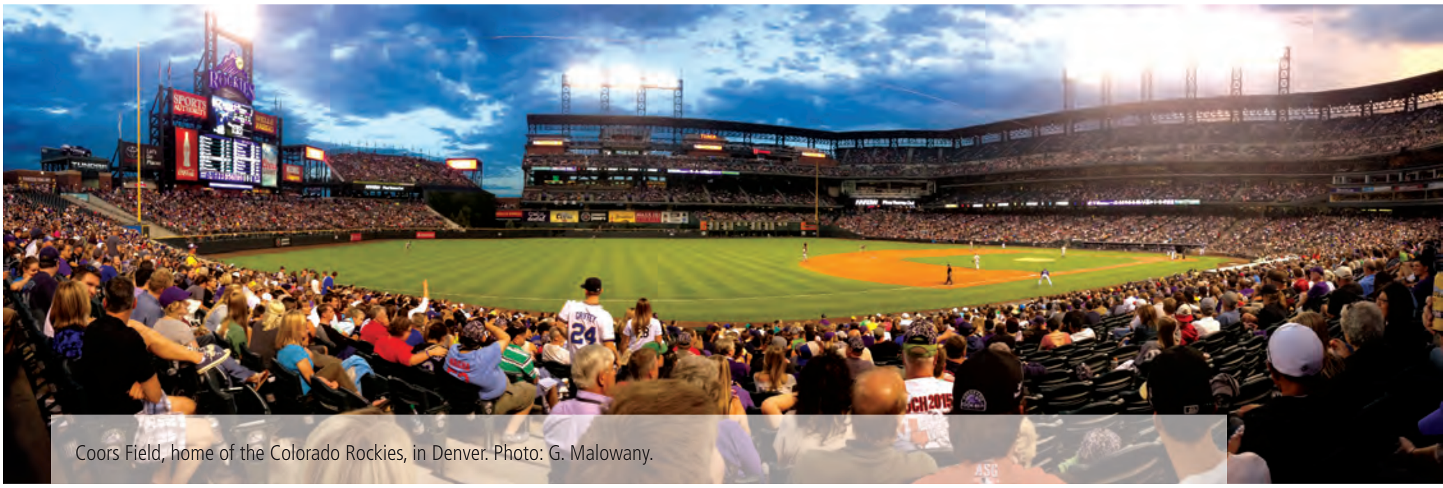
South Platte River Basin

Basin Description: The South Platte River Basin is the most populous basin in the state. Per SWSI 2010, the South Platte Basin population may nearly double from about 3.5 million people to 6 million people by 2050. Approximately 85 percent of Colorado's population resides in the South Platte Basin, and the Front Range area of the basin is Colorado's economic and social engine. The South Platte River Basin also has the greatest concentration of irrigated agricultural lands in Colorado.

The topographic characteristics of the South Platte River Basin are diverse. Its waters originate in the mountain streams along the Continental Divide in the northern portion of the Front Range. The river emerges from the mountains southwest of Denver and travels north through the Denver area, where numerous tributaries, such as Cherry Creek, Clear Creek, Coal Creek, Boulder Creek, St. Vrain Creek, the Big Thompson River, and the Cache La Poudre River join the South Platte before crossing northeast across the High Plains. The western portions of the basin and its mountainous and subalpine areas are mostly forested, while the High Plains region is mainly grassland and planted or cultivated land. Approximately one-third of the South Platte Basin land area is publicly owned, and most of these lands are situated in the forested mountains. The South Platte River crosses the Colorado Nebraska state line near Julesburg and merges with the North Platte River in southwestern Nebraska to form the Platte River.

The hydrology of the South Platte Basin is highly variable, with an approximate average-annual native-flow volume of 1.4 million acre-feet. About 400,000 acre-feet of TMDs from the Colorado River Basin and approximately 100,000 acre-feet from the Arkansas, North Platte and Laramie River Basins supplement the water supply in the South Platte Basin. In addition, these basins pump more than 30,000 acre-feet from nontributary groundwater aquifers to supplement supplies. Yet, surface-water diversions in the South Platte Basin average about 4 million acre-feet annually, with groundwater withdrawals totaling an additional annual 500,000 acre-feet on average. The amount of diversion in excess of native-flow highlights the return flow-dependent nature of the basin's hydrology, and the basin-wide efficient use and reuse of water supplies. On average, only 400,000 acre-feet of water leaves the basin.

The Platte River Recovery Implementation Program (PRRIP) and the Upper Colorado River Endangered Fish Recovery Program provide limited ESA coverage for program participants. Participation in these programs protects existing uses and allows continued water development.



Coors Field, home of the Colorado Rockies, in Denver. Photo: G. Malowany.

Center pivot irrigation waters the fields at Sakata Family Farms in Brighton. Photo: M. Nager.

Basin Challenges: The South Platte Basin is Colorado's most economically diverse basin. Urban sector businesses and industries within the South Platte Basin provide for most of the state's overall economy, and agricultural production is the highest among basins across Colorado. This basin also supports a wide range of ecological systems and important water-dependent ecological and recreational attributes. Thanks to the basin's many environmental features, Coloradans and tourists regularly take advantage of the South Platte's recreational opportunities, including skiing, boating, fishing, and wildlife viewing and hunting. Willing water transfers from the agricultural sector to the M&I sector have proven reliable, although the State views these as unsustainable if the South Platte and the State of Colorado continue to diversify their economy as the population continues to grow. The challenge of preserving the M&I, agricultural, and recreational economies as well as the basin's environmental features makes water management in the South Platte Basin especially complex. Several of the complexities include:

- Accounting for 85 percent of total water diversions, agriculture is the dominant water use in the basin. Agricultural transfers, or conversion of agricultural water to M&I uses, will continue to be an important option for meeting future M&I needs, especially in those areas where agricultural land will be urbanized. However, agricultural transfers are likely to have negative effects on rural communities, open spaces, wetlands, and recreation areas that are tied to irrigated lands. Loss of irrigated agricultural lands will negatively affect the local economy and the state's economy, as well as the state's food security.
- Competition for additional M&I water supplies is substantial, and in some cases, multiple M&I suppliers have identified the same water supplies as future water sources. Competition increases the costs to M&I customers, and competition for the same water supplies could result in the chance that some M&I suppliers will lack sufficient water in the future.
- A substantial amount of the basin's water supply originates in the Colorado River Basin. As such, compliance with the Colorado River Compact, and efforts to avoid a compact curtailment, are critical to the South Platte Basin.

- Notwithstanding the recent construction of Reuter-Hess Reservoir, the lack of new major water storage in recent decades has led to reliance on non-renewable groundwater in Douglas and Arapahoe Counties. Strong economic and population growth in these counties, coupled with the lack of surface-water supplies, has led to the need to develop renewable surface-water supplies and additional water storage for the south metro area.
- Conjunctive use of surface water and alluvial groundwater, as well as use of alluvial aquifers for storage, offer opportunities to expand sustainable water use. Aquifer storage is generally considered to have fewer environmental effects, and water stored in alluvial aquifers is not subject to evaporation losses. Aquifer storage poses control and administrative issues that state agencies and water managers will need to address to ensure that other water rights are not injured.
- Water quality will continue to be a challenge as entities divert more water for use and as point and non-point sources discharge to the basin's waters. The salt content of soil and water in the South Platte River Valley, and sedimentation and erosion in parts of the basin, are likely to continue to increase over time, which will negatively affect the ability to use this water for agricultural and M&I purposes. Technological solutions are expensive and non-sustainable because of high energy demands and environmental issues associated with disposal of concentrated treatment residuals.
- The South Platte Basin is leading the state in M&I water-use efficiency. Efficient use of the basin's resources through water reuse and conservation is a critical step toward meeting future water needs. Nevertheless, increased M&I water-use efficiency will reduce the quantity of water available for agricultural and ecological practices and other uses, because M&I return-flows will diminish.
- The urban environment is an important component of the quality of life for many South Platte Basin residents. Judgments about the value of the urban environment, including both the need to provide water for irrigated landscape and the vital benefits that landscape provides to citizens and the environment, make the discussions about water supply development needs all the more difficult.
- The environmental and recreational features within the basin, including amenities such as mountain streams and rivers for fishing and rafting, city green ways, flatwater reservoirs, wetlands, and open space, are all extremely important to Colorado's tourism economy and quality of life for the state's residents.

The joint BIP, completed in partnership with the Metro Basin Roundtable, identifies specific projects and methods needed for meeting the future water needs of the South Platte Basin.

Republican River Basin

Basin Description: The Republican River Basin in Colorado is located on the Northeastern High Plains. The headwaters of the North Fork and South Fork of the Republican River, as well as the Arikaree River, originate in the Northeastern High Plains of Colorado near Wray, Cope, and Seibert, respectively. The Republican River is formed by the confluence of the North Fork of the Republican River and the Arikaree River just north of Haigler, Nebraska, while the South Fork of the Republican joins just southeast of Benkelman, Nebraska. Other major drainages within the Republican River Basin include Frenchman Creek, Beaver Creek, and Red Willow Creek. The Republican River Basin in Colorado encompasses approximately 7,760 square miles, which represents 31 percent of the total Republican River Basin located in Colorado, Nebraska, and Kansas.

The topographic characteristics of the Republican River Basin, which are similar to the High Plains region of the South Platte River Basin, consist mainly of grassland and planted or cultivated land. The Republican River Basin in Colorado is underlain by the High Plains or Ogallala aquifer, which is one of the largest water bodies in the United States, extending from South Dakota to Texas.


Arikaree River wetland habitat. The Arikaree is a tributary to the Republican River.

In 2004, the General Assembly established the Republican River Water Conservation District to cooperate with and assist Colorado regarding compact compliance. The Republican River Water Conservation District recently completed the construction of the Republican River Compliance Pipeline to assist in compact compliance.

Administration of surface water in the Republican River Basin is separate from groundwater administration. The water courts have judicial authority regarding surface-water rights, whereas the Colorado Ground Water Commission has regulatory and adjudicatory authority regarding the management and control of designated groundwater. Much of the Republican River Basin lies within the Northern High Plains Groundwater Management District.

Basin Challenges: The Republican River Basin will face several key issues and challenges pertaining to water management over the next 40 years. These challenges and issues are as follows:

- Republican River Compact compliance.
- Depletions to the Ogallala Aquifer. These depletions continue to reduce the amount of readily available water supplies for the agricultural economy in the basin. In some cases, this presents feasibility issues related to providing adequate water supplies for crop irrigation or, in some cases, providing no water supply.
- The continuation of detailed coordination and communication among multiple water-rights and administrative authorities, including the Colorado Ground Water Commission, Department of Water Resources, Ground Water Management Division, and Colorado Water Court, among others.

North Platte River Basin

Basin Description: The North Platte River Basin, also known as North Park, is a high-altitude valley covering about 2,000 square miles in north-central Colorado, adjacent to Wyoming. The basin includes all of Jackson County and the small portion of Larimer County that contains the Laramie River watershed.

Both the North Platte and Laramie Rivers flow north into Wyoming, and are subject to use-limitations stemming from Supreme Court decrees. Water use in the basin is dominated by irrigated pastures associated with ranching operations. More than 400 irrigation ditches divert water from the mainstem and the numerous tributary streams throughout the basin. Total irrigated acreage in the basin, based on 2001 estimates, is approximately 116,000 acres. The basin exports a portion of North Platte water to the Front Range via Michigan Ditch and Cameron Pass Ditch which, together, divert about 4,500 acre-feet per year out of the basin. The basin also contains a major wildlife refuge in addition to numerous public lands and the recreational opportunities they offer.


North Platte River near Cowdry. Photo: M. Nager.

The Three State Agreement of the PRRIP governs water use in the basin, and water use is tied to endangered species-recovery efforts on the Platte River in Central Nebraska. The agreement employs a "one-bucket concept" for the North Platte Basin of Colorado, which currently limits water use in the basin to depletions associated with the irrigation of up to 134,467 acres, while allowing for flexibility in the type of water use.

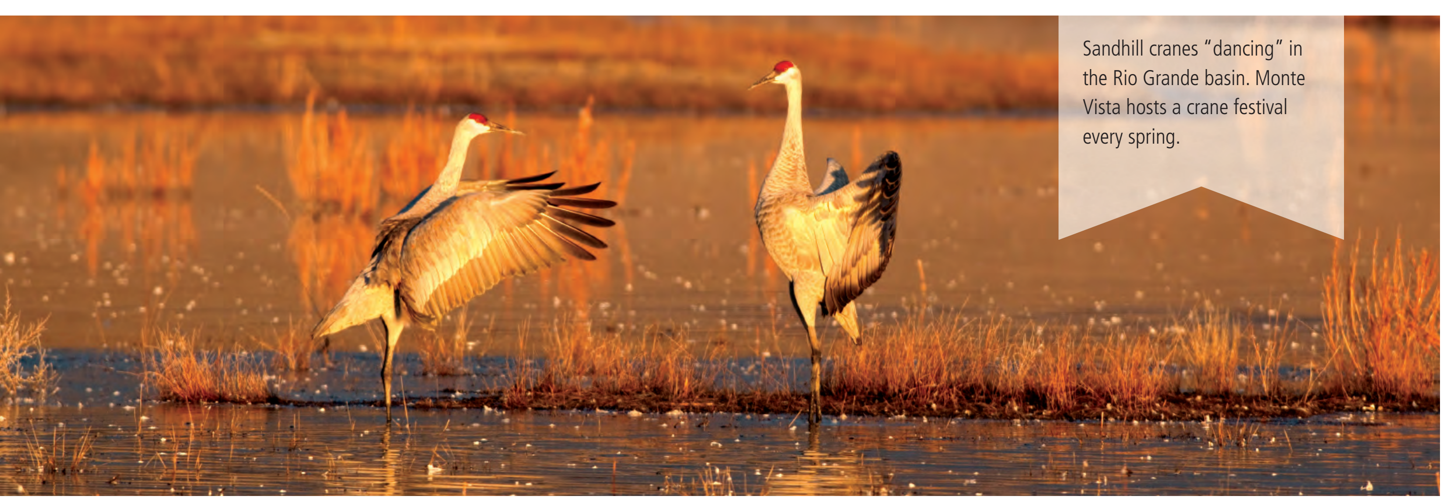
Basin Challenges: The North Platte River Basin will face several key issues and challenges pertaining to water management over the next 40 years. These include:

- Maintaining compliance with the equitable apportionment decrees on the North Platte and Laramie Rivers. The decrees quantify the amount of available water and lands that can be irrigated.
- Increasing economic development and diversification through strategic water use and development.
- Continuing to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies.
- Gaining knowledge of the basin's consumptive uses and high-altitude crop coefficients.
- Quantifying and strategically developing available unappropriated waters within the basin.
- Successfully resolving endangered species issues on the Platte River in Central Nebraska through the PRRIP in a manner that does not put pressure on water users to reduce existing uses.
- Maintaining healthy rivers through the strategic implementation of projects that meet prioritized nonconsumptive needs.
- Promoting water-rights protection and management through improved streamflowgauging data.
- Enhancing forest health and management efforts for wildfire protection and beetle-kill effects.

Rio Grande Basin

Basin Description: The Colorado portion of the Rio Grande drainage basin is located in south-central Colorado and encompasses less than 10 percent of the state's land area, or approximately 7,700 square miles. The San Juan Mountains to the west, the Sangre de Cristo Range to the north and east, the Culebra Range to the southeast, and the Colorado-New Mexico state line to the south define the boundaries of the Rio Grande Basin within Colorado. Between the San Juan Mountains and the Sangre de Cristo Mountains lies the San Luis Valley, a principal feature of the Rio Grande Basin, with an average elevation of 7,500 feet and precipitation of less than eight inches per year.

Basinwide, land is evenly divided between public and private ownership. Nevertheless, most of the land in the San Luis Valley is privately owned. The primary use of more than 600,000 acres of irrigated land is for agricultural purposes in the central portion of the basin, and producers in the valley are the second-largest provider of fresh potatoes in the United States. Non-irrigated areas in the valley are mostly classified as shrubland (24 percent) and grassland (31 percent). The



Sandhill cranes "dancing" in the Rio Grande basin. Monte Vista hosts a crane festival every spring.

A potato farm in the San Luis Valley, where agriculture has long been the basis of the economy. Other principal crops grown in the Rio Grande Basin are alfalfa, native hay, barley, wheat, and vegetables like lettuce, spinach and carrots.

San Juan and the Sangre de Cristo Mountain ranges are largely forested. The northern one-third of the basin is considered a "closed basin" and does not contribute any surface-flows to the Rio Grande.

Interstate compacts and international treaties affecting water use in the Rio Grande Basin include the Rio Grande, Colorado, and Tijuana Treaty of 1945 between the U.S. and Mexico; the Rio Grande Compact of 1938; and the Amended Costilla Creek Compact of 1963. In particular, the Rio Grande Compact establishes Colorado's obligations to ensure delivery of water at the New Mexico state line and New Mexico's obligation to ensure delivery of water at Elephant Butte Reservoir, with some allowance for credit and debit accounts. The compact dictates that obligations be calculated based on the amount of flow at indexed stations, which then determine the amount of flow that must be delivered to the downstream states during that year. The Rio Grande Compact established the Rio Grande Compact Commission to administer the terms of the agreement. The commission consists of one representative from each state and a non-voting federal representative.

Basin Challenges: The Rio Grande Basin will face several key issues and challenges related to water management and needs over the next 40 years. These include:

- The Rio Grande Compact and the effects of sustained drought make the objective of sustainability difficult.
- Groundwater use for agriculture is currently at unsustainable levels.
- Economic effects of reduced irrigation use based on groundwater supplies will be difficult, but working on community-based solutions offers the best hope of minimizing the effects.
- Residential growth, primarily in the form of second homes and vacation homes (especially in the South Fork area) is creating a need for additional water supplies.
- Groundwater is a key component of water use in the basin for both M&I and agriculture. Groundwater management presents an ongoing challenge.

Basin Implementation Plan Themes

Throughout the BIP process, roundtables engaged in public outreach activities, technical outreach with basin entities, and a series of discussions regarding the priorities and values within the respective basins. While the BIPs outline projects and methods by which water supply needs may be met, they also serve as an up-to-date summary of issues of concern and greater water policy management themes within each basin. The following section presents some of the major themes each draft BIP identified. Chapter 6 discusses in more detail the goals and measurable outcomes each roundtable generated, along with projects and methods they identified. The discussion in this chapter is limited to major themes and points of consideration that guide the work of the roundtables.

Arkansas Basin

A major emphasis of the Arkansas Basin Roundtable was a public outreach program that aspired to reach all corners of the basin. The roundtable held a series of public meetings and provided information about Colorado's Water Plan and the BIP process. In addition to these public meetings, the annual Arkansas River Basin Water Forum served as a point for receiving major input into the BIP. [2]

> "The roundtable first identified 'the interdependence of all water usage types,' recognizing the connections among agricultural use, environmental and recreational uses, and the effects of M&I supplies."

The roundtable identified several important points of consideration that underpin the BIP document. These points represent the major challenges and opportunities the roundtable faces in planning for the water supply future of the Arkansas basin. The roundtable first identified "the interdependence of all water usage types," recognizing the connections among agricultural use, environmental and recreational uses, and the effects of M&I supplies.[3] As an importing and exporting basin, the roundtable faces complex hydrology, and faces the complicated administration of water the *Kansas v. Colorado* lawsuit mandated. Moving forward, declining levels of groundwater, in addition to the demand for augmentation water, will represent a major challenge to basin users.[4]

Recognizing the variety of needs and capacities of water providers and municipalities, the BIP process has also continued robust discussions regarding conservation within the basin. On the heels of a year in which Colorado saw record wildfires, drought, and floods, the roundtable also formed the Watershed Health Working Group, which brought together stakeholders to discuss the ways in which agencies and affected parties can collaborate before, during, and after such natural disasters.[5]

During the public outreach process, the roundtable solicited input forms to gather basin residents' ideas and concepts related to projects or methods.[6] As part of the roundtable's organization of basin needs, projects, and methods, the roundtable created a comprehensive database. Projects that met a basin need were categorized within the database as follows:

- All Input List
- Preliminary Needs List
- Master Needs List
- IPP List

The All Input List is the most comprehensive, and includes the Preliminary Needs, Master Needs, and IPP Lists. The IPP List is the most narrow, with a more rigorous definition of IPP as the CWCB defines it in the SWSI.[7] The roundtable also commissioned the creation of a Simplified Water Allocation Model, which demonstrates at a large scale water availability and potential future shortages, with an eye toward future demands.[8] The creation of the project database, and this high-level model, are useful tools for future planning efforts in the basin, as well as for the roundtable's evaluation of projects and methods.

The Arkansas BIP is available here.[9]

Colorado Basin

In the creation of the BIP, the Colorado Basin Roundtable looked within the basin's boundaries to enumerate the projects and processes by which stakeholders plan to meet future water needs. The roundtable conducted interviews with water providers and provided information about identified projects or methods.[10] This process resulted in a comprehensive list of ongoing and planned efforts within the basin—the first aggregation of its kind. The roundtable organized projects and methods, as well as overarching concerns and challenges, by subregion within the BIP.

The roundtable also articulated a set of prevailing basin themes that reflect the concerns of basin stakeholders and roundtable members. Within the Colorado Basin, a major concern is the development of a new transmountain diversion (TMD), beyond the diversions the Colorado River Cooperative Agreement addresses.[11] Concerns regarding the Colorado River Compact, as well as issues regarding environmental health within the mainstem and tributaries, drive this theme. The BIP identifies the relationship among various water uses, and the potential negative effects to uses resulting from overdevelopment of the river.

> "Within the Colorado Basin, a major concern is the development of a new transmountain diversion, beyond the diversions the Colorado River Cooperative Agreement addresses. Concerns regarding the Colorado River Compact, as well as issues regarding environmental health within the mainstem and tributaries, drive this theme."

As a result of the public input process and roundtable discussion, the roundtable identified six themes representing the overarching messages of basin stakeholders. The themes are as follows:

1. Protect and restore healthy streams, rivers, lakes, and riparian areas.
2. Sustain agriculture.
3. Secure safe drinking water.
4. Develop local water-conscious land-use strategies.
5. Assure dependable basin administration.
6. Encourage a high level of basinwide conservation.[12]

Within each theme, the roundtable identified potential actions and strategies to address these areas. For example, the roundtable suggested a Stream Management Plan as a path toward achieving the first theme, and identified major water rights, such as the Shoshone Hydroelectric Plant, as crucial to meeting the fifth theme.[13]

The BIP was divided into several sections that each focused on a different subregion within the greater basin. Within each subregion, the roundtable identified concerns and challenges within the greater context of the basinwide themes. Roundtable members took a closer look at identified projects and methods within the subregions, including identifying a few representative "Regional Top Projects" that meet basin themes and the criteria the subregion stakeholders proposed.[14] The roundtable examined in more detail these top projects, and developed project information sheets about project proponents and the basin needs these projects and methods seek to meet.[15] Looking forward, roundtable members have identified several future actions. These include supporting the implementation of stream management plans basinwide, and a modeling effort to gain greater understanding of potential larger-scale hydrologic effects on the basin.

The Colorado BIP is available here.[16]

Gunnison Basin

The Gunnison Basin Roundtable began with one primary goal: "Protect existing water uses in the Gunnison Basin."[17] From this foundation, the roundtable established eight additional complementary goals and six statewide principles.[18] The roundtable completed targeted, technical-outreach activities throughout the basin, with the goal of identifying ongoing and planned projects and methods. Additionally, the roundtable built upon previous public outreach and education efforts, ensuring that the established goals and principles reflected the concerns of basin citizens and stakeholders.

The roundtable selected projects and methods by highlighting those that met or reflected the concerns and priorities of basin goals, and further sorted them according to their implementation schedule. The roundtable then identified those that were "likely feasible by 2025" and represented an "excellent job of meeting basin goals," and classified them as Tier 1 projects.[19] These projects and methods are intended to provide solutions to basin water needs as enumerated within the BIP, and include agricultural shortages, M&I needs, and environmental and recreational needs.

> "...the roundtable built upon previous public outreach and education efforts, ensuring that the established goals and principles reflected the concerns of basin citizens and stakeholders."

For the benefit of other roundtables and Colorado's Water Plan, the BIP identifies statewide principles that communicate the roundtable's position on interbasin issues in Colorado. As part of the Colorado River system, the statewide principles include a few points regarding the development of water supply from that system. The Gunnison Basin Roundtable primarily emphasizes the variability of Colorado River supply, as well as the importance of the prior appropriation system to protecting existing uses from adverse effects.[20] Additionally, the statewide principles advocate for local solutions to water needs and the equitable application of conservation strategies.[21]

The Gunnison BIP also includes several basin evaluations of hydrologic modeling and mapping of potential projects and methods, as well case studies in water management.[22] The modeling exercise aided an assessment of water availability under current hydrology and legal administration. The major emphasis of this BIP is the identification of projects and methods, and the relationships among these proposed projects and basin goals. To that end, the roundtable recommends a path to implementation that takes into consideration "securing project acceptance and demonstrating project feasibility."[23]

The Gunnison BIP is available here.[24]

North Platte Basin

The North Platte Basin Roundtable identified eight basin goals, which reflected the basin's unique water management challenges and values. The projects and methods this roundtable identified must operate within two major legal frameworks as expressed in the basin goals: "Maintain and maximize the consumptive use of water permitted in the Equitable Apportionment Decree and the baseline depletion allowance of the Three State Agreement."[25] Within these boundaries, the roundtable identified further goals, and ongoing public outreach and education efforts helped to further inform those goals.

> "...the roundtable recognizes the benefits that agricultural uses provide to environmental and recreational attributes, such as healthy rivers and wetlands."

Of primary importance in the North Platte BIP is the maintenance of agricultural uses within the basin. Basin goals reflect this concern, as they identify the need to strategically develop water while maintaining and upgrading existing critical infrastructure. Additionally, the roundtable recognizes the benefits that agricultural uses provide to environmental and recreational attributes, such as healthy rivers and wetlands.[26] The BIP also articulates statewide issues, advocating for the management of forest health through wildfire and beetle-kill efforts, as well as the "equitable statewide application of municipal water conservation."[27]

The North Platte Basin Roundtable also used hydrologic modeling and mapping to provide a technical assessment of the effect of projects and methods within the greater basin. Through these basin evaluations, roundtable members were able to gauge the feasibility of particular identified projects and methods, and identify situations in which the implementation of multiple projects or methods would present a challenge.[28]

The North Platte Basin Roundtable chose to address its basin goals through the identification of projects and methods that meet identified needs and concerns. In its analysis of projects, the roundtable determines which specific basin goals each project may address, and generally outlines potential challenges to implementation. The roundtable also provides a list of planned environmental and recreational projects, which address specific attributes the roundtable has identified as important to basin citizens and stakeholders.

The North Platte BIP is available here.[29]

Rio Grande Basin

The Rio Grande Basin Implementation Plan provides an in-depth look at the basin's issues and proposed solutions, beginning with a comprehensive overview of the basin itself. The plan discusses processes for Colorado's Water Plan and the Basin Water Plan, with an explanation of the Rio Grande Basin's unique challenges and subcommittee approach to BIP development. The overview includes an analysis of factors that affect water management, including geography, the history of development, and legal frameworks, such as the Rio Grande Compact and the administration of water rights.[30] This overview provides a backdrop for the parts of the plan to follow, and describes the landscape in which the plan intends to establish solutions for water management challenges.

> "Modeling-efforts and scenario-planning support the goals and their accompanying measurable outcomes, with the vision of preventing 'harm to existing water rights while maximizing Colorado's entitlement under the Rio Grande and Costilla Creek compacts.'"

The plan defines goals and measurable outcomes, which the roundtable's public outreach process and discussions at the roundtable level helped inform. The goals seek to address the basin's key attributes, which are defined as "a resilient agricultural economy, watershed and ecosystem health, sustainable groundwater resources, the encouragement of projects with multiple benefits, and the preservation of recreational activities."[31] Modeling efforts and scenario planning support the goals and their accompanying measurable outcomes, with the vision of preventing "harm to existing water rights while maximizing Colorado's entitlement under the Rio Grande and Costilla Creek compacts."[32] The plan further explores the goals by identifying the particular water needs each goal meets, whether goals are related to agricultural, M&I, environmental and recreational, or water administration needs.[33] The plan discusses the needs, analyzes how these needs interrelate, and looks to the future of each sector.

After setting the stage with the basin overview and the goals, the plan explores solutions. It examines the projects and methods and compares them to the list of basin goals. It then selects for review certain projects that meet multiple basin goals, and summarizes them in a project fact sheet.[34] The fact sheet provides a closer look at the project, supplying information such as project proponent, estimated budget, and an indication of which basin goals the project meets. The plan also provides an estimate of funding needs for these identified projects and includes a list of projects that meet environmental and recreational information gaps, paving the way for more-informed project identification in the future.[35]

After project and method identification, the plan examines the means by which implementation may be possible. First, the plan summarizes the roundtable's outreach and educational efforts, and includes a plan for future efforts. Then, it discusses strategies for implementation.[36] These strategies include stakeholder involvement, future modeling improvements, and cooperative in-basin water management efforts.[37] The roundtable intends for the Rio Grande Plan to remain a living document, and will provide updates and additions that offer meaningful input into the basin's water management future.

The Rio Grande BIP is available here.[38]

South Platte Basin and Metro Basin

Recognizing the common geography and pertinent issues shared by the South Platte and Metro Basin areas, these two roundtables chose to work together on a BIP. In preparing the BIP, both roundtables sought to provide a reference for other basin roundtables, as well as stakeholders statewide, regarding the challenges and opportunities present in the South Platte Basin. Facing future challenges related to population growth, a wide variety of water needs, and numerous constraints, the roundtables plan to find solutions balancing these hurdles. The roundtables identified the following challenges for the water supply future: Limited native supply, groundwater and aquifer administration and management, interstate water commitments, project-permitting concerns, environmental and recreational values, and water quality issues.[39]

With this host of challenges, the roundtables recognized that they must carefully craft and select solutions that maximize benefits and use. To that end, the roundtables have identified three major assessment guidelines:

1. Minimize adverse impacts to agricultural economies.
2. Develop new, multipurpose projects that either offset transfers from agricultural uses or provide additional water to reduce current agricultural shortages.
3. Proactively identify and implement methods to protect and enhance environmental and recreational water uses.[40]

Additionally, in preparing for future needs, the roundtables have incorporated the "four legs of the stool" approach the IBCC posed. This approach consists of conservation and reuse, IPPs, agricultural transfers, and new Colorado River supplies.[41] Specifically, the BIP lists 11 implementation strategies. These strategies mostly follow the "four legs of the stool" discussion, with a focus on maximum implementation of IPPs, as well as the advancement of conservation and reuse efforts.[42] Other strategies address the maximization of native-basin supplies while using alternative-transfer methods to minimize traditional buy-and-dry of agricultural lands for municipal supply.[43] Regarding transmountain diversions, the roundtable advocates the following action: "Simultaneously advance the consideration and preservation of new Colorado River supply options."[44]

> "...in preparing for future needs, the roundtables have incorporated the 'four legs of the stool' approach the IBCC posed. This approach consists of conservation and reuse, IPPs, agricultural transfers, and new Colorado River supplies."

The roundtables believe that this suite of strategies is the best approach to meet the basin's varied needs while addressing the identified challenges. Looking to the future, the roundtables evaluated three representative portfolios, each portraying a different vision of future South Platte/Metro supply and demand, in order to demonstrate the challenges inherent in meeting future needs while maintaining basin values.[45] The roundtable also identified conceptual projects for which there are no current project proponents; the roundtable members believe these conceptual projects offer a good demonstration of the intent of the basin implementation strategies.

The South Platte BIP is available here.[46]

Southwest Basin

Through the BIP process, the Southwest Basin Roundtable sought to address the basin's many complexities, including the existence of nine sub-basins, various compacts and treaties, and the disparate interests of stakeholders within that corner of Colorado.[47] Agricultural, M&I, environmental, and recreational needs all play a role in the Southwest Colorado landscape, and the roundtable seeks to address them with equal attention throughout the BIP process.

The Southwest Basin Roundtable has expressed concern regarding new development of the Colorado River system as part of a new transmountain diversion.[48] Compact concerns, as well as potential future needs within the Southwest Basin itself, underpin the development issue. To that end, the roundtable has set forth eight factors to consider before development occurs, as well as communicates a commitment to remain involved in statewide discussions on the matter. Interwoven with these transmountain diversion policies is a commitment to higher levels of conservation for water providers receiving any new diversion.[49]

> "The BIP specifies that 'the roundtable encourage and support creative solutions sought through collaborative efforts' regarding federal policies and actions, as well as tribal water rights.."

The roundtable also identifies interaction between state and federal entities as a key concern and opportunity. The BIP specifies that "the roundtable encourage and support creative solutions sought through collaborative efforts" regarding federal policies and actions, as well as tribal water rights.[50] Recognizing the importance of environmental and recreational attributes within the basin, the roundtable has emphasized a greater understanding of the water needs toward maintaining these values, and identified two methods for addressing the need for data and assessment.[51]

The Southwest Basin Roundtable undertook an ambitious public outreach process to solicit input from basin stakeholders. Resulting from this public outreach and roundtable discussions, the Southwest Basin Roundtable adopted 21 goals and 30 measurable outcomes[52] and took an aggressive approach to listing newly identified projects and processes. It identified 80 new projects and methods, bringing the total list of IPPs for all sub-basins to about 160 proposals geared toward meeting future water needs.[53]

The Southwest BIP is available here.[54]

Yampa/White/Green Basin

The Yampa/White/Green Basin Roundtable views the BIP process as an opportunity to articulate stakeholder viewpoints from northwest Colorado, and to inform ongoing statewide discussions and Colorado's Water Plan process.[55] To that end, the roundtable encourages dialogue at the roundtable level and, in the public outreach process, set a vision for the basin moving forward. This basin vision includes an assessment of meeting in-basin future needs at the M&I, agricultural, and environmental and recreational levels. The roundtable also examines the Yampa/White/Green Basin's role within Colorado and establishes statements of policy on interbasin and interstate concerns.

Of key concern to the roundtable is the basin's role in the Colorado River system. The roundtable emphasizes the role of the Colorado River Compact and the competing needs of "downstream states, the needs of the urbanized eastern slope of Colorado, and its own in-basin needs."[56] As such, the roundtable advocates for an "equitable allocation of native flow in the Yampa, White, and Green Rivers to meet existing and future in-basin water demands, including PBO depletion allowances."[57] Chapter 8 of this plan discusses this concept in more detail.

> "The primary goal of the roundtable is to ensure the 'maintenance and protection of historical use in the Yampa/White/Green Basin as well as the protection of water supplies for future in-basin demands.'"

The primary goal of the roundtable is to ensure the "maintenance and protection of historical use in the Yampa/White/Green Basin as well as the protection of water supplies for future in-basin demands."[58] To that end, the roundtable members identified eight primary basin goals.[59] Within those goals, the roundtable seeks to address potential shortages and improve the current infrastructure, with an emphasis on water quality and nonconsumptive uses.[60]

The roundtable integrated ongoing studies into the BIP process, and used its 2014 Projects and Methods Study to analyze potential water supply solutions under various hydrologic scenarios. The study and the BIP outreach process resulted in the creation of a list of potential projects and methods within the basin, as well as an analysis of water availability, including implementation of identified projects and processes and their effects on nonconsumptive values.[61] Moving forward, the roundtable will continue to refine ongoing studies, seek additional projects and methods, and continue outreach and education efforts it initiated within the basin.[62]

The Yampa/White/Green BIP is available here.[63]

Conclusion

As this brief overview demonstrates, each basin features its own remarkable opportunities as well as its own distinct challenges that make planning for Colorado's water future difficult. Solutions will affect not only one basin, but basins throughout Colorado. Although unique issues and concerns characterize each area, Colorado's water future connects every region statewide. Every basin grapples with drought, interstate compacts and agreements, growing populations, important environmental and recreational values, and sustainable agriculture. Due to the fact that there are so many shared interests across the state, all stakeholders must continue working together to collectively solve Colorado's water supply gaps, so that the Colorado we all value can continue to flourish.

The Colorado River, flowing just south of Byers Canyon. Photo: M. Nager.

A LOOK AT HISTORY

1877 historic drainage [basin] map of Colorado.

source: Justice Gregory Hobbs' personal collection.

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[12] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015) 3-5.

[13] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015).

[14] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015), 125.

[15] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015), 125

[16] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015).

[17] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015) Executive Summary. https://www.colorado.gov/pacific/cowaterplan/gunnison-river-basin.

[18] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015).

[19] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015).

[20] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015).

[21] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015).

[22] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015).

[23] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015).

[24] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015).

[25] Wilson Water Group, *North Platte Basin Implementation Plan* (Denver: Wilson Water Group, 2014), 2.

[26] Wilson Water Group, *North Platte Basin Implementation Plan* (Wilson Water Group, 2014),

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Water Supply

Chapter 4 examines Colorado's water supply. Our state's water supply consists of both surface water and groundwater sources, and these supplies are dependent upon complex interactions among geography, weather, and laws and regulations—all of which influence how much water is available for beneficial uses. In Colorado, groundwater accounts for approximately 17 percent of water use, while surface water supplies the remaining 83 percent. Colorado's river and streamflows are highly variable, both seasonally and annually, and provide surface water and replenish alluvial groundwater supplies.

The quality of surface water and groundwater also influences the amount available for different types of uses. As Chapter 2 describes, the use of groundwater and surface water is subject to different management institutions.

Maroon Bells snowpack reflected in Maroon Lake. The Bells are the most photographed mountains in the country.

The Waters of Colorado

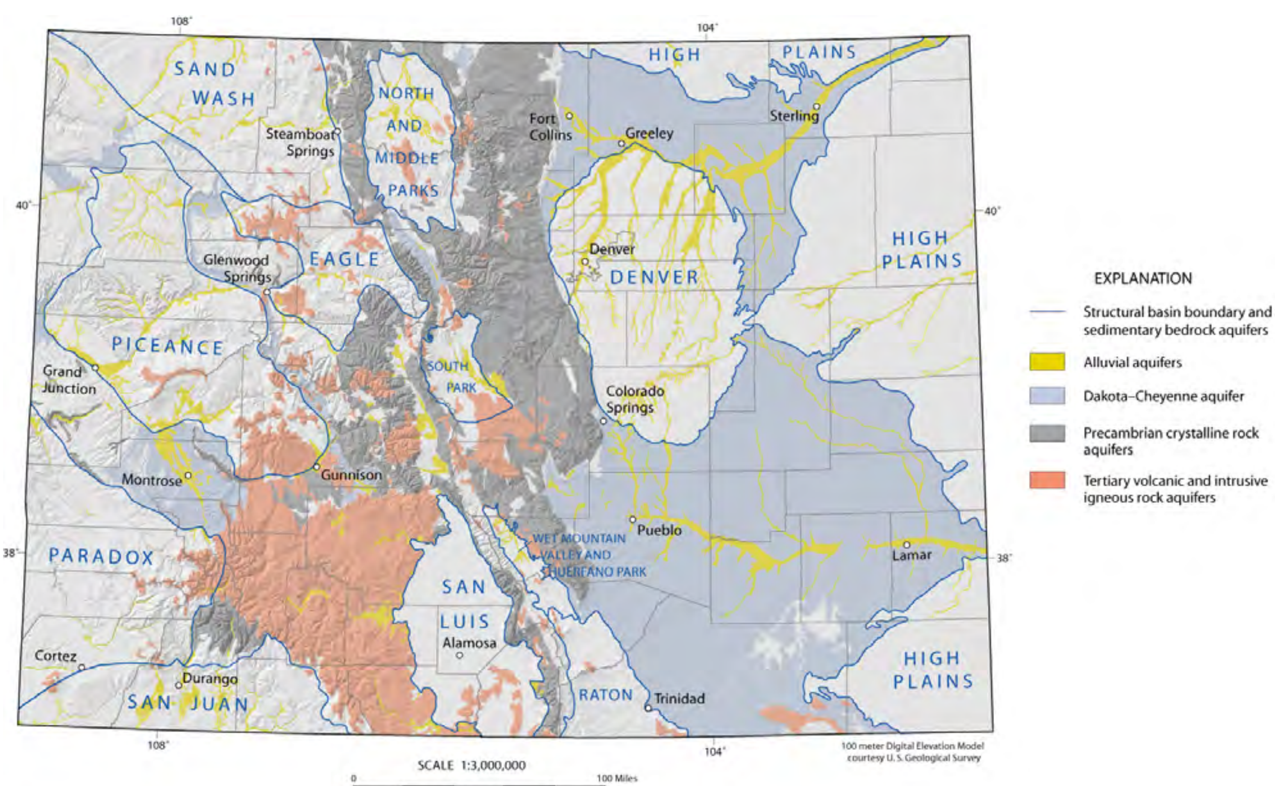
Colorado's geography is diverse, with terrain that ranges from the low-lying plains of Holly at 3,392 feet, to the high peak of Mt. Elbert; at 14,440 feet, Mt. Elbert is the highest peak in the contiguous Rocky Mountain states. The entire state of Colorado resides above 3,300 feet, with a mean elevation of 6,800 feet, the highest of any state.[1] This variability influences precipitation amounts and patterns across the state.

Many major rivers originate in the high Rocky Mountains, and collectively account for 70 percent of Colorado's surface water. These rivers flow east, west, north, and south from Colorado's mountains and plains out of the state, through 18 downstream states and Mexico, and into the Gulf of Mexico or the Pacific Ocean. Four major river systems begin in Colorado: the Arkansas, the Colorado, the Platte, and the Rio Grande.[2]

Colorado has eight primary river basins that span the state: South Platte; North Platte; Arkansas; Rio Grande; Gunnison; Colorado; the Northwest Basin, which includes the Yampa, White, and Green Rivers; and the Southwest Basin, which comprises the Dolores, San Juan, and San Miguel Rivers. The Republican River also begins in Colorado. These basins are dependent on winter snowpack and spring runoff to replenish and sustain their flow which, on average, produce approximately 15 million acre-feet of water annually. Of that, our state consumes roughly 5 million acre-feet, and approximately 10 million acre-feet flows out of Colorado to neighboring states.

The western side of the Continental Divide contains 70 percent of the surface water and 11 percent of the population.[3] The eastern side of the Continental Divide consumes 70 percent of the state's water. [4] As a result, many reservoirs on the western slope serve communities and demands along the Front Range and eastern plains.[a] Water managers rely on networks

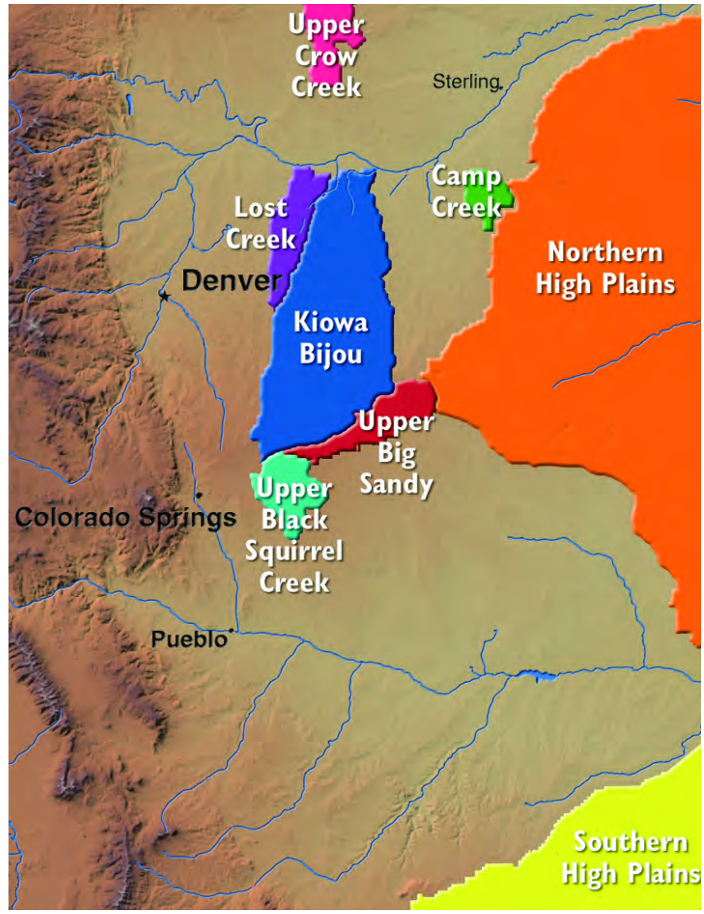
FIGURE 4-1 **PRINCIPAL AQUIFERS AND STRUCTURAL BASINS OF COLORADO**



[a] The western slope includes the Gunnison, Colorado, Yampa/White/Green River basins, and the basin of the Southwest, composed of the Dolores, San Juan, and San Miguel Rivers. The Rio Grande, North and South Platte, Arkansas, and Republican River basins are included in the calculations for the eastern slope. If the Rio Grande Basin is included in the western slope, then western slope water increases closer to 80 percent, which is the figure traditionally used. Nevertheless, since the Rio Grande is not truly west of the Continental Divide, 70 percent is a more accurate figure.

of reservoirs, pumps, tunnels, and ditches to store and move water and to meet demands at peak times. They also must comply with relevant environmental mitigation requirements to maintain ecosystem health. Demand management strategies can help alleviate stress on the system under both normal operating conditions and during shortages, as Chapter 6.3 discusses.

FIGURE 4-2 DESIGNATED GROUNDWATER[5]



Groundwater plays a major role in the statewide water supply. Nineteen of Colorado's 64 counties and about 20 percent of the state's population rely heavily on groundwater.[5] Most of the groundwater use occurs in the eastern part of the state and in the Rio Grande Basin. The western slope has not developed groundwater to the same extent.

Groundwater resources exist throughout the state in alluvial, sedimentary, and crystalline rock aquifers (Figure 4-1).[6] Alluvial aquifers occur along many of the state's streams and are usually tributary to the stream, in which case the groundwater is administered as part of the stream system. Alluvial aquifers in designated groundwater basins are an exception, and fall under the management and control of the Colorado Ground Water Commission. Designated groundwater basins include eight areas in the eastern part of the state that rely primarily on groundwater, having minimal to no surface water supplies (Figure 4-2). Sedimentary aquifers occur throughout the state, and include multi-aquifer systems such as the Denver Basin and Dakota-Cheyenne aquifers. Crystalline rock aquifers are found in most of the foothills and mountainous areas of the state. Primarily recharged by snowmelt into fractures in the rock, these aquifers have a low storage capability and are usually limited to domestic use.

Groundwater aquifers offer benefits through their natural infrastructure and their protection from evaporation. Nevertheless, relying on groundwater as a primary supply may be challenging due to uncertain and varied natural recharge rates. In some aquifers, such as those in the Denver Basin, the natural recharge rate is very low compared to extraction rates, so groundwater is considered a nonrenewable resource.

Both alluvial and bedrock aquifers offer potentially significant groundwater storage capability. The total, potentially available capacity statewide is approximately 10 million acre-feet of alluvial aquifer storage and more than 150 million acre-feet of bedrock aquifer storage. Many potential storage sites, however, are located far away from significant recharge water sources, and only a few applications of managed groundwater storage exist in Colorado; most are located in the Denver Basin aquifers. Colorado developed rules allowing for recharge and long-term storage in the nontributary Denver Basin aquifers, but there are currently no comparable rules for storage in alluvial aquifers. The State differentiates groundwater recharge for augmentation purposes from groundwater recharge for storage purposes. Recharge in shallower, unconfined alluvial aquifers is physically easier than in the deeper-confined bedrock aquifers. In contrast to recharge for augmentation, storage in alluvial aquifers may be more difficult to manage—and potentially more short-term—because of the transient nature of groundwater flow in tributary alluvial aquifers. While groundwater storage has its advantages, such as lack of evaporation, it also has its challenges, including slow recharge rates and challenges associated with controlling the recharged water, retrieving the water, and delivering the water to the customer.

Variability in Water Supplies

Precipitation varies in both amount and distribution across the state, and elevation and the orientation of the mountains and valleys influences it (Figure 4-3). While some regions of the state, such as the San Luis Valley, receive just seven inches of precipitation annually, other regions, such as Wolf Creek Pass, experience an annual average of more than 60 inches of precipitation. Overall, Colorado receives an average of 17 inches of precipitation each year. In general, the mountains receive more precipitation than the eastern plains, and winters are typically wetter than summers. Despite high precipitation during the winter months, demand for water is highest during the summer months and in the growing season.[7]

Our state's variable precipitation patterns have resulted in considerable hydrologic fluctuation, and floods and drought are possible within the same year. In 2011 and 2013, Colorado experienced both extreme flooding and severe droughts during the same periods. These variations from basin to basin may differ by thousands of acre-feet. Furthermore, basin streamflow is not equally distributed across the state, so a low flow in one basin may be greater than a high flow in another, as is the case with the Colorado River and the Southwestern Basins (Figure 4-5).

FIGURE 4-3 AVERAGE PRECIPITATION IN COLORADO (INCHES) 1981-2010

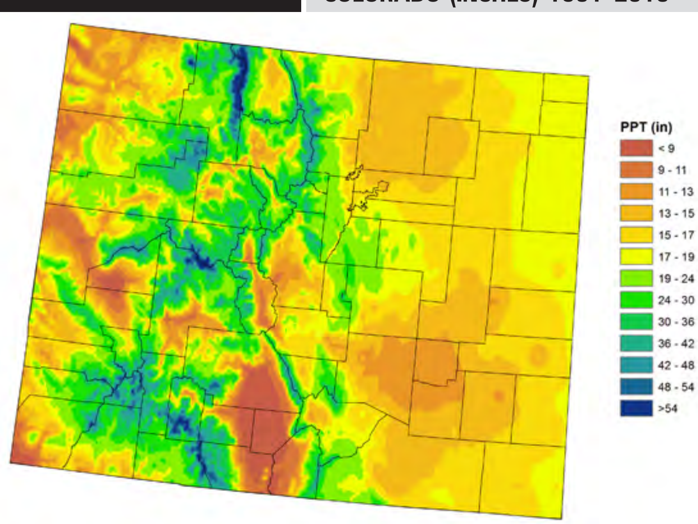


FIGURE 4-4 HYDROLOGIC CLASSIFICATION CRITERIA

Percentile range used to define drought, dry, average, wet, and flood condtions.

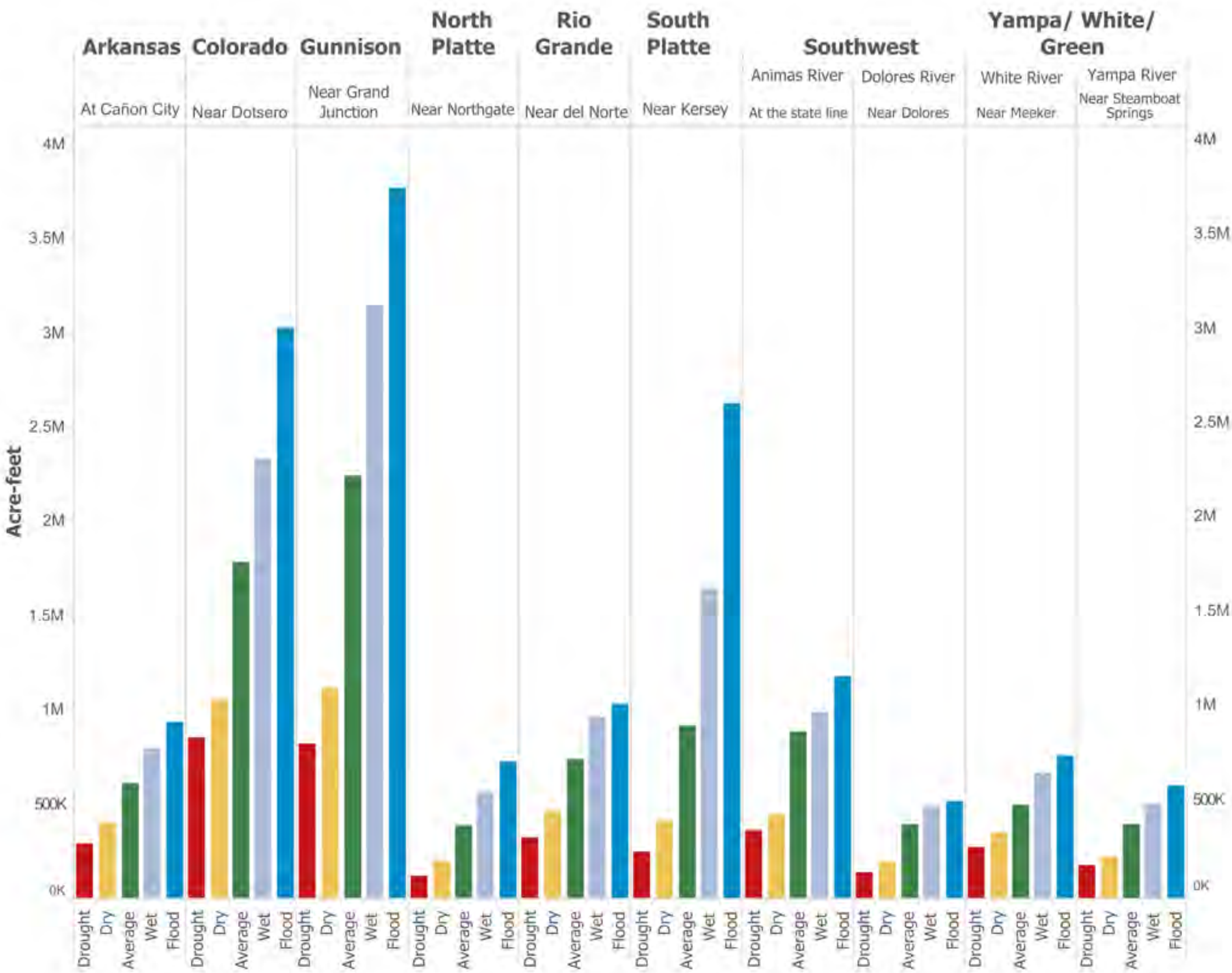
For the purposes of this plan, hydrologic classifications are assigned based on percentile ranking: drought, dry, average, wet, and flood (Figure 4-4). Drought and dry periods have substantial and lasting effects on water supplies and availability for years, while wet years offer relief with as much as six times the amount of annual water supplies compared to dry years (e.g. lower South Platte). Both extremes can affect water supplies and availability throughout the state for years (Figure 4-5). They also have other consequences, such as wildfires and negative economic effects.

For example, in 2002, the driest single year on record, Colorado suffered several severe wildfires. The largest of these fires, the Hayman Fire, raised levels of nitrate and turbidity in the burn area's streams—and those levels remained elevated for five years afterward.[8] Then in 2013, the West Fork Complex Fire damaged watersheds and diminished water quality in the Rio Grande Basin. Substantial hillside and stream erosion resulted from such events. Increased levels of debris in reservoirs affect not only water quality, but also water supply and treatment infrastructure operations.[9]

The CWCB coordinated field data and assisted in the development of reports on the substantial hillside and stream erosion that takes place following medium- and high-intensity wildfires.[10]

Wildfires can affect Colorado's economy and may cost the State millions of dollars in response and recovery efforts alone. They may also affect water providers' budgets. The 1996 Buffalo Creek and 2002 Hayman Fires cost Denver Water $20 million in wildfire-related dredging and maintenance at the Strontia Springs Reservoir, without complete resolution of the problem.[11] In 2012, another year of statewide drought, Colorado Springs Utilities and the City of Fort Collins incurred costs from separate wildfires in the watersheds that supply their municipal water. These naturally occurring events can greatly affect the amount of water supplies that are available for use.

FIGURE 4-5 ANNUAL FLOW VALUES FOR VARYING CONDITIONS AT SELECT GAGES (ACRE-FEET PER YEAR)



Annual flow values for drought, dry, average, wet, and flood conditions for 10 locations across the state. This graphic illustrates the variability that exists both within basins and between basins of the state, and shows the uppermost threshold of the percentile range for each of the selected gages. As this was an independent analysis, values may differ slightly from volumes the individual basin implementation plans reported.

Aside from the effects of wildfire, drought and its associated decreased water availability can also have substantial fiscal effects. Colorado State University estimates that in 2012, lost revenues due to the drought in the agricultural sector alone exceeded $409 million statewide.[12] Factoring-in secondary and tertiary economic effects to local communities, the loss increases to $726 million statewide.[13] Drought can also negatively influence air quality, water delivery infrastructure, wildlife, the environment, recreation, and tourism. Drought is unique in that it can last for weeks, months, or years, and the longer a drought persists, the larger its effect. For instance, a municipality may be able to weather a single-year drought by using reservoir storage and drought response measures, but if the storage is not replenished, subsequent years become increasingly more difficult to manage. The same is true in the agricultural sector; ranchers forced to cull herds in response to drought may need decades to recover their stock, or may never recover at all. Both the Rio Grande and Arkansas Basins have been dry most of the past decade, with only three above-average precipitation years since 2000.[14] The Colorado River Basin has experienced the driest 14-year period since 1963, with above-average flows in only three of the last 14 years.[15]

On the other end of the variability spectrum are floods: Too much moisture can result in overflowing

FIGURE 4-6 AVERAGE MONTHLY FLOWS BY HYDROLOGIC CLASSIFICATION

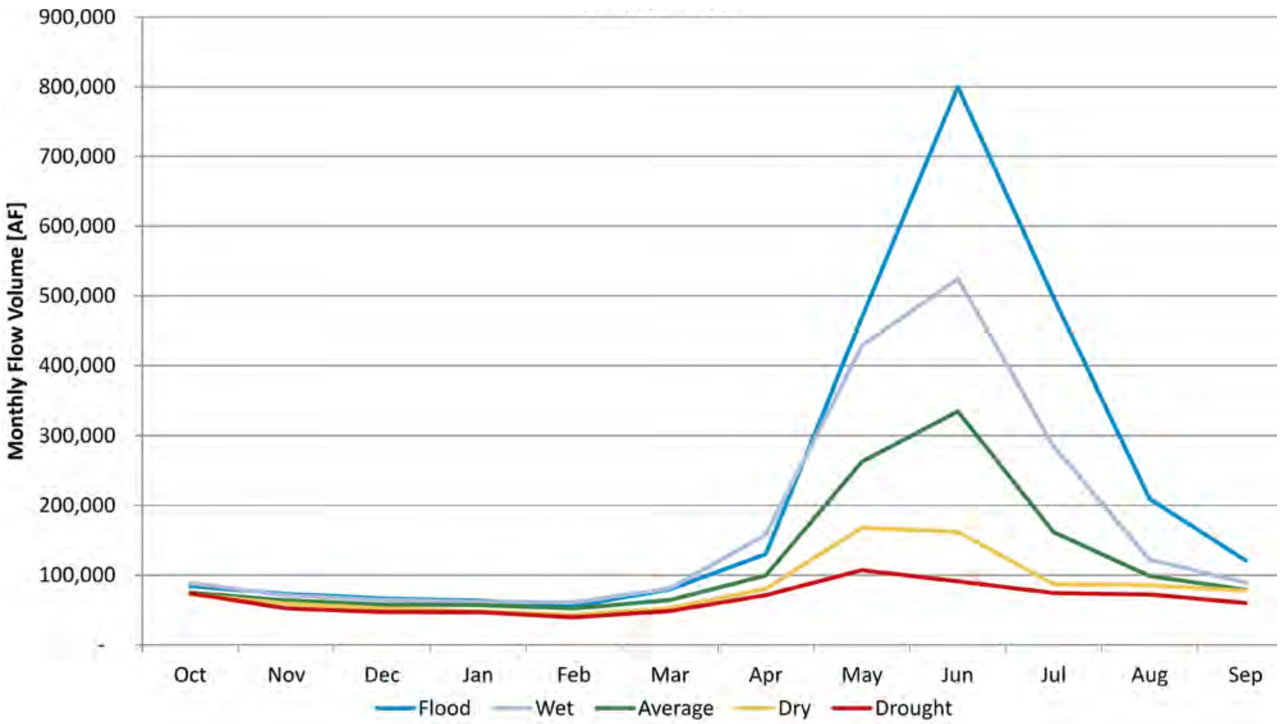


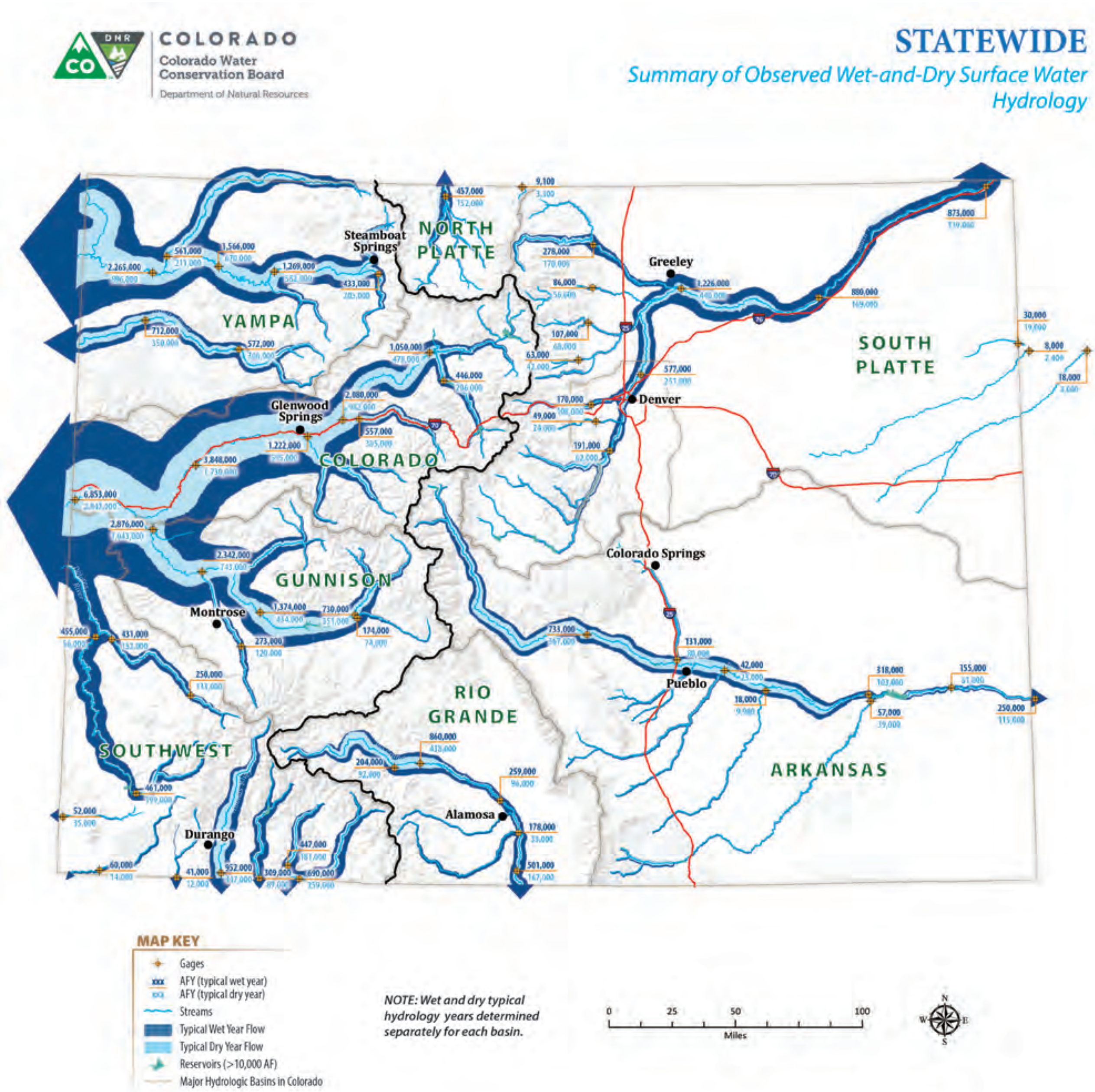
Figure 4-6 uses the same hydrologic classifications as Figure 4-5, but shows average monthly flow volumes on the Colorado River at Dotsero to illustrate the wide variance that can exist among classifications, especially during the runoff season.

reservoirs and extensive damage. In fall 2013, widespread flooding occurred in some regions of the state after as many as 19 inches of rain fell in a few days. For these areas, the events were equivalent to nearly a full year of precipitation. As many as 88 weather stations exceeded 24-hour precipitation records, and the hardest hit areas received more than 600 percent of average precipitation for the month.[16] Water inundated entire communities.

The September 2013 floods resulted in loss of life, power, homes, businesses, and roads. Initial estimates of economic losses have reached $2.9 billion.[17] These events caused Halligan Reservoir to rise 30 feet, capturing nearly 6,000 acre-feet of water in just over 24 hours. Halligan Reservoir transformed from a nearly-empty to a full vessel in a matter of days. Unfortunately, flows were so high that many storage facilities lost the infrastructure necessary to store the excess water.

Floods not only cause community damage; they also affect agricultural operations and water supply because of damaged delivery systems. Flooding events can leave water supply infrastructure, such as diversions and headgates, completely disconnected from their historical source of water. These effects may take weeks, months, or years to fully repair, and some damage may be too great to ever repair economically.

FIGURE 4-7 WET- AND DRY-YEAR FLOWS AT SELECT GAGES



Uncertainties Affecting Supply

In addition to the high hydrologic variability we face as a state, climate change and dust-on-snow events present additional complexities and uncertainties that affect water supply. In recent decades, Colorado has experienced warming and will likely continue to do so in the future. Across the state, average yearly temperature has increased by 2°F in the last 30 years, and by 2.5°F in the last 50 years. This increase affects the timing of snowmelt and peak runoff, which now occur earlier, and there is an increase in heat waves and wildfires. Climate projections show Colorado warming by an additional 2.5°F to 5°F by mid-century, with temperatures in summer increasing more than those in winter. While projections are less clear about whether precipitation will increase or decrease, warming temperatures that drive physical processes, such as evapotranspiration, will result in an earlier

TABLE 4-1 SUMMARY OF PROJECTED CLIMATE CHANGES AND POTENTIAL EFFECTS ON COLORADO'S WATER RESOURCES[18]

ELEMENT	PROJECTED CHANGES AND POTENTIAL EFFECTS	STUDIES THAT HAVE ASSESSED THIS VULNERABILITY FOR COLORADO
Overall Surface-Water Supply	Most projections of future hydrology for Colorado's river basins show decreasing annual runoff and less overall water supply, but some projections show increasing runoff. Warming temperatures could continue the recent trend toward earlier peak runoff and lower late-summer flows.	Colorado Water Conservation Board (CWCB) (2012); Bureau of Reclamation (BOR) (2012); Woodbury et al. (2012)
Water Infrastructure Operations	Changes in the snowpack and in streamflow timing could affect reservoir operations, including flood control and storage. Changes in the timing and magnitude of runoff could affect the functioning of diversion, storage, and conveyance structures.	CWCB (2012); BOR (2012)
Crop Water Demand, Outdoor Urban Watering	Warming temperatures could increase the loss of water from plants and soil, lengthen growing seasons, and increase overall water demand.	CWCB (2012); BOR (2012)
Legal Water Systems	Earlier and/or lower runoff could complicate administration of water rights and interstate water compacts, and could affect which rights-holders receive water.	CWCB (2012)
Water Quality	Warmer water temperatures could cause many indicators of water quality to decline. Lower streamflows could lead to increasing concentrations of pollutants.	Environmental Protection Agency (EPA) (2013)
Groundwater Resources	Groundwater demand for agricultural use could increase with warmer temperatures. Changes in precipitation could affect groundwater recharge rates.	
Energy Demand and Operations Costs	Warmer temperatures could place higher demands on hydropower facilities for peaking power in summer. Warmer lake and stream temperatures, and earlier runoff, could affect water use for cooling-power plants and in other industries.	Mackenick et al. (2012)
Forest Disturbances in Headwaters Region	Warmer temperatures could increase the frequency and severity of wildfire, and make trees more vulnerable to insect infestation. Both have implications for water quality and watershed health.	
Riparian Habitats and Fisheries	Warmer stream temperatures could have direct and indirect effects on aquatic ecosystems, including the spread of non-native species and diseases to higher elevations. Changes in streamflow timing could also affect riparian ecosystems.	Rieman and Isaak (2010)
Water- and Snow-based Recreation	Earlier streamflow timing could affect rafting and fishing. Changes in reservoir storage could affect recreation on-site and downstream. Declining snowpacks could affect winter mountain recreation and tourism.	BOR (2012); Battaglin et al. (2011); Lazar and Williams (2008)

runoff, a longer irrigation season, and a decrease in annual streamflow—especially in the state's southern basins. Even moderate increases in precipitation will not be sufficient to overcome the drying signal. All of these changes are likely to substantially affect water available for beneficial use in Colorado in the coming decades. Table 4-1 illustrates the potential water-related effects of climate change in different areas and sectors, while Table 4-2 highlights projected effects of increased temperatures on a wide array of indicators, as the 2014 Climate Change in Colorado Report describes.

Colorado is accustomed to dealing with variability and drought over the last 150 years, yet tree ring-reconstructed streamflows indicate that the state has endured longer-lasting and more severe droughts than we have seen in our relatively brief, observed record. In fact, the 20th century is unique in that during that time, Colorado experienced two prolonged wet periods and no multi-decadal droughts.[20] Figure 4-8 shows multiple droughts (shaded highlights) that exceed the intensity and duration of the state's observed record.

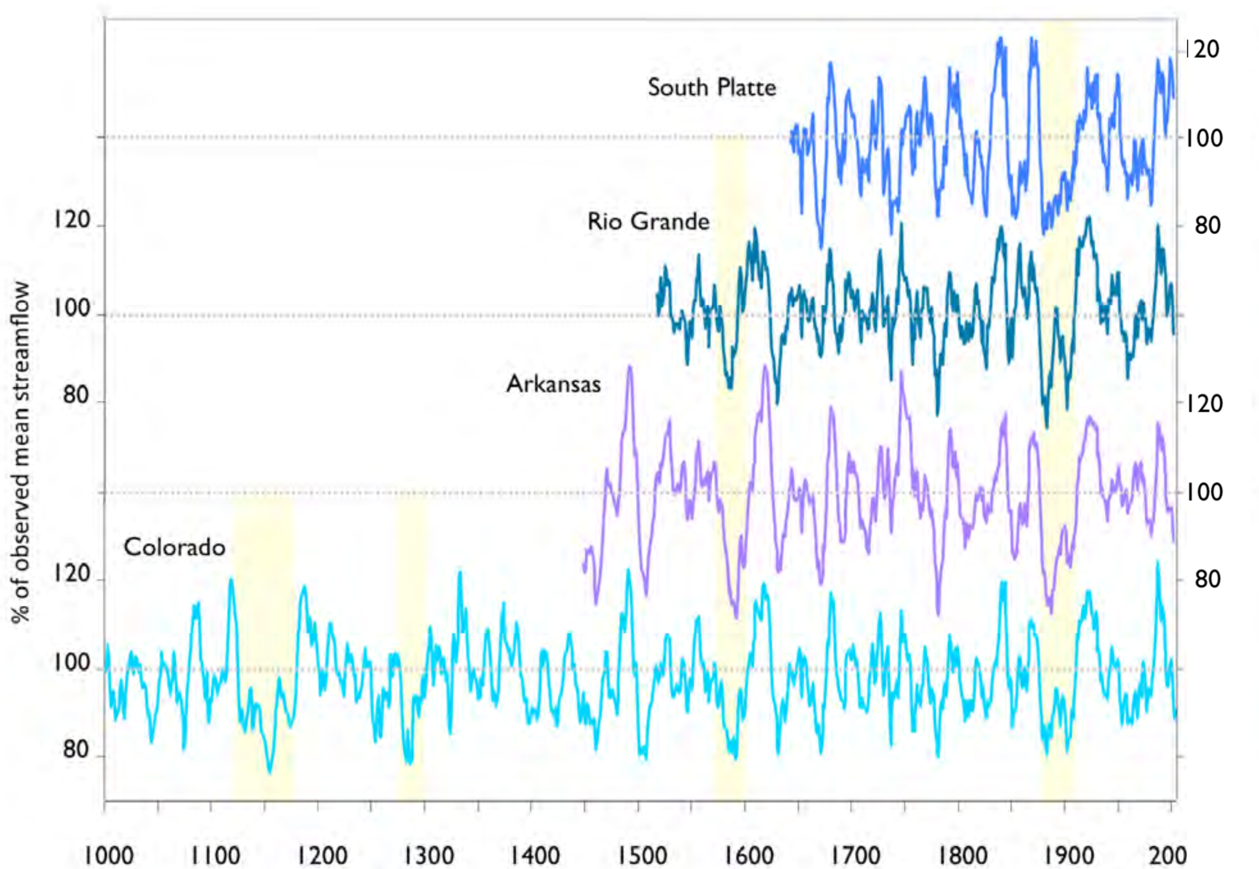
As Section 6.1 describes, the scenarios the IBCC developed will help the State prepare for whatever may unfold in the future. Three scenarios have a climate different from what was observed during the 20th century, including two scenarios that experience "hot and dry" conditions, and one that features a hydrology and climate described as "between 20th century-observed and hot and dry." Figure 4-9 (page 4-11) illustrates where these scenarios fall in comparison to the current climate, or the 20th century-observed climate.

TABLE 4-2 PROJECTED CLIMATE AND HYDROLOGY CHANGES[19]

INDICATOR	EFFECT OF CLIMATE CHANGE
Annual Streamflow	Decreases in most of the climate projections
Peak Runoff Timing	Earlier in all projections
Crop Water Use	Increases
April 1 Snowpack	Decreases in most projections
Palmer Drought Severity Index	More drought
Heat Waves	More frequent
Cold Waves	Less frequent
Frost-Free Season	Longer

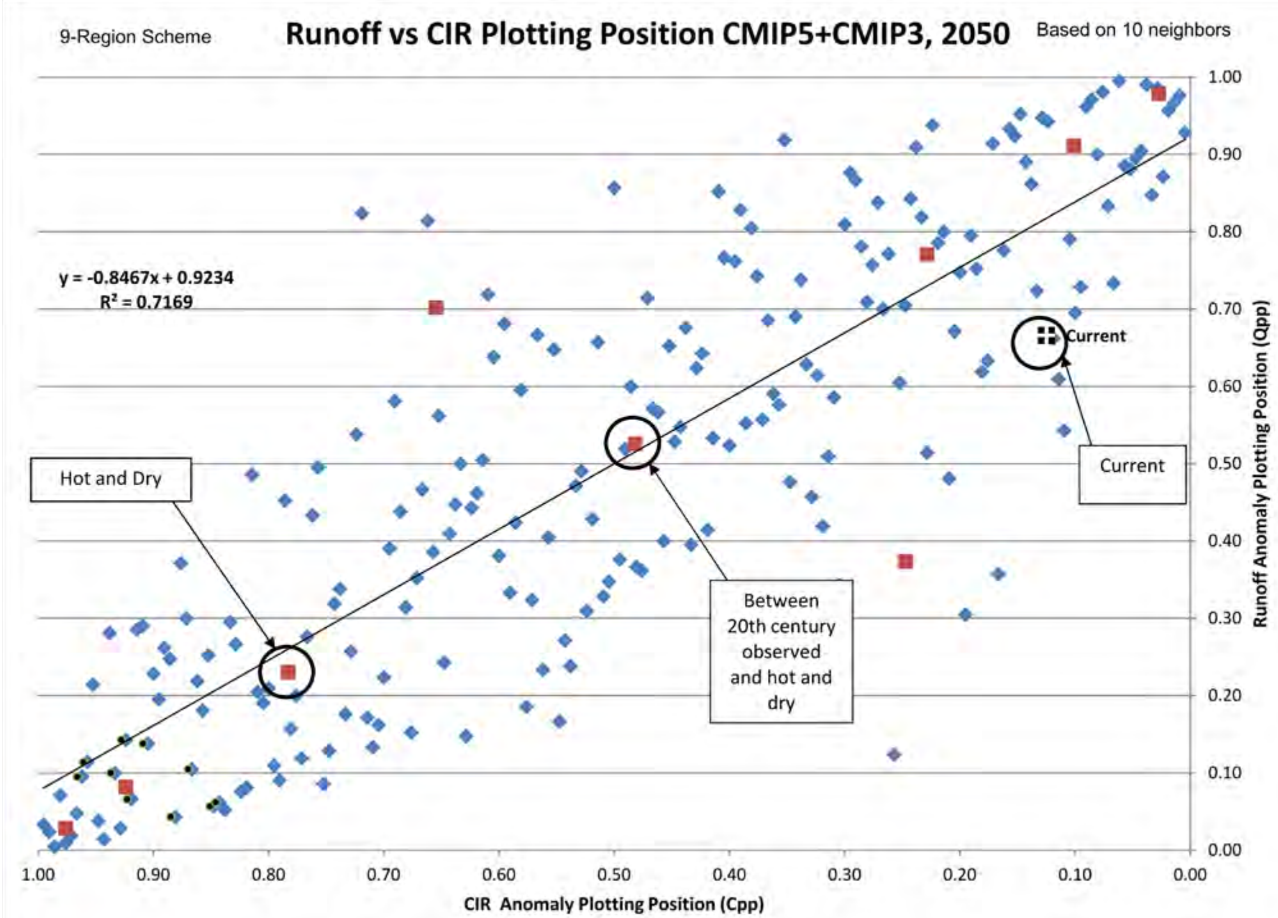
Having quantitatively defined the scenarios, the CWCB's technical team used the data to determine the effects on streamflow. Figure 4-10 (Page 4-13) illustrates projected depleted flows for the year 2050 in acre-feet per year at 11 different sites around the state. In some scenarios, projected flows are less than zero, indicating that some users, both senior and junior, would be unable to obtain their historical supply of water.[22] This analysis projects that both the Arkansas and Rio Grande Rivers will experience these conditions under both climate scenarios, and that the South Platte will experience these conditions under the "hot and dry" climate scenario. While these basins are accustomed to calls dating back well into the 19th century, climate change has the potential to substantially alter the amount of water available to even those with well-established senior water rights. Continued monitoring, research, and planning are critical to determining whether future supplies will fulfill future demands—and continue to fulfill *current* demands. The ability to successfully address these challenges will require collaboration and innovative solutions. In the ongoing efforts of the SWSI, the State will continue to examine the effects climate change may have on our water supplies and demands.

FIGURE 4-8 TREE-RING RECONSTRUCTED WATER-YEAR STREAMFLOWS FOR FOUR MAJOR RIVER BASINS IN COLORADO[21]



Tree-ring reconstructed water-year streamflows as percent of observed mean, showing the 10-year running average, for four gauges representing major Colorado basins: The Colorado River at Lees Ferry, Ariz. (762–2005, shown here from 1000–2005); the South Platte River at South Platte, Colo. (1634–2002); the Rio Grande at Del Norte, Colo. (1508–2002); and the Arkansas River at Salida, Colo. (1440–2002). All four records show the occurrence of droughts before 1900 that were more severe and more sustained than any modern droughts. The yellow shading highlights several notable multi-decadal paleodroughts in the mid-1100s, the late 1200s, the late 1500s, and the late 1800s. The 20th century was unusual in having two persistent wet periods and no droughts longer than 10 years. (Data: TreeFlow web resource; http://treeflow.info.)

FIGURE 4-9 PLOT OF RUNOFF CROP IRRIGATION REQUIREMENTS USING THE BUREAU OF RECLAMATION ARCHIVE



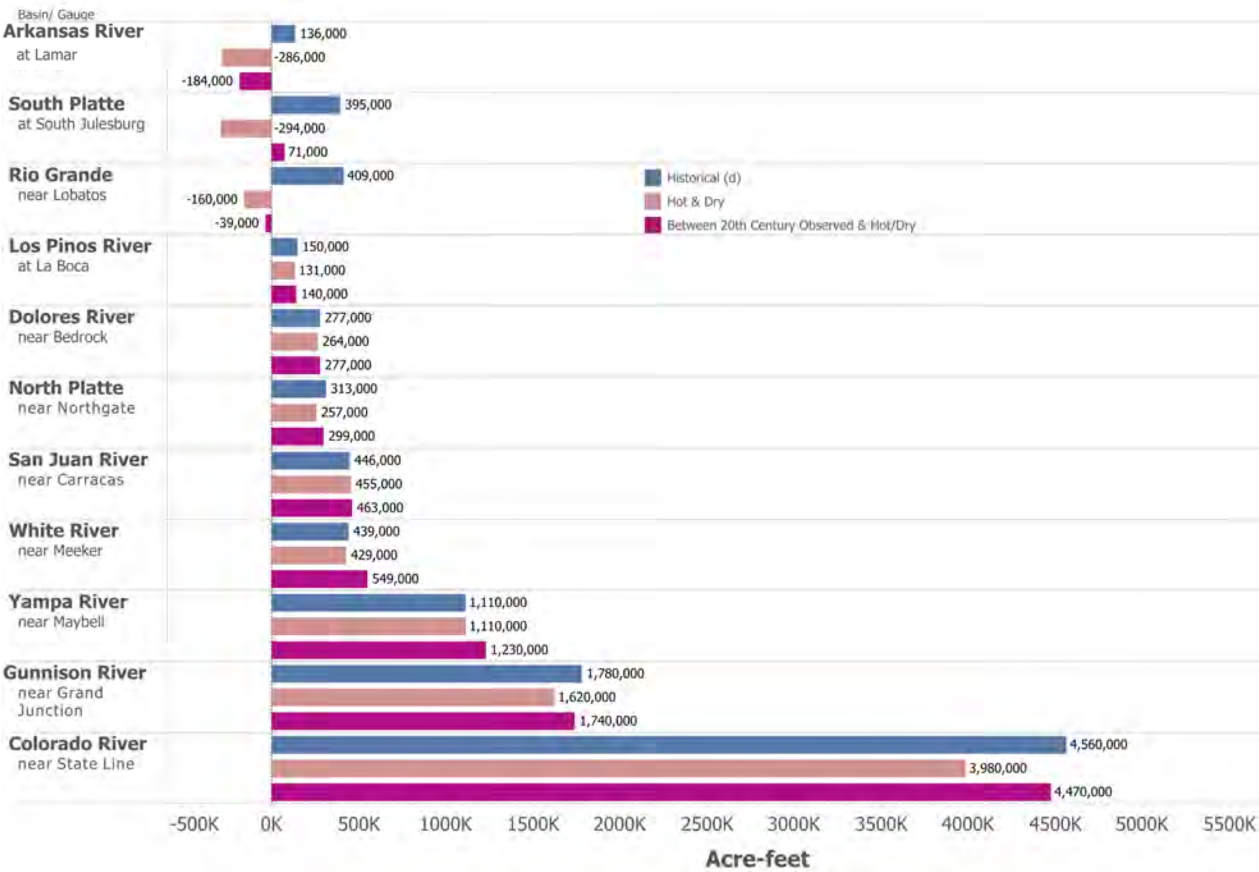
"Hot and dry" is defined as the 75th percentile of climate projections for crop irrigation requirements (water use), and the 25th percentile for natural flows. In other words, only 25 percent of projections have lower natural flows and 25 percent of projections have higher crop irrigation requirements. "Between 20th century-observed and hot and dry" is defined as the 50th percentile for both natural flows and crop irrigation requirements. This scenario represents the middle of the range in terms of severity. Historical or current conditions, which represents no change in runoff or in crop irrigation requirements, fall at roughly the 9th and 67th percentiles; this means that 91 percent of runs show increases in crop irrigation requirements and about two-thirds show reductions in runoff.

Additionally, Colorado's Water Plan will work in concert with the Colorado Climate Plan, which provides state-level policy recommendations and actions that help to improve state agencies' level of preparedness, while simultaneously identifying opportunities for agencies to mitigate greenhouse gas emissions.

In addition to the work the State conducted on climate change, several of the basin roundtables also incorporated uncertainties associated with climate change into their BIPs. Many basins now recognize that, because of climate change, previous assumptions used for planning purposes are no longer sufficient. For example, the Colorado Basin recognizes that while it historically relied on previously firm, dry yields, this is not a reliable source in the future, and therefore encourages water providers to update their master plans accordingly (and to consider implementing interconnected water systems to help mitigate the influences of climate change). The South Platte, Arkansas and Rio Grande Basins all recognize that they must plan for a decrease in water supplies because of the effects of climate change, and Rio Grande Basin expressed that it expects to see its water resources reduce by as much 30 percent in the next 50 to 100 years. In response, the Arkansas Basin is considering conjunctively using tributary and nonrenewable sources to alleviate the effects of reduced yields from climate change, as well as the potential dry-up of nontributary sources.

Colorado's snowpack melts and often feeds rushing streams like this one.

FIGURE 4-10 PROJECTED DEPLETED FLOWS FOR 2050 (ACRE-FEET PER YEAR)



Projected depleted flows for 2050 in acre-feet per year at 11 different sites around the state using the three classifications of historical, hot and dry, and between 20th century-observed and hot and dry.

Almost all BIPs specifically address the need to continue monitoring the effects climate change will have on Colorado's river basins. For example, the Gunnison Basin referenced throughout its plan the need to study the effects of climate change as a means to achieve its primary and complementary basin goals, and to identify actions to protect existing uses. *Research and Public Education on Anticipating, Mitigating and/or Adapting to Climate Changes* describes one approach the Gunnison Basin proposes for meeting this goal. Several other basins identified education and outreach as goals. For instance, as a way to better refine its present and future water planning efforts, the Southwest Basin committed to educating its roundtable members about climate change.

Several basins, including the South Platte/Metro, Yampa/White/Green, Arkansas, and Southwest, incorporated into their own planning processes certain scenarios or projected and potential effects of climate change. As basin and communities continue to examine the effects of climate change on their water supplies, the CWCB will offer technical support as appropriate.

Dust-on-Snow Events

"Dust-on-snow" events also introduce a level of uncertainty into managing water supplies. Dust-on-snow events occur when wind deposits dust from southwestern deserts (and other loose-soil surfaces lacking vegetation) onto mountain snowpack. This increases the effect of solar radiation, which speeds up snowmelt and leads to earlier spring runoff. Studies have shown that dust events can advance snowmelt timing, enhance snowmelt runoff intensity, and decrease snowmelt yields.[23] Dust-on-snow events can result in peak runoff three weeks earlier than normal. This shift is independent of climate change, which may also result in earlier snowmelt patterns.[24] Since 2005, when dust-tracking began, 91 dust-on-snow events have occurred. Ten of these events occurred in 2013, when Colorado observed the heaviest deposition to date.[25]

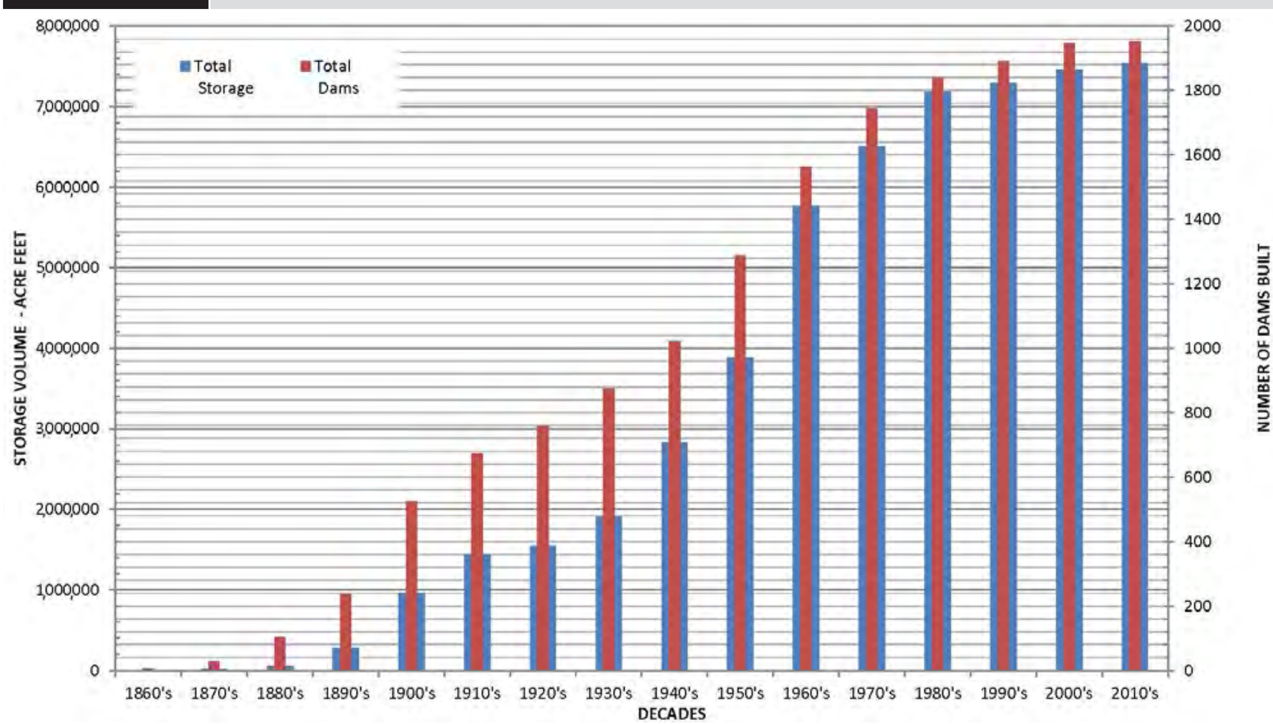
The severity of future dust-on-snow events is uncertain. Nevertheless, if events continue at recently observed rates, they will affect Colorado's present and future water supply by decreasing flows by 5 percent, on average. On the Colorado River, this reduction would result in a decrease of 750,000 acre-feet of water, or twice the amount of water the City of Denver uses annually.[26]

The Role of Storage

While snowpack is Colorado's greatest storage "facility," the State has taken measures to meet the year-round needs of agriculture, municipalities, recreation, and the environment. This includes the construction of numerous reservoirs to hold water during plentiful times and to release water during heightened demand or periods of drought. Nearly half of Colorado's storage capacity is located on the western slope in the Colorado River Basin and its tributaries.[27] Colorado's total storage capacity is approximately 7.5 million acre-feet within 1,953 reservoirs (Figure 4-11), and approximately 4.2 million acre-feet of the state's total storage is located in 113 federally owned reservoirs.

Colorado's water infrastructure, including water storage, is critical to the ability to maintain stable water supplies; water storage infrastructure allows Colorado to use its legal entitlements before water flows out of the state. In addition, water storage infrastructure is essential in assisting with flood control; supporting all types of use—including agricultural, environmental, municipal, and industrial—in periods of drought; complying with interstate compacts; and augmenting stream systems to allow water use by water users that would otherwise not have a right to divert under the prior appropriation system. Most storage

FIGURE 4-11 COLORADO DAM AND RESERVOIR CUMULATIVE CONSTRUCTION AND STORAGE HISTORY



Dust on snow can speed up the snow melting process.

projects, however, were developed in the middle of the last century, and the construction of both new infrastructure and storage has remained relatively static over the last 30 years (Figure 4-12). In fact, construction of storage has declined so much that Colorado's current rate of building storage capacity resembles that of the Great Depression.

While storage is a critical element for managing Colorado's future water supplies, new storage projects may be contentious and face numerous hurdles, including permitting and funding. In many cases, it may be more practical and efficient to reallocate or enlarge an existing dam and reservoir than to build a completely new structure. In determining whether a reservoir is suitable for enlargement, one must consider the legal and physical availability of excess water that can be stored (including the legal and physical availability of water through exchange). The suitability of the structure from a construction and operations standpoint, interstate compacts, and environmental benefits and threats, must also be taken under consideration.

Given these factors, basin roundtables and the IBCC have begun to address the water supply challenges ahead by emphasizing the role of multipurpose projects. These types of projects take into account multiple users and multiple benefits, and diverse interests become involved during the planning process. In planning for Colorado's water supply future, it will be important to enable these types of collaborative approaches to new storage projects, elicit proposals for the enlargement of existing reservoirs and dams, and consider the potential for alluvial and bedrock aquifer storage. Section 6.5 further discusses the future development and implementation of projects and methods with a storage component.

The Colorado DWR's dam database contains information that is useful in examining enlargement potential for existing reservoirs and dams. This includes data about the volume of water a reservoir can hold when filled to the normal high water line, and the volume of water that would be present if the reservoir were filled to its capacity. The "storage delta" is the difference between the volumes of normal storage and maximum storage. For many reservoirs, the storage delta is "flood storage" that is needed for containing floods' flows and, therefore, is not available for storage enlargement. Nevertheless, advances in meteorology, hydrology, and dam engineering make it possible to reassess reservoirs and potentially use existing flood storage for active storage. The portion of the reservoir associated with the storage delta has the largest surface area; therefore, a relatively small increase in the water surface elevation will result in a large increase in water storage capacity. For example, at John Martin Reservoir, an increase of one foot in the normal high water line results in an increased storage capacity of nearly 9,000 acre-feet.[b]

Further, an existing reservoir is understood to have the potential to inundate a known land area that includes the area associated with its maximum capacity. Therefore, a reservoir with a large storage delta can expand its additional storage capacity without increasing the area that is potentially inundated, thereby minimizing the associated environmental effects.

FIGURE 4-12 COLORADO DAM AND RESERVOIR CONSTRUCTION HISTORY AND VOLUME BY DECADE

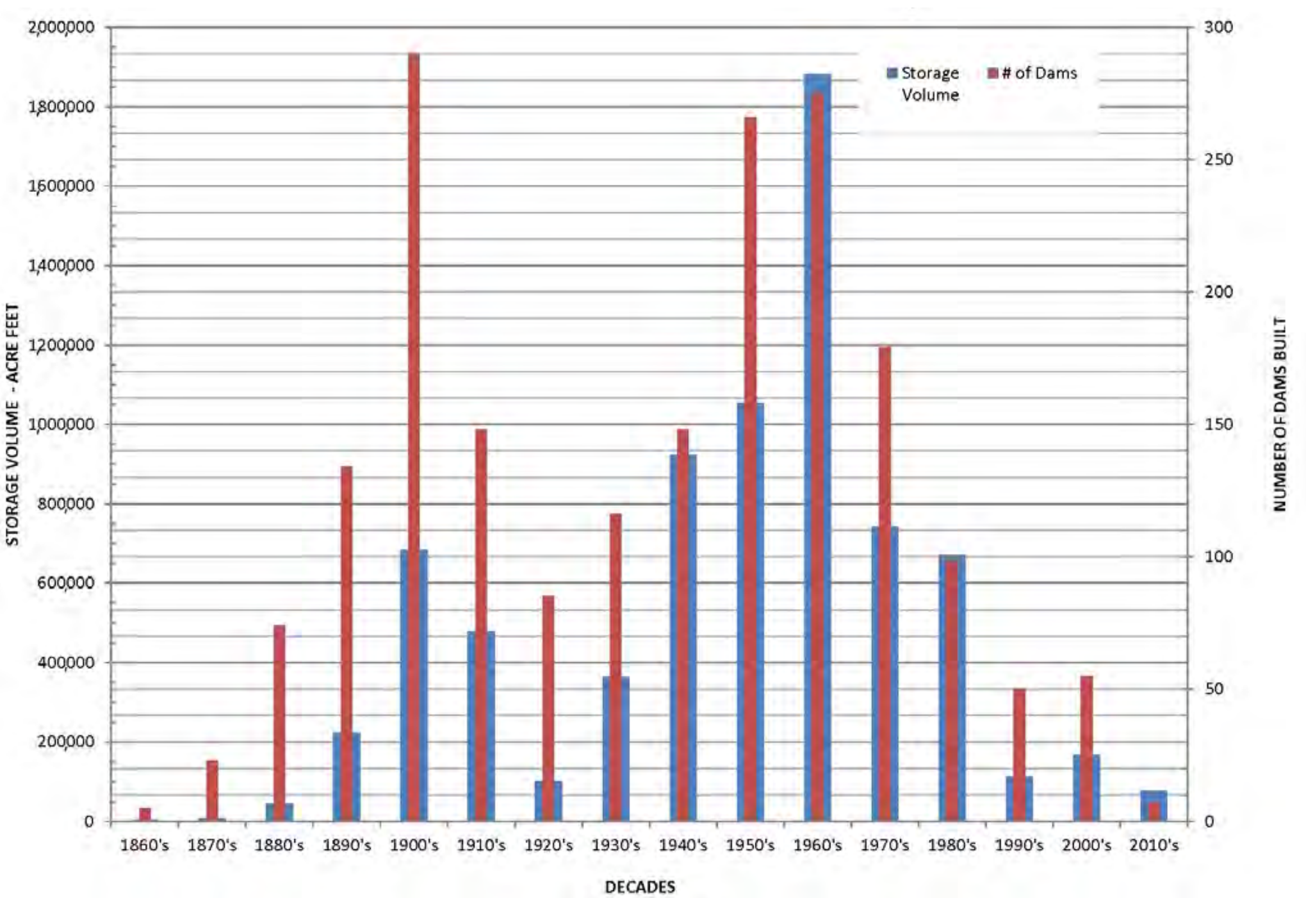
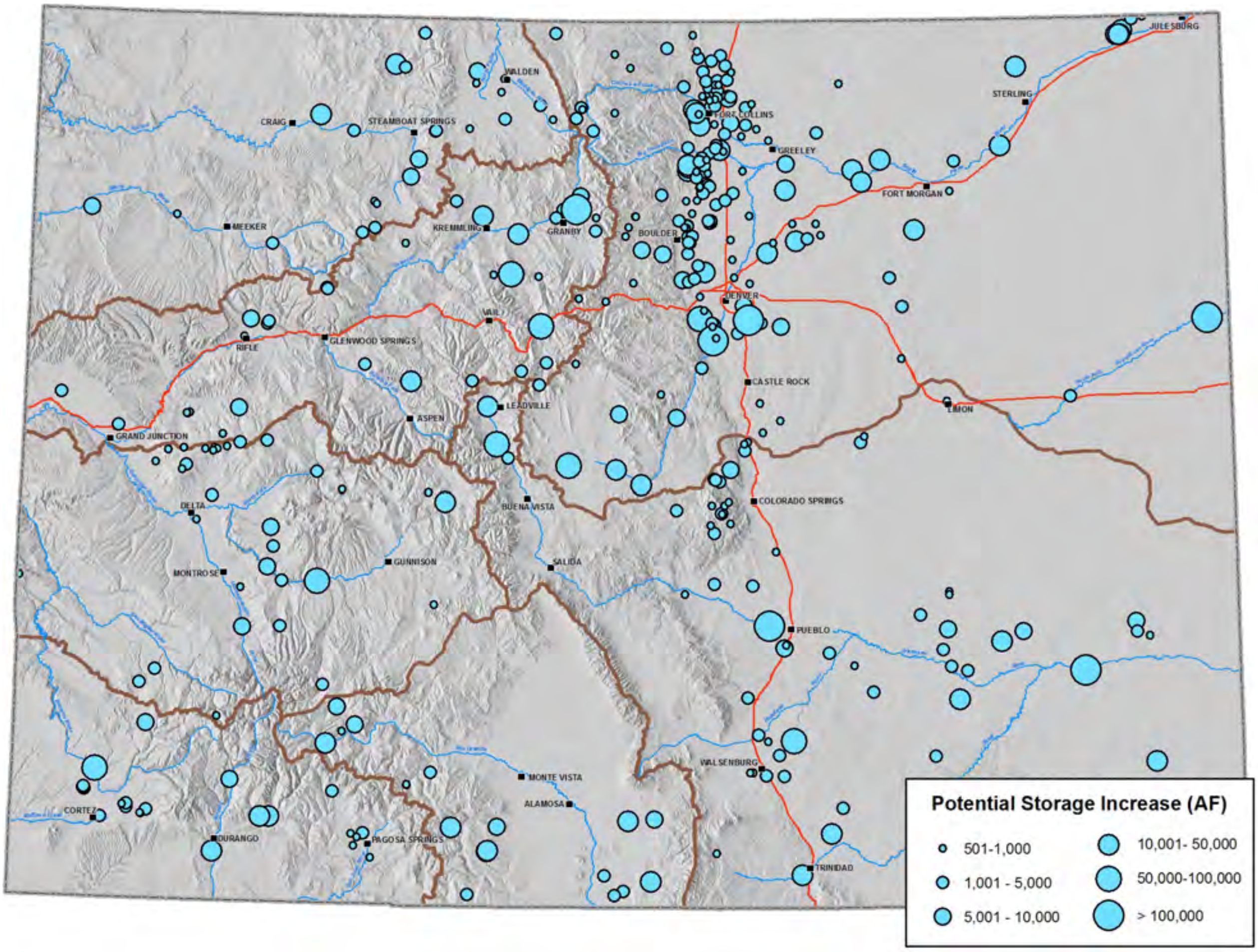


Figure 4.12 does not include storage capacity associated with flood-control reservoirs because storage capacity for flood control can be used on only a limited basis for water supply storage.

[b] This table shows potential reservoir-storage increase. Agreements, interstate compact obligations, and other constraints—notably the unavailability of flood storage and the need to retain freeboard for dam safety purposes—may make the potential increase unusable.

FIGURE 4-13 **POTENTIAL STATEWIDE RESERVOIR STORAGE INCREASE BASED ON STORAGE DELTA FACTOR ONLY**



The dams database contains information about maximum storage, normal storage, and surface area for reservoirs. One can use that information to create a list of reservoirs that have a large storage delta and, therefore, have potential for enlargement. While it is not the only indicator regarding the potential for enlargement, a large storage delta is a threshold criterion. Therefore, one approach for investigating the potential for enlarging storage infrastructure would be to query all 1,900 jurisdictional dams in the database and create the list of reservoirs with a large storage delta—then eliminate reservoirs whose storage delta is associated with necessary flood storage capacity.

In general, the federal BOR and the U.S. Army Corps of Engineers own the reservoirs with the largest storage delta. The BOR reservoirs are primarily for storage of project waters, not for flood storage. Conversely, the U.S. Army Corps of Engineers dams are dual purpose; they have the largest storage deltas because they include dedicated flood storage capacity.[28] After eliminating from the list reservoirs for which the storage delta is associated with necessary flood storage capacity, one would further examine the list according to the factors described above. Figure 4-13 illustrates geographic distribution of the dams by the range of existing potential storage.

Weather Modification

Weather modification, also known as cloud-seeding, increases available water supplies. The World Meteorological Organization has stated that well-designed, well-executed weather modification programs have demonstrable results; furthermore, these programs have no documented, negative environmental effects from the use of silver iodide for cloud-seeding.[29] With seven permitted, ground-based, wintertime cloud-seeding programs, Colorado is a leading state for weather modification activities. The goal of these programs is to increase snowpack and streamflow. In comparison to other sources of new water, cloud-seeding is a relatively low-cost means of increasing system supplies. The recreation sector, especially the ski industry, relies heavily on cloud-seeding. Because of prolonged water supply shortages in the Colorado River Basin, the CWCB in 2006 signed agreements with the New Mexico Interstate Stream Commission, California Six Agency Committee, Southern Nevada Water Authority, and Central Arizona Water Conservation District to collaborate and financially support cloud-seeding in Colorado. Additional information on weather modification efforts within the state is available on the Weather Modification Program pages of the CWCB website.[30]

Water Quality

Water quality and water quantity are inextricably connected, and understanding water supply and demand alone creates an incomplete picture. Enough water with suitable quality for irrigation, drinking, recreational activities, and the protection of aquatic life must be available for use. This section briefly outlines some of the key connections between quality and quantity, while Section 7.3 provides a more detailed discussion.

According to the 2012 Integrated Report, for the reporting period 2010-2011:

- 65 percent of river- and stream-miles and 28 percent of lake and reservoir acreages statewide attain water quality standards.
- For 25 percent of river- and stream-miles and 49 percent of lake and reservoir acreages statewide, data are insufficient for determining whether these bodies meet water quality standards.
- 10 percent of river- and stream-miles and 23 percent of lake and reservoir acreages statewide are not meeting water quality standards for one or more pollutants (i.e., they are impaired water bodies).[31]

Over the past 40 years, Colorado water quality management programs have ensured clean water for uses such as growing crops, providing drinking water, and enjoying water-based recreation. These programs benefit all Coloradans, because clean water is essential to the state's healthy environment, diverse economy, and quality of life. This is why both protecting and restoring water quality are fundamental to supporting Colorado's water values and implementing Colorado's Water Plan.

Water supply decisions must include water quality management considerations in order to enable the State to sustain and improve existing statewide water quality conditions. Section 7.3 provides a more specific discussion about the relationships between water quality and quantity.

Cloud seeding can help to ensure Colorado enjoys a healthier snowpack for recreational activities like skiing.

A LOOK AT HISTORY

Both the Great Depression and the Dust Bowl gripped eastern Colorado in the 1930s, with dust storms often blotting out the sun. This 1937 dust cloud in Prowers County was typical. source: University of Oklahoma, Western History Collection.

caption: Thomas V. Cech, J William McDonald, Defened and Develop: *A Brief History of the Colorado Water Conservation Board's First 75 Years,* [Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

1 U.S. Census Bureau, "Statistical Abstract of the United States; Table 366. Extreme and Mean Elevations by State and Other Areas," (2012). https://www.census.gov/compendia/statab/2012/tables/12s0366.pdf.

2 U.S. Geologic Survey, *Water Fact Sheet: Largest Rivers in the United States,* (USGS, 1990). http://pubs.usgs.gov/of/1987/ofr87-242/pdf/ofr87242.pdf.

3 B. Harding, "DRAFT Technical Memo: SWSI Climate Impact Support, Development of Projected Gauged Flows," October 8, 2014. http://cwcbweblink.state.co.us/weblink/0/doc/196326/Electronic.aspx?searchid=dc2702e2-4f8c-4a0b-b693-11fe220e6340

4 B. Harding, "DRAFT Technical Memo: SWSI Climate Impact Support, Development of Projected Gauged Flows," October 8, 2014. http://cwcbweblink.state.co.us/weblink/0/doc/196326/Electronic.aspx?searchid=dc2702e2-4f8c-4a0b-b693-11fe220e6340

5 Colorado Geologic Survey, "Groundwater," 2014, http://coloradogeologicalsurvey.org/water/groundwater/.

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Water Demands

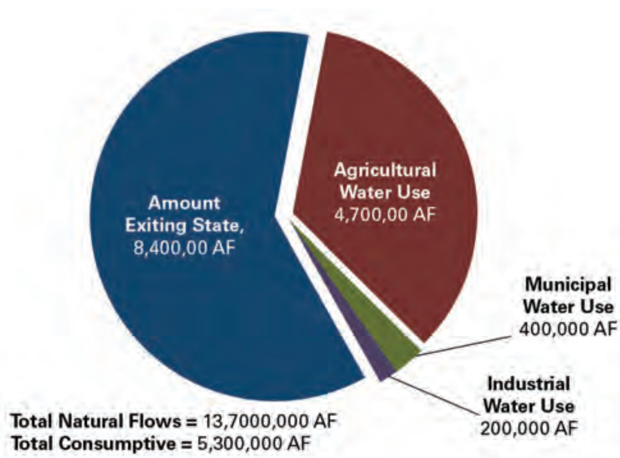
Chapter 5 provides an overview of Colorado's current and projected municipal, industrial, agricultural, environmental, and recreational uses of water. To assess the road ahead, it is essential to understand the many ways in which Coloradans use water throughout the state and how these uses are connected. As M&I needs expand, pressure on agriculture, the environment, and water-based recreation rises. And as the state grows, associated municipal-supply needs will likely increase, more people will seek the outdoor opportunities Colorado offers, and Coloradans will continue to increase their consumption of a variety of locally grown agricultural products that ranches and farms across the state provide.

A father leads his daughter through an agricultural field. Agriculture uses the most water of any industry in Colorado.

Overview

Water use is calculated in acre-feet, which is the amount of water required to cover one acre to a depth of one foot. An acre is about the size of a football field, including both end zones.

FIGURE 5-1 STATEWIDE CONSUMPTIVE WATER USE[1]



Colorado often uses water multiple times, as the following sequence demonstrates: 1) Water is diverted for a given use; 2) the plant, person, or process consumes a portion of the water; 3) the unconsumed portion of water makes its way back to the river (known as "return-flows"); and 4) other water users downstream subsequently use the return-flows, and the cycle repeats. On average, Colorado consumes 5.3 million acre-feet of water per year, but the state may use the water multiple times, as described above, with total diversions of 15.3 million acre-feet per year.

The total amount of water that originates within Colorado averages 13.7 million acre-feet per year. More than 60 percent of this water exits the state to downstream users. Less than 40 percent, or 5.3 million acre-feet, is consumed on average per year in Colorado.[2] Agricultural interests use 89 percent of consumed water, followed by municipalities, which use 7 percent, and large industries, which use 4 percent (Figure 5-1).[3] In addition to meeting the requirements of communities and food production, water is necessary to support aquatic- and riparian-dependent species, as well as boating, fishing, camping, and other water-based recreational activities.

Overview of M&I Water Needs

Summary of Municipal Water Needs

The State refers to water Coloradans need in their homes, yards, businesses, and small industry as "municipal water needs." One critical factor the State uses to quantify future water needs is population, and population projections rely on a multitude of economic trends. A vibrant economy, for instance, leads to the creation of more jobs and to an increase in the number of people staying in and moving to Colorado.[4] The CWCB determines water needs for municipalities by multiplying per-person water use by the number of additional people expected to live in Colorado, subtracting water conservation demand reductions, and adding any expected increases due to higher temperatures or commercial activities.[a]

Looking ahead to 2050, the future population within Colorado is difficult to accurately predict. For that reason, the State developed low, medium, and high population estimates (Figure 5-2). However, even under slow economic growth conditions, the State projects that most communities throughout the state will grow.5 Current indications show that Colorado has one of the fastest-growing state economies nationwide, Colorado received the top-growth ranking in some analyses.6 Under the high-growth scenario, the state's population could nearly double by 2050; some communities may grow moderately while others are expected to triple in size.7 Such growth will increase water demands.

Playing soccer on a grassy field. Parks and sports fields require a small percentage of Colorado's total water usage.

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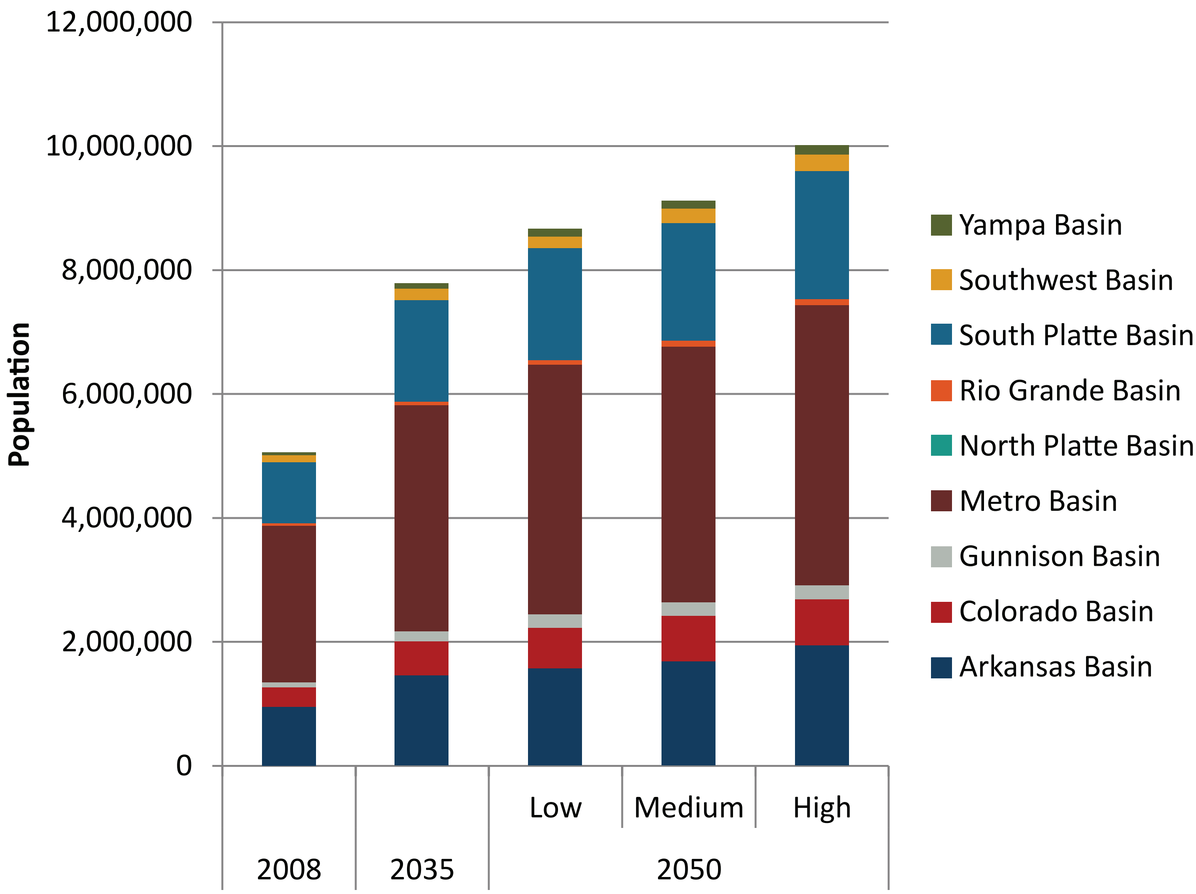
[a] For the purposes of the CWCB's technical work, conservation savings were divided into two categories. The first is passive conservation, which the CWCB used to reduce demand projections. Passive conservation results from the replacement of old indoor fixtures and appliances with newer, more efficient ones. Active conservation takes a concerted effort on the part of water providers and their customers. The CWCB treats this as a method to address the water supply gap. Section 6.3 examines ways to reduce demands through active conservation.

FIGURE 5-2 LOW, MEDIUM, AND HIGH 2050 POPULATION PROJECTIONS BY BASIN[8]



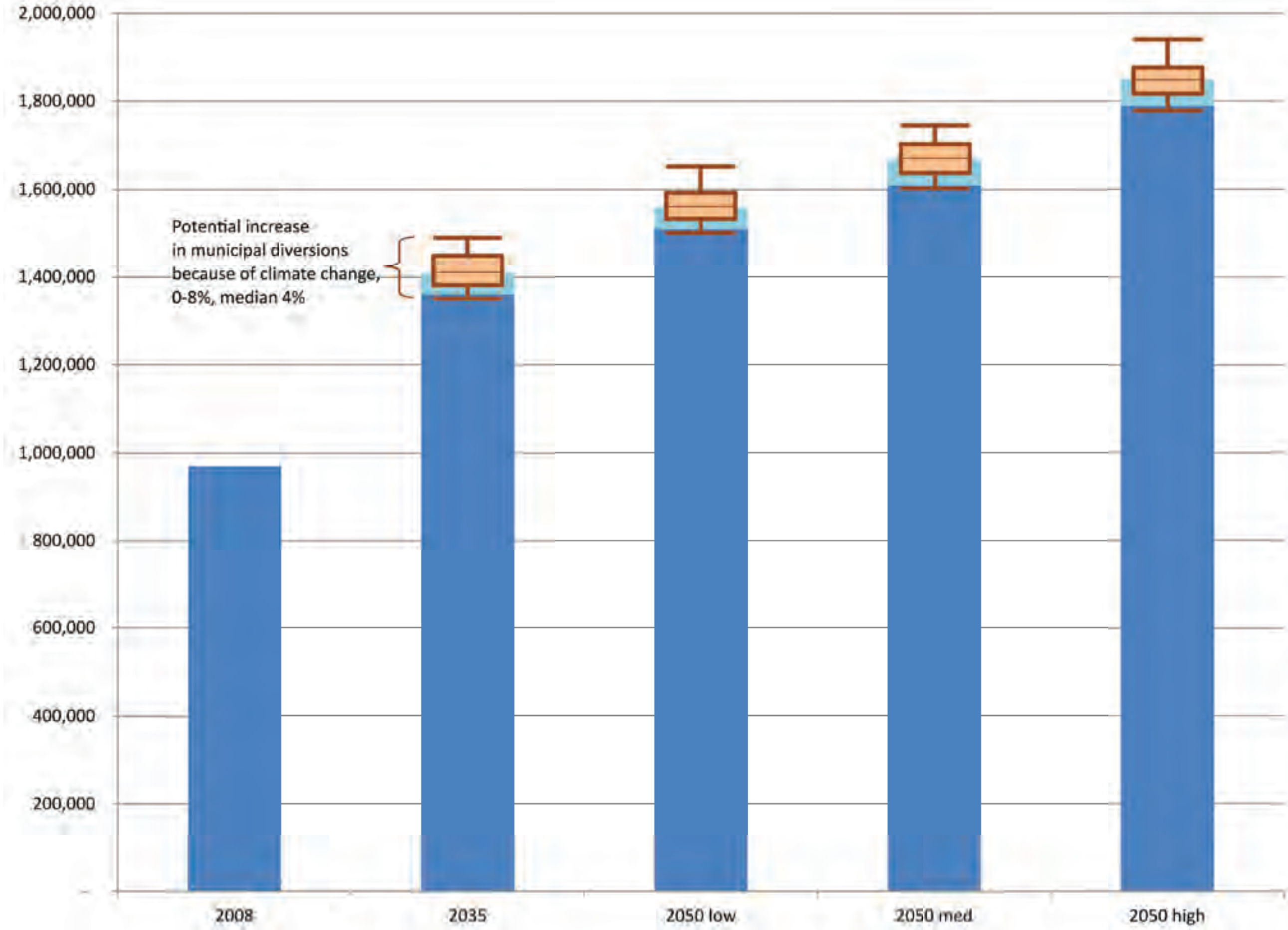
Colorado's growing economy leads to population growth in two primary ways. First, Coloradans have children who remain in the state as working adults and start their own families. With the birth rate exceeding the death rate, roughly half of the state's growth comes from residents born in Colorado.[9] Second, Colorado is a desirable place to live. A diverse and healthy economy, combined with vibrant communities, natural beauty, and a high quality of life, draw people and businesses to the state—and keep them here.[10]

As people migrate to Colorado to fill jobs, the population grows and changes, often driving further growth. For instance, with a growing elderly population, more people will require medical care. To serve this population, the state will need additional health workers, some of whom must come from out of the state.[11]

Looking forward, Colorado requires additional technical work in order to better inform the statewide discussion. The CWCB will update the SWSI 2010 technical analysis to take into account the length and severity of the recent economic recession and rebound.

Population projections from the DOLA indicate that even with the recent economic recession, the population may reach between 8.3 and 9.2 million people by the year 2050, compared to the current population of 5.2 million.[12] The CWCB is in the process of applying new water-use data to future population projections for low, medium, and high population scenarios. These data will result in updated water demand projections.

FIGURE 5-3 **PROJECTED MUNICIPAL AND INDUSTRIAL WATER DEMANDS (ACRE-FEET) WITH RANGE OF POTENTIAL CLIMATE CHANGE INCREASES**



Colorado's current municipal diversions total approxknj jhcfgdtreimately 970,000 acre-feet annually (Figure 5-3).[13] Municipal use is split among indoor use, outdoor use, and water loss in distribution systems. Statewide, Colorado municipalities on average use 53 percent of their diversions indoors and 39 percent outdoors. The remaining 8 percent is not metered, and goes to fire protection and maintenance or is lost due to leaks in distribution systems (Figure 5-4).[b] One may further divide these numbers among residential, park, and commercial uses.

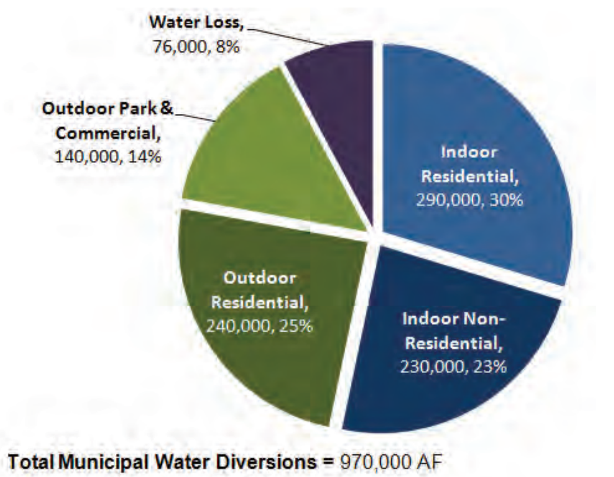
Population growth in Colorado is inevitable, but state and local governments can influence how and where the population grows, and how much water is needed to support such growth. Section 6.3 further discusses strategies for making that happen. Climate change could also increase municipal needs as outdoor landscapes adapt to longer growing seasons, higher temperatures, and higher rates of evapotranspiration. The State expects the effects of climate change on total annual municipal diversions to range from no-effect to up to an 8 percent increase (Figure 5-3).[14] If Colorado experiences a future in which the population rises while the climate becomes hotter and drier (a scenario known as "hot growth"),[c] the state could need nearly 1 million acre-feet of water per year by 2050, well beyond the 2008 demand levels.[16] However, if Colorado experiences weak population growth matched with historical temperature conditions, the additional annual demand for water beyond 2008 levels is approximately 600,000 acre-feet.[17]

[b] Water loss is defined as the difference between system-input volume and metered consumption, and consist of apparent losses plus real losses.

[c] This scenario is also known as the "hot growth" scenario in the IBCC scenario-planning work, which has hot and dry climate matched with high population growth.

The degree to which climate change could affect municipal demands varies considerably across the state due to differences in the amount of outdoor irrigation, potential temperature increases, and potential changes in precipitation patterns.[18] Increases in demand due to climate change do not take into account potential hydrological changes, which could further decrease municipal supply, thus exacerbating future municipal needs, as Chapter 4 discusses.

FIGURE 5-4 **STATEWIDE MUNICIPAL-USE PATTERNS**[15]



While climate change has the potential to intensify municipal needs, water conservation, reuse, and land-use planning have the potential to attenuate them. As Section 6.1 describes, no matter the future that Colorado faces, the state will need a substantial amount of conserved water to ensure that there is enough water to meet Colorado's needs.

State of Knowledge on Water Conservation

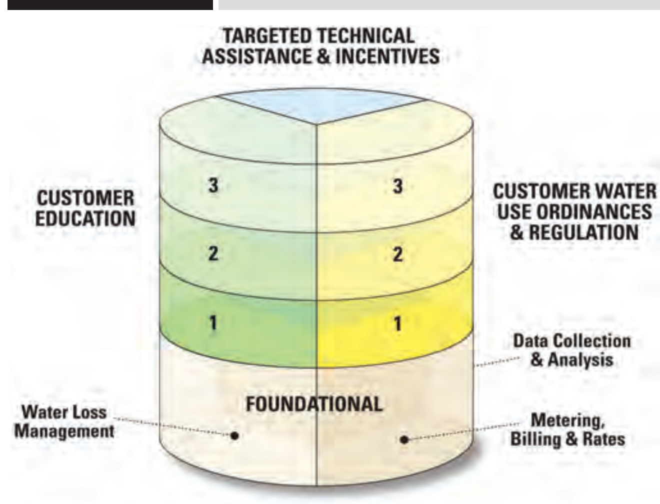
Colorado communities plan to build upon the success of existing conservation and efficiency programs to further reduce per-person water needs. Since the year 2000, Colorado as a whole reduced per-capita demands by 20 percent—even by as much as 30 percent in some communities.[19] To continue this trend, Colorado must implement additional best practices.

In 2010, the CWCB funded the first *Best Practices Guidebook for Municipal Water Conservation in Colorado.* Colorado WaterWise created the guidebook with a large technical and stakeholder group, and established 14 best practices that outline the potential benefits and costs for active water conservation measures, and for indoor, outdoor, residential, and non-residential practices. The guidebook provides a menu of options that water providers can select and add to their water conservation programs. The best practices require financial and human resources to accomplish, and implementation varies greatly among water providers.[20]

The CWCB created the levels-analysis framework, and prioritized the best practices a local water provider can use to achieve its goals. The levels analysis focuses on foundational practices first, and then outlines practices with varying degrees of difficulty. These practices are organized into three categories: technical assistance and incentives, local ordinances, and education (Figure 5-5). This analysis will help water providers focus their human and financial resources on the most cost-efficient activities first (those that save the most acre-feet or reduce resource expenditures), and later expand to pursue the more difficult and costly activities.[21]

Using the best practices as a basis, the SWSI 2010 estimated low, medium, and high strategies for active water conservation savings. Active water conservation is water conservation that occurs due to the enactment of programs at the local level, where financial and human resources commit to carrying out water

FIGURE 5-5 **STATEWIDE WATER SUPPLY INITIATIVE LEVELS ANALYSIS FRAMEWORK**



efficiency programming. Depending on the level of projected savings, varying amounts of effort are required to achieve penetration rates consistent with the savings estimates. The SWSI 2010 M&I Water Conservation Strategies report states:

"If water conservation is to be part of Colorado's future water supply portfolio, it must be supported and funded like other supply initiatives. To obtain the savings forecast in this report, the strategies described must be rigorously implemented at the state, regional, local, and customer level. Water is saved by municipal customers, but customers can be aided in the effort. State polices that promote conservation-oriented rates, water loss control measures, water efficient landscape and building standards, improved plumbing codes, and education and outreach set the stage for regional and local conservation program measures that target high demand customers and ensure new customers join the water system at a high level of efficiency."

The total potential savings in SWSI 2010 range from 160,000 to 461,000 acre-feet statewide in 2050 (Figure 5-6).[22]

Even at the highest level of conservation savings, individual water utilities still maintain considerable flexibility. For instance, under high-conservation savings, 50 to 80 percent of utilities statewide will need to implement targeted audits for customers that use high amounts of water on their landscapes (Table 5-1). This practice makes the most sense for water providers whose customers and commercial properties have large lots and outdoor space. By following best practices, water providers can get favorable results while implementing audits in ways that make sense for the utility. Furthermore, high conservation levels still allow for attractive landscapes that include grass, parks, and trees that maintain property values and continue to mitigate increased urban temperatures. Efforts to address outdoor water conservation must balance the vital importance of urban landscape with the benefits of conservation, including improved air, surface water and groundwater quality; increased property values; improved aesthetics; and an enhanced general quality of life.

The IBCC and CWCB identified a minimum of low to medium levels of active water conservation practices as a "no-and-low regret." Section 6.1 further describes this. In addition, the CWCB adopted an aspirational goal of 400,000 acre-feet in water conservation savings identified by the IBCC. This is equivalent to medium to high levels of savings. Section 6.3 describes this further.

Not all conservation savings can or should be applied to meet future growth. Not every municipality that conserves water will need all of that water to meet future growth, and legal barriers restrict water providers from sharing conserved water. Furthermore, most entities do not have the infrastructure to either share water or re-time conserved water in order to make it available for use. Additionally, some entities may choose to use conserved water as part of their strategic drought reserve. The roundtables' initial estimates indicate that Colorado water providers could use between 50 and 60 percent of conserved water to meet future growth.[23]

In addition to active conservation savings, an additional 150,000 acre-feet of savings will likely accrue by 2050 due to natural replacement of fixtures and appliances.[24] These passive water conservation savings occur when home and property owners replace their indoor water fixtures and appliances. Their choices save water as a result of large-scale regulatory or legislative initiatives, such as the Energy Policy Act of 1992 (1992 EPACT). Passive water conservation

FIGURE 5-6 **POTENTIAL WATER SAVINGS FOR 2030 AND 2050 IN THE STATEWIDE WATER SUPPLY INITIATIVE 2010**

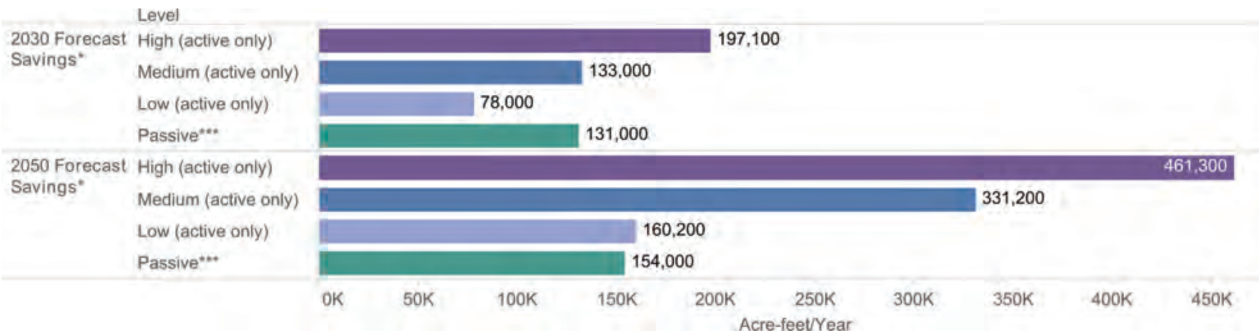


TABLE 5-1 COMPARISON OF 2050 IMPLEMENTATION AND PENETRATION LEVELS FOR THREE CONSERVATION STRATEGIES AND DEMAND REDUCTION USED IN FORECASTS

MEASURE	Implementation or Penetration Level by 2050		
	LOW STRATEGY	MEDIUM STRATEGY	HIGH STRATEGY
System-wide Conservation Measures with Potential to Affect All Customers			
Public information and education	~100%	~100%	~100%
Integrated resources planning	~100%	~100%	~100%
Conservation-oriented water rates	~100%	~100%	~100%
Water budget-based water rates	<=10% of utilities implement	<=30% of utilities implement	<=50% of utilities implement
Conservation-oriented tap fees	0 - 5% of utilities implement	5 - 10% of utilities implement	<= 50% of utilities implement
Smart-metering with leak-detection	<=10% of pop.	<=50% of pop.	50 - 100% of pop.
Residential Indoor Savings and Measures			
Reduction in residential per capita indoor use	Res. Indoor gpcd = 40	Res. Indoor gpcd = 35	Res. Indoor gpcd = 30
Conservation-oriented plumbing and building codes, green-building, rules for new residential construction	30-50% of state affected	50-70% of state affected	70-100% of state affected
High-efficiency toilets, clothes washers, faucets, and CII equipment	Passive ~100%	Passive ~100%	Passive ~100%
Submetering of new multifamily housing	0%	~50%	~100%
Reduction in customer side leakage	33% savings: passive from toilet replacement	37% savings: passive from toilet replacement and active repairs	43% savings: passive from toilet replacement and active repairs
Non-residential Indoor Savings and Measures			
Reduction in nonresidential per capita indoor use	15% reduction	25% reduction	30% reduction
High-efficiency toilets, urinals, clothes washers, faucets, and showers	Passive ~100%	Passive ~100%	Passive ~100%
Conservation-oriented plumbing and building codes, green-building, rules for new nonresidential construction	30-50% of state affected	50-70% of state affected	70-100% of state affected
Specialized nonresidential surveys, audits, and equipment efficiency improvements	0-10% of utilities implement	10-50% of utilities implement	50-80% of utilities implement
*Landscape Conservation Savings and Measures			
Landscape water-use reductions (residential and nonresidential)	15% reduction	22-25% reduction	27-35% reduction
Targeted audits for high-demand landscape customers	0-30% of utilities implement	30-50% of utilities implement	50-80% of utilities implement
Landscape transformation of some high-water requirement turf to low-water requirement plantings	<=20% of landscapes	20-40% of landscapes	>50% of landscapes
Irrigation efficiency improvements	<=10% of landscapes	<=50% of landscapes	50 - 100% of landscapes
Utility Water Loss Control			
Improved utility water-loss control measures	<=7% real losses	<=6% real losses	<=6% real losses

*Landscape water demand reductions include the expected effects of urban densification.

can be considered a baseline of water savings that will occur naturally, and thus, Colorado includes this in demand projections. As customers replace their toilets, dishwashers, clothes washers, showers, and other water-using appliances, many will choose WaterSense- or EnergyStar-labeled fixtures and appliances, which use less water. Colorado may experience these savings sooner than expected because of recent legislation, such as Senate Bill 14-103. Section 6.3 describes this further.

Municipal Reuse

According to the SWSI 2010, the CWCB projects reuse of existing supplies to provide 43,000 to 61,000 acre-feet of water per year, which accounts for about 10 percent of the total projected yield from the IPPs.[25] The full use of reusable water supplies and efficient reuse of water will play an integral role in closing the supply gap.

Colorado water law defines which water supplies Colorado can reuse, and the extent to which the State can reuse each source. With limited exceptions, Colorado can legally reuse the following sources:

- **Non-native water:** In most cases, Colorado can reuse to extinction water imported into a basin through a transbasin diversion or a TMD. Such diversions account for a substantial quantity of the total reusable supply in Colorado.
- **Agricultural-municipal water transfers:** Agricultural transfers are generally available for reuse; however, the State limits reuse to the historic consumptive use of the original agricultural water-right decree. This includes water from a traditional purchase of agricultural water rights and from alternative transfer methods.
- **Nontributary groundwater:** The State allows reuse of nontributary groundwater.
- **Other diverted water:** Users may reuse any water right with a decreed reuse-right to the extent the decree describes.

Users may reuse these sources directly or indirectly. Directly, they may pipe the recycled water from the water reclamation facility to beneficial uses, such as non-potable irrigation sites or industrial uses. Indirectly, they may augment a surface water or groundwater body with reusable return flows and divert an equal amount of flow from a different point of diversion.[26]

The Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Commission (WQCC) developed Regulation 84, which guides the use of reclaimed domestic wastewater. This regulation currently authorizes the use of reclaimed water for landscape-related beneficial uses, such as non-potable irrigation (including single-family residential irrigation), and various commercial and industrial uses, such as cooling-tower use, dust control, soil compaction, mechanized street cleaning, fire protection, and zoo operations.[27]

Municipal Land Use

Land-use patterns affect how much water a community uses. Land-use tools, such as higher-density developments or tap-fee incentives for water-efficient developments, save water by increasing the efficiency of water distribution systems, limiting lawn size, and installing efficient indoor fixtures and appliances. The 2009 California Water Plan Update showed that a 20 percent increase in housing density could yield a 10 percent water savings,[28] and initial data from Colorado confirm these results in a technical memorandum.[29] Denser development can also enhance other elements that help define a community, such as transportation, open space, neighborhood design, and walkability. Best practices in landscape and irrigation may yield more benefits within a denser land-use environment than within a traditional, less dense environment. Because healthy urban landscapes enhance the livability of a city or town and are a crucial asset in urban populations, urban parks and landscapes will not disappear with denser urban development.

Large Industry

Colorado's large industries include beer brewing, snowmaking, energy and mining extraction, power generation, food processing, and a multitude of others. Collectively, these industries require approximately 200,000 acre-feet of water annually. Projections indicate that future large-industry needs could increase by 50,000 to 130,000 acre-feet per year by 2050. [30]

Future water planning efforts will incorporate additional analyses of industrial needs regarding water use associated with energy and extraction. Through statewide and basin-wide planning efforts, the CWCB will confirm existing data and update future uses. For instance, the Colorado and Yampa/White/Green Basin Roundtables conducted an Energy Development Water Needs Assessment Update, and have asked the CWCB to incorporate this work into future statewide planning efforts.[31]

Summary

Demand management strategies such as water conservation, water reuse, and land use will play a central role in reducing future municipal water demands. As this section has outlined, Colorado water providers have accomplished much work in the areas of demand management and alternative supplies. Additionally, innovative work is occurring across the United States and points to trends that Colorado may wish to follow. Section 6.3 describes next steps and future actions.

Overview of Agricultural Needs

Statewide, agriculture diverts 34 percent of the total amount of water originating within Colorado, which represents 89 percent of the total amount of water consumed. The CWCB estimates current agricultural consumptive use to be approximately 4.7 million acre-feet of water on an average annual basis.[32] However, taking into account crop irrigation requirements, current agricultural crops would use an additional 2 million acre-feet of water if a plentiful supply existed.[33] It is important to note, on the other hand, that some water shortages are due to management decisions in addition to physical or legal limitations on water supplies. The CWCB does not expect that every agricultural shortage can or should be met in the future.

CARL & CURRAN TRICK

NORTH PLATTE RIVER BASIN

Carl, a North Platte rancher and water leader, served on the Colorado Water Conservation Board. He is passing on the responsibility to help keep agriculture viable in Colorado to his daughter Curran, who is a water rights and natural resources attorney.

Carl Trick grew up in North Park, Colorado on the family's cattle ranch, and after leaving for a stretch to attend New Mexico University in Las Cruces, returned to manage the ranch where he raised his family and daughter, Curran. At the North Park Angus Ranch, Carl passed on to Curran an appreciation for the importance of water. Through ranching and working with multiple generations of the family, both Carl and Curran learned how important water is to agriculture's livelihood. Both have been involved in local, basin-wide and statewide issues and recognize how important our precious resource is in Colorado...

CONTINUED AT END OF CHAPTER

PROFILE

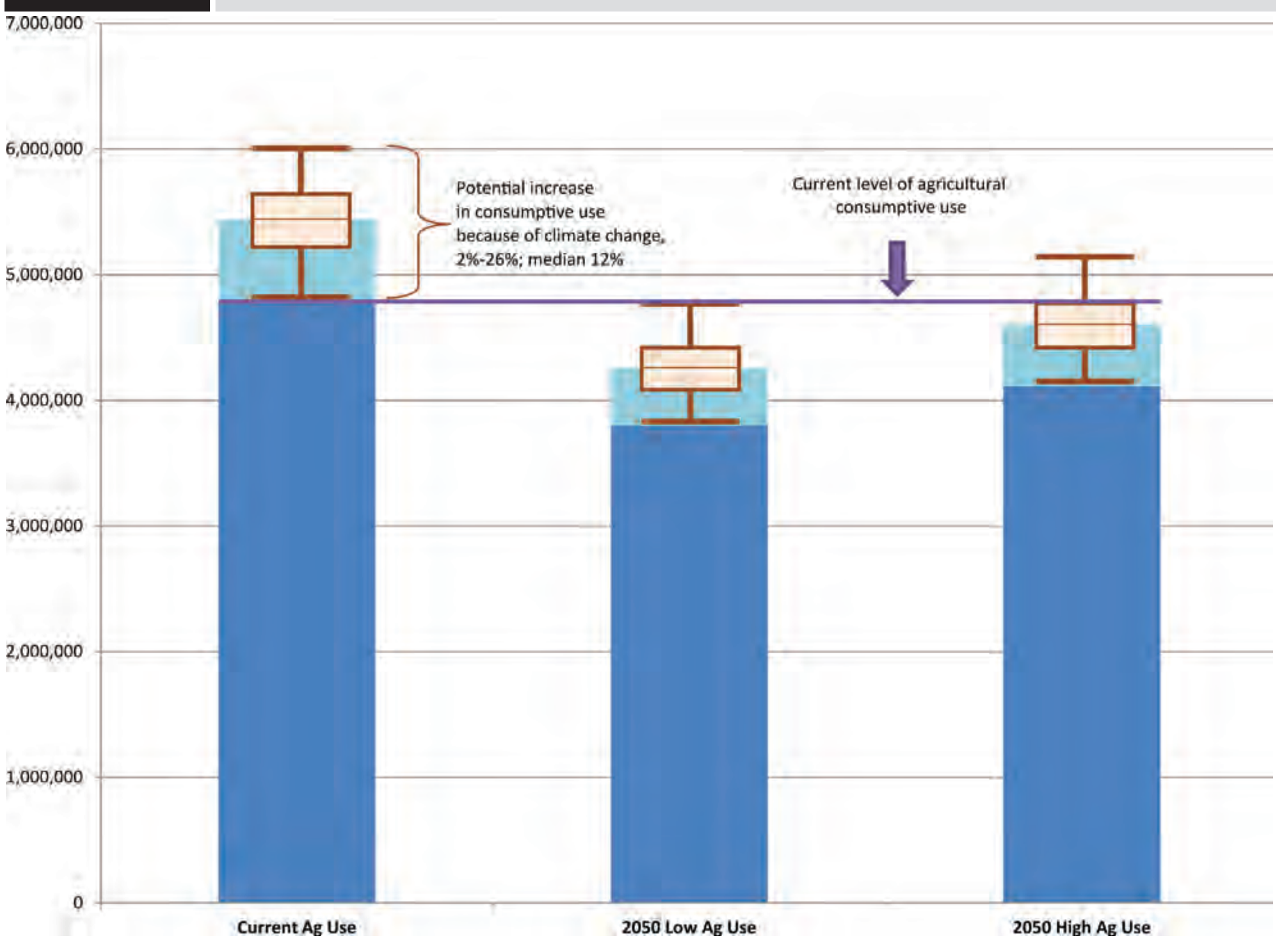
The CWCB expects statewide irrigated acreage to decline for a variety of reasons:

- Many municipalities turn to agricultural water rights as an affordable, reliable source of water, and purchase them from willing sellers.
- Developers purchase irrigated farmland to expand urban areas, thus urbanizing those agricultural lands.
- Due to aquifer sustainability and some compact-related issues, the South Platte, Republican, and Rio Grande Basins have reduced, or are in the process of reducing, irrigated acreage.[34]

TABLE 5-2 SUMMARY OF AGRICULTURAL GOALS INDICATED IN THE BASIN IMPLEMENTATION PLANS

BASIN	IDENTIFIED AGRICULTURAL GOALS
Arkansas	Increase amount of agricultural augmentation water by 30,000-50,000 acre-feet
Colorado	Reduce agricultural shortages
Gunnison	Reduce agricultural shortages by approximately 17,000 acre-feet
Metro/South Platte	Reduce agricultural shortages
North Platte	Add 28,000 acres of irrigated farmland; continue to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies
Rio Grande	Manage water use to sustain optimal agricultural economy throughout the basin's communities
Southwest	Increase agricultural efficiencies by implementing at least 10 projects
Yampa/White/Green	Add 14,000 acres of irrigated farmland; reduce agricultural shortages

FIGURE 5-7 PROJECTED AGRICULTURAL WATER DEMANDS (ACRE-FEET) WITH RANGE OF POTENTIAL CLIMATE CHANGE INCREASES



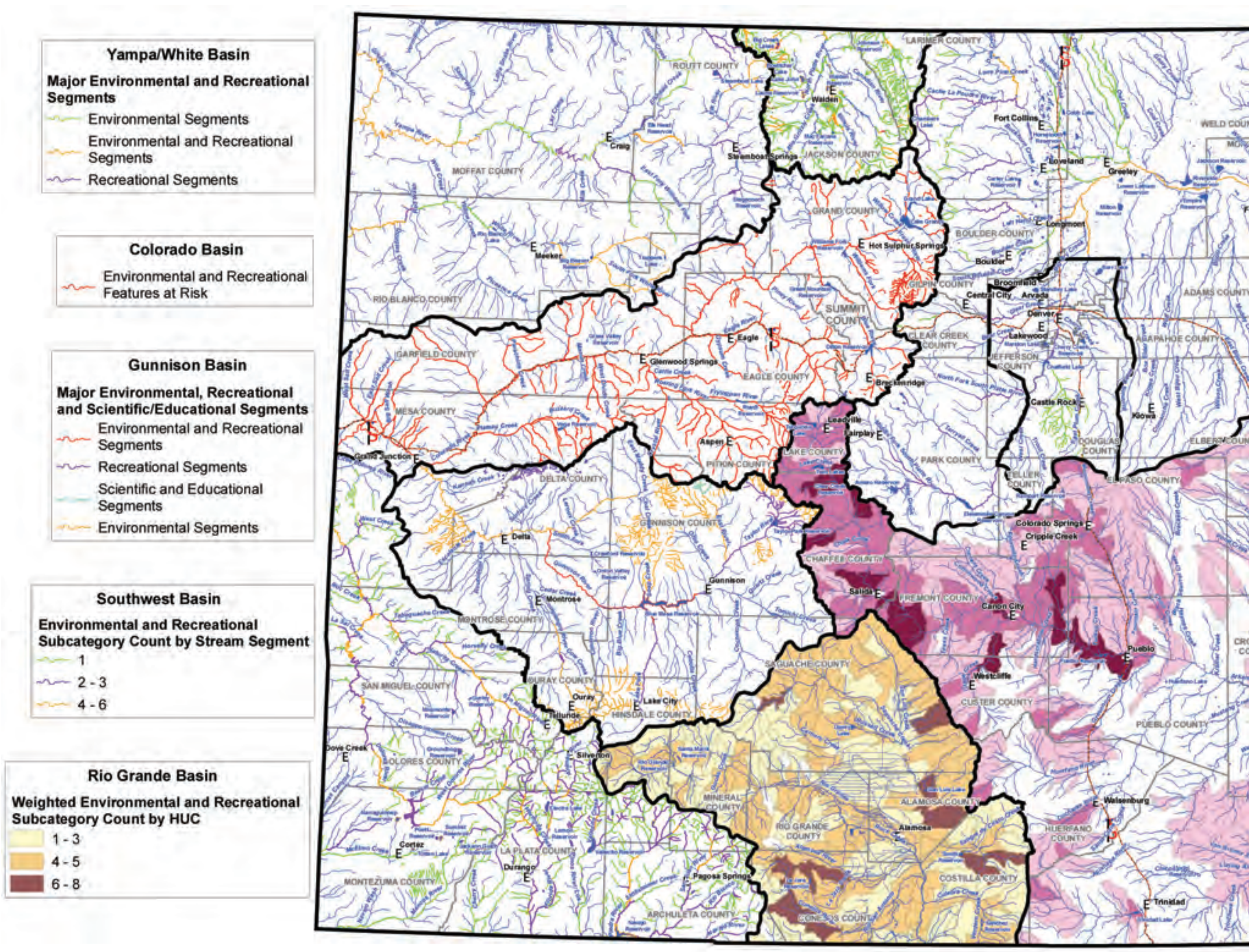
Watering vegetable seedlings with siphon tubes on Sakata farms in Brighton. Photo: M. Nager.

Irrigated acres could decrease from 3.5 million to 2.7 million acres statewide.[35] The potential effect is most pronounced in the South Platte Basin, where a decrease could remove as much as 35 percent of the irrigated acres from production.[36]

In addition to potential decreases in irrigated acres, climate change could further affect agricultural producers. Depending on the location, higher temperatures in the future could increase water consumption by 2 to 26 percent on lands that are still in production (Figure 5-7, page 5-11).[37] More frequent or severe droughts could also affect agricultural production and slow economic agricultural activity. During the 2012 drought, the State experienced a loss of agricultural revenues of $409 million, and an additional loss of $317 million in secondary spending in local communities.[38]

As part of the BIP process, basin roundtables examined future agricultural water needs. Six basins expect decreases in irrigated acres, while two expect increases. All of the basin roundtables aim to reduce expected shortages. The roundtables identified several agricultural goals (Table 5-2, page 5-11). Section 6.5 further explores projects and methods to achieve these goals.

FIGURE 5-8 STATEWIDE ENVIRONMENTAL AND RECREATIONAL NEEDS[42]



Overview of Environmental and River-Based Recreational Needs

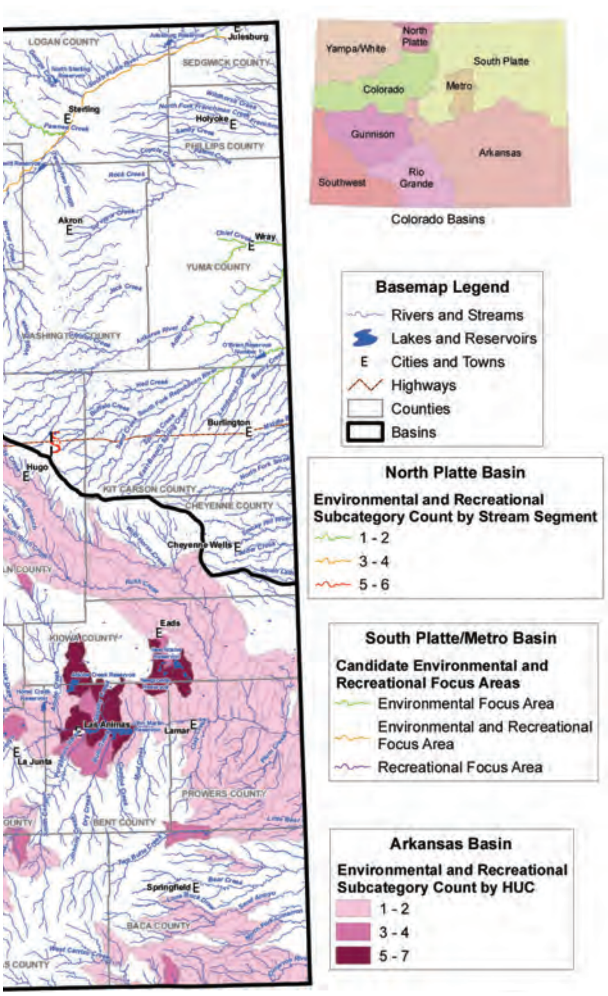
River flows, aquatic and riparian habitat, water quality, bank stability, stream access, water temperature, and habitat connectivity are all critical factors to consider when determining environmental and river-based recreational needs. Therefore, river-based environmental and recreational needs are often represented by the number of stream-miles or acres of wetland that have important attributes and need protection or restoration. As part of the SWSI 2010, a collaborative effort between the CWCB and the basin roundtables identified 13,500 perennial stream-miles in Colorado that have important attributes, and therefore selected these as "focus areas."[39] Examples of important attributes include imperiled fish species, outstanding examples of riparian habitat, and important boating and fishing areas.[d] Figure 5-8 illustrates these areas. The basin roundtables did not intend to include every stream with important attributes in every basin. The roundtables will continue to place importance on additional analysis to define what the focus areas need and to identify other streams with substantial values.

Analysis of the focus areas is a critical step in describing the needs of specific basin attributes, and the roundtables will ultimately develop strategies to address these environmental and recreational needs. Below are a few examples of this analysis:

- The roundtables identified 2,260 perennial stream-miles of Colorado River and greenback cutthroat trout habitat in focus areas across the state.
- The roundtables identified 3,164 perennial stream-miles of warm-water fish habitat in focus areas. These reaches include endangered, threatened, or imperiled fish species.
- The roundtables identified 7,642 perennial stream-miles of substantial riparian areas and wetlands. These include occurrences of exemplary-plant communities as well as rare-plant communities.

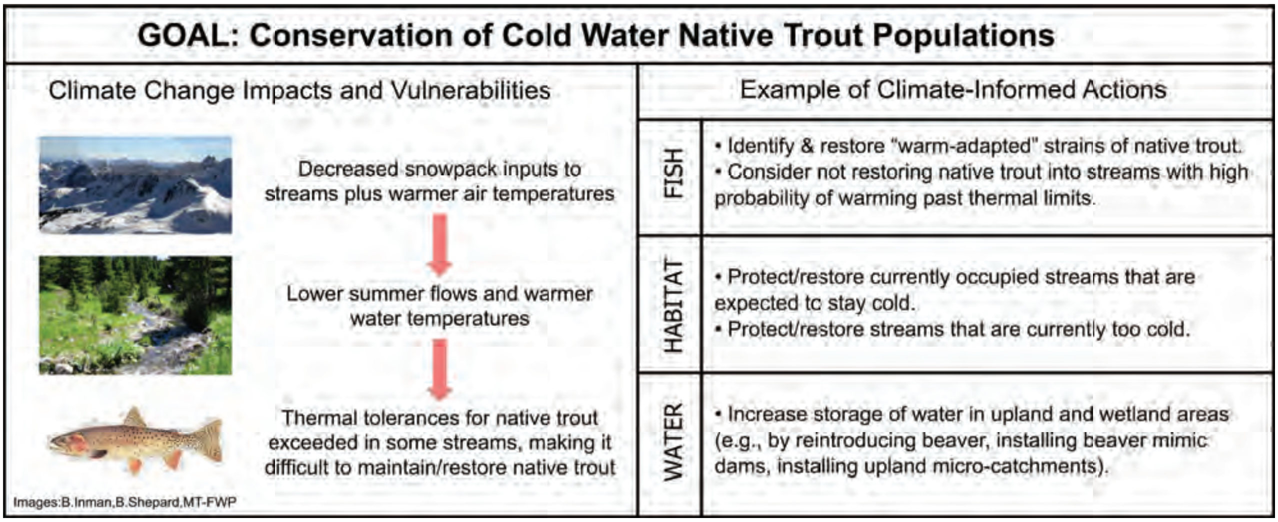
The number of water rights appropriated for instream flows, natural lake levels, and recreational in-channel diversions demonstrates some of the ongoing flow needs for the environment and recreation:

- Instream flows: 9,180 stream-miles for 1,595 decreed water rights
- Natural lake levels: 126,000 acre-feet for 476 decreed water rights
- Recreational in-channel diversions: 20 decreed water rights, ranging in size from 5 to 1,800 cubic feet per second



[d] Recreation in Colorado's Water Plan includes boating, fishing, camping, wildlife viewing, and waterfowl hunting. Many other recreational activities in Colorado require water in some form, but are counted as part of other uses. The irrigation of sports fields, golf courses, and parks are primarily served by municipal water providers and are included as a municipal use. Likewise, skiing depends on snowmaking, and the water rights associated with this use are typically owned by resort operators. Therefore snowmaking is classified as an industrial use.

FIGURE 5-9 ILLUSTRATIVE CLIMATE-INFORMED ACTIONS IN RESPONSE TO CLIMATE-CHANGE EFFECTS ON THE AVAILABILITY OF SUITABLE HABITAT FOR COLD-WATER NATIVE TROUT[43]



Environmental and recreational water needs often overlap. For example, the ability to keep a stream flowing can be beneficial for aquatic life as well as for anglers. Boulders and other structures that enhance boating experiences can also improve aquatic habitat for fish. In some cases, however, needs conflict—for example, conflicts arise when there are different optimal flow levels for rafting and fishing.

While identifying environmental and recreational attributes of importance is a necessary step to evaluating nonconsumptive needs, gaps, and potential projects and methods, a quantification of the amount of water required to support these attributes may be needed in some cases. Section 6.6 explores tools, projects, and methods to meet Colorado's environmental and recreational needs.

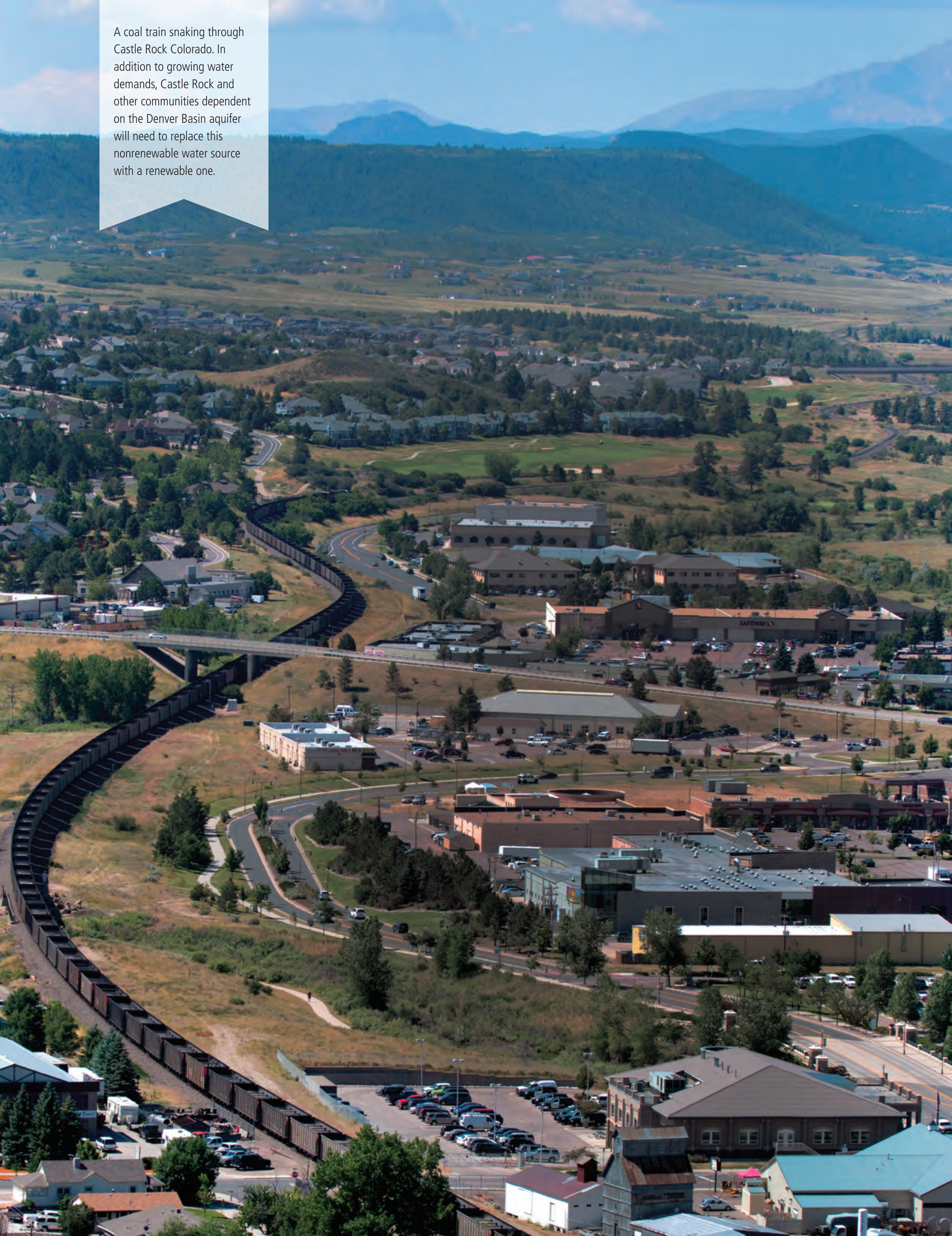
This document and the BIPs refer to the term "nonconsumptive," and use it to refer to environmental and recreational uses. However, environmental and recreational uses often consume water through evaporation or evapotranspiration. Both environmental and recreational uses involve keeping water in streams and designating water for those specific uses. Agricultural, municipal, and industrial water users downstream often reuse this water multiple times.

Climate change could affect environmental and recreational needs as well. Scientists expect that if temperatures continue to increase, the range of suitable habitat for cold-water fish species will diminish (Figure 5-9). Rising temperatures could also adversely affect plant communities.[40] Reduced water supplies due to increased evapotranspiration could also be a factor in maintaining the same range of cold-water species due to the lower capacity of reduced flows to dissipate heat.[41]

Releasing trout back into the river.

In addition to the tools mentioned above, various projects and methods—such as flow-maintenance agreements and habitat restoration—help meet environmental and recreational needs. As Figure 5-9 indicates, environmental, agricultural, and municipal partnerships, as well as mitigation measures, will be critical to maintaining existing cold-water fish reaches as functional habitats. Sections 6.6 and 9.2 list several examples of multipurpose projects. Below are a few multipurpose projects that meet multiple needs:

- Upper Arkansas Voluntary Flow Management Program,
- Alternative Wild and Scenic Processes (e.g., the Upper Colorado, Lower Colorado, and Dolores Rivers),
- Colorado River Cooperative Agreement,
- Elkhead Reservoir Enlargement,
- Rio Blanco River Restoration.



A coal train snaking through Castle Rock Colorado. In addition to growing water demands, Castle Rock and other communities dependent on the Denver Basin aquifer will need to replace this nonrenewable water source with a renewable one.

A LOOK AT HISTORY

Horsetooth Reservoir was completed in 1949 as a part of
the Colorado-Big Thompson project to supply a growing Northern Colorado
with water for municipal and irrigation uses.

CARL AND CURRAN TRICK, CONTINUED FROM PAGE 5-10

Carl's water resume is vast, in the past he was a CWCB member and the North Platte Representative for the IBCC. Currently he is a board member of the North Platte Basin Roundtable, Mountain Parks Electric, Tri State G&T, and the Jackson County Water Conservancy District. He also is the President of the Walden Reservoir Company.

Curran also ventured out from Colorado to attend Grinnell College in Iowa, where she was a member of the women's basketball team. After graduation Curran returned to the North Platte basin where she was also involved in the North Platte Basin Roundtable as their Recorder and Education Liaison. She then went on to Law School at University of Wyoming, where she received her J.D. in 2012.

Curran participated in the Colorado Foundation for Water Education's Water Leaders Program in 2008 and recently joined the firm of Lawrence Jones Custer Grasmick LLP to practice law in the area of Water Rights and Natural Resources Law. Here she is able to work on her goal of keeping agriculture viable in Colorado. Curran hopes to be involved in projects that give agriculture more flexible options than buy and dry, and will focus on representing conservancy districts and agricultural users to assist them with water issues.

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Water Supply Management

Chapter 6 discusses the dynamic strategy Colorado envisions to meet its future water needs—including the types of projects and methods Colorado needs, and the actions it requires, to implement them. Scenario planning provides the framework for this strategy, and indicates what Colorado must accomplish in the short term in order to best balance tradeoffs among meeting future municipal needs, agricultural viability, and the health of Colorado's rivers and streams.

Section 6.1 and Section 6.2 provide information to help assess how close Colorado is to realizing this strategy. They also discuss the remaining municipal, industrial, agricultural, environmental, and recreational water gaps, and the methods by which basins propose to address those gaps.

Demand management strategies, such as conservation and reuse, will help address Colorado's growing demands while upholding our state's water values. Section 6.3 looks at various ways to use water efficiently and reduce water demands. Water sharing is worth special attention as an alternative method for effectively reducing the permanent dry-up of Colorado's irrigated lands. Section 6.4 discusses opportunities to share water between agricultural and municipal or environmental and recreational interests. These sections, as well as Sections 6.5 and 6.6, provide a summary of projects, methods, and policies the basin roundtables identified as necessary for meeting Colorado's future water needs. Section 6.5 focuses on the types of initiatives, projects, and methods that will support Colorado's cities and towns and ensure agriculture that remains viable into the future. Section 6.6 details the initiatives, projects, and methods needed to support the environment and river-based recreation.

Planning for Colorado's water future presents many challenges and opportunities, and this chapter demonstrates the variety of ways in which stakeholders at the state and local levels are collaborating to address these important issues.

Kayakers in Salida, including several children, enjoying the benefits of the Arkansas River's Voluntary Flow Management Program,which balances benefits across multiple needs.

> Rather than trying to predict the future by looking at the past, scenario planning allows us to identify and account for key uncertainties.

6.1

SCENARIO PLANNING AND DEVELOPING AN ADAPTIVE WATER STRATEGY

GOAL

Colorado's Water Plan considers a range of possible future conditions. Through public engagement and sound science, the plan develops a practical, adaptive, and balanced path forward for meeting Colorado's future water needs.

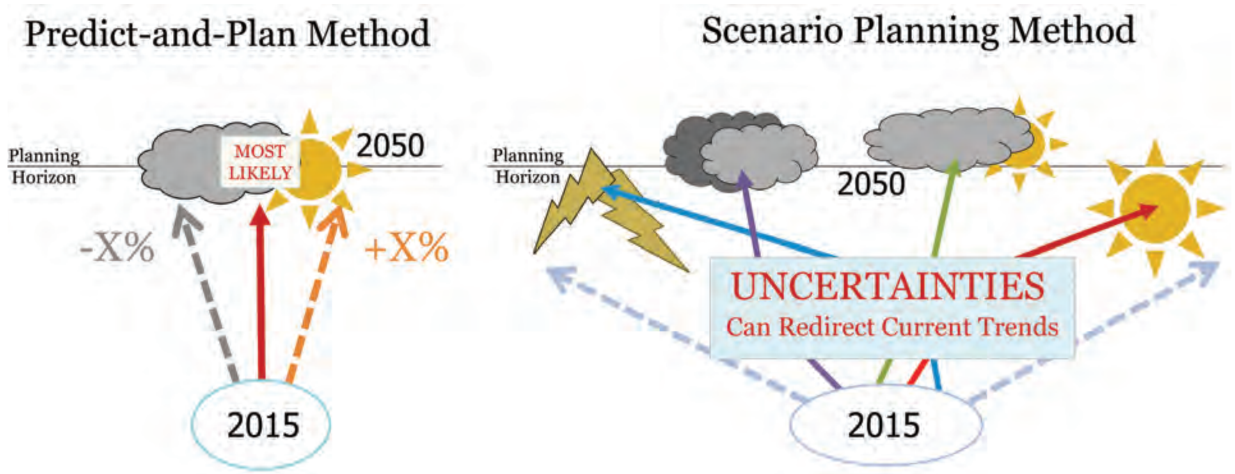
The purpose of scenario planning is to develop strategies to meet Colorado's future water needs that are based on the best available science as well as input from stakeholders. Section 6.1 broadly describes what is required to meet our state's future needs over the next 10 to 15 years and prepare for a broad range of possible futures. Scenario planning also provides the opportunity to consider Colorado's water values and build portfolios of solutions. The state needs conservation, reuse, completion of planned projects, and development of alternative agricultural transfers in the near term. At the same time, Colorado must prepare for the possibility of further agricultural transfers, an additional TMD as Chapter 8 describes, and even higher levels of conservation to meet future M&I needs—while concurrently implementing environmental and recreational projects and continuing to support agriculture.[1]

The elements of Colorado's adaptive strategy arose from significant technical work and the early and ongoing engagement of stakeholders. In developing Colorado's Water Plan, the CWCB, basin roundtables, and the IBCC adopted the scenario planning process to initiate a conversation among stakeholders about planning for uncertainties and emerging water resource challenges.[2] These groups worked together to explore how to meet the increasing water needs of Colorado's growing communities while balancing water interests.[3] Of particular concern, Colorado must contend with the significant and growing municipal water needs by 2050.[4] Scenario planning helps answer questions about how much water Colorado may need in the future, how much water may be available to meet our state's future needs, and what sources of water supply future generations will support. Subsequent sections in Chapter 6, as well as Chapter 8, provide details about ways in which Colorado can employ the scenario planning approach to more specifically respond to an uncertain future.

Scenario Planning: *Planning for Multiple Futures*

Given the uncertainties of future water supply and demand, the CWCB adopted a planning approach that many major water providers across the West use: scenario planning.[5] The use of scenario planning assumes that the future is unknown and provides flexibility in responding to various future conditions.[6] Rather than trying to predict the future by looking at the past, scenario planning allows the CWCB and stakeholders to identify and account for key uncertainties operating within the planning period (Figure 6.1-1).

FIGURE 6.1-1 THE TRADITIONAL "PREDICT-AND-PLAN" APPROACH COMPARED TO THE SCENARIO-PLANNING APPROACH

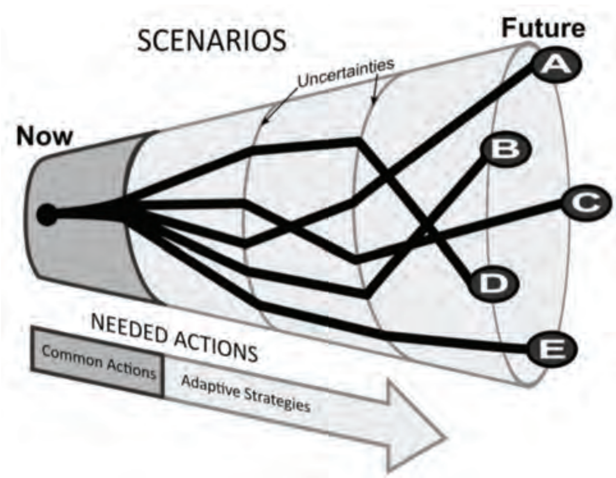


Adapted from Global Business Network, 2012 & Marra, 2013[7]

Scenario planning relies on several key driving forces in order to build multiple plausible futures (i.e., scenarios), whereas, by contrast, the more traditional "predict-and-plan" approach develops the most probable future. The IBCC and basin roundtables worked in partnership with the CWCB to explore the implications of multiple plausible futures. Given the unpredictability of factors driving Colorado's future, such as climate change, economic and population growth, and social values, the necessity of planning for multiple scenarios in Colorado's future requires a much more comprehensive planning and preparation tool. The IBCC and basin roundtables developed descriptions of several futures Colorado could face, and used those descriptions to identify and evaluate a prospective series of implementable projects and initiatives called "portfolios." One goal of this work was to identify projects and policies that are needed across multiple scenarios. Common actions would therefore apply to multiple futures, and Colorado can plan for and prioritize those first, while still monitoring uncertainties that may redirect recent trends.

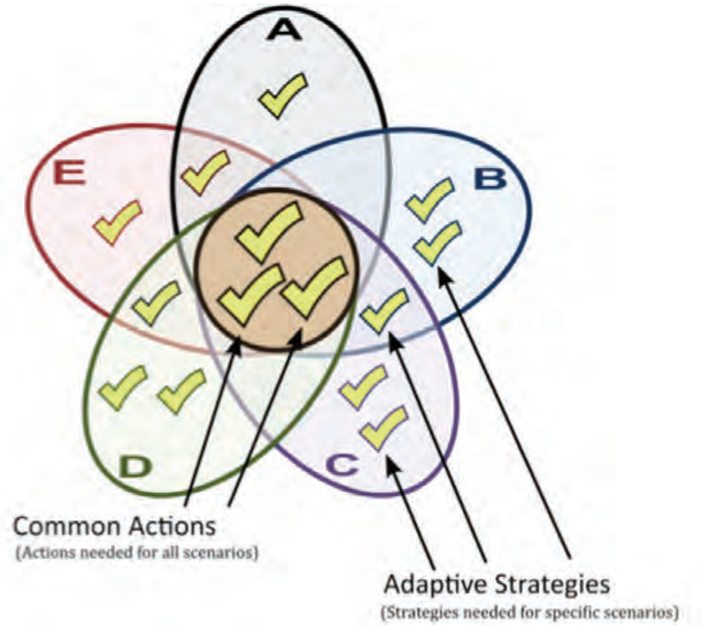
By implementing successive sets of common actions over time, decision makers can be more confident that the policies and investments Colorado makes in the near term will also be viable in the longer term. The near- and long-term actions combine with the scenarios to create a forward looking pathway of actions that both anticipate and prepare for the emerging needs of the future. Figure 6.1-2 conceptualizes ways in which Colorado can align various potential future conditions with near-term actions and long-term adaptive strategies.

FIGURE 6.1-2 SCENARIO PLANNING IDENTIFIES SUCCESSIVE SETS OF COMMON ACTIONS THAT APPLY TO MULTIPLE FUTURES



Adapted from Marra & Thomure, 2009.[8]

FIGURE 6.1-3 COMMON ACTIONS AND ADAPTIVE STRATEGIES IN SCENARIO PLANNING



In the near term, Colorado's way forward involves implementing actions that are common to all or most of the envisioned futures. These common actions have broad applicability, as Figure 6.1-3 shows. The common actions are necessary regardless of which scenario Colorado eventually encounters, and they can be implemented immediately. By contrast, the adaptive strategies are dependent on the specific scenario and will be evaluated based on future information. In the mid-to-long term, the direction forward may narrow and favor a smaller set of possible futures. In that case, the CWCB would work with stakeholders to reevaluate and update the planned actions as well as the strategies. The CWCB would base these updates on the status of predetermined "signposts" or decision points that reveal whether past uncertainties now have more clarity. For water in Colorado, these uncertainties include water needs, water supply, and Colorado's social values. The use of scenarios enables planners to respond and adapt to still-emerging issues and to explore the opportunities and challenges each possible future presents—without reducing options available going forward.[9]

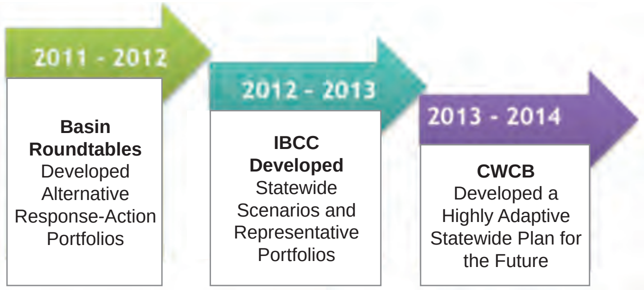
Developing Alternative Water Supply Portfolios

The SWSI 2010 report introduced the "status-quo portfolio"—a set of prospective water-supply actions that would likely be required if current trends continue their trajectories. The status quo is counter to Colorado's water values (as Chapter 1 presents), and leads to the transfer of large quantities of water out of the agricultural sector to satisfy M&I water-supply needs. Such a transfer would result in a substantial loss of agricultural lands and could potentially cause harm to the environment and to Colorado's economy. This plan discusses additional challenges with the status-quo portfolio below. The general statewide consensus is that the status-quo portfolio of actions, and the projected future it assumes, is not desirable for Colorado.[10]

Given these concerns, the CWCB initiated a multi-year, stakeholder plan development process in conjunction with the nine basin roundtables and the IBCC. Each basin roundtable represents the water interests of a specific region within Colorado, and the IBCC facilitates conversations among the basin roundtables and addresses broader, statewide water issues. Figure 6.1-4 on the following page summarizes the plan development process.

Each of the nine basin roundtables developed one or more statewide water supply portfolios to respond to the projected low, medium, or high future water needs of communities.[11] Each portfolio constitutes a unique combination of possible strategies communities could use to meet a range of projected M&I water needs. The strategies include conservation, reuse, agricultural transfers, development of water projects within each basin, and TMDs. The CWCB developed an interactive tool that quantifies tradeoffs—associated with Colorado's water values—that each portfolio would generate. These tradeoffs include effects on the environment, agriculture, reliability, and cost. This work brought basin roundtables together by showing how one water supply decision has multiple effects across the state. Most of the 34 portfolios the basin roundtables developed reduced these tradeoffs, thereby minimizing negative effects statewide and in each basin. They also presented combinations of solutions that both met a variety of possible future conditions and aligned with Colorado's water values.

FIGURE 6.1-4 SUMMARY OF THE STAKEHOLDER AND PLAN DEVELOPMENT PROCESS



The IBCC subsequently synthesized and reduced the 34 basin roundtable-generated portfolios into a smaller set of 10 "representative" portfolios to address projected low-, mid-, and high-range M&I water demands (as Chapter 5 describes). The basin roundtables determined that the representative portfolios successfully captured the intent and character of the original 34 portfolios.

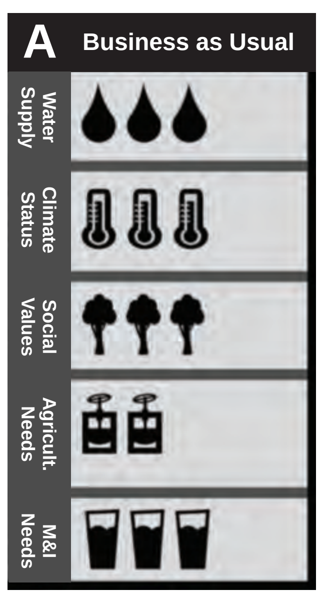
Formulating Plausible Scenarios

Potential changes in future M&I water demand and available water supply were among the most important drivers all of the basin roundtables considered when developing their portfolios. Some of the basin roundtables also considered changing societal values and other drivers outside of the water community's control. The IBCC took these perspectives into account when developing the list of nine high-impact drivers, which it factored-in to the scenario development process. These drivers will greatly influence the direction of Colorado's water future:

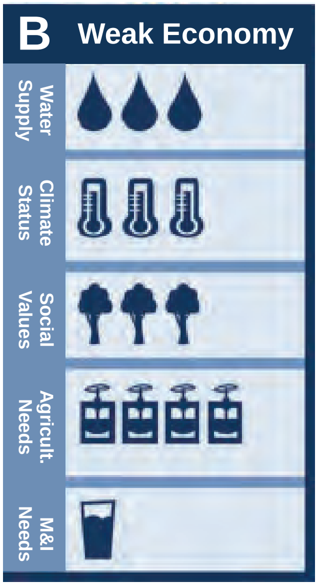
1. Population/Economic Growth
2. Social/Environmental Values
3. Climate Change/Water Supply Availability
4. Urban Land Use/Urban Growth Patterns
5. Energy Economics/Water Demand
6. Level of Regulatory Oversight/Constraint
7. Agricultural Economics/Water Demand
8. M&I Water Demands
9. Availability of Water-Efficient Technologies

Using these drivers, the IBCC developed five scenarios that represent plausible futures. It then matched the scenarios with five of the 10 representative portfolios of solutions that best met the needs each scenario described, and that aligned with Colorado's water values. The scenarios represent how Colorado's water future might look in 2050, even though the actual future at that time will likely contain a mixture of multiple scenarios. The scenario summary also includes a visualization of five of the main drivers. A chart for each scenario shows the relative increase and decrease in levels for each driver compared to current levels. The descriptive scenario names portray the overall essence that each scenario embodies in its respective views of the future.[12] The IBCC describes the scenarios as follows:

A. **Business as Usual:** Recent trends continue into the future. Few unanticipated events occur. The economy goes through regular economic cycles but grows over time. By 2050, Colorado's population is close to 9 million people. Single-family homes dominate, but there is a slow increase of denser developments in large urban areas. Social values and regulations remain the same, but streamflows and water supplies show increased stress. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation of new water development slowly increases. Municipal water conservation efforts slowly increase. Oil-shale development continues to be researched as an option. Large portions of agricultural land around cities are developed by 2050. Transfer of water from agriculture to urban uses continues. Efforts to mitigate the effects of the transfers slowly increase. Agricultural economics continue to be viable, but agricultural water use continues to decline. The climate is similar to the observed conditions of the 20th century.

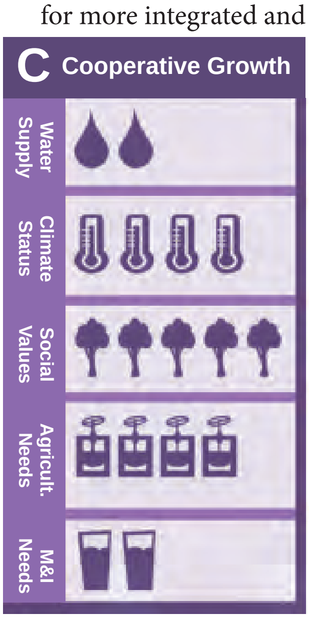


B. **Weak Economy:** The world's economy struggles, and the state's economy is slow to improve. Population growth is lower than currently

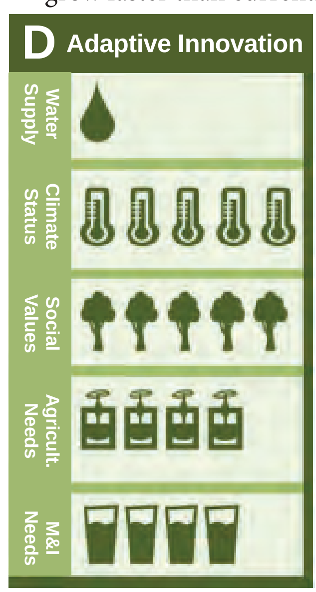


projected, slowing the conversion of agricultural land to housing. The maintenance of infrastructure, including water facilities, becomes difficult to fund. Many sectors of the state's economy, including most water users and water-dependent businesses, begin to struggle financially. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation decreases due to economic concerns. Greenhouse gas emissions do not grow as much as currently projected and the climate is similar to the observed conditions of the 20th century.

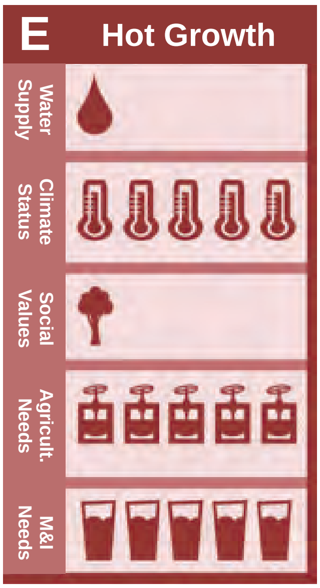
C. **Cooperative Growth:** Environmental stewardship becomes the norm. Broad alliances form to provide for more integrated and efficient planning and development. Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and in mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development. Coloradans embrace water and energy conservation. New water-saving technologies emerge. Eco-tourism thrives. Water-development controls are more restrictive and require both high water-use efficiency and environmental and recreational benefits. Environmental regulations are more protective, and include efforts to re-operate water supply projects to reduce effects. Demand for more water-efficient foods reduces water use. There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting streamflows and supplies. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.



D. **Adaptive Innovation:** A much warmer climate causes major environmental problems globally and locally. Social attitudes shift to a shared responsibility to address problems. Technological innovation becomes the dominant solution. Strong investments in research lead to breakthrough efficiencies in the use of natural resources, including water. Renewable and clean energy become dominant. Colorado is a research hub and has a strong economy. The relatively cooler weather in Colorado (due to its higher elevation) and the high-tech job market cause population to grow faster than currently projected. The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand. The warmer climate reduces global food production, increasing the market for local agriculture and food imports to Colorado. More food is bought locally, increasing local food prices and reducing the loss of agricultural land to urban development. Higher water efficiency helps maintain streamflows, even as water supplies decline. The regulations are well defined and permitting outcomes are predictable and expedited. The environment declines and shifts to becoming habitat for warmer-weather species. Droughts and floods become more extreme. More compact urban development occurs through innovations in mass transit.



E. **Hot Growth:** A vibrant economy fuels population growth and development throughout the state. Regulations are relaxed in favor of flexibility to promote and pursue business development. A much warmer global climate brings more people to Colorado with its relatively cooler climate. Families prefer low-density housing and many seek rural properties, ranchettes, and mountain living. Agricultural and other open lands are rapidly developed. A hotter climate decreases global food production. Worldwide demand for agricultural products rises, greatly increasing food prices. Hot and dry conditions lead to a decline in streamflows and water supplies. The environment degrades and shifts to becoming habitat for species adapted to warmer waters and climate. Droughts and floods become more extreme. Communities struggle unilaterally to provide services needed to accommodate the rapid business and population growth. Fossil fuel is the dominant energy source, and there is large production of oil shale, coal, natural gas, and oil in the state.



The five scenarios above collectively capture a broad range of future supply-and-demand possibilities and uncertainties. Of the five scenarios, "Business as Usual" is the most conventional, while "Adaptive Innovation" and "Hot Growth" are the most difficult to prepare for because of high water demands combined with the effects of climate change. The challenge is not to pick the most likely or attractive future; rather, it is to develop the capacity to prepare Colorado for all of them.

Developing an Adaptive Water Management Plan

In analyzing the portfolios, the IBCC identified common near-term strategies and actions that would provide baseline benefits for all five of the envisioned scenarios. Most of these actions would be necessary no matter what future Colorado faces, and would fully meet low demands, as the "Weak Economy" scenario describes. Some strategies prepare Colorado for future projects and methods that may be needed in one or more futures. These near-term commonalities are called "no-and-low-regret" strategies and actions, since they would most likely be viable no matter how the future might ultimately unfold.

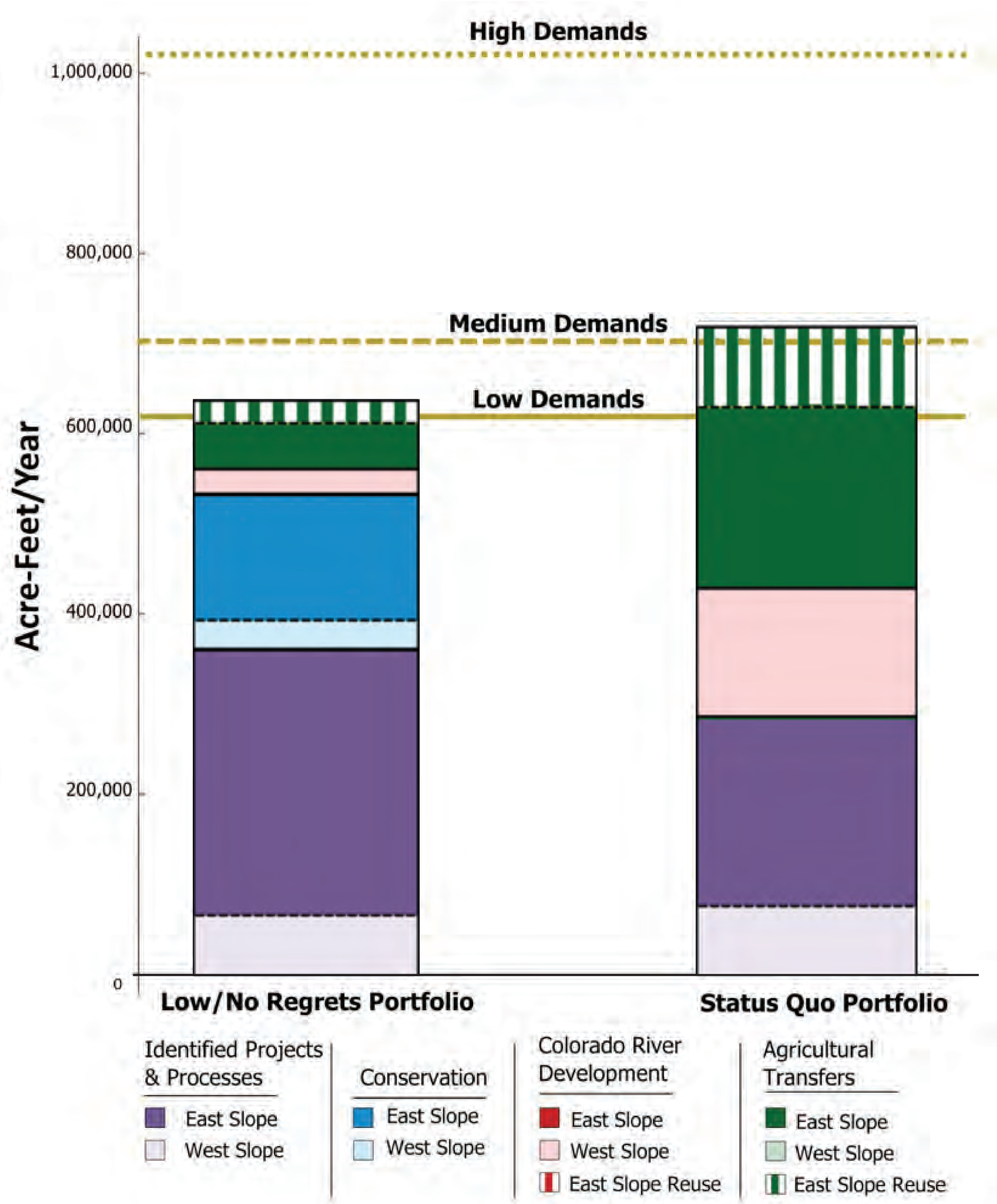
In this context, a "regret" is an action in which Colorado enters a future where there are:

1. Water shortages due to an insufficient number of implemented necessary projects and methods;
2. Significant consequences to Colorado's agriculture, environment, or economy because Colorado's water community did not implement projects and methods consistent with Colorado's water values; or
3. Too many unneeded and costly projects.

By implementing the No-and-Low-Regrets actions sooner rather than later, Colorado will be prepared for any future, without provoking serious tradeoffs. Figure 6.1-5 (page 6-9) illustrates how the No-and-Low Regrets party compares to the status-quo portfolio.

In contrast to the Status-Quo Portfolio, the No-and-Low-Regrets Portfolio reduces potential effects to the environment and agriculture by increasing the success of planned projects and levels of water conservation. The No-and-Low-Regrets Portfolio aligns with Colorado's water values; it avoids the unacceptable consequences resulting from the continued drying-up of Colorado's irrigated agriculture and the use of more Colorado River water. Nevertheless, the No-and-Low-Regrets Portfolio only meets the low-demand scenario (as Figure 6.1-5 shows), and additional water supplies or increased conservation will be required if Colorado faces medium or high water demands. In addition, several portfolios address higher demands while continuing to align with Colorado values; this chapter explores these below.

FIGURE 6.1-5 NO-AND-LOW-REGRETS PORTFOLIO VERSUS THE STATUS-QUO PORTFOLIO

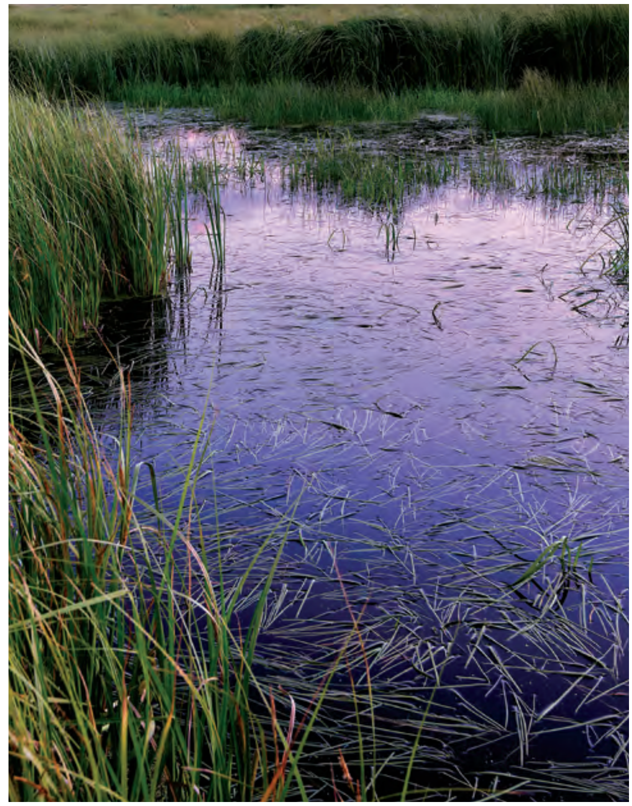


Below are descriptions of the recommended No-and-Low-Regrets actions, along with the adaptive strategies that will prepare Colorado for other potential futures:

- **Minimize the transfer of statewide agricultural acres and implement agricultural sharing projects:** Limit traditional permanent dry-up of agricultural lands by supporting lower-impact alternatives for more than 300,000 people (requiring 50,000 acre-feet of water) in the near future. Simultaneously, track the reliability of these alternatives, and plan and preserve the option of additional agricultural transfers should a future scenario necessitate this action. Section 6.4 describes these opportunities.
- **Plan and preserve future options for developing unappropriated waters:** Develop additional water supplies from unappropriated water on the western slope for local use to serve a minimum of 200,000 people (requiring 35,000 acre-feet of water), and to support their associated jobs in the near future. At the same time, plan for and preserve the option of an additional TMD, should a future scenario necessitate such a project through the conceptual framework parameters Chapter 8 describes.
- **Establish low to medium conservation strategies:** Implement strategies to meet low to medium levels of conservation, and apply at least half of these savings to meet future M&I needs in order to support approximately 1 million people (requiring 170,000 acre-feet of water) and their jobs in the near future. At the same time, track the reliability of these conservation savings, and plan for ways to achieve additional conservation savings, should a future scenario necessitate this action. Section 6.3 describes several avenues for accomplishing this.
- **Implement projects and methods that support environmental and recreational uses:** Implement local projects, especially those that support imperiled species and recreational areas that are important to local economies. Section 6.6 describes these projects and methods.
- **Strive for high success rates for projects and methods that are already planned:** Work to support the projects that are already planned, as these already have a project proponent and are often smaller and less controversial than many of the other project options. Statewide, these projects may provide enough water for more than 2 million people (requiring 350,000 acre-feet of water) and their associated jobs in the near future. Continue to track the success rate of these projects and their ability to meet future community water needs. Section 6.5 further describes these projects and methods.
- **Assess and implement storage projects and other infrastructure:** Implement storage and other infrastructure to maximize flexibility and reliability. Focus on options that support multiple needs for communities, agriculture, and the environment. Section 6.5 further discusses storage.
- **Implement water reuse strategies:** Implement strategies that encourage increased use of recycled water, as Section 6.3 describes.

As indicated in SWSI, "Colorado faces a shortage of water for meeting the state's consumptive and nonconsumptive water needs. In order to meet Colorado's water management objectives, a mix of local water projects and processes, conservation, reuse, agricultural transfers, and the development of new water supplies should be pursued concurrently."[13] The No-and-Low-Regrets actions bring together the need to advance each of these which, together, are known as the "four legs of the stool."

The No-and-Low-Regrets Portfolio only satisfies the M&I water supply needs of the "Weak Economy" scenario, and would only be possible if the portfolio were successfully implemented in the near term. If medium or high water demands had to be met as the other scenarios envisioned, additional portfolio actions would be required in the mid and long term.



Colorado must be prepared for a range of possible futures, which may be dry or wet. Drought photo courtesy of USGS.

Building on the earlier work of the basin roundtables and the IBCC, the CWCB developed a scenario-based adaptive water strategy. While the No-and-Low-Regrets Portfolio is necessary no matter what future Colorado may face, the adaptive framework recognizes that the future hinges upon how much the primary drivers—M&I water demand, waters-supply availability, and social values—change over time. These drivers could tip the still-evolving future toward one scenario or another. The tipping points serve as water management decision points, or "signposts," that can lead toward the need to implement a certain portfolio of solutions. By developing an adaptive water management framework, managers and decision makers will be more aware of approaching signposts and can anticipate the need to make timely water management decisions.

An explanation of the primary drivers follows:

- Future changes in *M&I water demands* may trend "lower" or "higher" relative to the mid-level water demand forecasts previous SWSI efforts used. The State may anticipate such changes by tracking indicators of economic activity and demographic growth, as well as other secondary factors.
- Water *supply availability* may similarly trend "lower" or "higher" depending on climate change, watershed hydrology, and legal constraints associated with Colorado's interstate compacts, water law, and environmental regulations. The State will assess water supply availability as trending lower or higher over time as compared to earlier versions of the SWSI.

- The third primary driver, *social values,* is a measure of statewide public sentiment; it may trend toward a more "green" orientation or it may shift toward greater "resource utilization." "Green" values will likely favor more dense, low-impact urban development, greater reliance on water reuse and energy efficiency, greater protection of environmental and recreational resources, and preservation of local agriculture and open space. Values associated with more intensive resource utilization will gravitate toward full use of existing natural sources as well as the development of new sources to satisfy M&I water demands.

This scenario-based framework allows for incremental implementation of future portfolio response actions beyond the No-and-Low-Regrets actions recommended in the near term (Figure 6.1-6). Pre positioned portfolio actions—such as increased levels of conservation, agricultural transfers, or TMDs—can be implemented at specified key signposts. This will allow decision makers to adaptively respond in real time to changes in critical drivers that cannot be predicted with certainty. Critical drivers include water demands, water supply, and social values.[14]

Table 6.1-1, on page 6-13, illustrates the relationships between the three primary drivers, scenarios, and portfolios of solutions. The five portfolios that match the scenarios best meet both future conditions and Colorado's water values.

The No-and-Low-Regrets actions will not be easy to accomplish. Nevertheless, if Colorado does not implement these in the next 15 years, the effects will be severe. The water supply gap will be greater than any basin roundtable has envisioned, and the solutions will dry up more agriculture and cause further harm to the environment. If Colorado faces high demands and does not fully implement the No-and-Low-Regrets actions, the state will have to implement projects and methods beyond anything the basin roundtables have planned and prepared for in the portfolio development process.

FIGURE 6.1-6 COLORADO'S SCENARIOS AND THEIR MATCHING PORTFOLIOS

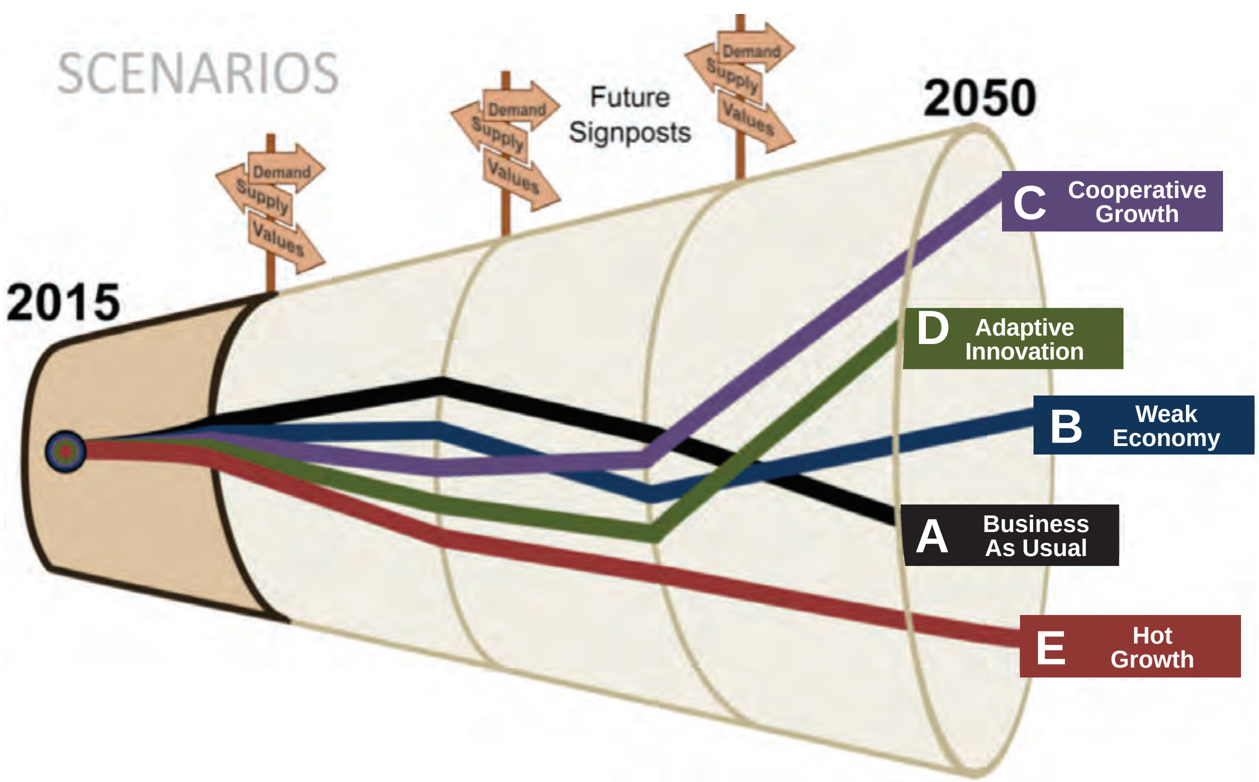
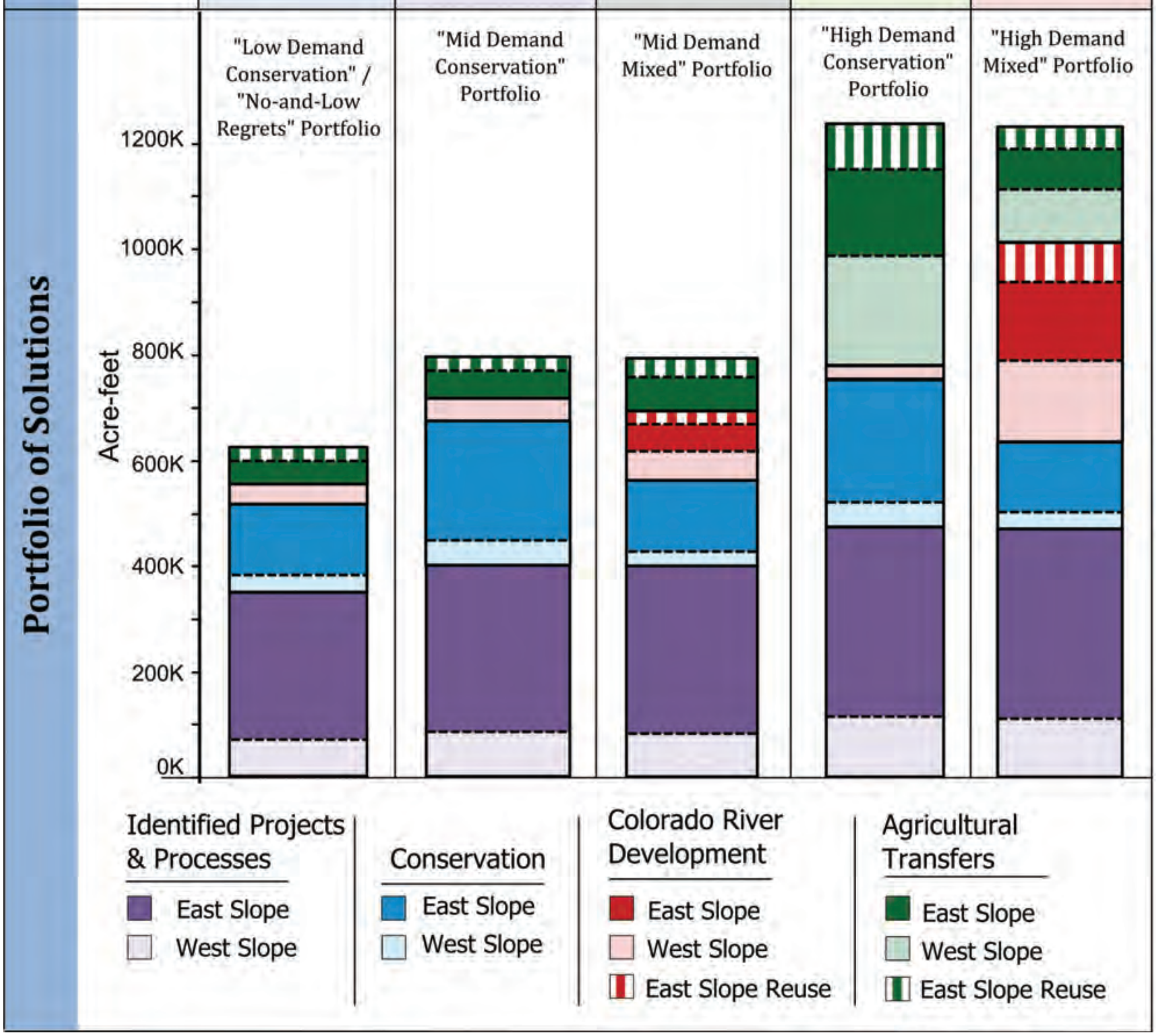


TABLE 6.1-1 SCENARIOS AND THEIR MATCHING PORTFOLIOS

		Scenarios				
		B Weak Economy	C Cooperative Growth	A Business as Usual	D Adaptive Innovation	E Hot Growth
Scenario Drivers	Water Demand	Lower	Lower	Higher	Higher	Higher
	Water Supply	Higher	Lower	Higher	Lower	Lower
	Social Values	No Change	“Green”	No Change	“Green”	“Resource Utilization”



Depending on the scenario, this could be an even larger TMD, draconian conservation measures, or even greater amounts of agricultural dry-up—and these approaches would not be consistent with Colorado's water values. It is imperative that Colorado implement the No-and-Low-Regrets actions.

Section 6.2 assesses whether or not the BIPs would be able to meet the No-and-Low-Regrets actions. Sections 6.3 through 6.6 and Chapter 8 explore in detail how Colorado, at a minimum, can implement the No-and-Low-Regrets actions through the BIPs and other stakeholder projects and methods; the State would accomplish this by obtaining financial support, pursuing education efforts, forming partnerships, and pursuing legislative solutions.

If successfully implemented, this adaptive water strategy will provide a roadmap to a still-evolving future. Given the whims inherent in predicting future conditions, the plan must be a living document. As new critical drivers arise, or as decision points change over time, the CWCB in partnership with stakeholders, will need to assess and revise the scenarios and associated response-action portfolios in subsequent updates to the SWSI.

ACTIONS

The following actions will continue to support scenario planning and Colorado's adaptive strategies:

1. **Support the implementation of the No-and-Low-Regrets strategy:** The CWCB, in partnership with other state agencies, will commit state financial, technical, and regulatory resources to the near-term implementation of prioritized water management projects as specified in the No-and-Low-Regrets actions. As part of this work, and in partnership with the basin roundtables, the CWCB will evaluate progress toward achieving the No-and-Low-Regrets actions.
2. **Monitor drivers:** To determine which scenario Colorado will most likely face, the CWCB will work with partners, such as the Climate Change Technical Advisory Group, to monitor the critical drivers of water supply, demand, and the level of "green" versus "full-resource use" values through future SWSI updates and other technical work. As part of this work the CWCB will work with stakeholder groups to update the scenarios and adaptive strategies.
3. **Promote use of scenario planning and adaptive strategies:** The CWCB and the basin roundtables will continue to use and promote scenario planning and the use of adaptive strategies to respond to, mitigate, and prepare for climate change. In partnership with project proponents, the CWCB will also encourage and facilitate the adoption of adaptive strategies for municipal, industrial, agricultural, environmental, and recreational needs as Colorado moves into the future.
4. **Support Colorado's Decision Support Systems (CDSS):** The CWCB and the DWR will continue to develop and support the CDSS to encourage data-driven planning and decision making.
5. **Support innovative and collaborative science:** The CWCB will continue to work with local, state, and federal partners to build coalitions to purchase, deploy, maintain, and operate new equipment and new science necessary for 21st-century water management. Concepts and technologies such as watershed-based gap-filling radars for continuous weather coverage, radiometers for improved profiles of the atmosphere and modeling support, and improved high -resolution atmospheric and hydrological modeling specific to Colorado, lead to accurate quantification of the snowpack and runoff, regardless of the scenario.

6.2 MEETING COLORADO'S WATER GAPS

GOAL

Colorado's Water Plan uses a grassroots approach to formulate projects and methods that avoid some of the undesirable outcomes of the supply-demand gaps. The plan addresses the gaps from multiple perspectives—such as water storage, reuse, recycling, integrated water management, restoration, and conservation.

Overview

This section describes how the basin roundtables' BIPs meet Colorado's growing municipal, industrial, agricultural, environmental, and recreational water needs. It also describes the BIP goals and measurable outcomes, and identifies by basin the remaining needs Colorado must meet to accomplish those objectives. These remaining needs are referred to as "gaps." This section relies on previous technical work the SWSI 2010 conducted, the basin needs assessments, and the No-and-Low-Regrets work Section 6.1 describes.

In addition, this section assesses the projects and methods identified in the BIPs to determine whether they address the gaps. Finally, the section ends with a list of actions to support closing Colorado's water gaps. Sections 6.3 through 6.6 indicate the types of projects and methods the BIPs are considering, and actions to support them.

Colorado's Water Plan does not prescribe or endorse specific projects. However, the implementation of a combination of projects and methods, as the BIPs outline, will be necessary to meet Colorado's current and future municipal, industrial, agricultural, environmental, and recreational water needs. Failure to implement those projects and methods will result in an even greater water gap in Colorado's future.

In compiling its BIP, each basin roundtable developed goals and measurable outcomes that add up to each basin's vision for plans to support each major sector. While it is relatively easy to quantify a water supply gap for M&I needs, the future needs of agriculture, the environment, recreation, and other uses the BIPs identified are based on each basin roundtable's vision.

Goals and Measurable Outcomes by Basin

The degree to which the BIP goals and measurable outcomes demonstrate concurrence across Colorado is remarkable. The CWCB developed several long-term themes to meet the objectives the Governor's Executive Order outlined.[15] These include:

1. Meet Colorado's municipal water needs.
2. Meet Colorado's agricultural water needs.
3. Meet Colorado's environmental and recreational water needs.

In addition, Colorado has a long-term goal related to water quality, which Section 7.3 discusses:

4. Meet Colorado's water quality management needs.

The BIP goals and measurable outcomes reflect each of these major themes. Additionally, the basin roundtables identified several major themes that reach across all BIPs. These include:

- Protect and restore watershed health.
- Develop multipurpose storage/balance all needs and reduce conflict.

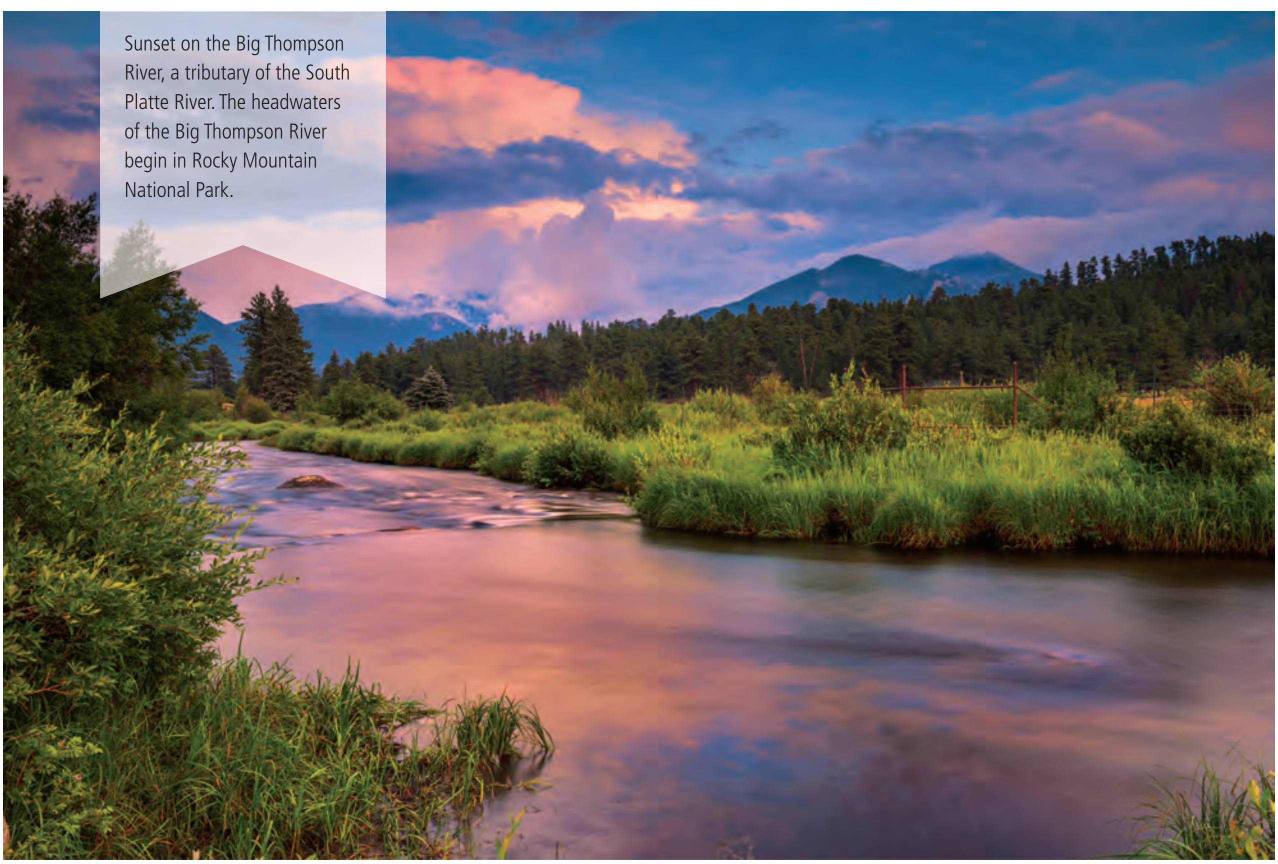
- ❖ Comply with and manage the risk associated with interstate compacts and agreements.
- ❖ Continue participation, education, outreach, and communication.

Table 6.2-1, on page 6-17, demonstrates the common themes across the eight BIPs, and outlines the steps by which the BIPs propose to specifically address these themes.

Below is a brief summary of how the basins addressed these themes through their BIPs.

Meet Colorado's Municipal Water Needs through Conservation and Identified Projects and Methods: Every basin roundtable discusses the importance of conservation. This is especially a focus for the Arkansas, Colorado, Metro, South Platte, and Southwest Basin Roundtables. In the Southwest and South Platte BIPs, the roundtables focus on implementing already-specified IPPs from SWSI 2010. The Southwest and the Colorado Roundtables also identify additional projects and methods. The Colorado, South Platte, Metro, and Arkansas Roundtables also feature reuse in their BIPs.

Meet Colorado's Agricultural Needs: In general, the Arkansas, Colorado, Rio Grande, and Southwest Basin Roundtables are approaching agricultural needs from an economic and productivity standpoint. The North Platte and Yampa/White Basin Roundtables seek to increase their irrigated acres, while several basins, such as the Gunnison and Colorado, seek to reduce agricultural shortages. Nearly every basin also focuses on improving agricultural efficiencies and modernizing water infrastructure. The South Platte and Metro Basin Roundtables are concerned about maintaining the viability of agriculture in the South Platte against the pressure of agricultural transfers and urbanization. They are therefore exploring alternative options, including the successful implementation of conservation, reuse, IPPs, alternative agricultural transfers, and the development of new supplies from the Colorado River system. Some western slope roundtables, such as the Southwest Roundtable, indicate that agriculture across the state is important, and have expressed support for strategies such as high-conservation to minimize the potential loss of irrigated acres. In the South Platte BIP, the South



Sunset on the Big Thompson River, a tributary of the South Platte River. The headwaters of the Big Thompson River begin in Rocky Mountain National Park.

TABLE 6.2-1 COMMON THEMES ACROSS BASIN IMPLEMENTATION PLANS

✓ = BIP goal or measurable outcome; ✓* = BIP activity

	Ark	Co	Gu	NP	RG	SP/Mt	SW	Y/W/G
A. Meet Municipal Water Needs thoughout Colorado								
• *Focus on M&I gaps*	✓	✓	✓	✓	✓	✓	✓	✓
• *Focus on conservation / demand management*	✓*	✓	✓	✓	✓*	✓	✓	✓
B. Meet Colorado's Agriculture Needs								
• *Focus on agricultural economy*	✓	✓	✓*		✓	✓*		
• *Focus on reducing shortages*		✓	✓			✓	✓	✓
• *Improve agricultural efficiencies*	✓	✓	✓		✓		✓	✓*
• *Increase irrigated acres*				✓				✓
• *Conduct the goals while protecting private property rights*	✓*	✓	✓	✓*	✓	✓	✓	✓
C. Meet Colorado's Environmental and Recreational Water Needs								
• *Focus on recovering imperiled and/or endangered species*	✓	✓	✓	✓	✓	✓	✓	✓
• *Protect wetlands and riparian areas*	✓	✓	✓	✓	✓	✓	✓	✓
• *Protect recreation*	✓	✓	✓	✓	✓	✓	✓	✓
• *Quantify nonconsumptive needs*	✓*	✓*	✓			✓	✓	✓
D. Protect and Restore Watershed Health								
• Include one or more goals / activities associated with watershed health	✓*	✓	✓*	✓	✓	✓	✓	✓
E. Balance All Needs and Reduce Conflict / Multi Purpose Storage								
• *Protect private property rights / water rights*	✓*	✓	✓	✓	✓	✓	✓	✓
• *Multi-purpose focus*	✓	✓	✓	✓	✓	✓	✓	✓
• *Modernize water infrastructure*	✓		✓	✓	✓	✓	✓	✓
• *Determine how agriculture supports nonconsumptive needs*	✓	✓	✓	✓	✓	✓		✓
• *Increase storage*	✓	✓*	✓*	✓*	✓	✓	✓*	✓*
F. Comply with Interstate Compacts, Agreements, and Manage the Risk Associated with These								
• Include one or more goals /activities associated with this	✓*	✓	✓	✓	✓	✓	✓	✓
G. Continue Participation, Education, Outreach, and Communications								
• Include one or more goals / activities associated with this	✓*	✓	✓	✓*	✓	✓	✓	✓*
H. Meet Colorado's Water Quality Management Needs								
• Include one or more goals / activities on water quality	✓	✓	✓	✓*	✓	✓	✓	✓

Platte and Metro Roundtables indicate that they will need to consider all of these strategies to reduce the pressure on agricultural transfers. The Rio Grande Roundtable expresses concern about maintaining the viability of agriculture in light of current unsustainable groundwater depletions.

Meet Colorado's Environmental and Recreational Needs: Each of the state's basins has environmental water quality and water quantity needs and objectives it must meet. Every roundtable discusses the need to recover imperiled and/or threatened and endangered species, and to protect recreational opportunities, wetlands, and riparian areas. In addition, several roundtables state the need to further quantify environmental and recreational needs, and the Gunnison, South Platte, Metro, and Yampa/White/Green Roundtables discuss the need to better determine how agriculture supports environmental and recreational values.

Meet Colorado's Water Quality Management Needs: Although water quality is not an issue the basin roundtables traditionally study, every roundtable addresses water quality in its BIP. Section 7.3 summarizes this.

Protect and Restore Watershed Health: While the Arkansas, North Platte, Rio Grande, and Southwest Basin Roundtables are the most focused on watershed health, every roundtable recognizes the importance of watershed health in its BIP. Many roundtables link watershed health to environmental needs or the protection of important infrastructure for municipal and agricultural needs. Section 7.1 summarizes the watershed health efforts.

Continue Participation, Education, Outreach, and Communication: Every basin roundtable has active education and outreach activities, as Section 9.5 describes.

While each of the above topics demonstrates a gap associated with the goals and measurable outcomes, several other important themes do not directly address the gaps. Some of these include:

- **Protect private property and water rights:** Every roundtable makes it clear in its BIP that basins must pursue solutions to protect agriculture and the environment in the context of protecting private property and water rights. This general theme is consistent with Colorado's Water Plan.
- **Comply with and manage the risk associated with interstate compacts and agreements:** Every basin in Colorado must grapple with interstate compacts or agreements, and each basin has addressed this topic explicitly in its BIP. Chapter 8 discusses how the basins address the issue of TMDs.
- **Develop multipurpose storage and projects/ Balance all needs and reduce conflict:** In their BIPs, all roundtables stress an interest in multipurpose projects and approaches. Some, like the Arkansas, Colorado, Gunnison, North Platte, Rio Grande, and South Platte/Metro Basin Roundtables, are interested in ways in which agriculture supports nonconsumptive needs.

Meeting M&I Water Needs Throughout Colorado

In the BIP process, the CWCB identified three statewide long-term goals to meet community water needs throughout Colorado:[16]

- Use water efficiently to reduce overall future water needs.
- Identify additional projects and processes to meet the water supply gap for municipalities while balancing the needs of agriculture, the environment, and recreation across the state.
- Meet community water needs during periods of drought.

The SWSI 2010 indicated that under current conditions, the M&I gap could total between 310,000 and 560,000 acre-feet, depending on the rate of population growth in Colorado. As Section 6.1 discusses, this assumes that planned projects, or IPPs, are ultimately implemented at fairly high rates.[17]

As described in the updated SWSI glossary,[18] IPPs meet the following criteria and are listed in SWSI 2010:[19]

- The project or method has a project or method proponent.
- When the proponent is a retail water provider, the project or method is being used to meet the water supply needs of its customers by 2050.

- When the project proponent is a wholesale water provider, at least one retail water provider must express interest in writing and plan on using the project or method to meet the water supply needs of its customers by 2050.
- The project or method must have at least preliminary planning, design, conditional or absolute water rights, rights of way, and/or written negotiations with local governments the water project could affect.
- The water supply needs must be identified and included in the BIPs and/or SWSI documents.

The majority of Colorado's water providers responsibly plan to address their water needs according to their timelines and objectives. However, there is still a water supply gap. To address the minimum water gap, the basin roundtables and the IBCC developed several No-and-Low-Regrets goals and measurable outcomes, as Section 6.1 describes. In offering guidance to the basin roundtables, CWCB demonstrated how these measurable outcomes could inform the BIPs at a basin specific level. Table 6.2-2 compares BIP actions to these measurable outcomes, which include measures for conservation, IPPs, reuse, agricultural transfers, and Colorado River supplies:[20]

- *Establish low-to-medium conservation strategies*
    - Implement strategies at the basin-level to meet medium levels of conservation, and apply half of that to meet the M&I gap, equivalent to 67,000 acre-feet per year by 2030 and 167,000 acre-feet by 2050 statewide.
    - 2050 conservation savings by basin:
        - Arkansas: 36,000 acre-feet
        - Colorado: 15,000 acre-feet
        - Gunnison: 4,300 acre-feet
        - North Platte: 85 acre-feet
        - Rio Grande: 3,200 acre-feet
        - South Platte (including Metro Area): 97,000 acre-feet
        - Southwest: 7,500 acre-feet
        - Yampa/White/Green: 3,700 acre-feet
- *Have a high success rate for IPPs*
    - Implement IPPs to yield 80 percent of the statewide planned water deliveries, equivalent to 70,000 acre-feet per year for the western slope and 280,000 acre-feet per year for the eastern slope
    - 2050 No-and-Low-Regret IPP success by basin:
        - Arkansas: 76,000 acre-feet
        - Colorado: 45,000 acre-feet
        - Gunnison: 12,000 acre-feet
        - North Platte: 100 acre-feet
        - Rio Grande: 6,000 acre-feet
        - South Platte (including Metro Area): 200,000 acre-feet
        - Southwest: 13,000 acre-feet
        - Yampa/White/Green: 7,000 acre-feet
- *Implement reuse strategies*
    - Produce 25,000 acre-feet per year of yield resulting from new agricultural-transfer and TMD projects above and beyond the IPPs in the South Platte and Arkansas Basins.
- *Plan and preserve options for existing and new supply*
    - Develop 35,000 acre-feet per year of new supplies in the Colorado River system for the western slope.
    - Develop a conceptual framework among basin roundtables regarding ways to preserve the option for a potential future TMD from the western slope to the eastern slope. (Chapter 8 discusses the conceptual framework the IBCC developed.)

Many of the basins seek to meet these short- and long-term M&I goals in their BIPs; this subsection reviews BIPs by basin. Table 6.2-2 summarizes the success of each basin in meeting the overall water supply gap for municipalities and industry.

The current No-and-Low-Regrets actions and SWSI 2010 gap calculations do not take into account the potential effects of climate change. As this plan discusses, warming temperatures can affect water supply, water availability, and water demands. Should average annual temperature continue to increase at projected levels (2.5 to 5° F) by mid-century, it is reasonable to expect that the existing gap will increase.

TABLE 6.2-2	SUMMARY OF BASIN IMPLEMENTATION PLANS ADDRESSING THE MUNICIPAL AND INDUSTRIAL NO-AND-LOW-REGRETS AND GAPS					
Basin	2050 New Needs (acre-feet)[21]	2050 Gap (acre-feet)[22]	BIP-Identified Potential New Projects and Methods (acre-feet)[a]	# of New Projects w/ acre-foot info	Are No/Low Regrets Likely Met?	Notes
Arkansas	110,000 - 170,000	59,500[23] (M&I Shortage) 45,000 - 94,000 (SWSI 2010)	125,000	10	Yes: IPP success, identify additional projects to meet the gap.	A database categorized which projects listed in the BIP count as IPPs
Colorado	65,000 - 110,000	26,000 - 48,000	40,000 (20,000 in projects and 20,000 from high active conservation)	3	Yes: High conservation; some IPP success; identify additional Colorado River Basin supply projects	The BIP identified priority projects by region, and the largest project has a large agricultural component, so it is unclear if the gaps will be fully met with only the priority projects[24]
Gunnison	16,000 - 23,000	3,700 - 6,100	17,500 (12,000 in projects and 5,500 from high active conservation)	5	Yes: High conservation; success of IPPs; identify additional Colorado River Basin supply projects	BIP indicates M&I needs "are generally expected to be managed with sufficient existing supplies and/or through planned projects"[25]
North Platte	100-300	10 - 30	N/A	Completed Project	Yes: Accept conservation standards; IPP success.	The North Platte has met its municipal gap[26]
Rio Grande	7,700 - 13,000	2,300 - 5,100	800	1	Partially: Little conservation discussion; some IPP success	Because the basin is focused on groundwater sustainability, the BIP did not identify additional acre-feet for municipal projects.[27]
South Platte (including Metro)	340,000 - 505,000	204,000 - 310,000	98,000 (45,000 in projects and 53,000 from active conservation)	8	Partially: Some conservation, IPP success, reuse success, some agricultural transfers.	The BIP developed portfolios, which conceptually fill the gap with additional agricultural transfers, ATMs, multipurpose projects, and potentially a new TMD[28]
Southwest	20,000 - 31,000	8,800 - 16,000	49,000 (40,000 in projects and 9,000 from high active conservation)	7	Yes: High conservation; high IPP success; develop additional Colorado River Basin supplies.	Projects and methods identified will meet M&I gap as well as the infrastructure needs of the basin[29]
Yampa / White / Green	34,000 - 95,000	24,000 - 83,000	203,000 (198,000 in projects and 5,000 from high active conservation)	8	Yes: Some conservation; high IPP success; develop additional Colorado River Basin supplies.	85 percent of the yield for M&I projects stems from one large project.[30]
TOTALS	590,000 - 950,000	310,000 - 560,000	530,000	**42**		

a. This column represents the total number of acre-feet gathered from the projects and methods (P&M) the roundtables identified in the BIPs, which could serve municipal or industrial uses. Conservation is included as a method. The values do not consider hydrological limitations. These values do not include the IPPs previously identified in SWSI 2010.

Arkansas

The Arkansas Basin faces an immediate municipal gap in some areas, especially if one takes into account the need to replace nontributary groundwater in El Paso and Elbert Counties.[31] Future needs in the Arkansas Basin are likely to increase by 110,000 to 170,000 acre-feet, and currently planned projects leave a municipal water supply gap of between 45,000 and 94,000 acre-feet within the basin. This assumes that the basin implements identified projects and processes at a relatively high success rate.[32]

Arkansas Goals and Measurable Outcomes

To address this municipal gap, the Arkansas Roundtable identifies four goals related to meeting M&I needs.[33] These goals and their associated measurable outcomes, as stated in the BIP, are:

- *Meet the municipal supply gap in each county within the basin.*
  - *Generate a study by December 2015 determining surpluses and deficits within sub-regions/counties.*
  - *Funds provided in support of collaborative efforts reported annually.*
- *Support regional infrastructure development for cost-effective solutions to local water supply gaps.*
  - *Agreements to regional use of identified IPPs such as Southern Delivery System.*
  - *New Water Supply Reserve Grant (WSRA) grant request for regional infrastructure studies.*
  - *Agreements for off take of conduit water; funding of conduit processes and construction.*
- *Reduce or eliminate Denver Basin groundwater dependence for municipal users.*
  - *Presentations by groundwater dependent entities on solutions that have been implemented.*
  - *Presentations on interim solutions and funding requests to support those solutions and funding requests to support those solutions.*
  - *Funds provided in support of collaborative efforts reported annually.*
- *Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions.*
  - *Pilot project implemented as reported annually.*
  - *Engineering template implemented by the DWR to expedite temporary transfers at reduced cost.*
- *Increase surface storage available within the basin by 70,000 acre-feet by the year 2020.*
  - *Storage capacity and percentage of stored water annually from 2015 to 2020.*
- *Annual reporting of projects that have been permitted and/or constructed.*

Meeting the Arkansas' M&I Gaps

The BIP supports the three primary recommendations to address the Arkansas Basin's M&I supply gap:[34]

- *The Arkansas Basin Roundtable acknowledges that a limited number of IPPs may be able to meet most of the gap.*
- *Storage is essential to meeting all of the basin's consumptive, environmental, and recreational needs. In addition to traditional storage, aquifer storage and recovery must be considered and investigated as a future storage option.*
- *The roundtable identified a critical gap as the need to replace nonrenewable groundwater and augment the sustainability of designated basins.*

Within its 2015 IPPs list, the basin has identified six projects that address M&I needs, four projects that address both M&I and agricultural needs, and one conservation project for a total of 125,000 acre-feet. The M&I projects identify 77,000 new acre-feet; the combined M&I and agriculture projects identify 48,000 new acre-feet; and the conservation project may reduce 500 acre-feet by 2030. These projects meet basin M&I gaps. Additionally, the basin identified examples of rehabilitation of nonfederal Arkansas Basin reservoirs to modern standards. If all potential rehabilitations were implemented, they would affect 220,775 acre-feet, and the estimated costs of the repairs would total $37,500,000.[35]

Actions required in order to meet the basin goal of increasing surface storage available within the basin by 70,000 acre-feet by 2020 include:

- *Implement a critical IPP.*
- *Work with the Office of Dam Safety to identify storage projects for restoration, rehabilitation, and increased capacity.*
- *Support funding, including grant contributions where appropriate, for storage restoration and expansion projects.*

These actions will work to meet both M&I and agricultural gaps.

Colorado

The Colorado Basin faces a gap in Mesa County that could begin as early as 2030.[36] Future needs in the basin are likely to increase by 65,000 to 110,000 acre-feet, and currently planned projects leave a municipal water supply gap within the Colorado Basin of 26,000 to 48,000 acre-feet. This assumes that the basin implements identified projects and processes at a relatively high success rate.[37]

Colorado Goals and Measurable Outcomes

To address this municipal gap, the Colorado Basin Roundtable identifies seven goals in their BIP related to meeting M&I needs.[38] These goals and their associated measurable outcomes are:

- *Develop land use policies requiring and promoting conservation.*
  - *Develop recommendations for city, county, and state governing bodies promoting water awareness and efficiency in land use policy.*
  - *Develop educational materials or opportunities for municipal and county elected officials and planning officials on water supply issues and conservation options.*
  - *Preserve agriculture and reduce the transfer of agriculture water to municipal use.*
- *Raise awareness of current obstacles and efforts facing water providers.*
  - *Publish a summary of state and basin water providers' true cost of water by analyzing operation and maintenance costs including sustainable infrastructure replacement programs.*
  - *Development of national, state or local funding assistance programs to replace aging infrastructure.*
  - *All basin water providers have sustainable infrastructure replacement funding programs.*
- *Protect drinking water supplies from natural impacts such as extended droughts, forest fires, and climate change, among others.*
  - *Every basin water provider has a reliable redundant water supply to meet 2050 demands.*
  - *Colorado Basin Roundtable or the CWCB to establish a biannual basin conference on natural disaster planning for water providers and government officials.*
- *Improve water court process*
  - *Recommendations to improve the objector process.*
  - *Recommendations to limit vulnerability of water rights when changing existing water rights in water court.*
  - *Improvements to Colorado water law to encourage agricultural water efficiency practices without harming water right value.*
- *Secure growing water demand by developing in-basin supplies and expanding raw water storage supply.*
  - *All basin water providers to meet current supply needs with redundancy, drought plans, and viable project options to meet future water needs.*

- *Reduce average permitting time for a reservoir project to less than 10 years.*
- *Establish regional water provider and ditch company cooperatives focused on improving regional relationships, water supply redundancy and flexibility, water quality, coordinated efforts for multi-beneficial projects, and addressing environmental and recreational needs.*
- *Reduce demands by establishing water conservation goals and strategies.*

❖ *Improve Colorado Water Law to encourage efficiency, conservation, and reuse.*

- *Revised Colorado water law through legislation to allow more flexibility among water providers and the agricultural community to promote stream health through conservation, bypass flows, and flexibility in diversion location.*
- *Reduce time of average Division 5 water court process by adding staff including judges, referees, and supporting staff.*

❖ *Pursue continued M&I conservation.*

- *Achieve and sustain a high level of conservation by all basin water providers and industrial users.*

Meeting the Colorado's M&I Gaps

The Colorado Basin Roundtable underwent a prioritization process to identify and include high-ranking projects in its BIP. From its initial list of high-priority projects, it quantified 20,272 acre-feet of additional supplies beyond the IPPs to meet both M&I and agricultural gaps. In addition, the roundtable plans to implement high conservation. Half of total savings, which is equivalent to 20,000 acre-feet, could be used to address new demands. Together, at just over 40,000 acre-feet, the Colorado mainstem could have sufficient water to meet the 26,000 acre-feet needed under the No-and-Low-Regrets scenario, but not enough for the high potential M&I gap of 48,000 acre-feet the SWSI 2010 identified.[39]

In addition, the basin roundtable developed an extensive list of potential M&I projects by interviewing more than 60 water providers throughout the basin.[40]

If all of the projects and methods identified were implemented, as a whole the Colorado Basin's M&I gap would be more than met. The BIP identified 54 potential M&I projects that quantified the acre-feet, which added up to nearly 510,000 to 540,000 acre-feet—far exceeding the amount needed under the high potential M&I gap.[41] However, given that many have not identified a project proponent, uncertainty exists about whether communities can count on many of these water projects becoming a reality.

In summary, even the high potential M&I gap could be fully met if the Colorado River Basin implements high conservation, the high-priority projects identified, and a small portion of the projects from the full list of potential projects. However, uncertainty about the viability of many of the projects, and about specific commitments from water providers, makes reliance on these projects and commitment to high conservation levels uncertain.

Gunnison

The Gunnison Basin faces a gap that could begin as early as 2035 in Delta County.[42] Future needs in the basin are likely to increase from 16,000 to 23,000 acre-feet, and currently planned projects leave a municipal water supply gap of 3,700 to 6,100 acre-feet within the Gunnison Basin. This assumes that the basin implements identified projects and processes at a relatively high success rate.[43] In addition, the Gunnison BIP states that demands in Ouray County may be higher than the SWSI 2010 indicated.[44]

Gunnison Goals and Measurable Outcomes

To address this municipal gap, in its BIP the Gunnison Basin Roundtable identifies one goal related to meeting M&I needs.[45] That goal and its associated measurable outcomes are:

❖ *Identify and address M&I water shortages.*

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

In addition, the Gunnison BIP outlines the following statewide principles related to municipal conservation, including implementation steps:[46]

- *Water conservation, demand management, and land use planning that incorporates water supply factors should be equitably employed statewide.*
  - *Work with other basin roundtables to support conservation, demand management, and the incorporation of water supply factors into land use planning and development.*
  - *Promote programs that encourage drought tolerant vegetation and discourage lawn irrigation.*

Meeting the Gunnison's M&I Gaps

The Gunnison Basin Roundtable identified two water conservation activities and five tier-1 projects that would help meet future M&I needs and that were not previously identified in the SWSI 2010. "Tier 1" signifies that implementation is likely feasible by 2025, and that the project does an excellent job of meeting basin goals. If the basin implements the five projects, they will provide nearly 12,000 acre-feet.[a] This volume fully meets the gap the SWSI 2010 identified. The Gunnison BIP states that, "M&I needs … are generally expected to be managed with sufficient existing supplies and/or through planned projects."[b] Given this analysis, the Gunnison Basin meets its M&I gap.

In addition to these projects, the Gunnison Basin Roundtable also advocates for high-conservation standards, as the SWSI 2010 identified. The implementation of these standards and active conservation would likely result in water savings of another 5,500 acre-feet, which the basin could apply to meet future demands.

North Platte

The North Platte Basin no longer has an M&I supply gap. As stated in the North Platte BIP, "The North Platte Basin has only one municipal water provider, the Town of Walden, serving a population of about 600. Limitations to the town's water supply were identified in the original SWSI report, and subsequently addressed through a CWCB funded study and multi-alternative project, eliminating the only municipal water supply gap in the basin."[47]

North Platte Goals and Measurable Outcomes

Nonetheless, the basin indicated support for municipal conservation, which could help meet any additional needs. As expressed in the BIP, this goal and its associated measurable outcome are:

- *Support the equitable statewide application of municipal water conservation.*
  - *Comply with future statewide municipal-conservation strategies and any related legislation by 2020, or as appropriate.*

Meeting the North Platte's M&I Gaps

The North Platte has met its future M&I needs.

Rio Grande

The Rio Grande Basin has a relatively small, though important, M&I gap. According to the CWCB's analyses, this gap could begin as early as 2025 in Costilla County.[48] The studies indicate that future needs in the Rio Grande are likely to increase by 7700 to 13,000 acre-feet, and currently planned projects leave a municipal water supply gap of between 2300 to 5100 acre-feet within the Rio Grande Basin.[49] This assumes that the basin implements the identified projects and processes at a relatively high success rate.[50] The Rio Grande Basin would like to better determine the amount, timing, and location of the gap once the Rio Grande Decision Support System groundwater model is ready. The basin expects that most water providers will have a gap and will need to join a groundwater management subdistrict or develop an independent augmentation plan.

Rio Grande Goals and Measurable Outcomes

To address this municipal gap, in its BIP the Rio Grande Basin Roundtable identifies three primary goals for meeting M&I needs. These goals and their associated measurable outcomes are:[51]

- *Operate, maintain, rehabilitate, and create necessary infrastructure to meet the basin's long-term water needs, including storage.*
  - *A database of existing water infrastructure including documentation of infrastructure condition and mapping of all storage reservoirs and major ditch diversions is created.*

[a] Wilson Water Group, Gunnison Basin Implementation Plan.
[b] Wilson Water Group, Gunnison Basin Implementation Plan.

- *Reservoirs operate at full design capacity without restrictions.*
- *Diversion structures and conveyance systems function optimally.*
- *Municipal potable water supplies are adequate to meet needs.*
- *Water supplies and wastewater treatment systems are fully functional and meet all necessary standards.*

❖ *Support the development of projects and methods that have multiple benefits for agricultural, M&I, and environmental and recreational water needs.*

- *Opportunities for multiple use benefits have been explored and implemented where possible.*
- *Multiple-purpose projects will have preference in the funding process.*

❖ *Meet new demands for water, to the extent practicable, without impacting existing water rights and compact obligations.*

- *Reduce per capita per day water use to a reasonable level.*
- *Inventory existing and expected future M&I and environmental and recreational water needs.*
- *Add hydropower electrical generating capacity where possible.*
- *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 effects on other uses.*

Meeting the Rio Grande's M&I Gaps

The Rio Grande Basin Roundtable identified very few municipal projects beyond the identified projects and processes in SWSI 2010, and only one of these projects provides additional acre-feet to meet growing municipal needs. In its BIP, it acknowledges this by stating:

❖ *While M&I and Self-Supplied Industrial (SSI) water use will remain a small percentage of overall basin water use, it is important to provide additional resources to M&I water providers to assist them in meeting future needs by identifying and assisting in the development of:*

❖ *Measures to manage water demands and return flows and develop methods to receive augmentation credits for wastewater discharges and lawn irrigation return flows.*

❖ *Water rights, storage and augmentation supplies, either directly or through the groundwater management subdistricts.*

❖ *Finalization of the Rio Grande Decision Support System groundwater model so that M&I pumping depletions can be determined in amount, timing, and location.*[52]

The Rio Grande has not yet quantified its future M&I gap. Once the basin determines well-pumping depletions by amount, timing, and location, the M&I providers will either join a subdistrict or develop an independent augmentation plan.

South Platte (including the Metro Area and Republican Basin)

The Metro, South Platte, and Republican Basins face a municipal gap that could begin as early as 2020 in the Lower South Platte. When taking into account the need to replace nontributary groundwater, that gap already exists in the South Metro Area Basin.[53] The potential gap in the Lower South Platte is relatively small compared to that of the urbanized Front Range, which holds the largest gap in Colorado. Future needs in the basin as a whole are likely to increase by 340,000 to 505,000 acre-feet. However, water needs for hydraulic fracturing must be added to the water supply gap. With existing data, currently planned projects leave a municipal water supply gap within Colorado's northeast region of 204,000 to 310,000 acre-feet. This assumes that the basin implements identified projects and processes at a relatively high success rate.[54]

South Platte Goals and Measurable Outcomes

To address this M&I gap, the South Platte BIP developed a long-term goal:[55]

Meet community water needs throughout Colorado by: 1) Using water efficiently with high levels of participation in conservation programs; 2) Developing additional water throughout the state through balanced, multi-purpose projects and methods; and 3) Assuring strong drought protection programs through broad development of protection plans and dedicated reserves potentially including storage, interruptible service agreements (ISAs), water banks, water use restrictions and nontributary groundwater, among others.

In the short term, the South Platte developed four goals and associated measurable outcomes to meet the large M&I water supply gap in the South Platte Basin:[56]

- *Continue the South Platte River Basin's leadership in wise water use.*
  - *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.*
  - *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.*
  - *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 elation to water available for exchanges; 3) reuse and successive uses of water downstream including effects on agricultural water shortages.*
  - *Ensure conservation, reuse, and drought management plans take into consideration environmental and recreational focus areas and attributes.*
- *Bring a high percentage of entries in the updated IPP list online as a key strategy consistent with the "no/low regrets" scenario planning approach.*
  - *Maximize implementation of the updated IPP list.*
  - *Encourage multi-purpose projects that also provide environmental and recreational considerations. Foster opportunities to improve environment and recreation conditions of affected watersheds in association with IPPs.*
- *To the extent possible, develop multi-purpose storage, conveyance, system interconnections, and other infrastructure projects to take advantage of limited remaining South Platte supplies and enhance water use efficiencies and supply reliability.*

Baseball fields dot the landscape near the Denver Technological Center (DTC). The DTC is home to several major businesses and corporations.

- *Explore opportunities to maximize yield from additional South Platte Basin strategic and multi-purpose storage and other infrastructure including collaborative interconnections between water supply systems and above ground and groundwater (e.g. Aquifer storage and recharge (ASR) and alluvial recharge) storage.*
- *Encourage multi-purpose projects that provide environmental and recreational considerations.*
- *Take into consideration environmental and recreational attributes when considering Storage and Other Infrastructure projects and methods.*

❖ *Maintain, enhance and proactively manage water quality for all use classifications.*

- *Maintain or improve the delivery of safe water supplies throughout the basin.*
- *Monitor, protect and improve watershed water quality and identify and document progress and improvements.*
- *Improve areas where water quality may be limiting the suitability of focus areas identified by BRTs through environmental and recreational mapping efforts.*

❖ *Develop agreements governing additional trans basin water imports that: 1) are in accordance with the South Platte Basin's overarching theme that economic, environmental and recreational benefits should equitably accrue to both the western slope and the eastern slope; 2) include project(s) or project elements that provide multiple types of uses; 3) supported with state investment; and 4) provide enough certainty in conditions to substantially lessen current trends of traditional buy-and-dry transfers from agricultural uses to M&I uses.*

- *Through the IBCC, negotiate a conceptual agreement with the western slope basin roundtables on investigating, preserving, and developing potential options so that future multi-purpose projects benefiting both slopes can be addressed on a timely basis.*
- *Encourage multi-purpose projects that provide environmental and recreational considerations.*

Meeting the South Platte's M&I Gaps

The South Platte BIP includes a list of potential M&I projects, a conservation strategy, and some initial portfolios to accomplish its goals and meet the identified M&I gaps.[57] It used similar categories to the No-and-Low-Regrets work Section 6.1 describes. A comparison is provided below:

❖ The BIP partially meets the No-and-Low-Regrets goals associated with conservation. The Metro and South Platte Basins estimate they will further reduce M&I demand to 129 gallons per day per capita (GPCD) and 146 GPCD, respectively. The BIP applies 50 percent of active conservation savings, plus all passive savings, to meet future needs in their portfolio work. Approximately 53,000 acre-feet of active conservation savings apply to future needs. The basins would need to apply a substantially higher percentage of active conservation in order to fully meet the No-and-Low-Regrets goal of applying 97,000 acre-feet to meet new demands.

❖ The BIP meets the No-and-Low-Regrets goal of 199,000 acre-foot yield from the IPPs. The total yield from the IPPs the basin describes in its BIP exceeds the No-and-Low-Regrets goals, yielding about 225,000 acre-feet. This is partly attributed to the fact that the BIP identifies 16 new projects (seven for reuse, four for agricultural transfers, and five for basin projects) that were not previously in the SWSI 2010.

❖ The No-and-Low-Regrets actions indicate that basins would need to generate 22,000 acre-feet of reuse water from new agricultural diversions and any new TMD projects. The BIP proposes 45,010 new acre-feet of water from reuse. Although the South Platte BIP discusses reuse, the BIP's portfolio work did not calculate reuse from these new projects.

❖ The No-and-Low-Regrets actions indicate that the basin needs a minimum of 44,000 acre-feet of additional agricultural transfers, and that these transfers should ideally be alternative agricultural transfers. The BIP identifies 4560 acre-feet of alternative transfer methods (ATMs). It also indicates that, by applying conservation to meet new demands, portfolios B and C would need between 25,000 and 90,000 acre-feet of additional agricultural dry-up. Therefore, the BIP likely meets this No-and-Low-Regrets goal. Portfolios B and C identified about 30,000 acre-feet of alternative transfer-method water. The BIP also includes recommendations to streamline transaction costs for ATMs.

Southwest

The Southwest Basin faces a gap that could begin as early as 2015 in Montrose County.[58] Future needs in the Southwest Region are likely to increase by 20,000 to 31,000 acre-feet, and currently planned projects leave a municipal water supply gap within the Southwest region of 8,800 to 16,000 acre-feet. This assumes that the basin implements identified projects and processes at a relatively high success rate.[59]

Southwest Goals and Measurable Outcomes

To address this municipal gap, in its BIP the Southwest Basin Roundtable identified four goals related to meeting M&I needs. These goals and their associated measurable outcomes are below:[60]

- *Pursue a high success rate for identified specific and unique projects and processes to meet the municipal gap and to address all water needs and values.*
    - *Complete 40 IPPs aimed at meeting municipal water needs.*
- *Provide safe drinking water to Southwest Colorado's citizens and visitors.*
    - *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.*
    - *Implement at least one IPP that protects or enhances the ability of public water supply systems to access and deliver safe drinking water that meets all health-based standards.*
- *Promote wise and efficient water use through implementation of municipal conservation strategies to reduce overall future water needs.*
    - *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 defined as requiring a water court change case state by 2030.*
    - *Implement three informational events about water reuse efforts, tools, and strategies.*
    - *The water providers in the state that are using dry up of agricultural land[c] and/or pursuing a new TMD[d] 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.*
- *Support and implement water reuse strategies.*

Meeting the Southwest's M&I Gaps

The Southwest BIP includes a list of potential M&I projects compiled from interviews with providers in each sub-basin.[61] The roundtable identified seven new projects to include components that would meet future municipal supply needs, and several others that would address other infrastructure needs within the basin. Among these seven projects, a total of nearly 40,000 acre-feet was identified. However, it is not clear whether each geographic region in the basin will be able to meet its future needs if it implements the listed projects.[62]

The Southwest Basin Roundtable acknowledged that while it did not quantify every identified project in its BIP, the projects and methods would fully meet their M&I water supply gap as well as the basin's infrastructure needs.

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[c] Defined as requiring a water court change case.
[d] As defined by the IBCC to be a new western slope to eastern slope diversion project.

Yampa/White/Green

The Yampa/White/Green Basin faces a gap that could begin as early as 2015 in Rio Blanco and Moffat Counties.[63] According to SWSI 2010, future needs in this northwest Colorado region are likely to increase by 34,000 to 95,000 acre-feet. However, these needs will likely be revised downward, since all indications show that oil shale will not become commercially viable by 2050.[64] Energy development from hydrologic fracturing is a new need that basins should also take into account when calculating the M&I water supply gap. With existing data, currently planned projects leave a municipal water supply gap of 24,000 to 83,000 acre-feet within Colorado's northwest region. This assumes that the basin implements identified projects and processes at a relatively high success rate.[65]

Yampa/White/Green Goals and Measurable Outcomes

To address this M&I gap, the Yampa/White/Green BIP identified four goals related to meeting M&I needs. These goals and their relevant measurable outcomes and processes are below:[66]

- *Protect and encourage agricultural uses of water in the Yampa/White/Green Basin within the context of private property rights.*
  - *Process*
    - *Identify agricultural water shortages and evaluate potential cooperative and/or incentive programs to reduce agricultural water shortages.*
    - *Identify projects that propose to use at-risk water rights, alternative transfer methods, water banking, and efficiency improvements that protect and encourage continued agricultural water use.*
    - *Encourage and support M&I projects that have components that preserve agricultural water uses.*
  - *Outcomes*
    - *Preserve the current baseline of about 119,000 irrigated acres and expand by 12 percent by 2030.*
    - *Encourage land use policies and community goals that enhance agriculture and agricultural water rights.*
- *Identify and address M&I water shortages.*
  - *Processes*
    - *Identify specific locations in the Yampa/White/Green Basin where M&I shortages may exist in drought scenarios and quantify shortages in time, frequency, and duration.*
    - *Identify effects throughout the Yampa/White/Green Basin in the context of water shortages (drought and climate change), wildfire and compact shortage on M&I demands.*
    - *Identify projects and processes that can be used to meet M&I needs.*
    - *Encourage collaborative multi-purpose storage projects.*
    - *Support efforts of water providers to secure redundant supplies in the face of potential watershed effects from wildfire.*
    - *Encourage municipal entities to meet some future municipal water needs through water conserv*ation and efficiency
  - *Outcomes*
    - *Reliably meet 100 percent of M&I demands in the basin through the year 2050 and beyond through the following processes:*
- *Maintain and consider the existing natural range of water quality that is necessary for current and anticipated water uses.*
  - *Processes*
    - *Encourage and support water quality protection and monitoring programs in the sub-basins of the Yampa/White/Green Basin through watershed groups, municipalities, land management agencies and other efforts.*
  - *Outcomes*
    - *Consider and maintain the existing water quality necessary for current and future water uses when reviewing IPPs.*
    - *Support the implementation of water-quality monitoring programs to create quality-controlled baseline data for all sub-basins of the Yampa/White/Green Basin.*

Meeting the Yampa/White/Green's M&I Gaps

The Yampa/White/Green Basin Roundtable conducted the most thorough analysis of how well the implementation of future projects and methods would meet M&I needs. In addition, the roundtable assessed these needs under a hot-and-dry future. Below is an excerpt from the BIP describing potential future shortages:

> *Municipal Shortages:*
>
> *M&I demands are small compared to agricultural demands in the Yampa/White/Green Basin. Under Baseline Conditions, no shortages exist to M&I demand nodes because of generally adequate water supply and augmentation from reservoirs.*
>
> *While M&I shortages exist under the high demand, low water supply scenarios of the Dry Future IPP Scenario and the Dry Future Scenario, the shortages remain below 10 percent. Under both scenarios, District 43 existing M&I in Rio Blanco County (Rangely Water, Meeker Demand) and District 58 existing M&I in Routt County (the City of Steamboat Springs) begin to exhibit shortages, whereas Moffat County municipal nodes do not show M&I shortages under either scenario. If IPPs are developed that include M&I use, shortages would likely decrease in locations with supply augmentation.*
>
> *Industrial Shortages:*
>
> *Under Baseline Conditions, no shortages exist for SSI, which consist of thermoelectric power generation needs. Slight shortages exist for the Hayden Station and units 1 and 2 of Craig Station under the Dry Future IPP Scenario and the Dry Future Scenario. These scenarios meet thermoelectric demands with redundant water supplies from Steamboat Lake for Hayden Station and Elkhead and Stagecoach Reservoirs for Craig Station. Using historical data, hypothetical shortages would have occurred for the Hayden Station in the dry months of August 1961, March 1962, September 1977, and September 2002) and for the Craig Station in the dry months of November 1963, September 1977, December 2002, and a few months in 1949.*

Nevertheless, SSI water users consider their water supply short when they must rely upon redundant water supplies. For example, some SSI water users considered the years 2002, 2003, 2012, and 2013 to be "water supply-short" or "borderline-short" due to their reliance on redundant supplies. Further discussions will take place regarding the most appropriate baseline conditions and shortage assessments in light of drought, climate change, and evolving power generation technologies[67]

Overall, the roundtable modeled nine M&I projects and methods, including conservation in Steamboat Springs, which the SWSI 2010 did not previously identify. The roundtable only modeled projects that identified a project proponent, a location, physical characteristics, and operations. It quantified acre-feet that are associated with eight of the projects, and that meet the potential needs of the energy industry. The total, newly quantified acre-feet to meet M&I needs adds up to 198,000.[68] In conclusion, the BIP identified projects that meet future M&I demands.

Meeting Colorado's Agricultural Needs

The agricultural gap is the difference between the status quo, which shows a reduction in irrigated acres in almost every basin (Figure 6.2-1, page 6-32), and what the State or a basin indicates it *wants to achieve* with regard to agriculture in accordance with its goals and measurable outcomes, minus the projects and methods that are *planned* to meet those needs.[69] While every basin indicated that maintaining viable agriculture is one of the most important aspects of its BIP, this definition allows for considerable variability between basins, which face different issues related to agriculture.

Colorado expects its irrigated acres to decline in almost every basin by 2050 (Figure 6.2-1, page 6-32)—but these projected declines have differing causes. Similarly, every basin has agricultural shortages. The BIPs work to address these challenges by identifying projects that could reduce shortages, maintain the agricultural economy and, in some cases, increase irrigated acres.

To address the challenges associated with shortages and declining irrigated acres, the CWCB has identified four statewide long-term goals:[70]

- *Ensure that agriculture remains a viable economic driver in Colorado by supporting food security, jobs, and rural communities while protecting private property rights.*
- *Meet Colorado's agricultural needs.*

- *Implement efficiency and conservation measures to maximize beneficial use and production.*
- *Protect and enhance Colorado's natural resources, and provide ecosystem services.*

Before exploring how the basins developed solutions within their BIPs to meet these and other local goals, it is important to understand some of the statewide issues related to shortages and the decline in irrigated acres. The CWCB expects irrigated acres to decline for three primary reasons:[71]

1. Urbanization of agricultural lands, which is primarily an issue in the South Platte and Colorado Basins;
2. Conversion of agricultural water rights to municipal rights in order to meet future municipal needs, which is mostly occurring in the South Platte, Colorado, and Arkansas Basins; and
3. Voluntary reductions in water use associated with sustainable groundwater supplies and compact obligations, which are ongoing in the Rio Grande and Republican Basins.

Underlying many of the reasons for agricultural decline are temporary and downward state, national, and international agricultural economic trends. However, by 2050, the CWCB expects the agricultural economy to be increasingly viable because of a global increase in the number of people who need food, and the number of people who can afford high-quality and high-protein agricultural products.[72] Colorado's agricultural production is also vital locally. As Chapter 3 describes, 50 percent of jobs are related to agriculture in some counties.

From a statewide perspective, it is important to provide options and incentives that help maintain, or even increase, Colorado's agricultural economy and production in light of the loss of irrigated acres. The "agricultural gap" described above will need to be addressed in order to meet the strategic position that

Headgates help water users control the flow of water throughout the state.

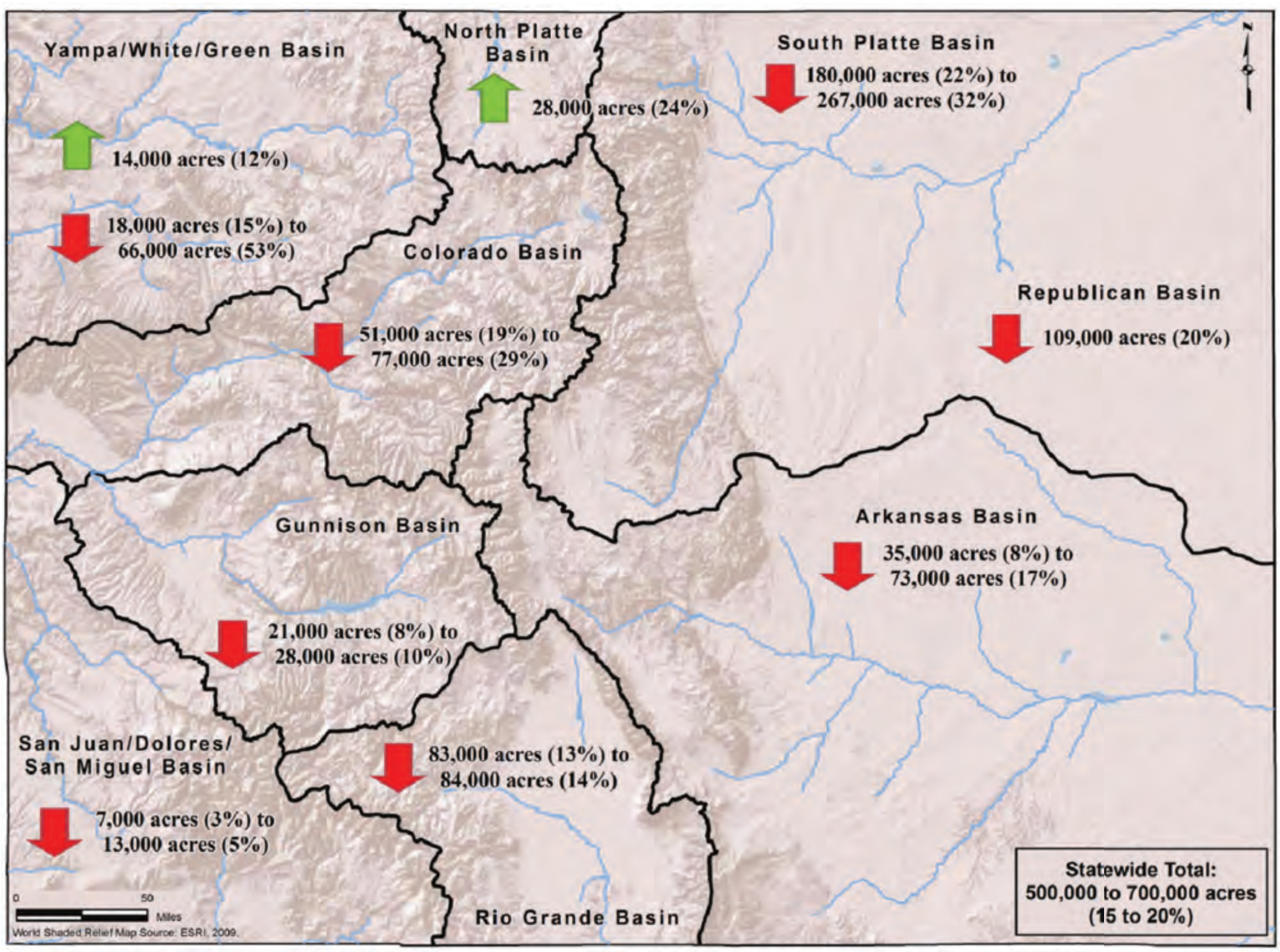
Colorado and the basins seek to achieve in 2050 from an agricultural perspective. Nevertheless, quantifying this prospective agricultural gap is difficult. As a result, many basins choose to reduce agricultural shortages or find alternative sources of water so that the transfer of agricultural water is not the default solution to meeting Colorado's growing needs.

Several basins discuss reduction of shortages, and it is therefore important to understand the definition of agricultural shortage. As the Gunnison BIP describes, three primary factors can cause agricultural shortages:[73]

> ***Physical shortages*** *are because of lack of physical supply. Such shortages are often seen later in the irrigation season principally by irrigators on smaller tributaries. Though irrigation water rights may be* in *priority, there is not enough supply. Although these shortages are exacerbated in dry years, on many of the tributaries physical flow is not sufficient to meet the crop irrigation requirement (CIR) for the entire growing season even in wet years.*
>
> ***Legal shortages*** *are those because of lack of legal supply; there may be physical supply at a headgate, but it must be bypassed to meet downstream senior water rights. This type of shortage is often seen later in the season by irrigators with junior water rights in average and wet years, and may be the situation for junior irrigators the entire growing season in dry years.*
>
> ***Irrigation practice "shortages"*** *result from specific irrigation practices; the irrigator may have physically and legally available supply but chooses not to irrigate. For example, some irrigators may need to reduce or cease irrigation to allow the land time to dry before haying or grazing. In addition, an irrigator may cease diverting because there is*

FIGURE 6.2-1 POTENTIAL CHANGES IN IRRIGATED ACRES BY 2050[74]

(⬆ = increase in irrigated acres; ⬇ = decrease in irrigated acres)



not enough time left in the growing season for an additional cutting. Note, though this [is] a very different type of shortage, it is equally important to document. Identification of shortages related to irrigation practices helps to quantify the difference between CIR and actual consumptive use in SWSI and other statewide planning efforts. In addition, since irrigation practice shortages cannot be addressed by increased water supply, their identification helps to focus on the implementation of projects that meet physical and legal shortages.

Due to variables such as economic viability, irrigation practice "shortages," and other factors, an agricultural shortage is not necessarily an agricultural gap. Colorado continues to have a healthy agricultural economy, despite shortages ranging between 17 and 45 percent statewide.

This subsection reviews information by basin, and Table 6.2-3 summarizes each basin's success in meeting its agricultural gaps as defined by its goals.

Arkansas

The Arkansas Basin has the third-highest acreage of irrigated land in Colorado and the highest percentage of shortages (45 percent) in comparison to other basins.[78] In addition, irrigated acres are likely to decline by 8 to 17 percent.[79] These estimated declines are primarily due to agricultural transfers from both within the basin and from municipal interests in the South Platte Basin. Still, as many as 3000 irrigated acres (1 percent) may urbanize.

Arkansas Goals and Measurable Outcomes

To address these pressures, in its BIP the Arkansas Basin Roundtable identified four goals related to sustaining agriculture.[80] These goals and their associated measurable outcomes are:

- *Sustain an annual $1.5 billion agricultural economy in the basin.*
    - *Increase in measured economic productivity by update of Colorado State University study in 2020.*
- *Provide augmentation water as needed to support increased farm efficiencies.*
    - *Document the baseline of current augmentation water available.*
    - *Track available storage facilities for augmentation sources.*
- *Develop a viable rotating fallow and/or leasing program between agriculture and municipal interests to address drought and provide risk management for agriculture.*
    - *Report on pilot projects underway as of December 2015.*
    - *Complete and present report by December 2015.*
    - *Survey of permanently retired acreage as of year 2020.*
- *Sustain recreational and environmental activities that depend on habitat and open space associated with farm and ranch land.*
    - *Measure the economic contribution of tourism to the basin economy within the CSU 2020 update.*
    - *Change of status for "protected" attributes as measured by nonconsumptive projects and methods in SWSI 2016 report.*
- *Increase surface storage available within the basin by 70,000 acre-feet by the year 2020.*
    - *Storage capacity and percentage of stored water annually from 2015 to 2020.*
- *Annual reporting of projects that have been permitted and/or constructed.*

Meeting the Arkansas' Agricultural Gap

The primary goal is to support the $1.5 billion agricultural economy in light of agricultural loss.[81] As the BIP indicates, a multipronged strategy is necessary:

> *To maintain that level of economic productivity, projects and methods described in [the BIP] focus on development of rotating fallowing, conservation easements, and increased storage capacity to allow agricultural water to sustain agricultural productivity. In particular, a three-pronged approach to understanding rotational fallowing within the Prior Appropriation Doctrine is underway — an administrative and accounting tool, pilot projects and public policy dialogue — and will continue.*[82]

The Arkansas Basin identified 89,000 new acre-feet associated with seven projects that focus primarily on agricultural needs, and four projects that focus on agricultural and M&I needs. One of the multipurpose projects, which meets both agricultural and M&I needs, will also irrigate 2000 new acres. Adaptive

TABLE 6.2-3 SUMMARY OF HOW EACH BASIN MET ITS AGRICULTURAL GAPS

Basin	Irrigated Acres[75]	Shortage (Acre-feet/Year)[76]	Potential New Acre-feet	# of New Projects	Summary of How BIPs Met Their Agricultural Goals/Gaps
Arkansas	428,000	30,000 – 50,000 (augmentation gap)[e]	89,000	22	Yes decrease shortages; potential to sustain agricultural $1.5 billion economy w/ actions; don't develop specific augmentation water projects; policies and projects support rotational fallowing, policies support agriculture- related recreational and environmental uses with conservation easements
Colorado	268,000	100,000	20,000	3	Partially decrease shortages; discuss some efforts to develop incentives and decrease urbanization and agricultural to urban transfers
Gunnison	272,000	116,000[77]	129,000	17	Yes decrease shortages, partially discourage agricultural transfers through policies
North Platte	117,000	110,000	12,000	12	Increase irrigated acreage to partially meet 17,000 acre goal; increase storage to partially meet 37,000 acre-feet goal
Rio Grande	622,000	428,000	800	1	Yes, improve infrastructure; partially improve agricultural economy
South Platte	1,381,000 (831,000 SP, 550,000 Republican)	434,000 (160,000 SP, 274,000 Republican)	0	0	Partially reduce permanent dry-up w/ conceptual ATMs and alternative sources, don't reduce urbanization or shortages
Southwest	259,000	198,000	20,000	6	Partially decrease shortages; Yes, increase efficiency w/ IPPs; discuss policy to minimize acres transferred, have no agricultural-sharing IPPs
Yampa / White / Green	119,000	54,000	25,000	3	Increase number of irrigated acres to partially meet 15,000 acre goal; partially decrease shortages by 46%
TOTALS	**3,466,000**	**1,470,000 – 1,490,000**	**296,000**	**64**	

[e] The Arkansas Basin Roundtable aspires to maintain the agricultural economy in the basin, and does not identify the agricultural gap in terms of irrigated acreage. Under the Arkansas River Compact, consumptive use is limited, so the roundtable believes that a gap expressed in terms of an "augmentation gap" is a more appropriate evaluation of needs.

Resources, Inc.[83] recently prepared a study for the Lower Arkansas Valley Water Conservancy District showing that the basin needs 25,000 to 30,000 acre-feet for augmentation today, and those needs will grow to more than 50,000 acre-feet by the year 2050. If the basin implements the identified projects it will meet its 2050 augmentation agricultural gap.

To meet its goal of increasing available surface storage by 70,000 acre-feet by 2020, the basin has identified the following actions in its BIP:

- *Implement a critical IPP.*
- *Work with the State Engineer's Office of Dam Safety to identify storage projects for restoration, rehabilitation, and increased capacity.*
- *Support funding, including grant contributions where appropriate, for storage restoration and expansion projects.*

These actions will work to meet both M&I and agricultural gaps.

Actions to meet the basin goal of providing augmentation-water to support increased farm efficiencies include:

- *Establish long-term sources of augmentation-water through leasing, water banks, or interruptible supply agreements.*
- *Construct recharge facilities to capture and re-time fully consumable water supplies.*

Colorado

The Colorado Basin has the fifth-highest acreage of irrigated land in Colorado and the lowest percentage of shortages as a basin (17 percent).[84] The CWCB expects irrigated acres to decline by 19 to 29 percent.[85] This likely decline is primarily due to urbanization, which accounts for 65 to 80 percent of the loss—and totals about 40,000 to 50,000 acres. The remaining agricultural loss is due to agricultural-to-municipal transfers.[86]

Colorado Goals and Measurable Outcomes

To address these pressures, in its BIP the Colorado Basin Roundtable identified four goals related to sustaining agriculture.[87] These goals and their associated measurable outcomes are:

- *Reduce agricultural water shortages.*
    - *Identify multi-purpose storage projects and methods that address the annual 100,000 acre-feet agricultural shortage.*
    - *Maintain existing irrigated agricultural acreage.*
    - *Research local agricultural shortage values in the Colorado River Basin.*
    - *Improve Colorado water law to encourage agricultural water efficiency practices without harming water right value.*
    - *Establish lease programs for excess water from existing supply projects in the M&I sector or multi-use projects.*
- *Minimize potential for transfer of agricultural water rights to municipal uses.*
    - *Identify farm improvements to develop strong sustainable farm economics.*
    - *Develop a set of quantifiable factors of agriculture pressures that can be measured and evaluated in the future to incentivize production and reduce trends towards transfers.*
    - *Adopt local land use codes to conserve water and reduce pressures for agricultural water transfers.*
    - *Promote conservation easements with the anticipated result that they will be more widely considered by the agricultural community.*
- *Develop incentives to support agricultural production.*
    - *Reimburse agriculture for value added to the environment including,water quality, wildlife, and views capes.*
    - *Track effectiveness of agricultural incentives in maintaining irrigated acres.*

- *Minimize regulatory disincentives such as overly stringent requirements for reservoir construction.*
- *Reduce taxes for true self-sustaining agriculture.*
- *Develop incentives that encourage continued agricultural production.*

- *Promote agricultural conservation that maintains agricultural production and viability.*
  - *Revise Colorado Water Law to allow agricultural conservation and improved efficiency measures without impacting water right value or risk of abandonment.*
  - *Strive towards a high level of conservation and efficiency within the agricultural industry.*

Meeting the Colorado's Agricultural Gaps

The Colorado Basin Roundtable identified 21 high-priority projects that meet basin theme 2: Sustain agriculture. The high-priority projects quantified a total of 20,272 acre-feet as meeting both agricultural and M&I gaps. While this amount is insufficient to fully address agricultural shortages in the basin, the Colorado BIP identified 41 projects with quantifications of acre-feet that could reduce agricultural shortages in the basin by a total of 453,000 to 483,000 acre-feet. These projects could eliminate the 100,000 acre-feet of shortages in the basin. However, neither a spatial nor a hydrological analysis has been done to confirm this. Furthermore, the number of projects the basin is likely to implement is unclear, as several of them lack active project proponents.

With regard to addressing agricultural losses due to urbanization, the BIP has several suggestions concerning land use. If these suggested actions are implemented, they could reduce urbanization, but the BIP has not quantified those effects. In addition, the BIP states a need to promote other activities to minimize agricultural loss from water rights transfers, improve agricultural efficiency, and support agricultural production. For policy implementation to occur, the BIP must provide more detail.

In summary, the basin will likely need to implement both high-priority projects and methods and some projects from the full projects list in order to fully address its agricultural shortages and partially address its other goals.

Gunnison

The Gunnison Basin has the fourth-highest acreage of irrigated land in Colorado and the second-lowest percentage of shortages as a basin (20 percent).[88] In addition, irrigated acres are likely to decline by 8 to 10 percent.[89] This anticipated decline is primarily due to urbanization, which could take 20,000 to 26,000 acres out of production.[90]

Gunnison Goals and Measurable Outcomes

To address these issues, the Gunnison BIP identified two goals related to sustaining agriculture.[91] These goals and their associated measurable outcomes are:

- *Improve agricultural water supplies to reduce shortages.*
  - *Reduce basin-wide agricultural shortages by developing 10 projects from the list of recommended solutions in the Gunnison BIP by the year 2030.*
  - *Implement the Inventory of Irrigation Infrastructure Improvement Needs projects from the list of recommended solutions in the Gunnison BIP by 2020.*
- *Discourage the conversion of productive agricultural land to all other uses within the context of private property rights.*
  - *Preserve the current baseline of 183,000 protected acres in the Gunnison Basin and expand the participation in conservation easements by five percent by 2030 through programs like the Gunnison Ranchland Conservation Legacy.*

The primary basin goal identified in the Gunnison BIP was to "Protect existing water uses in the Gunnison Basin." This goal framed much of the BIP discussion, especially with regard to meeting agricultural needs.

Meeting the Gunnison's Agricultural Gaps

The Gunnison Basin Roundtable identified 17 projects that it expects the basin to implement in the near term. If the basin implements these projects, it will reduce shortages by approximately 129,000 acre-feet. In addition, infrastructure improvement projects will improve agricultural efficiencies, even though they may not yield acre-feet. The Gunnison BIP also states a goal of protecting more irrigated acres. Currently, based on data from the Gunnison Ranchland Conservation Legacy, 183,000 acres are protected through conservation easements. The Gunnison Basin Roundtable would like to see the protection of another 9,150 acres by 2030, but it is not clear if policies within the BIP will enable this to occur. Therefore, the BIP has partially met the second goal.

North Platte

The amount of irrigated land in the North Platte Basin has declined since the Supreme Court's Equitable Apportionment Decree, which states that the North Platte in Colorado can continue to irrigate at the historical levels the decree defines. The North Platte BIP has indicated an interest in irrigating more lands.[92]

North Platte Goals and Measurable Outcomes

To address this issue, the North Platte Basin Roundtable BIP contains two goals related to sustaining agriculture.[93] These goals and their associated measurable outcomes are:

- *Maintain and maximize the consumptive use of water permitted in the Equitable Apportionment Decree and the baseline depletion allowance of the Three State Agreement.*
    - *Develop three projects from the list of recommended solutions by 2020.*
    - *Incrementally bring up to 17,000 additional acres under irrigation by 2050.*
    - *Develop 37,000 acre-feet of additional storage (doubling of current storage) by 2050.*
- *Continue to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies.*
    - *Develop three projects from the list of recommended solutions by 2020.*

Meeting the North Platte's Agricultural Gaps

The North Platte identified 12 projects, and associated estimates of acre-feet, acreage, or cubic feet per second. The basin has access to water volume information for six of the projects, and half of those projects do not reveal the amount of associated increase in acreage they would provide. The basin estimates that these projects could generate approximately 12,000 acre-feet. Similarly, nine potential projects provide information on the acreage they could serve, but six of the descriptions do not identify the number of acre-feet associated with the projects. In sum, the BIP identified an increase of more than 12,000 acres. The CWCB assumes that the three projects without associated acreage would add to that number, but given the available data, the North Platte BIP meets about 70 percent of its goal to increase acreage. Additionally, several listed projects are working to restore, maintain, and modernize water infrastructure in the basin; however, the roundtable identified projects that only partially meet the basin's goal to increase storage by 37,000 acre-feet.

Rio Grande

The Rio Grande Basin has the second-highest acreage of irrigated land in Colorado and the basin as a whole uses 67 percent of its crop-irrigation water requirement.[94] Agriculture is the primary water use and is the base of the economy. At the same time, the basin must correct the water balance to achieve sustainability between senior surface-water rights and the more junior groundwater rights. To achieve sustainability and protect senior water rights, the CWCB estimates that approximately 15 percent, or 80,000, of currently irrigated acres may be dried up. These issues will be addressed by either the new rules and regulations the DWR is develoing or through the formation of groundwater management subdistricts.[95] The purpose of the rules and regulations is as follows:

The overall objective of this subdistrict plan is to provide a water management alternative to state-imposed regulations that limits the use of irrigation wells within the subdistrict, that is, a system of self-regulation using economic-based incentives that promote responsible irrigation water use and management and insure the protection of senior surface water rights.[96]

Rio Grande Goals and Measurable Outcomes

To address these issues, in its BIP the Rio Grande Basin Roundtable identified two goals related to sustaining agriculture.[97] These goals and the their associated measurable outcomes are:

- *Operate, maintain, rehabilitate, and create necessary infrastructure to meet the basin's long-term water needs, including storage.*
    - *A database of existing water infrastructure including documentation of infrastructure condition including M&I facilities, storage*

reservoirs and major ditch diversions is created.

- *Reservoirs operate at full design capacity without restrictions.*
- *Diversion structures and conveyance systems function optimally.*

❖ *Manage water use to sustain an optimal agricultural economy throughout the basin's communities.*

- *The cultural heritage of agricultural water use in the San Luis Valley is recognized.*
- *Agriculturally supported jobs are sustained.*
- *Rangeland is maintained and improved.*
- *Soil health is enhanced and soil loss is minimized on both farmland and rangeland.*
- *Alternative agriculture practices that improve soil health and/or reduce consumptive use without impacting crop yields are supported and implemented to the extent practicable.*

Meeting the Rio Grande's Agricultural Gaps

As a result of the Rio Grande Compact's delivery requirements to downstream states, as well as current unsustainable groundwater pumping, the Rio Grande seeks to better manage its agricultural water resources and economy. It aims to achieve this with the formation of groundwater subdistricts that reduce pumping and sustain aquifer levels. Consequently, most of the 12 agriculture-related projects the Rio Grande Basin Roundtable analyzed are not associated with new acre-feet. Six of the projects the basin identified in its BIP focus on monitoring, assessment, and planning. The storage improvement and expansion projects largely focus on improved augmentation and administration opportunities that will help meet irrigation as well as environmental and recreational water needs. In summary, the Rio Grande's BIP meets its defined agricultural gap.

South Platte (Including the Metro Area and Republican Basin)

The South Platte and Republican River Basins have the highest acreage of irrigated land in Colorado, and on average, experience shortages of 25 percent.[98] The basin projects a gap of 160,000 acre-feet in the South Platte and 274,000 acre-feet in the Republican. In addition, according to SWSI 2010, irrigated land is likely to decline by 22 to 32 percent in the South Platte Basin and by 20 percent in the Republican Basin.[99] Using past trends as a baseline, the South Platte Roundtable reexamined potential loss of irrigated lands in the South Platte Basin, and estimated a range of 10 to 20 percent loss, and could be as much as 50 percent under one of the scenarios described in the BIP.[100] These anticipated declines are primarily due to agricultural-to-municipal transfers, but the CWCB expects urbanization to account for 6 to 7 percent of the loss—the equivalent of 47,000 to 61,000 acres.[101] In the Republican Basin, the loss of more than 100,000 irrigated acres is related to factors associated with sustainable groundwater and compact-related issues.

South Platte Goals and Measurable Outcomes

To address these issues, in their BIP the South Platte Basin and Metro Roundtable identified one goal related to sustaining agriculture.[102] This goal and its associated measurable outcomes are:

❖ *Fully recognize the importance of agriculture to Colorado's future well-being, support continued success, and develop new voluntary measures to sustain irrigated agriculture.*

- *Support strategies that reduce traditional and permanent dry-up of irrigated land; achieve this through implementation of other solutions, including conservation, reuse, successful implementation of local IPPs, successful implementation of ATM, and development of new Colorado River supplies.*
- *Support municipalities' and other local and state land-use authorities' strategies to reduce loss of irrigated land due to urbanization.*
- *Support strategies involving IPPs, new multi-purpose projects, and innovative measures to address agricultural water shortages and maximize use of available water supplies.*

- *Develop local tools and elicit political and community support for tools to sustain irrigated farmland.*
- *Encourage the maintenance of existing wetlands in focus areas associated with agricultural lands.*
- *Ensure that agricultural dry-up and other alternatives take environmental and recreational focus areas and attributes into consideration.*

Meeting the South Platte's Agricultural Gaps

The roundtables discussed several strategies to reduce agricultural shortages and minimize permanent agricultural losses. Conceptually, the BIP indicates that ATMs could meet 30,000 acre-feet of future municipal demands. However, the BIP also lists several barriers to ATMs that the basin must overcome. The BIP also includes recommendations for streamlining transaction costs for ATMs and ATM grant programs in the South Platte Basin. In addition, the roundtables discussed the need to preserve the option for developing additional TMD water, which would lessen the need for significantly more agricultural transfers. The roundtables have not identified any IPPs that explicitly address agricultural shortages. The BIP indicates that the basin roundtable would like to further investigate land-use options, which could increase urban densities and therefore reduce the urbanization of a number of agricultural acres. The BIP does not go into depth about developing local political tools or ensuring that the basin take environmental and recreational values associated with agriculture into account. Therefore, the BIP has partially met its goals and measurable outcomes.

Southwest

The basins in the Southwest have the sixth-highest acreage of irrigated land in Colorado and the third-highest percentage of shortages (34 percent).[103] In addition, irrigated acres are likely to decline by 3 to 5 percent.[104] These anticipated declines are primarily due to urbanization, although, if Colorado River supplies are not available, some agricultural-to-urban transfers may be necessary.[105]

Southwest Goals and Measurable Outcomes

To address these issues, in its BIP the Southwest Basin Roundtable identified three goals related to sustaining agriculture.[106] These goals and their associated measurable outcomes are:

- *Minimize statewide and basin-wide acres transferred.*
  - *Implement projects (e.g. ATMs, efficiency, among others) to help preserve agriculture and open space values, and to help address municipal, environmental, recreational, and industrial needs; while respecting private property rights.*
  - *Implement strategies that encourage continued agricultural use and discourage permanent dry-up of agricultural lands.*
  - *The water providers in the state that are using dry-up of agricultural land and/or pursuing a new TMD shall have a higher standard of conservation. The goal for these water providers is a ratio of 70 percent use occurs in-house while 30 percent use occurs outside (70/30 ratio).*
- *Implement efficiency measures to maximize beneficial use and production.*
  - Implement at least 10 agricultural water efficiency projects identified as IPPs (by sub-basin).
- *Implement IPPs that work towards meeting agricultural water supply shortages.*

Meeting the Southwest's Agricultural Gaps

The Southwest Basin Roundtable identified six projects that have a combined 20,000 of new acre-feet associated with them. Of these projects, only one is not also considered for M&I uses. These projects work toward reducing agricultural water supply shortages. As the BIP states, none of the projects supports agricultural-sharing or implements strategies that discourage permanent dry-up of agricultural lands. This is because the basin does not expect the agricultural transfers to meet future municipal needs beyond urbanization of agricultural lands. Therefore, the BIP meets its defined agricultural gaps.

Yampa/White/Green

Of the Colorado basins, the Yampa/White/Green River Basin contains among the least number of irrigated acres, and the third-lowest percentage of shortages (23 percent).[107] In addition, irrigated acres could either increase by 12 percent with adequate investment, or decrease by 15 to 53 percent.[108] The CWCB's estimated potential losses are determined by whether oil shale or other energy interests grow into a large commercial industry and need to rely on agricultural transfers to meet their needs. However, these needs will likely be revised downward since all indications are that oil shale will not be at full-scale production by 2050. Additional declines in irrigated acres are related to urbanization of agricultural lands.[109]

Yampa/White/Green Goals and Measurable Outcomes

To address these issues, in its BIP the Yampa/White/Green Roundtable identified two goals related to sustaining agriculture.[110] These goals and their associated measurable outcomes are:

- *Improve agricultural water supplies to increase irrigated land and reduce shortages.*
  - *Reduce agricultural shortages basin-wide by 10 percent by the year 2030.*
- *Preserve the current baseline of 119,000 irrigated acres and expand by and expand by 12 percent by 2030. Protect and encourage agricultural uses of water in the Yampa-White-Green Basin within the context of private property rights.*
  - *Preserve the current baseline of approximately 119,000 protected acres and expand by 12 percent by 2030.*
  - *Encourage land use policies and community goals that enhance agriculture and agricultural water rights.*

Meeting the Yampa/White/Green's Agricultural Gaps

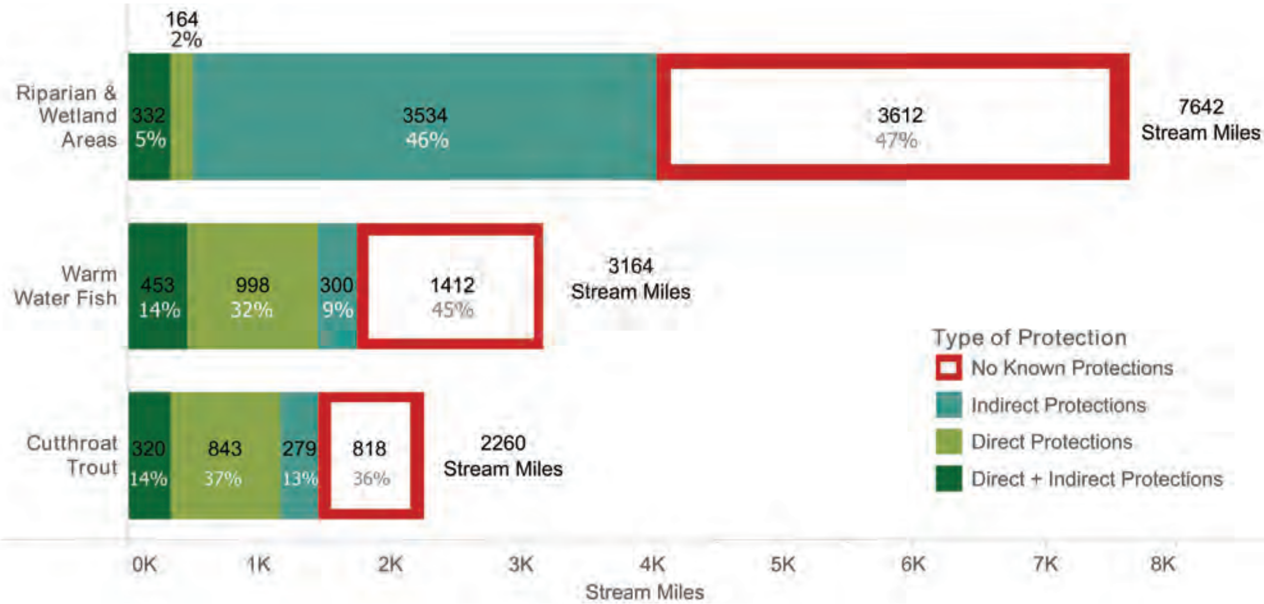
Three of the proposed agricultural projects include estimated acre-feet, totaling nearly 25,000 acre-feet. The projects address both agricultural needs as well as needs related to potential energy production and municipal growth. The planned energy project would meet many full-scale, oil-shale industry needs, and would therefore decrease the potential number of transferred irrigated acres for industrial purposes. On the other hand, some of these projects could cause additional shortages in the basin, although shortages are significantly reduced in the Yampa River between Craig and Maybell—an area with some of the most significant agricultural land in the basin. In addition, the identified projects would help develop some of the additional acreage the BIP included in its plans. While the document stresses the need for land-use policies that support agriculture, it identifies no specific policies. All in all, the BIP mostly meets its defined agricultural gaps, and the basin roundtable plans to continue to refine this work.

Meeting Colorado's Environmental and Recreational Needs

The water gap for environmental and recreational use is the difference between what a basin indicates it *wants to achieve* in accordance with its goals and measurable outcomes, and what projects and methods it *could implement* to meet those needs.[111] While every basin indicated that meeting its environmental and recreational needs is an important aspect of its BIP, this definition allows for considerable variability among basins, which face different issues related to the environment and recreation.

Colorado can meet its environmental and recreational needs through protection or restoration projects and methods. These projects and methods could include such components as flow, habitat, water quality, species connectivity, and non-native species management. In some cases, senior water rights holders help meet environmental and recreational needs upstream. Because of the diversity of the projects and methods that can help the environment and recreation, one often measures the water gap in stream-miles. With support from the CWCB, each basin roundtable developed focus-area maps as part of its 2011 needs assessment. These maps indicate the locations of significant species, recreational areas, and other environmental attributes. The CWCB then conducted a study to identify and determine the locations of existing and planned projects that meet the needs of some of the environmental and recreational focus areas each basin roundtable identified. From this data, stakeholders can identify areas with no known protections, compared to

FIGURE 6.2-2 PERCENT OF PERENNIAL STREAM-MILES STATEWIDE WITH PROTECTION FOR CUTTHROAT-TROUT SPECIES, WARM-WATER FISH, AND IMPORTANT RIPARIAN AND WETLAND FOCUS AREAS



areas with some type of protection (Figure 6.2-2, page 6-41). The Nonconsumptive Toolbox maps and features this information. Figure 6.2-3, page 6-41, shows an example.[112]

While a specific project or method may not sufficiently protect the stream in which it is implemented, and not every stream reach within the focus areas needs protection, these maps provide a good starting-point for assessing the locations of potential environmental and recreational gap areas. The CWCB is currently working to further refine this methodology and to include the additional projects and methods identified in the next update of SWSI.

To address the challenges of meeting Colorado's environmental and recreational needs, the CWCB identified five statewide long-term goals:[113]

- *Promote restoration, recovery, and sustainability of endangered, threatened, and imperiled aquatic and riparian-dependent species and plant communities.*
- *Protect and enhance economic values to local and statewide economies that rely on environmental and recreational water uses, such as fishing, boating, waterfowl hunting, wildlife watching, camping, and hiking.*
- *Support the development of multi- purpose projects and methods that benefit environmental and recreational water needs, as well as water needs for communities or agriculture.*
- *Protect, maintain, and improve conditions of streams, lakes, wetlands, and riparian areas to promote self-sustaining fisheries and functional riparian and wetland habitat, and to promote long-term sustainability.*

FIGURE 6.2-3 NONCONSUMPTIVE TOOLBOX

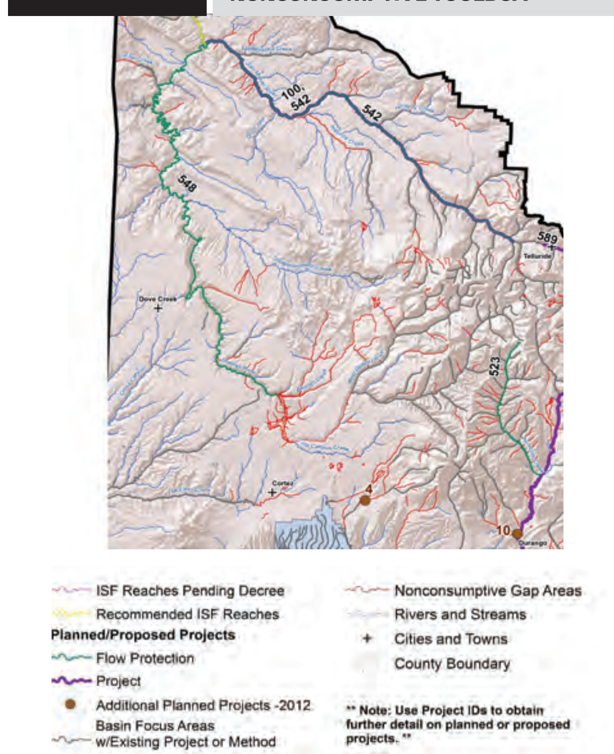


TABLE 6.2-4 SUMMARY OF HOW EACH BASIN MEETS ITS ENVIRONMENTAL AND RECREATIONAL GAPS*

Basin	Focus Area: Perennial Stream-miles	Number of Perennial Stream-Miles with No Known Protections	Quantified Stream-miles with New Projects or Methods	Number of New Projects with Stream-mile Info	Summary of How BIPs Met Their Environmental and Recreational Goals and Gaps
Arkansas	3,124	1,372 (44%)	380	15	Partially, through IPP support of greenback cutthroat trout, southern redbelly dace, Arkansas darter, and other target species
Colorado	1,762	844 (48%)	None identified	0	Partially, through support of projects and methods; did not identify new funding source or regional cooperatives that the basin deemed important
Gunnison	1,106	270 (24%)	None identified	0	Yes, through identification of 4 environmental projects, 30 multipurpose projects; support of federally listed endangered fish; explored some alternative funding sources
North Platte	954	231 (24%)	None identified	0	Mostly, through identification of more than 3 environmental and 2 multipurpose projects to be implemented; likely increases fishing, waterfowl hunting & viewing by 5 percent if implemented
Rio Grande	2,735	397 (15%)	410	11	Partially, through project implementation, but do not perform quantification of how to meet goals and measurable outcomes
South Platte	959	325	1 (plus 1,000 acre-feet)	3	Partially, through support of greenback cutthroat trout, boreal toad, common shiner, plains minnow, and other target aquatic species
Southwest	2433	1,009 (34%)	200	9	Partially, through project implementation, and will provide further quantification of how to meet goals and measurable outcomes
Yampa/ White/ Green	485	155 (32%)	370	16	Mostly, by quantifying and determining many projects that would support the current PBO on the Yampa, new PBO on the White, warm-water fish, riparian areas, and recreational boating; integrates consumptive and environmental and recreational interests
TOTAL	**13,558**	**4,601 (34%)**	**1,360**	**51**	

*NOTE: The percentage of streams with no known protections do not represent gaps for specific species or plant communities; those gaps may be larger

restoring watersheds that could affect critical infrastructure and/or environmental and recreational areas.

Arkansas

In the 2011 needs assessment, the Arkansas Basin Roundtable identified 342 perennial stream-miles containing Arkansas darter, 371 containing greenback cutthroat trout, and 1,811 featuring important riparian and wetland areas. There is protection for very few of the perennial stream-miles containing Arkansas darter. However, two-thirds of greenback cutthroat-trout stream-miles have some level of protection—whether directly through flow protection or aquatic habitat restoration, or indirectly through land ownership geared toward wildlife protection, or riparian projects. Approximately one-third of riparian and wetland areas the basin roundtable identified have some level of protection, and most of those are indirect protections. In addition, 57 percent of the identified fishing areas and 22 percent of the identified waterfowl hunting and view areas have some level of protection.

Arkansas' Environmental and Recreational Goals

To address its environmental and recreational needs, the Arkansas Roundtable established nine goals:[114]

- *Maintain or improve native fish populations.*
- *Maintain, improve, or restore habitats for fish species.*
- *Maintain or improve recreational fishing opportunities.*
- *Maintain or improve boating opportunities, including kayaking, and other non-motorized and motorized boating.*
- *Maintain or improve areas of avian (including waterfowl) breeding, migration, and wintering.*
- *Maintain or improve riparian habitat and aquatic habitat, and restore riparian and aquatic habitat that would support environmental features and recreational opportunities.*
- *Maintain or improve wetlands, and restore wetlands that would support environmental features and recreational opportunities.*
- *Maintain, improve, or restore watersheds that could affect environmental and recreational resources.*
- *Improve water quality as it relates to the environment and/or recreation.*

Meeting the Arkansas' Environmental and Recreational Gaps

In its BIP, the Arkansas Roundtable lists 15 environmental and recreation projects with quantifiable stream improvements. Projects include, but are not limited to, water quality improvements, invasive species removal, and fish habitat restoration and passage across 380 stream-miles.

The Nonconsumptive Subcommittee has identified the following priority objectives. The subcommittee adapted these from previously mapped, 12-digit hydrologic unit codes, which outlined areas with high concentrations of environmental and recreational attributes in three primary locations: 1) the main-stem Arkansas River upstream of Pueblo; 2) Fountain Creek watershed; and 3) areas around major reservoirs on the Lower Arkansas River between Las Animas and Eads. Priority objectives include:[115]

- *Lake Isabel is an important fishing lake with multiple associated recreational activities that has insufficient water resources to cover evaporative loss. Because of limited water rights, the lake level has been lowered, thereby diminishing fishing and other recreational opportunities and risking deleterious impacts associated with this reduced water level. It is a priority to obtain additional water rights to allow the lake to be raised to its full, functioning level.*
- *Grape Creek is an important fishery that runs through the Grape Creek Wilderness Study Area, which adds to its importance as a nonconsumtive resource that has suffered from inadequate flow. Efforts are ongoing with DeWeese-Dye Ditch & Reservoir Company to re-operate the ditch to provide additional water flow through the stream during crucial periods.*
- *Important wetland resource evaluation needs to be accomplished. Although some information exists on the wetlands in this basin, it is not available basin-wide.*
- *Chilili Ditch, a canal that runs through the center of Trinidad in Las Animas County, is extremely outdated and in serious need of renovation to improve nonconsumptive resources. This priority would involve a project that addresses both consumptive and nonconsumptive*

needs, including an update to the ditch diversion to make it fish friendly through the use of fish ladders or other methods that allow fish to move up and down the stream more easily.

The Nonconsumptive Needs Subcommittee will continue to identify priority areas as it obtains additional data and information from current projects and studies, stakeholders, and the public.

The basin supports using the Gap Analysis Framework to evaluate the level of protection a project provides to environmental and recreation attributes.[116] The basin will first segment projects in the basin's IPPs list into the following categories: Information/Knowledge/ISF/RICD, Implementation, or Stewardship. Then, it will use the framework to analyze the projects and assign levels of protections to individual attributes.[117] Not all attributes require protection, and projects and methods may not be necessary at this time for select areas. The basin will support its analysis with input from stakeholders, subject-matter experts, and basin roundtable members.

Colorado

In the 2011 needs assessment, the Colorado Basin Roundtable identified 676 perennial stream-miles containing Colorado River cutthroat trout, and 435 stream-miles containing imperiled warm-water fish, including endangered fish species. The roundtable also identified an additional 1,098 perennial stream-miles of important riparian and wetland areas. A full two-thirds of the stream-miles containing warm-water fish species have some level of protection—much of it direct. Three-quarters of Colorado River cutthroat trout stream miles also have some level of protection. Similarly, approximately three-quarters of riparian and wetland areas the basin roundtable identified have some level of protection; however, most of these protections are indirect. In addition, more than 90 percent of the identified fishing areas have direct protection.

Colorado Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Colorado BIP developed the theme, *"To protect and restore healthy streams, rivers, lakes, and riparian areas,"* and identified five goals. These goals and their associated measurable outcomes include:[118]

- *Protect and rehabilitate healthy rivers, streams, lakes, and riparian areas.*
  - *A map depicting high priority reaches that have insufficient or poorly timed flows (e.g., 15-Mile Reach, 303(d)) impaired streams, instream flows, monitoring and evaluation reaches, ecologically impacted, recreationally significant, reaches with existing dams.*
  - *Map or list of reaches where habitat has deteriorated as a result of non-flow related changes and could be restored.*
  - *Improve habitat conditions in all identified prioritized reaches to mitigate for harm caused by existing or additional water development.*
  - *Reduce the number of river miles where non-native invasive fish and invasive riparian species have degraded aquatic and riparian communities.*
- *Define water quality needs and at-risk water bodies (further described in Section 7.3).*
- *Preserve high quality recreational river and stream reaches with appropriate flows.*
  - *Maintain number of boater days on 28 reaches identified as recreation priorities by American Whitewater in cooperation with the Watershed Flow Evaluation Tool (WFET) work.*
  - *Protect access and flow levels for 28 popular recreational reaches.*
  - *Develop more recreational in-channel diversions (RICDs) structures and water rights on community and basin supported reaches to protect recreational flows.*
- *Develop a basin-wide funding system to meet basin environmental and recreational needs.*
  - *Establish a new funding agency or identify an existing agency for the basin or in every county in the basin to fund environmental and recreational management.*
  - *Leverage existing financial resources to*

- *further protect or restore all streams, rivers, and lakes that host prioritized recreational or natural attributes (determine source and scope of funding).*
  - *Fund the acquisition of conservation easements that retain agricultural purposes and current uses of water.*
- *Expand regional cooperation efforts to improve efficiencies, provide water supply flexibility, and enhance environmental and recreational amenities.*
  - *Establish regional water provider, ditch company and environmental and recreational advocate cooperatives focused on improving regional relationships, water supply redundancy and flexibility, water quality, coordinated efforts for multi-beneficial projects and addressing environmental and recreational needs.*
  - *Increase permanent interconnects between water providers where feasible.*

Meeting the Colorado Basin's Environmental and Recreational Gaps

The roundtable identified four top-priority projects that are explicitly environmental and recreational projects. The BIP listed 31 total projects, plus an additional 13 that address recreational needs, and 13 others that address water quality. Many of these are associated with the CRCA and the Windy Gap Firming Intergovernmental Agreement. Of these, approximately two-thirds are new projects and methods.

The roundtable recognizes that a basin-wide stream-management plan is a top priority, and the basin needs to better determine how to advance projects in ways that strategically meet the identified needs. The BIP states, "The most important project identified by the environmental and recreational PLT and the Colorado Basin Roundtable members is to continue assessing the systemic riverine environmental needs of the basin on-the-ground through the creation of a basin-wide stream management plan (SMP). The purpose of a SMP is to provide the framework for maintaining healthy stream systems while also protecting local water uses and planning for future consumptive and nonconsumptive water needs. SMPs identify environmental and recreational flow needs and assist in identifying areas where historical alterations of streamflows most likely affected the ecological resource conditions."[119]

The BIP further contends, "All basins statewide should make protecting and improving the health of our rivers and streams a top priority."[120]

At this point in time, it is not clear whether the dozens of identified projects would adequately address the environmental and recreational goals and measurable objectives, but these projects would at least partially meet the BIP's objectives. A streamflow management plan, if the basin implements it, would likely meet all of the objectives. One of the outstanding issues the BIP identified is the development of a new funding source within the basin.

Gunnison

In the 2011 needs assessment, the Gunnison Basin Roundtable identified 142 perennial stream-miles containing warm-water fish species, including federally listed species. Of these, more than 80 percent have some level of protection, and most of these stream-miles have one or more forms of direct protection. All of the identified 173 perennial stream-miles containing Colorado River cutthroat trout have some level of protection, with direct protection for approximately two-thirds of these miles. Nearly 90 percent of the

800 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection as well. However, nearly all of these protection methods are indirect.

Gunnison Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Gunnison Roundtable identified two goals. As described in the BIP, these goals and their associated measurable outcomes are:[121]

- *Quantify and protect environmental and recreational water uses.*
  - *Meet identified environmental and recreational needs basin-wide by developing 10 projects from the list of recommended solutions in the Gunnison BIP by the year 2030.*
  - *Implement the Environmental and Recreational Project Identification and Inventory projects from the list of recommended solutions in the Gunnison BIP by 2020.*
  - *Improve the current baseline of native trout and endangered fish populations in the Gunnison Basin through the year 2050.*
- *Describe and encourage the beneficial relationship among agricultural, environmental, and recreational water uses.*
  - *Complete at least five new multi-purpose water projects, including two storage projects, in the Gunnison Basin by 2025 that demonstrate the beneficial relationship among agricultural, environmental, and recreational uses.*
  - *Explore and develop recommendations on alternative sources of funding from recreational users within the basin to support development of those multi-purpose water projects.*

Meeting the Gunnison Basin's Environmental and Recreational Gaps

The Gunnison Basin Roundtable reexamined its environmental and recreational needs, and added 27 focus segments. The roundtable added to the 21 segments identified in the Phase 2 NCNA process.[122] Many of these segments offer the opportunity for development of multipurpose projects that are beneficial to both nonconsumptive and agricultural and municipal interests. The roundtable designed four planned inventory projects in different sub-basins to assess the feasibility of specific potential projects in meeting the focus segments' needs. Within those segments, the BIP explored how well existing programs support the Colorado River Recovery Program for endangered fish species, cutthroat trout, and the three imperiled warm-water fish species: bluehead sucker, flannelmouth sucker, and roundtail chub.

The roundtable indicated that it supports the ongoing recovery program and the reoperation of the Aspinall Unit to meet environmental flow requirements in support of these species. In 2012, the Record of Decision for the Aspinall Unit Operations Final Environmental Impact Statement was implemented. Peak flow targets were first required in 2014, when hydrologic conditions were considered 'moderately wet.' The BOR will continue to monitor the reoperation and adapt to the needs of the endangered-fish species. The roundtable highlighted that non-native fish species are the most significant cause for concern in the Gunnison Basin, and recommended "that Colorado explore a must-kill policy for non-native fish control."

The roundtable indicated that ongoing work associated with the Colorado River Cutthroat Trout Conservation Strategy that Colorado, Utah, and Wyoming adopted was likely sufficient to meet cutthroat-trout habitat needs.

An interstate Three Species Agreement is in place to protect the three warm-water fish species: bluehead sucker, flannelmouth sucker, and roundtail chub, and CPW is in the process of developing a state strategy to manage the protection of these species. In support of this work, the BIP states, "It is imperative that fishery managers' work with water managers to continue to implement the actions articulated in the Three Species Agreement. In the Gunnison, flow protection provided by downstream senior water rights (e.g., the Redlands Water and Power Company water rights) becomes an important means of maintaining the native fishery."[123]

The roundtable identified several efforts in addition to these ongoing ones. Tier 1 features 49 projects and methods that are slated for completion by 2020. Of those, 30 feature nonconsumptive components that meet one or more of the BIP's identified environmental and recreational goals. The roundtable also identified 34 important and ongoing environmental and recreational protection and monitoring projects that meet one or more of the goals. Included in the tier 1 projects are many studies that would further develop additional nonconsumptive projects to meet each region's needs. The roundtable identified several types of projects the basin could implement while preserving existing agricultural uses. These include:[124]

- *Diversion infrastructure improvements that increase accuracy and reduce maintenance costs while preserving stream connectivity.*
- *Temporary and voluntary instream flow leasing arrangements that sustain flows during critical drought periods.*
- *Voluntary partial instream flow donations that maintain historical irrigation practices on a more limited basis.*
- *Multi-purpose storage projects that include operational flow agreements and/or dedicated environmental and recreational flow components.*

In summary, if the basin fully implements the BIP, it will fully satisfy its goals and measurable outcomes, and will meet its environmental and recreational gaps.

North Platte

In the 2011 needs assessment, the North Platte Basin Roundtable identified 222 perennial stream-miles, and named important fishing areas as the roundtable's top priority. Approximately one-third of these miles have some direct protection, and the remaining stream-miles have no known protections. Ninety-three miles of perennial streams feature waterfowl hunting and viewing, and 45 percent of these have some form of direct protection. More than one-quarter of the 220 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection as well.

North Platte Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the North Platte Roundtable identified two goals. As stated in the BIP, these goals and their associated measurable outcomes are below:[125]

- *Maintain healthy rivers and wetlands through the strategic implementation of projects that meet prioritized nonconsumptive needs.*
  - *Increase fishing user days by five percent by 2020.*
  - *Increase waterfowl hunting and viewing days by five percent by 2020.*
  - *Develop three projects from the list of recommended solutions by 2020.*
- *Describe and quantify the nonconsumptive benefits of agricultural use.*
  - *Complete at least two new multi-purpose water projects in the North Platte Basin by 2025 that meet multiple needs as identified in this report and other studies.*

Meeting the North Platte Basin's Environmental and Recreational Gaps

To better determine where the basin roundtable should focus its efforts, the roundtable developed a weighted attribute map. The map takes into account both the number of attributes and the priority rank the basin roundtable gave during the needs assessment process. The BIP states, "This map will be used to help target projects to address identified environmental and recreational attributes in the basin, including both multipurpose projects and specific environmental and recreational projects."[126]

The roundtable identified 55 planned environmental and recreational projects, 33 of which are multipurpose. Of the potential projects on the list, the roundtable developed project summaries and methods for 14. Of these, five help maintain healthy rivers and wetlands, and four also demonstrate the connection among agricultural, environmental, and recreational values. The BIP describes these projects as follows:

- *Reservoir improvements to preserve a major water supply for the maintenance of habitat at the Arapahoe National Wildlife Refuge,*
- *The improvement of a major diversion structure to address fish connectivity while addressing other water user needs,*
- *Improvement of fisheries habitat at State Wildlife Areas (public access fishing), and*
- *Two inventory projects that could help identify other multipurpose project opportunities.*[127]

All in all, if the roundtable implements these projects, it will address the measurable outcomes calling for five projects that meet nonconsumptive needs. It is not clear whether these projects will reach the fishing and waterfowl hunting targets the BIP identified. However, the BIP mostly meets its identified environmental and recreational gaps.

Rio Grande

In the 2011 needs assessment, the Rio Grande Basin Roundtable identified 564 perennial stream-miles with Rio Grande chub, an imperiled fish species. Fifty-four percent of the stream-miles have some level of protection, most of which is direct. Another warm-water imperiled fish species is the Rio Grande sucker, which is listed as state-endangered. More than 60 percent of the 346 perennial stream-miles that support this species have some level of protection, though more than half of the protection is indirect. Nearly 40 percent of the identified 748 perennial stream-miles with Rio Grande cutthroat trout have some level of protection, although most of this protection is indirect. As of October 2014, the U.S. Fish and Wildlife Service (USFWS) determined that the Rio Grande cutthroat trout does not warrant an "endangered" listing, and that ongoing, extensive recovery efforts will continue for this species. Similarly, just over 40 percent of the 2,138 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection, most of it being direct.

Nevertheless, in the course of the BIP planning process, the Rio Grande's Environmental and Recreational Subcommittee chose to expand beyond the attributes previously identified in 2011 and undertake a more comprehensive approach. That approach uses updated geographic information systems (GIS) layers to determine where key environmental and recreation components exist in order to better determine their extent and conditions, identify where measures are in place to protect or restore those components, and identify where the basin needs to support action. Using these methods, the subcommittee has worked to identify the priority environmental and recreational attributes that need additional protection, restoration, and management.

For longer-term projects and methods, the Environmental and Recreational Subcommittee will continue to inventory, update, and quantify environmental attributes in relation to water needs. Through this process, the group will define and update maps of environmental and recreational focus areas in the Rio Grande Basin, and develop strategies to address needs and sustain their attributes.

The BIP also indicates that the San Luis Valley features approximately 200,000 acres of internationally important wetlands that provide critical habitat for endangered bird species as well as large numbers of migrating birds and waterfowl.

Rio Grande Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Rio Grande Basin Roundtable identified four goals. As described in the BIP, these goals and their associated measurable outcomes are below:[128]

- *Protect, preserve, and enhance terrestrial and aquatic wildlife habitats throughout the basin.*
  - *Species that are listed by either the federal or state government as threatened, endangered, or candidate species are recovered or de-listed.*
  - *Additional species are prevented from being*

listed by the federal or state government.

  - *Economic impact studies for environmental and recreational benefits are considered in the decision-making process for new water supply projects.*
  - *Wildlife habitat needs are considered in the decision-making process.*
  - *Natural resource agencies in the San Luis Valley (Rio Grande) coordinate and cooperate with each other to comply with the ground water rules and regulations and augmentation plans to benefit wildlife and recreation to the largest extent possible.*
  - *Water needs for wildlife habitat are addressed in plans, databases and San Luis Valley-wide surveys of appropriate wildlife populations.*
- *Conserve, restore, and maintain wetlands and riparian areas for the benefit of a healthy watershed.*
  - *Identify the needs for properly functioning wetlands and riparian areas.*
  - *Restore the ecological function of wetlands and riparian areas.*
  - *Develop and implement projects to restore, conserve, and sustain functioning wetlands, riparian areas, and associated habitats with a focus on incorporating species connectivity.*
- *Work to establish active river flows throughout the year in cooperation with water users and administrators to restore and sustain ecological function of the rivers and floodplain habitats within the context of existing water rights and compact obligations.*
  - *Negotiate active plans and cooperative agreements that enhance stream flows through re-operations while ensuring full compliance with Colorado water law.*
- *Maintain and enhance water dependent recreational activities.*
  - *Floatable flow levels are identified by reach.*
  - *Cooperative water management provides flows to extend recreational opportunities.*
  - *Recreational facilities are improved and/or enhanced.*
  - *Quality and quantity of fishing opportunities are improved.*
  - *Fish and boat passages are installed where appropriate.*
  - *Conservation pools are rehabilitated, secured and/or conserved as possible.*
  - *Quality and quantity of hunting (e.g., water fowl, small game, and big game) opportunities are improved.*
  - *Fish hatcheries have sustainable, secure, and adequate physical and legal water supplies.*
  - *Recognize economic benefits of recreation in decision-making processes.*

Meeting the Rio Grande Basin's Environmental and Recreational Gaps

Of the 18 projects the Rio Grande Basin Roundtable analyzed in its BIP, 12 help meet the goals above. The roundtable will analyze an additional 15 projects that address environmental and recreational information gaps, further clarifying those gaps. These projects add a total of almost 410 new stream-miles and 60,650 acre-feet. At this point in time, the BIP partially meets its environmental and recreational water gaps.

South Platte (Including Metro and Republican)

In the 2011 needs assessment, the South Platte and Metro Basin Roundtables identified 628 perennial stream-miles with warm-water imperiled plains fish species. Approximately two-thirds of these stream-miles have some level of protection. Approximately 90 percent of the 79 perennial stream-miles identified with greenback cutthroat trout have some level of protection, although more than half of this protection is indirect. Approximately half of the 628 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection, most of it direct. In addition, approximately half of the important fishing areas, and one-third of the waterfowl hunting and viewing stream-miles, have some level of protection.

South Platte Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the South Platte Basin Roundtable developed a goal. As described in the BIP, this goal and its associated measurable outcomes are listed below:[129]

- *Fully recognize the importance of, and support the development of, environmental and recreational projects and multipurpose projects that support water availability for ecologically and economically important habitats and focus areas.*
  - *Promote restoration, recovery, and sustainabiability of endangered, threatened, and imperiled aquatic, riparian and wetland dependent species and plant communities:*
    - *Maintain or increase the habitat for federally and state-listed threatened and endangered species or plant communities.*
    - *Maintain or increase habitats in the environmental and recreational focus areas with imperiled species or plant communities and secure the species in these reaches as much as they can be secured within the existing legal and water management context.*
    - *Maintain or increase the wetland, lake, or stream habitat used by migratory and breeding birds.*
    - *Develop tools and methodologies to adequately assess what is needed to maintain or increase aquatic, riparian, and wetland habitats throughout the basin.*
  - *Protect and enhance economic values to local and statewide economies derived from environmental and recreational water uses, such as fishing, boating, waterfowl hunting, wildlife watching, camping, and hiking.*
    - *Maintain or increase the surface area, stream miles, or public access for recreational opportunities.*
    - *Maintain or increase the miles and general appearance of trails and greenways to promote aesthetic values and enhance quality of life.*
    - *Maintain or increase public access to fishing opportunities in lakes and streams.*
    - *Maintain or increase the total area for birding, waterfowl hunting, and wildlife viewing.*
    - *Maintain or improve the amount of river miles or flatwater surface acres available to river and flatwater boaters.*
    - *Develop tools and methodologies to adequately assess what is needed to maintain or improve recreational opportunities derived from ecosystems throughout the basin.*
  - *Protect, Maintain, and Improve Conditions of Streams, Lakes, Wetlands, and Riparian Areas to Promote Self-Sustaining Fisheries and Functional Riparian and Wetland Habitat to Promote Long-Term Sustainability.*
    - *Maintain or increase the number of stream miles or surface area of streams, lakes, wetlands, and riparian areas for self-sustaining aquatic species populations, and wetland/riparian habitat.*
    - *Maintain or improve fish habitat by providing habitat enhancements, eliminating dry up points, and promoting connectivity.*
    - *Maintain or improve watershed health through source water protection, wildfire mitigation, sedimentation control, and erosion control.*
    - *Encourage existing and develop new innovative tools to protect instream flows where appropriate.*
    - *Develop tools and methodologies to adequately assess what is needed to protect, maintain or improve conditions of aquatic, riparian, and wetland habitat throughout the basin.*

Meeting the South Platte Basin's Environmental and Recreational Gaps

Through the BIP process, the roundtable identified seven additional focus-area reaches that it added to the basin needs assessment maps. This work expands the number of areas in which a focus on addressing environmental and recreational needs is important. The roundtable also assessed dry up points within the South Platte Basin, identifying 15 areas that experience no flows during some years at some points in time.

These dry-up points affect species connectivity and habitat.

To determine the types of projects the basin will need to implement in order to address these environmental and recreational concerns, the roundtable assessed the types of projects the following regions need:

1. Headwater areas (upper mountain area)
2. Metro corridor
3. Boulder/Fort Collins (northern area)
4. Plains (lower South Platte)

For each of these regions, the roundtable developed a suite of project types—including instream flows, stewardship projects, species reintroduction, fish passages, modification or improvements to dry-up points or diversion structures that inhibit fish passage, stewardship programs, and instream flow programs with water rights components that dedicate historic, consumptive use to a downstream user while improving streamflows within a reach of concern. In addition, the BIP assessed the number of miles with existing or planned protections. The BIP only included measurable objectives for three of these projects. Collectively, 1,000 new acre-feet and one stream-mile were identified, although more stream-miles are likely associated with these projects.

To move forward with addressing the South Platte Basin's environmental and recreational needs, the roundtable indicates in their BIP that:[130]

- *The South Platte vision includes working to meet the M&I gap, while minimizing the impacts to agricultural uses, and while also providing protections and enhancements to environmental and recreational attributes in candidate focus areas.*
- *The South Platte Basin will continue working to identify cooperative and attribute specific projects that protect or enhance environmental and recreational attributes.*
- *The South Platte Basin will encourage funding and cooperation to leverage new projects, improvements to, or replacements of structures which help provide protections.*
- *The South Platte Basin will continue working to quantify the environmental and recreational 'gap' and to assess projects that protect or enhance environmental and recreational attributes.*
- *Storage within the basin is vital to meeting the needs of the basin, and including storage for environmental and recreational needs is imperative.*

The current BIP partially meets the environmental and recreational gaps the goals and measurable outcomes process identified.

Southwest

In the 2011 needs assessment, the Southwest Basin Roundtable identified 834 perennial stream-miles with imperiled warm-water fish species, including the flannelmouth sucker, bluehead sucker, and roundtail chub. The CWCB's work in 2011 indicated that nearly two thirds of these stream-miles have or plan to have some level of protection, although most of these protections are indirect. Approximately 70 percent of the identified 178 perennial stream-miles with Colorado River cutthroat trout have some level of protection, and most of this protection is also indirect. Just under 60 percent of the 762 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection, all of which is direct. The needs assessment report also identified various forms of recreation, such as fishing, waterfowl hunting, and viewing. Very few stream-miles have identified protections for these values.

Southwest Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Southwest Roundtable identified three goals. As described in the BIP, these goals and their associated measurable outcomes are below:[131]

- *Maintain, protect, and enhance recreational values and the value to local and statewide economies derived from recreational water uses such as fishing, boating, hunting, wildlife watching, camping, and hiking.*
  - *Implement 10 IPPs to benefit recreational values and the economic value they provide.*
  - *At least 80 percent of the areas with recreational opportunities have existing or planned IPPs that secure these opportunities and supporting flows/lake levels within the contemporary legal and water management context. Based on*

the map of recreational attributes generated for SWSI 2010, 80 percent of each specific value equates to approximately 428 miles of whitewater boating, 185 miles of flat- water boating, 4 miles of Gold medal Trout Streams, 545 miles of other fishing streams and lakes, 3 miles of Audubon Important Bird Area, 143 miles of waterfowl hunting/viewing parcels, and 6 miles of Ducks Unlimited projects.

  - *Address recreational data needs.*

- *Encourage and support restoration, recovery, and sustainability of endangered, threatened, and imperiled aquatic and riparian-dependent species and plant communities.*
  - *Implement 15 IPPs to directly restore, recover, or sustain endangered, threatened, and sensitive aquatic and riparian-dependent species and plant communities.*
  - *At least 95 percent of the areas with federally-listed water dependent species have existing or planned IPPs that secure the species in these reaches to the extent possible within the existing legal and water management context.*
  - *At least 90 percent of areas with identified sensitive species (other than Endangered Species Act species) have existing or planned IPPs that provide direct protection to these values. Based on the map of environmental attributes generated for SWSI 2010, this 90 percent of areas with identified sensitive species equates to individual species as approximately 169 miles for Colorado River cutthroat trout, 483 miles for roundtail chub, 794 miles for bluehead sucker, 700 miles for flannelmouth sucker, 724 miles for river otter, 122 miles for northern leopard frog, 921 miles for active bald eagle nesting areas, and 229 miles for rare plants.*

- *Protect, maintain, monitor, and improve the condition and natural function of streams, lakes, wetlands, and riparian areas to promote self-sustaining fisheries, and to support native species and functional habitat in the long-term, and adapt to changing conditions.*
  - *Implement 26 IPPs to benefit the condition of fisheries and riparian/wetland habitat.*
  - *At least 80 percent of areas with environ mental values have existing or planned IPPs that provide direct protection to these values.*

Meeting the Southwest Basin's Environmental and Recreational Gaps

The Southwest Basin identified nine environmental and recreational projects and methods that included stream-mile information for more than 200 miles of stream. However, the Southwest Basin indicated that it can provide additional stream-mile information. If the basin implements them, these projects are sufficient to meet the number of IPPs the roundtable has identified in the above categories. The roundtable has not conducted an analysis of the extent to which these projects meet the stream-mile goals.[132] In addition, to better identify environmental and recreational needs, the roundtable identified two efforts that would extend across the sub-basin:

1. *Evaluation of environmental and/or recreational gaps is planned to be conducted for improvement of non-consumptive resources and/or in collaborative with development of consumptive IPPs. The evaluations may be conducted by a subgroup of the roundtable or by individuals, groups, or organizations with input from the roundtable. The evaluation may use methodologies such as the Southwest attributes map, Flow Evaluation Tool, R2Cross, and any other tools that may be available.*

2. *Where environmental and/or recreational gaps are identified, a collaborative effort will be initiated to develop innovative tools to protect water identified as necessary to address these gaps.*

Until additional stream-mile information associated with the identified projects and methods is available, it will remain unclear how well the BIP has met its measurable outcomes.

Yampa/White/Green

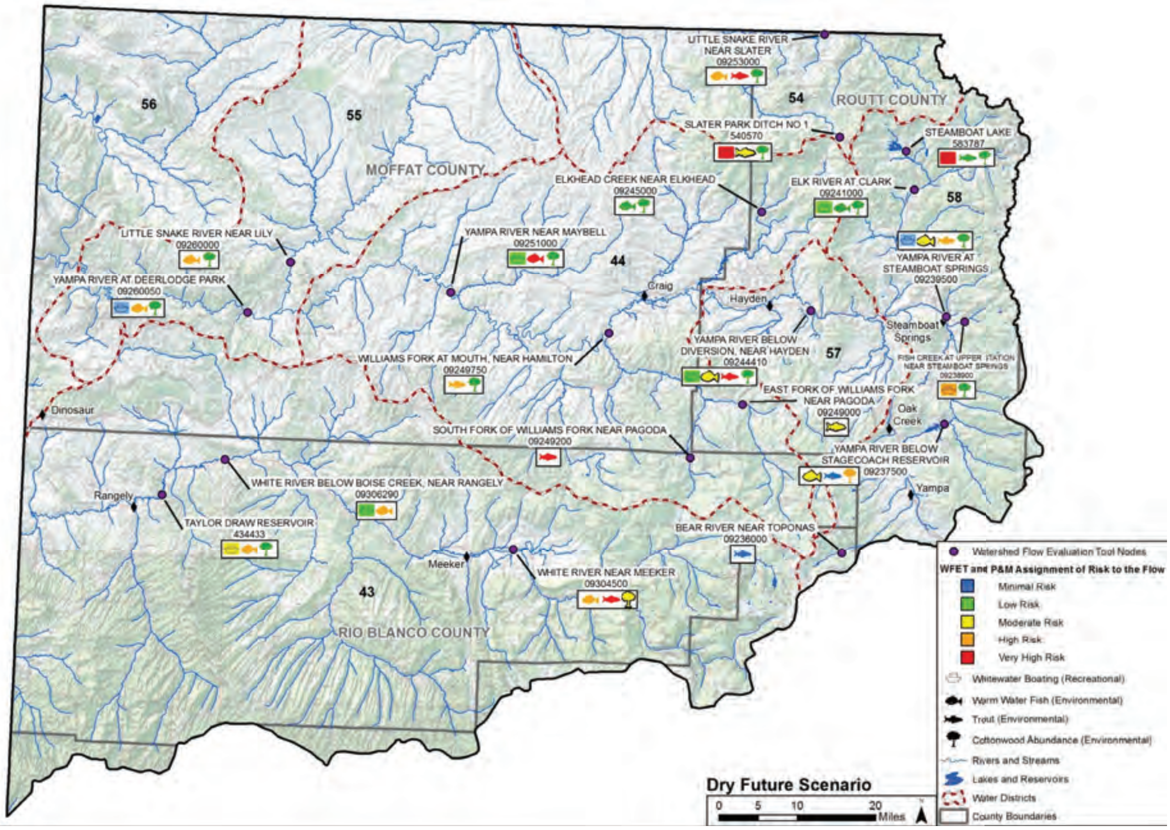
In the 2011 needs assessment, the Yampa/White/Green Basin Roundtable identified 218 perennial stream-miles with state-imperiled warm-water fish species, and 142 miles with federally listed warm-water fish species. Approximately 55 percent of these stream-miles have some level of protection, most of it being direct. Nearly two-thirds of the identified 35 perennial stream-miles containing Colorado River cutthroat trout have some level of protection, although most of this protection is indirect. More than three-quarters of the 275 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection as well, and nearly all of it is direct. The needs-assessment report also identified various forms of recreation. Very few stream-miles have identified protections for these values.

Yampa/White/Green Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Yampa/White/Green Basin Roundtable identified two goals. As described in the BIP, these goals and their associated measurable outcomes and processes are below:[133]

- *Quantify and protect non-consumptive water uses.*
  - *To the extent that non-consumptive needs can be specified and projects can be analyzed, there will be projects for non-consumptive attributes within the existing legal and water management context.*
  - *Multi-purpose projects and methods will be researched and designed to meet the other goals enumerated here.*
  - *The Programmatic Biological Opinion (PBO) and its depletion coverage for the Yampa River Basin for existing and future expected and unexpected depletions will meet base flow targets in critical habitat areas and assist with endangered fish recovery.*
  - *A new PBO is planned for the White River Basin that provides certainty for existing and future anticipated and unanticipated depletions and that assists with endangered fish recovery.*
  - *The flow protection and any water leasing or re-operation of projects needed for native warm water fish, for cottonwoods, and for recreational boating on reaches with greater and overlapping flow alteration risks are integrated with the flow protection for endangered fish recovery and with projects to meet in- basin, consumptive needs. The flow needs of these non-consumptive attributes are otherwise met, including the avoidance of or offsetting the loss of minimum or optimal boating days that are related to multi-purpose projects and unrelated to drier or wetter hydrology.*
  - *The flow needs for all other non-consumptive attributes are quantified, integrated with projects to meet in-basin consumptive needs, and otherwise met through nonconsumptive IPPs. Multi-purpose projects will be researched and designed to improve riparian or aquatic ecology and bank stability without changing the existing flow regime while voluntarily modernizing irrigation diversion systems and reducing bedload. Similar projects will be researched and designed to improve recreational boating for existing flows while voluntarily modernizing irrigation systems.*
  - *The economic values of the relatively natural flow regimes of the Yampa and White River systems are recognized and protected, along with the economic values of consumptive water use.*
  - *Acres of restored riparian areas, degraded streams, and wetlands to restore natural water storage capacity, and improve water quantity and quality for non-consumptive needs.*
  - *Assess and quantify impact of IPP's on peak flows and ascertain whether further non-consumptive IPP's need to be identified.*
- *Develop an integrated system of water use,*

FIGURE 6.2-4 YAMPA/WHITE/GREEN BASIN IMPLEMENTATION PLAN – ASSOCIATED RISK IN DRY-FUTURE SCENARIO WITH IDENTIFIED PROJECTS AND PROCESSES IMPLEMENTATION



storage, administration, and delivery to reduce water shortages and meet environmental and recreational water needs.

- *Success in permitting and constructing in-basin storage projects.*
- *Reduction in consumptive shortages in drought scenarios.*
- *Reduction in identified non-consumptive shortages in drought scenarios.*
- *Administration and infrastructure improvements making decreed amounts of water available to diversion structures with reduced need for seasonal gravel dams in the river.*
- *Reduce the potential incidence of severe low flows in order for water users to exercise their water rights.*

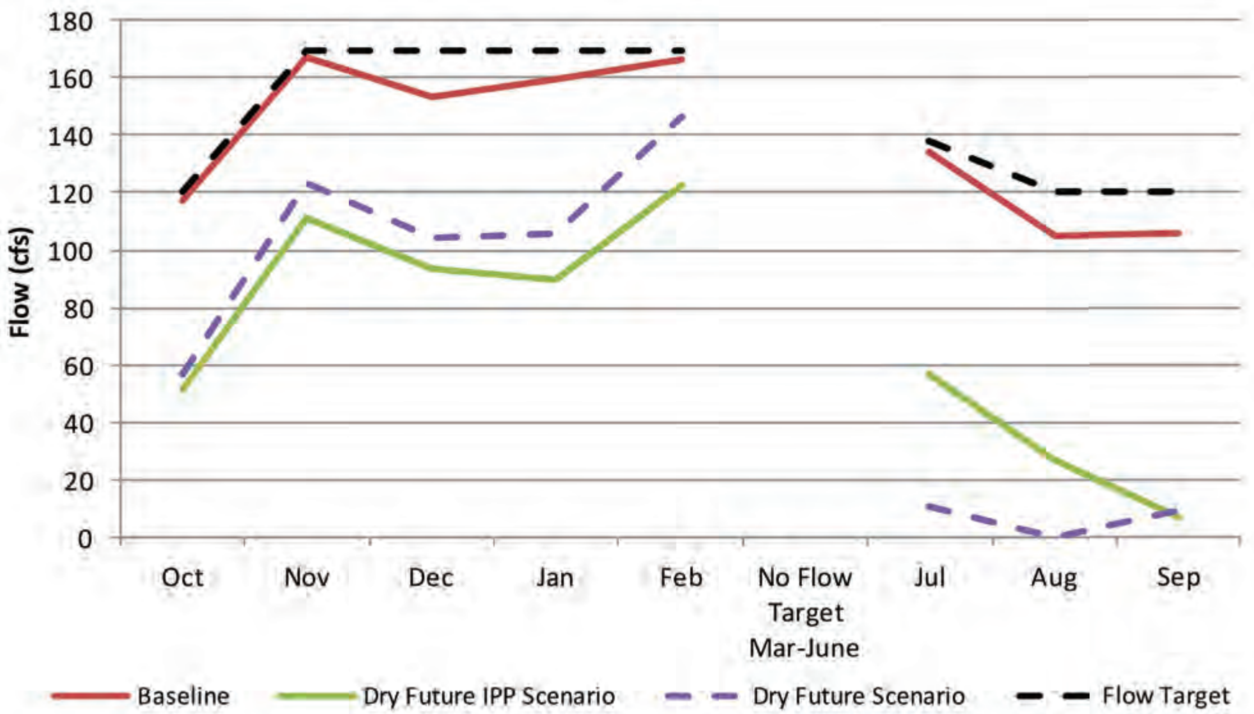
Meeting the Yampa/White/Green Basin's Environmental and Recreational Gaps

The previous Watershed Flow Evaluation Tool work examined whether cottonwood, warm-water fish, or cold-water fish were vulnerable to flow conditions within the basin roundtable's environmental and recreational focus areas. Additional analysis within the BIP assessed how often the basin was meeting instream flows and recreational in-channel diversions. These three efforts provide significant insight into how well the basin is currently addressing environmental and recreational needs. Furthermore, the roundtable overlaid potential future conditions within the basin to determine how future climate change and developing projects and processes would affect:

1. *The vulnerability of the species within the environmental and recreational focus areas,*
2. *The instream flow shortages, and*
3. *The recreational in channel diversion shortages*

For example, the BIP states that, "The modeling indicates that the implementation of the IPPs [in a

FIGURE 6.2-5 DEMONSTRATION OF HOW A DRY FUTURE COULD AFFECT THE YAMPA PROGRAMMATIC BIOLOGICAL OPINION, AND A DRY FUTURE WITH IMPLEMENTATION OF IDENTIFIED PROJECTS AND METHODS



dry future] would increase instream flow shortages by 27 percent on Trout Creek. The development of IPPs could reduce instream flow shortages on the following reaches: Oak Creek (by 1.4 percent, node 582290), Slater Creek (by 3.5 percent, node 542076), and Willow Spring and Pond (by 1.8 percent, node 582162)."[134] IPPs appear to have little effect on the environment for most locations (Figure 6.2-4), but could modestly influence endangered fish recovery flows in the Yampa River during the fall and winter (Figure 6.2-5).

The purpose of this analysis is to provide a course examination of potential environmental and recreational "shortages." This is the most thorough technical analysis any of the roundtables provided. In addition, the roundtable identified 16 environmental and recreational projects that include a measurable outcome, one of which is an agricultural project with some identified environmental and recreational benefits. The projects identify a total of 370 new stream-miles. As the BIP states, "The basin roundtable will continue to explore additional multipurpose opportunities where they may exist through future planning efforts."[135]

In summary, the BIP demonstrates progress towards meeting its future environmental and recreational needs and, if the basin supports the implementation of the projects, it will mostly meet the measurable outcomes listed above.

Other BIP-Identified Gaps

Other needs the basin roundtables identified in their BIPs include those associated with education, watershed health, and water quality. Section 9.5, 7.1, and 7.3 further explore these needs.

How Other States Have Worked to Meet Their Gaps

The challenges associated with meeting future water supply needs are not unique to Colorado's boundaries.

Other states across the West are facing the challenge of increased population and potentially limited water supplies. Other neighboring states have also undertaken water-planning efforts to increase certainty at both the intrastate and interstate levels.

State and federal water projects account for a substantial portion of the ongoing efforts around the West. For example, California's State Water Project, the Central Arizona Project, and the Lake Powell Pipeline all represent massive financial and political undertakings, with the goal of meeting future water supply needs. And efforts around water banking are underway in California. A key issue in the West is also the settlement of water rights concerns among tribes located throughout several states. Existing settlements in New Mexico and Arizona have provided a greater certainty to tribes and to water management agencies within those states. The State of Texas has invested large sums of capital into project implementation; Kansas has invested in corps-sponsored projects for storage; and the State of Utah has collaborated with the federal government on the Central Utah Project.

Appendix B contains more information on neighboring states' efforts to close water supply gaps.

ACTIONS

TABLE 6.2-5 STRATEGIES FOR IMPLEMENTATION OF THE BASIN IMPLEMENTATION PLANS

CATEGORY	CONSTRAINT	NEXT STEPS AND POTENTIAL ACTIONS
Project Evaluation	Conflict	• Partnerships • Cooperative Strategies
	Perception	• Public Education and Outreach • Incentive-Based Programs
	Regulations	• Cooperative Strategies • Effective and Efficient Permitting
Project Feasibility	Cost	• Creative Funding Mechanisms • Partnerships and Cooperative Strategies
	Water Availability	• Water Availability Analyses • Water Administrative Strategies
	Constructa-bility	• Feasibility Analyses • Engineering Design

The projects and methods in the BIPs met many of the identified gaps; however, gaps remain, even with the significant efforts described. Several next steps will help the basin round tables meet their needs. In its BIP, the Gunnison Roundtable summarized many of these next steps and potential actions; Table 6.2-5 illustrates this work.

A primary purpose of Colorado's Water Plan is to address Colorado's water gaps. To accomplish this, several of the next steps and potential actions include the following, as summarized in Table 6.2-5:

Partnerships and cooperative strategies are vital to overcoming conflict and building local con sensus so that a project can move forward. Section 9.4 further discusses this approach in the context of more effective and efficient permitting.

- ❖ Public education and outreach can also help inform people about Colorado's water needs and solutions. Section 9.5 explores avenues to better support water education throughout Colorado.
- ❖ Many sections of Colorado's Water Plan mention incentive-based programs. For instance, Section 6.3 explores opportunities to encourage conservation, reuse, and water-wise land-use practices. Section 6.4 explores opportunities to encourage ATMs.
- ❖ Funding is also a common theme throughout many of the BIPs. Section 9.2 further explores funding options.
- ❖ Many of the BIPs express concerns around permitting and other regulatory topics. Section 9.4 explores ways to make these processes more effective and efficient.

Colorado's Water Plan's success will ultimately be measured by whether the municipal water supply and demand gap is closed. With increased efforts on conservation, storage, land use, alternative transfer methods, and reuse, Colorado can close its gap, balance Colorado's water values, and also address the water resource impacts of a changing climate. Colorado's Water Plan sets a measurable objective to identify proponents for new projects, processes, and initiatives by 2030 that would reduce the projected 2050 municipal and industrial gap from as much as 560,000 acre-feet to 0 acre-feet.

In SWSI 2010, the gap was calculated based on future water needs and the identification of projects and methods that water providers indicated they were planning to implement in order to serve future customers. The basin roundtables partially reduce this gap by identifying additional projects and methods within the BIPs, as Section 6.5 describes. However many of these additional projects and methods either do not have project proponents identified, or are insufficiently developed. Further development of these projects and methods, reductions in water use from conservation and changes in land-use practices, and refinement of additional options such as ATMs and regional reuse will address the remaining gap.

Colorado must identify and address its water gaps. The CWCB will take the following steps to accomplish this starting in 2016:

1. The CWCB will support the evaluation, feasibility, and completion of the BIPs through WSRA grants.
2. The CWCB will support increased consistency and technical support in the BIPs in the following ways:
    - Provide technical support for several of the BIPs through continued decision-support development and maintenance in order to explore municipal, agricultural, industrial, and environmental shortage analyses similar to those in the Yampa/White/Green BIP.
    - Provide technical support for several of the BIPs to explore the use of project information sheets and project tiering, similar to those delineated in the Rio Grande, North Platte, and Gunnison BIPs.
    - Support the further quantification of costs associated with projects and methods, development of new acre-feet, development of new irrigated acres, and protection of new stream-miles.
3. The CWCB will incorporate the BIP information into the next version of SWSI, and will reassess the municipal, industrial, environmental, recreational, and agricultural gaps at that time.
4. The CWCB will establish guidelines for basin-roundtable WSRA grants, enabling the basin roundtables to facilitate implementation of their BIPs in their basins. The purpose of the grants would be to foster the ability to meet municipal, industrial, agricultural, environmental, and recreational needs in a manner that is consistent with the BIPs.

Eastern Phoebe in
Chatfield State Park.

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

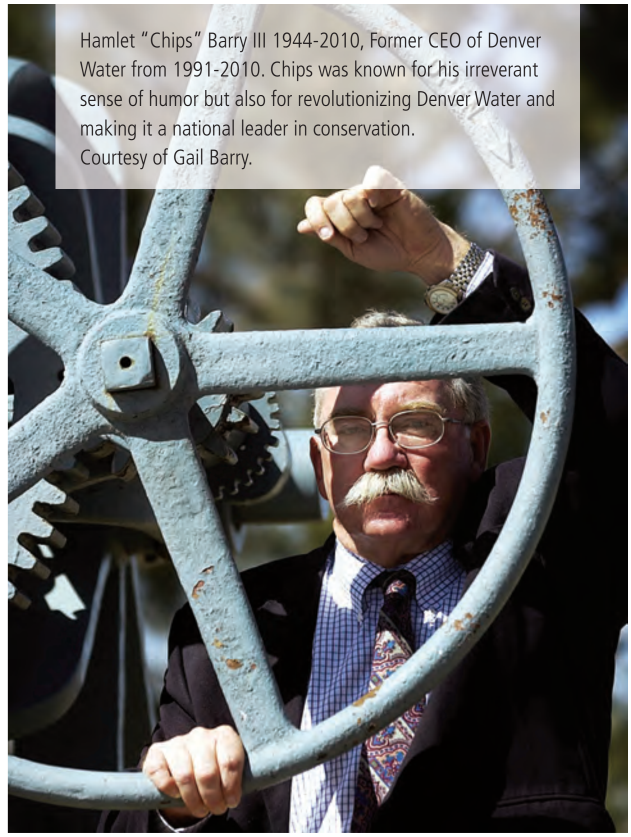
Introduction

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.

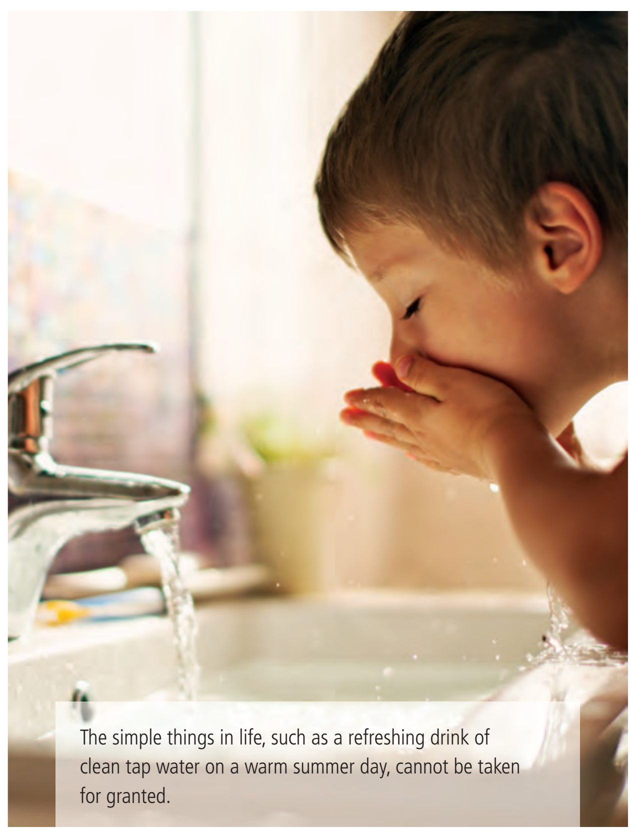
In 2015, Colorado enacted a law that provides incentives to encourage more participation in the precipitation harvesting pilot program.[148] Incentives include a less burdensome substitute water supply planning process. When calculating required stream replacements to account for captured precipitation, 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 municipal 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 principles 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:

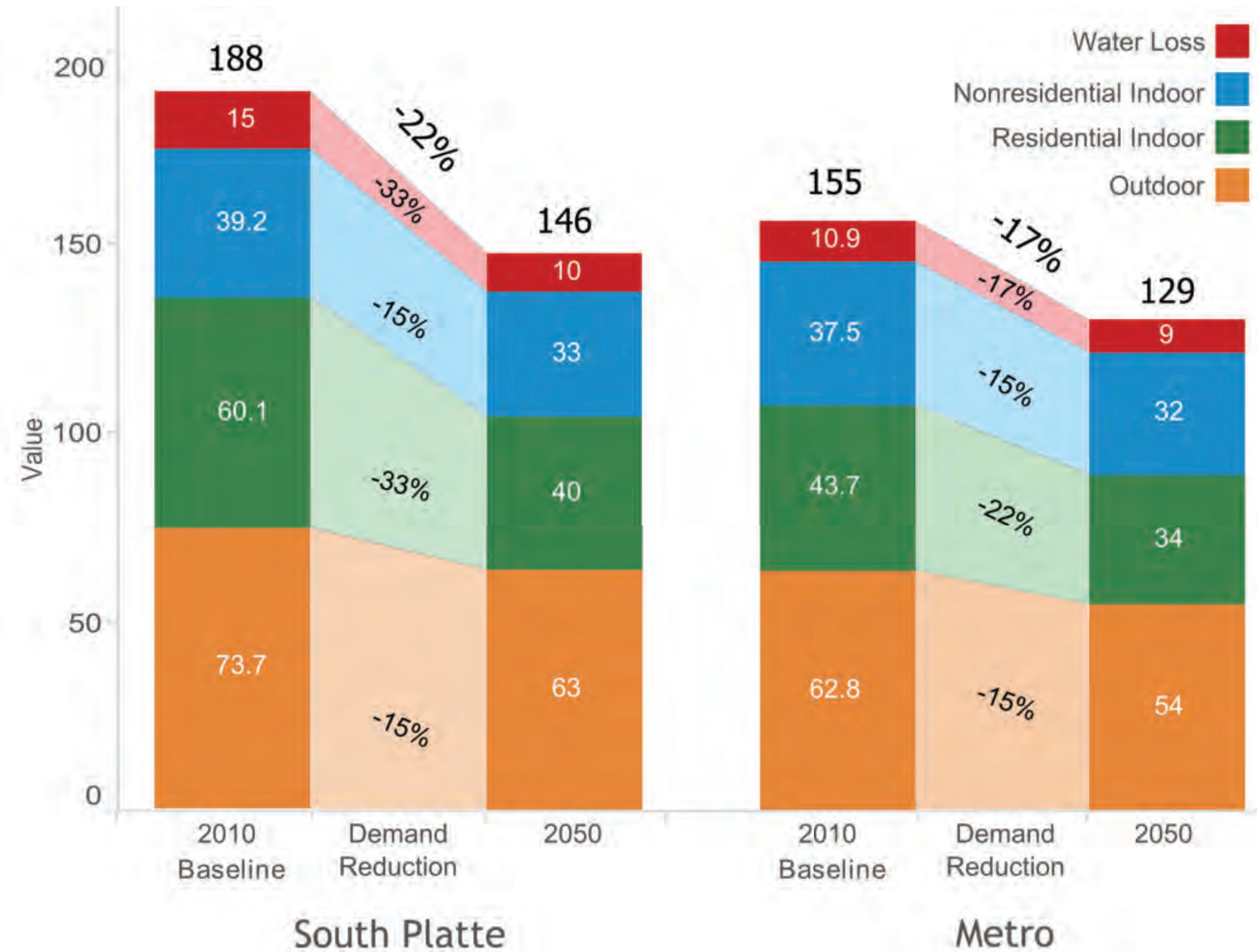
- *NC MO#1: Ensure conservation, reuse and drought management plans take into consideration environmental and recreational focus areas and attributes.*

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 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 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

> "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]

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.

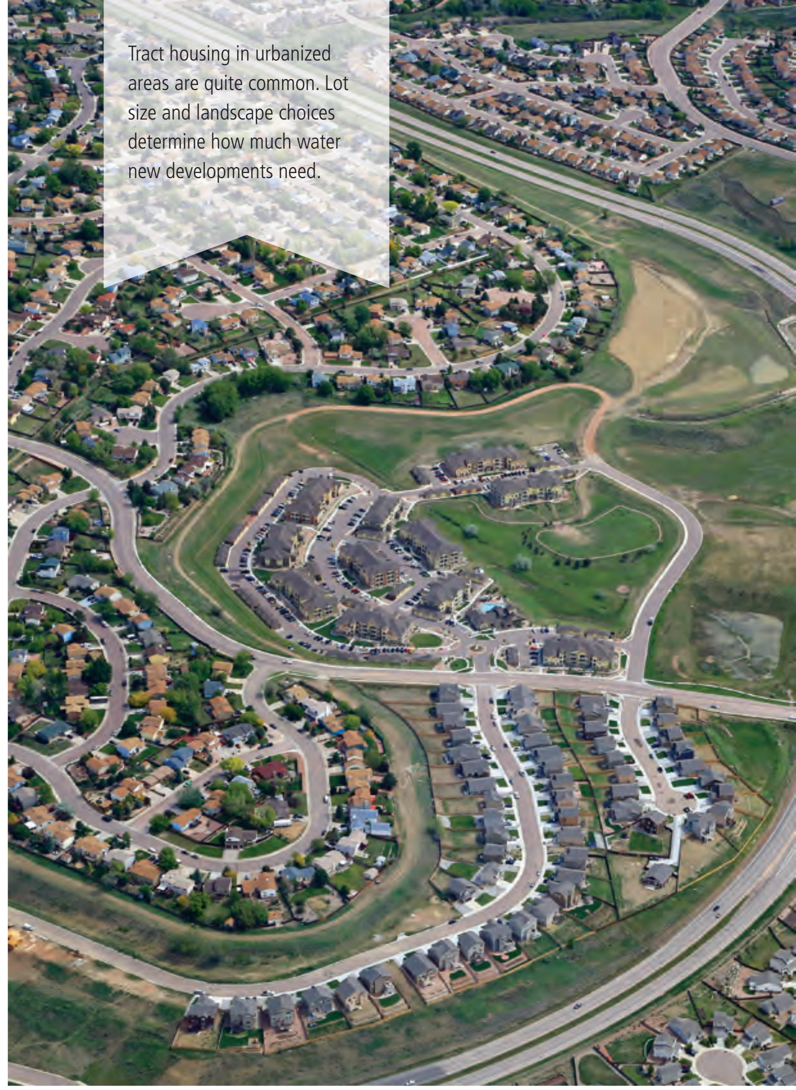
The manner in which Colorado develops into the future will have a strong influence on Colorado's future water supply gap, and vice versa. This topic is relevant today, as illustrated by the fact that six boards of county commissioners representing both the eastern and western slopes, including Boulder, 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 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 devel opment 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.

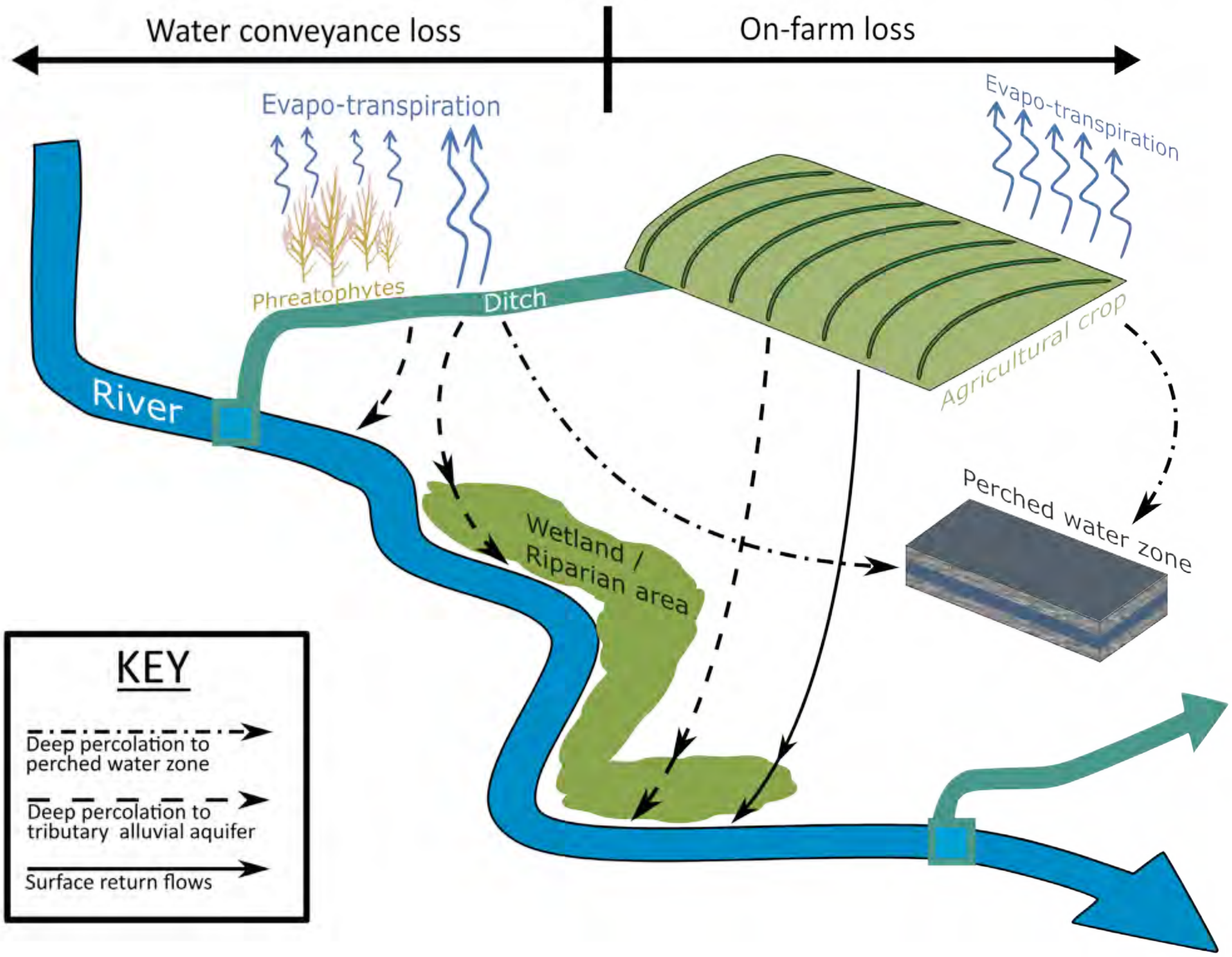
Background on Agricultural Water Use and Losses

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]

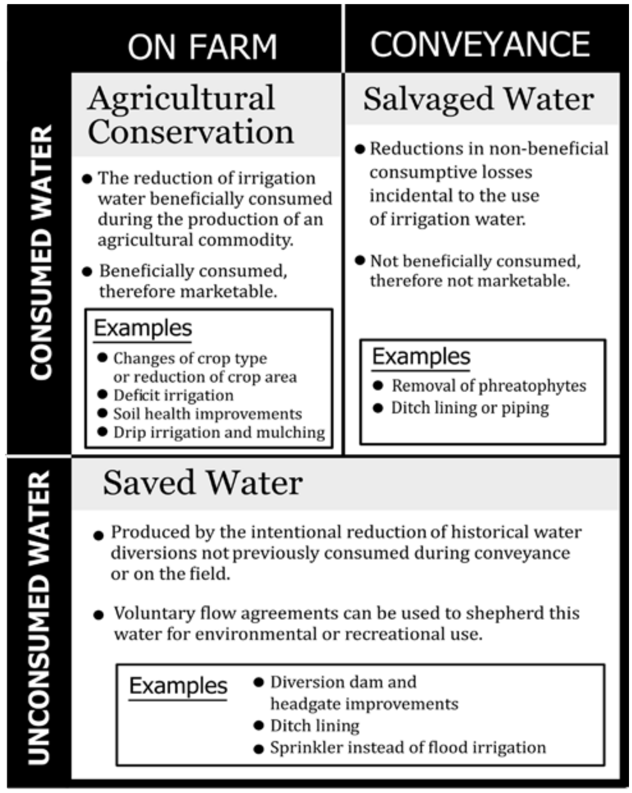
FIGURE 6.3.4-1 AGRICULTURAL WATER USE AND LOSSES



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]

FIGURE 6.3.4-2 IRRIGATION EFFICIENCY OUTCOMES



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.

- **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

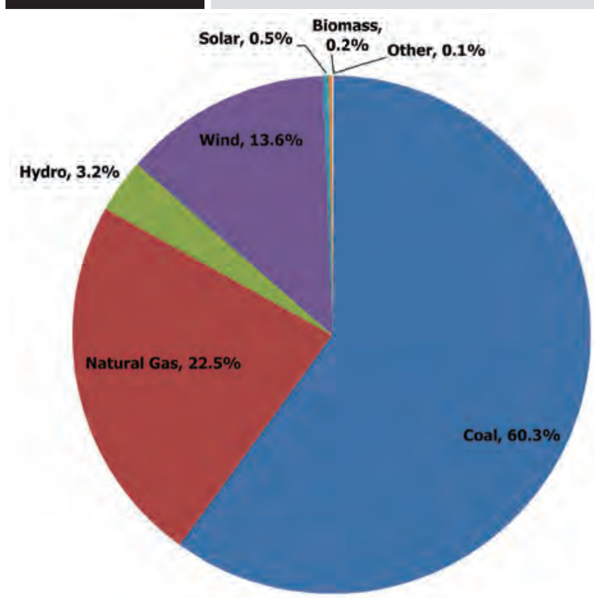
SSI water users describes industrial users that have developed their own, independent water supplies. Users include beer producers, power plants, mining-industry companies, and the ski industry, which uses water for snowmaking purposes. This section, however, will focus on the thermoelectric generation 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

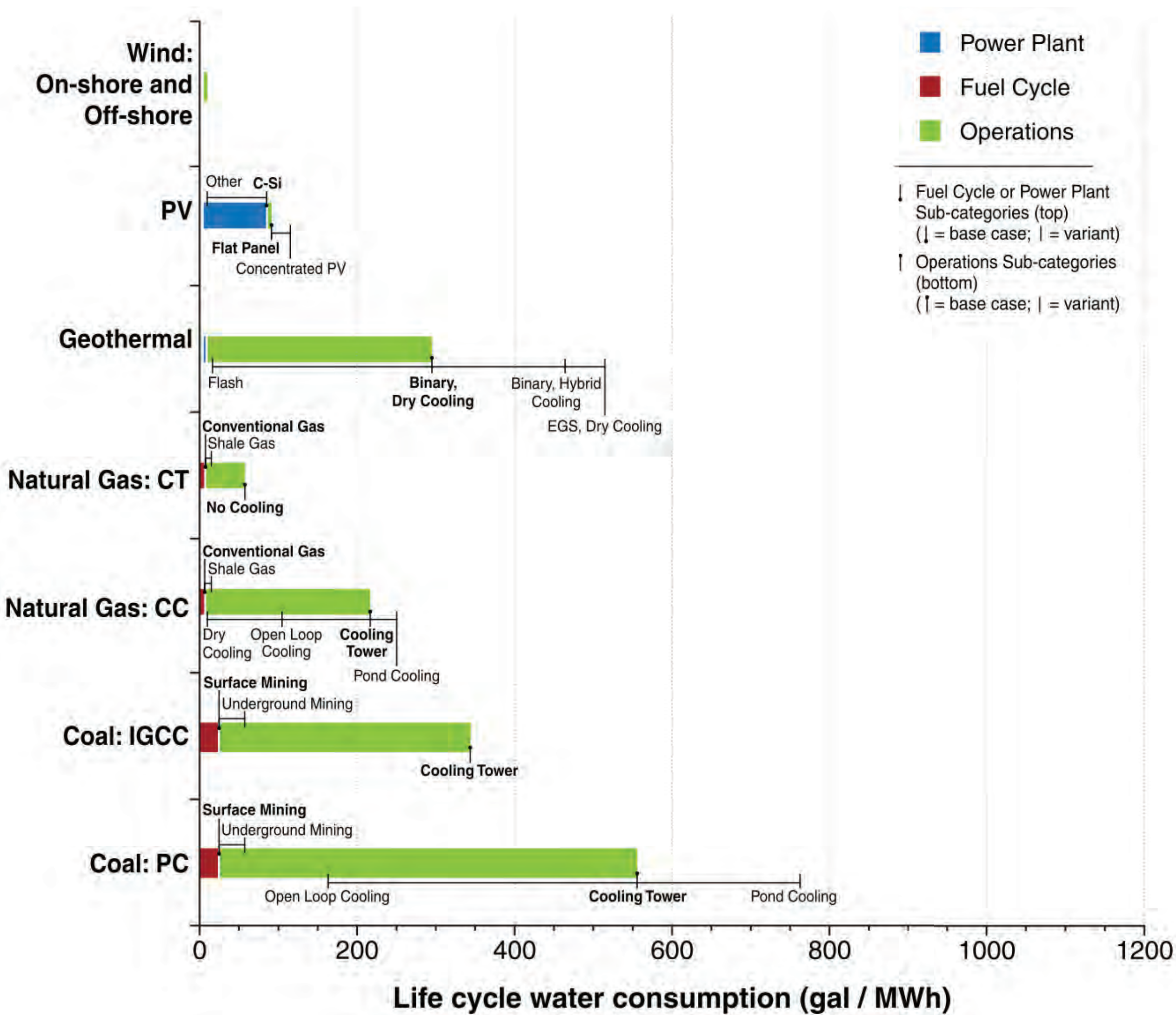
In 2012, thermoelectric facilities generated more than 85 percent of Colorado's electricity. Thermoelectric power generation heats water to produce steam, which in turn powers turbines to create electricity. While facilities can use a variety of fuel types to heat the water in thermoelectric power generation, 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-

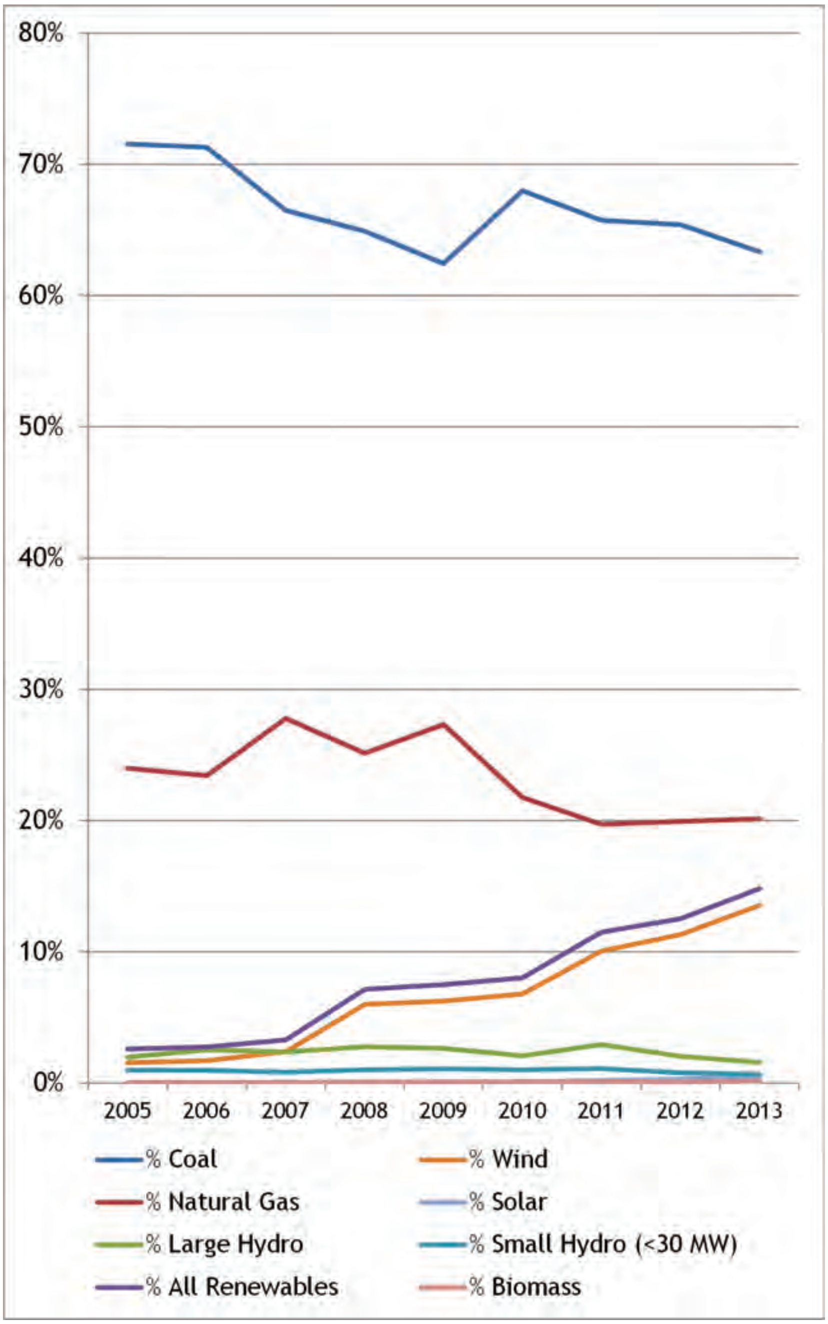
FIGURE 6.3.5-2 LIFECYCLE WATER CONSUMPTION FOR VARIOUS METHODS OF ENERGY PRODUCTION[272]



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.

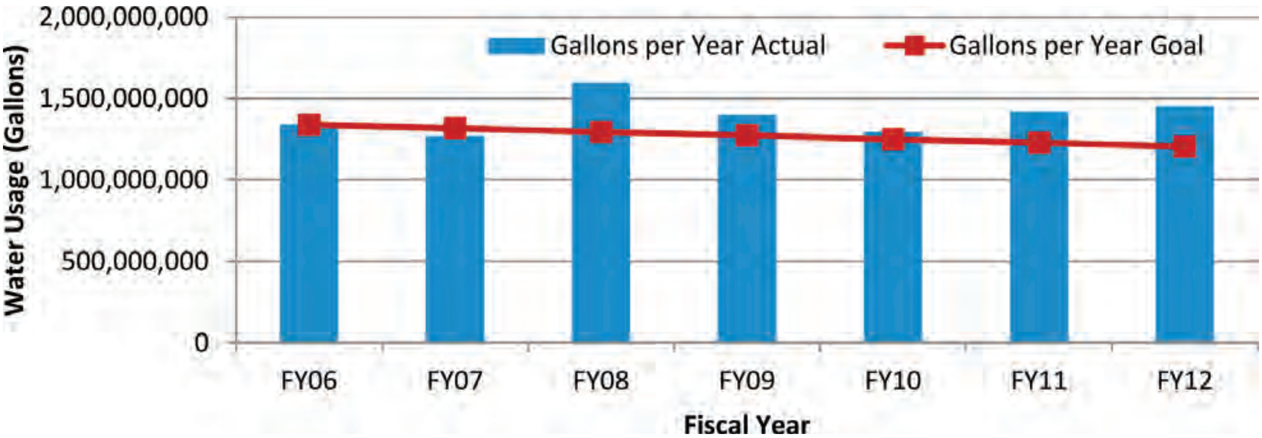
State agencies have been working for years, under greening government policies, to help reduce water and energy use in State facilities and are committed to doing so in the future.

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.

6.4

ALTERNATIVE AGRICULTURAL TRANSFERS

Respect the contributions of the agricultural industry by maximizing options to permanent buy-and-dry. Achievement of a sharing goal of 50,000 acre-feet could serve up to 350,000 people annually.

GOAL

Colorado's Water Plan will respect property rights and the contributions of the agricultural industry by maximizing options for alternatives to permanent agricultural dry-up.

Background

Agriculture uses the largest amount of water in Colorado and is the economic backbone for many rural communities. It supports important environmental attributes, strengthens Colorado's food security, and upholds our state's cultural identity. There are approximately 66.3 million acres of land in Colorado, of which 10.6 million acres are cropland.[289] Global, national, and state population growth will place additional pressure on our food sources, which means that the long-term economic viability of agriculture is strong.[290] Local economies in rural areas depend on wholesale, retail, banking, and support services related to agricultural production. When farmers stay in agriculture, cash-flow related to their operations can increase the vitality of their communities. Agriculture is an important contributor to Colorado's economy as a whole, which Chapter 5 further discusses.

Pressures at state, national, and international levels threaten to reduce agricultural lands in the short term. Future municipal water demands contribute to an increasing pressure to transfer agricultural water rights to help satisfy urban demands and other non-agricultural water needs across the state.[291]

Agricultural interests are concerned about the possibility of drying up more agricultural lands in the future.[292] If Colorado continues down its current path, the South Platte River Basin could lose up to one-third of today's irrigated land by 2050.[293] The Arkansas River Basin could lose another 17 percent of its total.[294] The main-stem watershed area of the Colorado River Basin could also lose another 29 percent of its irrigated lands.[295] Reduction of irrigated lands can be measured as actual acres lost, but can also be measured in economic terms based on a reduction of crops that are irrigated before the water transfer.

The SWSI estimates that by 2050, Colorado may lose 500,000 to 700,000 acres of currently irrigated farmland in order to meet municipal growth demands. The IBCC and basin roundtables conclude that the current status-quo path of buy-and-dry is not the best path for Colorado. Across the state, water stakeholders want to minimize buy-and-dry in a way that respects property rights, recognizes the importance of agriculture in Colorado, and supports a sustainable agricultural industry—while identifying solutions to provide water for municipal needs. As numerous groups, including the Colorado Agricultural Water Alliance and the IBCC, have indicated, a variety of alternative options have the potential to appreciably decrease the projected permanent losses of irrigated acres in Colorado.

These options, referred to as ATMs, do not limit the choice of private water-rights owners to permanently sell their water rights. ATMs offer voluntary, not mandatory, tools that enable both farmers and water users to depart from the status quo. In addition, ATMs can support the environment, recreation, industry, and groundwater sustainability and, through the creation of water-banks, reduce demands on a water system. ATMs are agile enough to focus on reducing net-profit loss or, on the other hand, to help protect higher-value crops for economic benefits.

The Low-and-No-Regrets scenario planning, which Section 6.1 discusses, indicates that the minimum goal of water needed from ATMs to meet the planning outlook is approximately 50,000 acre-feet. This amount would reduce permanent transfer of agricultural water rights, but would still result in agricultural dry-up. Currently, ATMs are more expensive and legally burdensome than traditional buy-and-dry approaches that permanently transfer water rights, making it difficult to obtain the estimated amount of water from existing alternatives. There are many creative and cutting-edge alternatives (as Table 6.4-1 shows) that can help decrease permanent reductions in irrigated acreage.

Goals of ATM Programs

Short-term or long-term temporary water-transfer alternatives provide options that address concerns about permanent agricultural buy-and-dry. Program goals related to ATMs are aimed at specific objectives for various regions across Colorado. It is highly unlikely that any one concept will be universally accepted in every basin. Rather than a one-size-fits-all approach, we understand that a variety of alternatives will be needed to meet specific needs. The goal of alternative water transfers is to benefit the agricultural community, as well as cities and towns that are seeking viable sources of water supply to keep up with demands. The State has learned important information about developing, evaluating, and monitoring ATMs from pilot and demonstration projects, but has more to learn to fully understand the potential of ATMs.

TABLE 6.4-1 TYPES OF ALTERNATIVE TRANSFER METHODS PROMOTED IN COLORADO
Rotational fallowing – Rotational fallowing keeps land in irrigated production mode while systematically fallowing specific plots. A rotation occurs to systematically fallow each plot in successive crop seasons. It allows leased water to become a base supply for a municipality, while keeping most the farming operation in production. It also works very well for drought supply, drought recovery, and conjunctive use. Revegetation protection, erosion control, and weed control of the fallowed plots are important considerations for this type of ATM.
Interruptible supply agreements – This type of ATM is between non-agricultural water users and farmers, shareholders, or a ditch company. Water is temporarily transferred from agricultural use to another use, such as municipal. Farms are fallowed during specific periods of time, and water is leased to the end-user based on the historical consumptive use portion of the water right. These arrangements are made through contractual agreements that satisfy the authorizing statutes. This could also include water conservation easements. See examples below. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.
Municipal-agricultural water-use sharing – This concept embodies a complex array of options based on continued farming operations for all lands associated with the sharing arrangement. Methods are used to reduce the consumptive use of crops, which makes water available for municipalities by sharing the historic consumptive use amount. Two main sub-categories are continued farming and deficit irrigation. In deficit irrigation, crop-watering is strategically limited to save water for other uses. Plants are typically stressed, but production and crop yield still occur. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.
Water cooperatives – Although there are a number of ways a water cooperative could work, only one concept has been tested in Colorado. This concept identifies periodic excess water supplies that can be used for optimization in the system. It includes use of surplus augmentation water and other supplies. The framework for moving water from one use to another involves mutually beneficial transactions that work within the existing system of water rights so that no injury occurs.[296] The Lower South Platte Cooperative is a current working example of this type of ATM.
Water banks – A water bank acts as an intermediary or broker based on water supply arrangements with owners of certain water rights. The bank could help avoid or endure a compact curtailment, for example.[297] Irrigators would be paid to reduce their consumptive uses, which could trigger fallowing of agricultural lands or deficit irrigation practices on a temporary basis. The saved water could be banked in a reservoir for later release into the system. This approach is being regularly discussed and studied in the Colorado River Basin. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.
Flex markets – These ATMs are defined as voluntary agreements between municipal and industrial water users, agricultural water users, and environmental/conservation water users.[298] The idea is to change the use of a senior irrigation right to include multiple end uses in addition to irrigation. These markets establish trading platforms to help provide water used by all participants. The goal of this approach is to allow part of the senior right to be used by cities and towns and for environmental purposes based on contractual arrangements. The economic benefit of the senior water right is kept in place by maintaining enough agricultural water to sustain robust farming operations. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.

Hay field along Highway 131 near Steamboat Springs. Photo M. Nager.

To achieve widespread implementation of ATMs across the state, researchers need to build a deeper understanding of their challenges and opportunities. To do so, Colorado needs more data and measurements on the outcomes from actual case studies. Researchers need to collect more information to be able to quantify results and inform decisions. In addition, there are significant legal, technical, and financial barriers to implementing ATMs. An in-depth look at existing ATMs and future project models will help identify program constraints and how to address them. There is potential for tremendous local, statewide, and regional benefits, but stakeholders need further information to expand their knowledge and ability to implement projects.

Potential Impediments to ATM Success

The execution of ATMs at this time can be difficult, or sometimes impractical, due to institutional, legal, financial, and court-related barriers, as well as the type of operation. For example, rotational fallowing would not work on an established orchard, since the trees would not survive without water during a growing season. Some legal impediments include long-standing water court procedures that change water rights, and legal requirements for ATM applications to prevent injury to other water rights. New and creative ATM ideas face many challenges because they do not fit into the historic way of handling water rights.

Other obstacles to success include irrigators' concern regarding the outcome of historic consumptive-use analyses and the potential for expanded uses of changed water rights. Cities and towns wonder if temporary supplies will actually be available when needed over the long haul.[299] Another impediment is the lack of necessary infrastructure for water transfers and the inability to form agreements, depending on the seniority of water rights or productivity of the lands involved.[300] Transaction costs tend to be relatively high, which can discourage potential water transfers. In addition, Colorado needs to assess fair and effective pricing for farmers and water suppliers, and the ability of farmers to invest ATM revenues back into their operations. To avoid the problem of where and how to store ATM water, Colorado needs to better understand and define the infrastructure that may be needed. Infrastructure improvements, expanded reservoir operations, or reservoir re-operations may bring needed utility and agility for storing ATM water. The CWCB believes that it would also be helpful to provide a means to support prioritization of research, as well as investments into technology systems such as automated delivery techniques.

Colorado's Water Plan encourages all interested parties to openly and constructively find ways to adapt to changing times. Colorado's Water Plan recognizes that water-sharing agreements between municipalities and agricultural interests for water transactions, such as the sale or lease of surplus water and use of excess return flows, can be important tools for moving forward to meet supply gaps. To alleviate water supply pressures, stakeholders need to find solutions to reduce barriers to implementing ATMs for enhanced success. The strength of Colorado's agriculture is its diversity. A full mandate of ATMs across all sectors is not the answer, whereas creative options and solutions can apply to feasible situations. Municipalities and agricultural interests can achieve successes and overcome barriers using creativity at the grass-roots level—which then could generate momentum at the ditch and basin levels.

Examples of ATMs

A variety of existing examples demonstrate ways in which ATMs work in Colorado, including:

- *Morgan Ditch Company & Xcel Energy* formed a voluntary lease arrangement in the South Platte River Basin. For more than 20 years, a separate water company that the Morgan Ditch Company developed has provided firm-yield supply to Xcel Energy's Pawnee power station. The power station is conveniently located near the ditch system on the eastern plains south of Brush, which enables several options for physically delivering the water to the power station. While a traditional water court process helped codify the legal ability to transfer water from agricultural use to industrial use, the arrangement has built-in agility to handle wet, average, and dry years. The dry-year deliveries typically involve temporary dry-up (fallowing) of sufficient farmland under the ditch to meet delivery requirements to Xcel. This also means that remaining farmland is fully irrigated with senior direct flows or senior reservoir rights. In those cases, the system does not operate in a deficit-irrigation mode to apply water to all lands during the really dry years. The mutually beneficial agreement is desirable in the eyes of those in the system, and has a proven track record of success. This is an example of ways in which industrial interests and farmers can continue to operate.
- *City of Thornton* formed a short-term lease and temporary substitute supply plan to provide emergency water to the Platte River Power Authority.
- *Lower Arkansas Valley Water Conservancy District* provided an economic and engineering analysis of the Lower Arkansas Valley Super Ditch Company (Super Ditch). The Super Ditch allows irrigators under a group of ditch companies to collectively lease agricultural water for other uses, including municipal use. The Super Ditch acts as a negotiating entity for irrigators that are interested in leasing water for temporary use by cities, towns, water districts, and other users.[301] The farmers still retain ownership of their water, keeping farms in operation for agricultural sustainability.

HAROLD GRIFFITH

SOUTH PLATTE RIVER BASIN

Harold was a dairy farmer for 50 years in Morgan County. He served on numerous boards supporting agriculture and pioneering temporary agricultural leases to support municipal and industrial interests. These lease agreements, now known as a form of alternative transfer methods, were ahead of their time and speak volumes about Harold's leadership and lasting legacy. Harold is pictured in his corn field near the Xcel Energy Pawnee Generating Station in Fort Morgan, which has a lease agreement with the Morgan Ditch Company.

When it comes to challenges, I believe that we are sometimes our own worst enemy by creating our own roadblocks. Being involved in the water court system and negotiating agreements, I knows it is a slow process, but perseverance and belief in the task at hand sees you through and makes a huge difference for the future of a community...

CONTINUED AT END OF CHAPTER

PROFILE

- *The Water Bank Working Group* consists of the Colorado River Water Conservation District, the Southwest Water Conservation District, the Front Range Water Council, the Nature Conservancy, the CWCB, and other interested parties. The working group is investigating the feasibility of a water-banking program within the Colorado River Basin. In the short term, the water bank could operate as part of the demand-management component of the State's contingency plan to prevent Lake Powell from dropping below critical levels. In the long term, a water bank could help prevent shortages under the Colorado River Compact and help Colorado water users during regional shortages. The Water Bank Working Group engages with agricultural users to gauge interest in participating in the program, and to identify potential costs or compensation for involvement. The "Colorado River Water Bank Feasibility Study," which the Water Bank Working Group crafted and released, with consulting firm assistance, in March 2012, details potential uses for such a program, as well as potential sources of supply. The preliminary study modeled the potential frequency of situations in which a water bank would be useful. The study examined several scenarios that showed water-bank annual-use estimates and an estimate of the number of irrigators willing to participate. The CWCB is examining additional studies about the water bank.
- *City of Aurora & Rocky Ford Ditch* partnered for a creative water-transfer arrangement to allow continued farming. Aurora invested to help purchase highly efficient irrigation equipment (e.g. drip or sprinkler technology) for farming operations. Farmers also received augmentation water from Aurora to supply new wells for irrigation rather than using water directly from the Rocky Ford Ditch. Several farmers have maintained strong agricultural production by using augmentation supplies for depletions from the well use on their farm. The farmers have reduced their consumptive use by switching to crops that need less water. This arrangement still maintains a healthy agricultural operation. For successful outcomes, municipalities offer strong financial commitments, and the farmers offer willingness and agility to modify their traditional practices.
- *City of Aurora & Rocky Ford Highline Canal* partnered for a water-leasing agreement in 2004 and 2005. Farmers under the Rocky Ford Highline Canal directly leased water to the City

The Catlin Canal pilot project is an excellent example of an alternative agricultural transfer. Courtesy of the Lower Arkansas Valley Water Conservancy District.

Once farmed, certain plots of land are systematically fallowed to provide temporary water that is leased to municipalities. The fallowed plot can be planted with non-irrigated vegetation to prevent blowing soils.

of Aurora. Reaching an agreement required a substantial amount of time and included complex contracts between the city, individual farmers, and the canal company. It also required approval of a substitute water supply plan from the Division of Water Resources at that time. Nevertheless, newer statutory authorizations for interruptible water supply agreements assist in the implementation of these types of ATMs. Intermittent leases of this nature fill a specific need, including drought relief and the recovery of reservoir levels following drought. They could also supplement base water supplies during dry periods.

- *Ducks Unlimited* partnered with Aurora Water and Colorado Corn Growers Association to develop augmentation ponds that support waterfowl.
- *Metropolitan Water District of Southern California & Palo Verde Irrigation District* agreed to a land-fallowing, crop-rotation, and water supply program.[302] They began the 35-year agreement for voluntary water transfers in 2004 to help to meet California's urban water demands through a mutually beneficial partnership. The program is designed to supply 25,000 to 118,000 acre-feet annually by temporarily drying up 7 to 28 percent of the irrigated farmland in the Palo Verde Valley.[303]
- *The Lower Arkansas Valley Water Conservancy District and Super Ditch, LLC* submitted a pilot project proposal, followed by a full application to the CWCB in 2014, which the CWCB ultimately approved. The pilot began during the 2015 irrigation season and involves temporary transfers of water from certain agricultural lands on the Catlin Canal system to the communities of Fowler, Fountain, and Security. This project will assist in helping the CWCB learn from an actual ATM implementation in the basin.

ATM Grant Program Overview

Colorado's Water Plan encourages alternatives to permanent dry-up. One way that Colorado continues to address ATMs is through the CWCB's long-standing grant program. The ATM grant program assists in developing and implementing creative alternatives to the traditional purchase and permanent transfer of agricultural water.

Colorado Senate Bill 07-122 (a CWCB Projects Bill) authorized the ATM grant program, which applies to a wide array of issues related to lease fallowing, pilot projects, flex market studies, demonstration efforts, and other alternatives for a variety of beneficial uses of agricultural water supplies. The CWCB has awarded nearly two dozen grants, ranging from about $8,000 to almost $500,000 each. Colorado Senate Bill 07-122 initially funded the program with a total of $4 million, and, through Colorado House Bill 14-1333 (also a CWCB Projects Bill), approved an additional $750,000 in funding. CWCB is making available detailed summaries of the program and awarded grants.[304]

ATM Related Existing Legislation

Colorado's Water Plan recognizes the need to increase agility within Colorado's system of water law, while respecting individual property rights. ATMs could provide a viable option for municipal water providers now and in the future, and the key to their success is the development of methods that meet the needs and respect the property rights of the agricultural water-rights owners. ATMs can also provide long-term security and financial practicality to urban water providers.

Irrigating the cornfields near Xcel Energy's Pawnee power station. This site is a great example of an ATM project at work in Colorado. The project is further explained within the text of this chapter.

State legislation influences the availability of tools necessary to further facilitate ATMs. This section of the water plan discusses one important legislative bill related to a fallowing-leasing pilot program. Colorado House Bill 13-1130 (HB13-1130 or C.R.S. 37-92-309) enacted legislation for Interruptible Water Supply Agreements, and the associated statute supplemented or amended previous authorizations. The legislation allows for a temporary change of an absolute water right for a new use once the DWR approves it.[305] The statute does not require the arrangements to go through a typical water court process. Table 6.4-1, page 6-116, includes a general description of this type of ATM.

Colorado House Bill 13-1248 (HB13-1248 or C.R.S. 37-60-115), which Governor Hickenlooper signed into law on May 13, 2013, authorized the Fallowing-Leasing Pilot Program. It allows for a pilot program to test the usefulness of fallowing-leasing as an alternative to permanent agricultural buy-and-dry.[306] The pilot program may include up to 10 separate pilot projects statewide; however, no more than three are allowed in any single river basin. Each pilot can operate for up to 10 years in duration.

In HB13-1248, the Colorado General Assembly declared its commitment to develop and implement programs to advance various agricultural-transfer methods as alternatives to permanent agricultural dry-up. It further stated that Colorado needs to evaluate whether fallowing-leasing is a practical alternative to traditional buy-and-dry methods.[307] The General Assembly designated the CWCB as the appropriate state agency to test the efficacy of implementing fallowing-leasing.

HB13- 1248 charged the CWCB, working in consultation with the DWR, to establish "criteria and guidelines" for the application, selection, and approval process for pilot projects. In accordance with the legislative directive, the cooperation and collaboration of the CWCB, DWR, and the public resulted in the development of a set of criteria and guidelines. These criteria and guidelines assist the CWCB and interested parties in fulfilling the spirit and intent of HB13-1248.[308]

HB13-1248 allows fallowing-leasing pilot projects to be tested in an effort to overcome challenges, and to develop and demonstrate opportunities for temporary agriculture-to-municipal water transfers.

The Lower Arkansas Valley Water Conservancy District and the Lower Arkansas Valley Super Ditch Company, Inc. formally submitted a proposal to the CWCB's staff on July 14, 2014 for a fallowing-leasing pilot project under the auspices of HB13-1248 and the CWCB's Criteria and Guidelines for the Fallowing-Leasing Pilot Projects. At its September 2014 board meeting, the CWCB approved the proposal to move forward on the full application. The sponsors then submitted an application, which calls for transfers of certain shares of agricultural water from farmland irrigated by the Catlin Canal (in Otero County) for temporary municipal uses by the Town of Fowler, the City of Fountain, and the Security Water District. The project proponents aim to implement the pilot operation beginning in the 2015 irrigation season (the "Examples of ATMs" section above also explains this).

More recently, the governor signed Senate Bill 15-198 into law, expanding upon the authorities in HB13-1248. The pilot program may now include temporary transfers from agriculture to agriculture, agriculture to the environment, agriculture to industry, and agriculture to recreation.

BIPs

The basins submitted their final BIPs to the CWCB in April 2015, and provided valuable information regarding their plans for agricultural needs. These needs are summarized below.

The Arkansas Basin Roundtable has three goals associated with ATMs. First is to "Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions" by continuing the ATM process of engineering, public policy, and pilot projects.[309] Second is to "Provide increasing quantities of augmentation water for increased farm efficiencies" by establishing long-term sources of augmentation water through leasing, water banks, or interruptible supply agreements.[310] Third is to "Develop a viable rotational fallow and/or leasing program between agriculture and municipal interests to address drought and provide risk management for agriculture" by: 1) Completing the ongoing technical studies and engineering to facilitate temporary transfers; 2) defining and quantifying potential third-party effects on shareholders within a ditch system that are engaged in a fallow program, by providing funding in support of an economic study; and 3) minimizing permanent dry-up.[311]

The Arkansas Basin is working on ATM projects, and others are under development. The use of stakeholder input and current pilot project data will identify future ATM projects.[312]

The Colorado Basin Roundtable notes the difficulties associated with ATMs. The main obstacles to alternative-transfer methods are loss of income, lost market share, and the lack of expertise in farming new crops. The plan also states that stakeholders need to address problems on a broad scale as they occur in each basin across Colorado.[313]

The Gunnison Basin Roundtable does not specifically identify ATMs as a method to meet its future needs. Nevertheless, the Gunnison Basin Roundtable does state that it is committed to the voluntary preservation of agriculture. The measurable outcome for this goal is to preserve the current baseline of approximately 183,000 acres of protected agricultural land, and to expand participation in conservation easements by 5 percent by 2030.[314]

The North Platte Basin Roundtable, like the Colorado and Gunnison Basin Roundtables, does not include ATMs as a means to achieve the goals and measurable outcomes of its basin. The plan does include agricultural use for the basin: "Describe and quantify the environmental and recreational benefits of agricultural use." The measurable outcome for this goal is to complete at least two new multipurpose water projects that meet multiple needs the plan identifies, by 2025.[315]

The Rio Grande Basin Roundtable explores innovative soil health and CU reduction techniques as part of the goal to achieve groundwater sustainability. While specific water-rights transfers may not be needed as part of these practices, the techniques are similar. As stated in the BIP:

> *The amount of water available to irrigators is projected to decrease, as discussed extensively in this Plan. As such, some producers may want to explore opportunities to reduce pumping through alternative cropping rather than drying up productive farm ground. Incorporating alternative crops and farming methods that reduce consumptive water use are opportunities to maintain an economically stable future for agricultural producers but have challenges, as equipment needs and market conditions make switching to new crops complex.*

Valley producers may consider growing fewer acres of higher-value crops, such as organics. Demand for locally grown, organic food continues to rise. Assistance for growers wanted to diversify their operations, switch to organic farming altogether, or enter into grower cooperatives would be a great benefit to expanding this option. Local farmers' markets have become a major source of local foods and are now a regular summer-into-fall feature in towns throughout the Valley.

Growers can also reduce water use by incorporating green manure into their crop rotation. Green manure is a mix of crops, such as mustards, radishes, and sorghum-sudan grass, which is specifically grown to be turned into the soil. Green manures improve soil health, as discussed in Section 5.2.6: Improving Soil Health, and require less water to go than other rotational crops. While the grower would not be selling a product in these years, the improvement to their operations has been shown to pay back the investment in green manure….

There are water savings through such methods as drip irrigation that will be realized through reduced evaporation losses. In addition to more efficient water use, the subsurface irrigation system may produce a higher quality of crop with less herbicides and pesticides required. , the widespread viability of subsurface irrigation has not yet been demonstrated in the Valley.

Improved water management techniques, such as irrigation scheduling, can also boost efficiency without reducing crop yields. Finally, such practices as deficit irrigation — giving crops just enough water to produce a minimal profit — may be a noteworthy technique for water rights holders on the cusp of receiving deliveries.[316]

The South Platte/Metro Basin Roundtable identifies successful implementation of ATMs as a measurable outcome for its plan's agricultural goal.[317] The joint plan also lists minimizing traditional agricultural buy-and-dry and maximizing the use of ATMs to the extent practical as one of 11 key elements to its plan. ATMs play a key role in the South Platte/Metro's B and C portfolios for meeting approximately 30,000 acre-feet of the basin's future water demands.[318] Through the CWCB's Alternative Agricultural Water Transfer Methods Grant Program, the South Platte/Metro Basin has completed and is currently working on several ATM grants, and lists one of these projects as a new IPP. The plan lists several recommendations for overcoming ATM barriers associated with water court and transaction costs:

- Development of special review procedures to facilitate ATM agreements.
- Adoption of presumptive CU procedures.
- Determination of historical CU for a canal or ditch system.
- Development of specific methodologies for measuring, calculating, and monitoring CU water transferred through ATM projects. (The Arkansas Basin is developing an "Administrative Tool" to calculate a farm's historic CU and return flow obligations.)
- State funding of infrastructure cost.
- Pursuit of transfer of a portion of a water right.[319]

The Southwest Basin Roundtable lists as a measurable outcome the implementation of ATMs as a means to preserve agriculture while addressing other water-use needs.[320]

The Yampa/White/Green Basin Roundtable mentions ATMs as a process to achieve its goal to "Protect and encourage agricultural uses of water in the Yampa/White/Green Basin within context of private property rights." Part of this goal's purpose is not only to preserve current protected agricultural acreage, but to expand it as well. The plan specifically states that a process for this goal is to "Identify projects that propose to use at-risk water rights, alternative transfer methods, water banking, and efficiency improvements that protect and encourage continued agricultural water use."[321] The plan has not identified any specific ATMs to meet this goal.[322]

IBCC No-and-Low-Regrets Action Plan

The IBCC developed several ATM recommendations as part of the No-and-Low-Regrets Action Plan, as Table 6.4-2 (page 6-125) summarizes.[323]

Additional details regarding IBCC low-and-no-regrets information pertaining to alternative agricultural-transfer methods are available in the latest version of the IBCC No-and-Low-Regrets Action Plan.

TABLE 6.4-2 NO-AND-LOW-REGRETS ALTERNATIVE TRANSFER METHOD ACTIONS

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Implement ATM Grant Program • Support CWCB and IBCC	1. Develop an Incentives Program a. Financial incentives b. Streamlined approval processes c. Selective and systematic considerations (encourage maintaining or increasing highly productive lands) 2. Establish ATM Demonstration Projects a. Overlay-district or authority b. Storage and other infrastructure c. Multipurpose objectives d. Adequate measurement and monitoring 3. Establish Basin Goals and Track Ongoing Progress 4. Implement ATM Program 5. Analyze Infrastructure Needs for Storage of ATM Water

ACTIONS

The CWCB should consider the following options or action steps to help ensure attainment of alternatives to permanent farmland dry-up:

1. Monitor current and future legislation necessary for the implementation of ATMs, including enhanced sharing opportunities and system agilit
2. Encourage funding grants that focus on implementing on-the-ground ATM projects, data collection, agile administration practices, ATM affordability, basin-specific ATM projects, and infrastructure modernization.
3. Support appropriate fallowing-leasing pilot projects, such as the Catlin Canal pilot project, by responding to and processing applications in a timely manner under House Bill 13-1248 (C.R.S 37-60-115). The ATM grant program could further support these projects. To proactively cultivate these projects, the CWCB will work with partners or co-sponsors to organize and conduct regional workshops. These events will enable stakeholders to share lessons learned on actual ATM projects, and to garner additional interest by discussing program benefits.
4. Encourage adaptive strategies that capture a “learning by doing” concept for pilot programs and other on-the-ground ATM applications.
5. Continue to provide ATM leadership as well as technical and financial support to basin roundtables during the development of their BIPs.
6. Assess quantitative information related to agricultural dry-up in SWSI 2016, including evaluating lessons learned and monitoring the effects of ATMs in reducing permanent agricultural dry-up.
7. Explore financial incentives through a stakeholder process as part of the funding Section 9.2 describes. These incentives or grants could include new and ongoing revenue streams and tax incentives at the local and state level.
8. Work with the South Platte, Metro, and Arkansas Basin Roundtables to explore a WSRA or an ATM grant, with municipal and agricultural stakeholders that could lead to the formation of one or more pilot regional water sharing cooperatives. The mission of a cooperative would be to facilitate water-sharing arrangements. The cooperative could include ways to determine initial start-up costs necessary to reach stated goals. For instance, methods may include acquiring funding needed to reduce barriers associated with the high transaction costs of water-rights transfers, and working through water court to make a water right more agile.
9. Continue collaborating with water users to develop tools and models that can be used as an approved common baseline for water court litigants and parties. Administrative change cases could rely upon these for conservative yet streamlined estimates of consumptive use, return flows, and injury.

10. Seek to help stakeholders understand the benefits and social barriers of ATMs and how they can function under existing and future law

11. Interact with the Colorado water community and decision makers to consider the following options in support of ATM goals:

   - Continue to monitor basin-level work and explore options to develop agility in the use of certain agricultural water rights for multiple purposes.
   - Implement tools Senate Bill 15-198 (C.R.S. 37-60-115) provides that broaden pilot-project end uses House Bill 13-1248 (C.R.S. 37-60-115) sets forth. Such pilot projects could demonstrate agricultural transfers that meet environmental, recreational, industrial, or compact needs in addition to urban needs. The CWCB will encourage pilot projects to test the latest concepts or meet multiple benefits.
   - Reduce barriers, such as high transaction costs associated with water-rights transfers and water-rights accounting uncertainties, through continued exploration of pilot projects and other voluntary transactions that demonstrate a streamlined approach or provide financial support.
   - After a thorough outreach and stakeholder process, consider legislation to protect existing municipal, transferred water-rights owners that choose to undergo the court process to demand that their permanent agricultural transfers operate as ATMs. Such legislation could help ensure that a water-rights owner could revert to its previously adopted stipulations, if the water court process for an ATM option yields an unfavorable outcome.
   - Strengthen recognition for new types of legal beneficial uses, such as leased or agile-use water.
   - Identify and develop a request for a multi-basin WSRA grant through the basin roundtables. The goals of a potential grant would be to compile ATM data, identify actions to encourage irrigators to enter agreements, analyze barriers, and increase program awareness.
   - Research benefits and challenges of "buy and supply," which could preserve local irrigated agriculture and associated benefits. The concept of "buy and supply" is that M&I water users purchase irrigated lands with associated water rights, establish a conservation easement for future farming, and then supply a full amount of water for a certain number of years within a 10-year period. The M&I user could then receive water supply in the remaining non-farming years.
   - Explore the possibility of third parties providing assistance in funding ATMs to ensure that farmers are appropriately compensated and that water suppliers pay a reasonable incremental cost for firm yield. In this case, the third party would essentially assist in the effort to uphold the value of continued viable agriculture.
   - Support research into the benefits and challenges of temporary rotational "idling" of crops, deficit irrigation, and split-season irrigation.
   - Incorporate improved water-use data into decision-making processes in a way that reduces uncertainty for water managers, and develop basin-specific models for use in water court cases to help reduce transaction costs.

6.5 MUNICIPAL, INDUSTRIAL, AND AGRICULTURAL INFRASTRUCTURE PROJECTS AND METHODS

GOAL

Colorado's Water Plan encourages the use of grassroots efforts to identify and implement projects and methods to meet community and agricultural water needs throughout Colorado, and to achieve the following statewide long-term goals:

- **Use water efficiently to reduce overall future water needs.**
- **Establish a process to identify the projects and processes to meet the water supply gap for communities while balancing the needs of agriculture, the environment, and recreation across the state.**
- **Obtain the State's encouragement and assistance in the development of balanced and appropriate storage that can meet multiple benefits, including instream flow and augmentation needs.**
- **Meet community water needs during periods of drought.**
- **Develop and implement policies and strategies that support meaningful agricultural viability statewide.**

Colorado will require the implementation of many identified projects, storage, other infrastructure, and methods to meet future municipal, industrial, and agricultural needs. This section discusses the different types of projects that communities must implement to meet Colorado's growing needs, how the basin roundtables identified these projects and methods, and what is required to support those communities. This section also includes a discussion of the IBCC's adopted No-and-Low-Regrets Action Plan as it relates to the implementation of projects and methods, and a summary of ongoing initiatives relating to the viability of agriculture statewide. Colorado's water values name agricultural viability as a priority, and Colorado's Water Plan includes specific policies and strategies to advance this concept. It also addresses the role of storage in meeting Colorado's future supply needs.

Overview

The draft BIP process produced a compendium of projects and methods to meet Colorado's future water needs. These projects and methods are the foundation of this section. In developing their respective lists of projects and methods, the basin roundtables relied upon previously developed IPPs, conducted interviews with water providers, and solicited public input to update existing IPPs and identify additional projects and methods. For the purposes of Colorado's Water Plan, the term projects and methods refers to IPPs and additional efforts the BIPs featured to close the M&I gaps and reduce agricultural shortages.

The basin roundtables vetted these proposed projects and methods in order to develop a draft list for their respective BIPs. Some roundtables vetted the preliminary list through the entire roundtable, while others reviewed projects and methods using subcommittees. In the end, each roundtable reviewed or adopted the draft BIPs. In addition, many roundtables tiered or prioritized their projects and methods to assist with future implementation.

The goal of developing lists of projects and methods is to meet Colorado's future water needs. In addition, this work will help calculate the remaining M&I water supply and demand gaps, determine residual agricultural shortages, estimate the costs of implementing the proposed projects and methods, identify the potential for intrabasin and interbasin collaboration on proposed projects and methods, and identify the interrelationships and the potential for collaboration between consumptive and nonconsumptive projects and methods.

The basin roundtables proposed a great number of projects and methods beyond those identified in SWSI 2010. Although they primarily designated some of the proposed projects and methods as single-purpose, many are multipurpose. The multipurpose projects could benefit agricultural M&I interests. Alternatively, these projects could benefit the environment or expand recreational opportunities while meeting municipal or agricultural needs. Those projects and methods that intentionally target consumptive and nonconsumptive benefits are categorized as *multipurpose*.

The basin roundtables' projects and methods aim to close the M&I gaps or reduce agricultural shortages—or both. They may require financial expenditures, and while many roundtables included implementation cost estimates, some did not. Proposing a project or method and developing cost estimates and financing mechanisms are two components of implementation. Roundtables have many well-developed proposed projects and methods that are currently in the permitting stages; however, some projects and methods are conceptual in nature, with uncertain or no stated cost estimates. The validity of cost estimates varies greatly across proposed projects and methods and across BIPs. With that caveat, individual project and method implementation costs range from $50,000 to $211 million.

It should also be noted that some proposed projects or methods are multi-year efforts and consist of a wide array of implementation strategies and approaches. Cost estimates to implement the proposed projects and methods range from $500,000 to $486 million per BIP, with a statewide preliminary total of approximately $2 billion. Many roundtables have not yet determined costs for their projects, and most have not done so on a consistent basis. Therefore, this number represents a minimum financial need.

Roundtables must also take into consideration their estimated yield for the identified projects and methods. Estimated yield affects the calculated M&I gaps and agricultural shortages, and is subject to some variability and further refinement by basin roundtables, as well as variability in project permitting and financing. That said, the estimated yield of the proposed projects and methods by BIP ranges from 6,030 acre-feet per year of new supply to 321,316 acre-feet per year. Similarly, the range of yield reflects the level of participation of project sponsors and project beneficiaries. Some projects and methods have multiple sponsors, ranging in size from small, localized water providers, to regional water providers such as conservancy and conservation districts or cities. Furthermore, while a single entity may sponsor some projects, there may be many associated beneficiaries; in other cases, a single entity may sponsor a proposed project or method, with only one beneficiary. The roundtables propose many combinations of project sponsors and project beneficiaries, reflecting the collaborative nature of the BIP process and the anticipated results. This section conducts a more in-depth examination of each BIP, and discusses the IBCC's No-and-Low-Regrets Action Plan and actions.

New and Emerging Water Supply Projects and Methods

As the State of Colorado and the basin roundtables move toward implementing BIPs and Colorado's Water Plan, they will need innovative and creative solutions to meet future demands, given the availability of funding and the nature of limited water resources. There is no perfect solution, but a range of emerging trends add to the suite of options that the State and the basins can implement.

Aquifer Recharge

Aquifer recharge, also referred to as artificial recharge, is the process of infiltrating water to an aquifer through ponds, basins, canals, or wells.[324] Artificial recharge to the alluvial aquifer is most commonly used in Colorado for augmentation of stream depletions because of well pumping. Most of these alluvial recharge projects for augmentation occur in the South Platte Basin, outside of the designated groundwater basins.[325] Permanent artificial recharge projects outside of the designated basins must ultimately receive a decree through water court, and must operate within the confines of Colorado's prior appropriation system. Additionally, a protocol for alluvial recharge within the South Platte Basin is available.[326]

ASR

Aquifer storage and recharge (ASR) uses aquifer recharge or injection to achieve water storage in the aquifer during times of low demand and high water supply, and it later recovers the water by pumping when demand exceeds surface supply.[327] In an alluvial aquifer, recharge for ASR occurs when water is allowed to seep into underlying aquifer. For confined aquifers, ASR uses wells to inject the water at pressures greater than what exists in the aquifer. Several water providers have used Colorado's Denver Basin Bedrock aquifers for the storage of water over the past several decades. The Denver Basin aquifers are confined bedrock aquifers, and they are not considered tributary to the stream system. The water in these aquifers is appropriated under a separate legal framework based on overlying land ownership. Additionally, specific rules govern ASR projects utilizing these Denver Basin aquifers. Although the majority of ASR projects use the Denver Basin aquifers, two ongoing ASR projects in Colorado involve the use of alluvial aquifers. These are Aurora's Prairie Waters project in the South Platte basin, and Cherokee Metropolitan District's aquifer replacement plan in the Upper Black Squirrel Basin.

Collaborative Management Solutions

These sort of projects and methods frequently cross basin boundaries, and comprise multiple parties working together to achieve often-disparate goals. Section 9.2 highlights several solutions in which entities representing many uses come together for creative water management. Examples include the CRCA, the Arkansas River Voluntary Flow Agreement, and the WISE Partnership. In these solutions, creative collaboration and the involvement of many stakeholders throughout the entire agreement process meet a host of different needs.

ATMs

For much of Colorado's water history, the agricultural water user has been faced with two options: continue operations as normal, or sell water rights to an interested party—often a municipality seeking to firm-up supply. Seeking potential alternatives to agricultural transfer, interested parties seek to provide a third option that falls within the boundaries of Colorado's prior appropriation system.

Though the CWCB and other stakeholders are still reviewing the viability of certain types of alternative transfers, ATMs should offer an avenue by which Colorado seeks to meet future needs, in contrast to the permanent "buy-and-dry" of agricultural lands. Section 6.4 discusses ATMs in more detail.

6.5.1 BIP IDENTIFIED MUNICIPAL, INDUSTRIAL, AND AGRICULTURAL INFRASTRUCTURE PROJECTS AND METHODS

The types of projects and methods basins could potentially implement are as varied as the needs in each basin, as well as statewide needs. While projects and methods generally fall into two generic categories (structural and non-structural), this overview of the BIPs warrants a more specific categorization. These summaries will present tallies of projects by type and use, even though many projects may have multiple benefits.

SWSI 2010 identified several categories of IPPs, which have been consolidated into the following:

- Agricultural water transfers (including ATMs)
- Reuse of existing fully consumable supplies
- Growth into existing supplies
- In-basin projects
- New transbasin projects.[328]

The majority of projects the roundtables identified fall into the category of "In-Basin Projects." For the purposes of this summary, in-basin projects could align with the following descriptions:

- Collaborative Management
- Storage Improvements & Expansion
- New Storage
- Ditch & Diversion Improvements
- Monitoring, Assessment, and Planning Efforts
- Municipal Infrastructure
- Energy
- ASR
- Water Rights and Supply
- Multipurpose

This section examines each BIP's "primary message," which summarizes the prioritized projects and describes how the projects or methods align with basin goals and measurable outcomes. This section also describes the process each basin used to garner public input, which demonstrates how basins generated project lists. Finally, this section describes highlights of the projects and methods, and identifies the acre-feet of development and costs, when available.

In the basin summaries, material in the BIPs identifies project costs and associated, identified acre-feet. Each basin conducted outreach and assimilated and evaluated projects in a manner that is unique to the respective basin. As the basin roundtables further refine the BIPs and projects and methods move to implementation, they will better define project information, costs, and associated acre-feet.

Arkansas Basin

Primary message: The basin roundtable identified additional storage as a primary goal of the implementation plan. Roundtable members believe preservation of existing storage is critical to continuing to meet the basin's supply needs for all uses, along with development of new storage. New storage can include reoperation of existing structures in need of repair, along with underground storage (ASR). Additional methods the basin roundtable identified include ASR projects and alternatives to ATMs. Moving forward, the roundtable plans to focus efforts on a disaggregation of the basin gaps to identify more localized needs at the county level. The roundtable will also take a closer look at identified projects and methods to prioritize available funding and resources. In project implementation, the roundtable identified compact compliance issues as a key challenge. The replacement of nonrenewable groundwater and sustainability of designated basins also represents a critical gap.[329]

ARKANSAS BASIN AT A GLANCE

120 projects identified on the IPP List that meet municipal, industrial, or agricultural needs

$344,700,000 in costs identified for **4** projects

166,500 acre-feet of development identified for **17** projects

Process: The roundtable reviewed the SWSI 2010 IPP list, and held 17 public outreach meetings at which stakeholders submitted more than 100 input forms.[330] These forms proposed projects, methods, and potential policy implementation. The roundtable will review and rank these input forms, and will invite some proponents to attend roundtable meetings and present the identified project, method, or suggestion. As part of the roundtable's organization of basin needs, projects, and methods, the group created a comprehensive database. The roundtable categorized projects that met a basin need as follows within the database:

- All Input List: all identified needs from all sources.
- Preliminary Needs List: filtered to remove complete or obsolete needs.
- Master Needs List: The provider of each need on the Preliminary Needs List was asked to identify a Solution and a Plan of Action to implement a solution for the identified need. All needs with a defined Solution and Plan of Action carried forward onto the Master Needs List. Projects on the Master Needs List were located by latitude and longitude for later mapping.
- IPP List: Needs on the Master Needs List were compared to the criteria for an IPP per the SWSI 2016 draft glossary. Needs on the Master Needs List that met the SWSI 2016 IPP criteria are included in the IPP List.

While projects and methods included in the "All Input List" may include obsolete or completed projects, the IPP list is designed to meet SWSI criteria for an IPP.

Projects and methods summary: The roundtable identified a total of 120 projects and methods on the IPP List that meet municipal, industrial, or agricultural needs.[331] Of these projects, 17 identify acre-feet, totaling 166,500 acre-feet of development.

Colorado Basin

Primary message: The Colorado Basin Roundtable is focused on completing a basin-wide stream management plan. The plan will contain more in-depth analysis and understanding of the amounts of water necessary to maintain environmental and recreational attributes. The roundtable expressed concern about uncertainty regarding current water supplies' capacity to meet in-basin consumptive use, as well as environmental and recreational needs, for future projects and methods. The basin emphasized the need for more in-depth studies and work about the effects of climate change on water supplies, and the variability of wet and dry years. The roundtable stated: "The most prudent planning approach… is to assume that there is no more water to develop for export from the Colorado Basin."[332] The extensive public outreach the basin undertook resulted in a comprehensive list of potential identified projects and methods. This list comprises a suite of options the basin can pursue to meet its future needs.

COLORADO BASIN AT A GLANCE

31 projects identified as Top Projects that meet municipal, industrial, or agricultural needs

$500,000 - $152,500,000 in costs identified for **13** projects

24,082 acre-feet of development identified for **3 top** projects

Process: The roundtable members divided into Project Leadership Teams (PLTs), which focused on particular subject matter areas within the BIP. The consumptive PLT worked to identify projects within the basin that would meet future water supply needs. The PLT interviewed water providers, either in-person or through a standardized questionnaire, throughout the basin. These information-gathering efforts focused on existing and forecasted supply, as well as on projects and methods to meet demands. The PLT also analyzed existing studies and reports for planned projects. The basin held town hall meetings, and roundtable members and consultants traveled to many meetings, including county commission and city council meetings, to gather information. Roundtable members took a closer look at the list of projects and methods, and then identified representative projects in each basin sub-region that met basin themes and sub-region goals. These projects were designated as "Top Projects" and represent important needs at both the basin-wide and sub-region levels.

Projects and methods summary: The roundtable identified a total of five basin-wide Top Projects and methods,[333] and 26 Top Projects by sub-region. It identified all 26 sub-region projects as multipurpose. Beyond the identified Top Projects, the BIP Exhibits lists additional projects and methods the public-input and targeted technical-outreach process generated.

Basin Top Projects were evaluated by basin goals:

- 21 Top Projects were identified that meet the basin goal of "Sustain Agriculture."
- 23 Top Projects were identified that meet the basin goal of "Secure Safe Drinking Water."[334]

Future basin efforts will focus on implementation of identified projects and methods. Modeling efforts are underway to further understand potential constraints and opportunities within the river system.

Gunnison Basin

Primary message: The primary goal of the Gunnison Basin is to "Protect existing uses in the Gunnison Basin."[335] With that overarching goal in mind, the basin is pursuing other goals that promote the continued importance of agriculture, the protection of environmental and recreational uses, and the maintenance of infrastructure within the basin. A primary focus is on agricultural shortages, and methods to address this need. The basin identifies and prioritizes projects and methods accordingly.

GUNNISON BASIN AT A GLANCE

49 projects identified on the Tier 1 list that meet municipal, industrial, or agricultural needs

$478,107,269 in costs identified for **33** projects

139,406 acre-feet of development identified for **21** projects

The roundtable quantified M&I needs, which it currently expects the basin to meet using currently existing supplies and implementing currently planned projects and methods. The roundtable modeled projects and potential constraints to evaluate the potential effects of project or method implementation on supply and water rights. This modeling effort provided a cursory feasibility analysis for projects at a basin-wide scale, taking into account water availability, irrigation decrees, agricultural effects on streamflows, and instream flows. The roundtable evaluated and divided into tiers the projects and methods the basin identified.

Process: Working with water management agencies and stakeholders to identify projects and methods intended to meet future basin needs, the roundtable members and consultants conducted a series of targeted technical outreach meetings throughout the basin. They created a list of current projects intended to represent the state of water planning at the time of BIP publication. The outreach process identified projects that the roundtable compared to the basin goals, and evaluated according to their timeline for completion. With these comparisons and evaluations in mind, the BIP committee approved three "tiers" of identified projects and methods:

- **Tier 1:** implementation likely feasible by 2025; project does excellent job of meeting Basin Goals.
- **Tier 2:** implementation likely not feasible by 2025; project would excel at meeting Basin Goals. Project may also have important conditional water rights and/or completed planning efforts.
- **Tier 3:** implementation likely not feasible by 2025; project in preliminary stages of planning and/or may meet Basin Goals to lesser degree.[336]

Modeling analyses also informed the tiering process, leading to the identification of projects and methods with multipurpose uses, and the selection of agricultural projects that most effectively address shortages. As stated, the project list is intended to be a "snapshot" of current planning efforts. Future updates and additions to the BIP may affect current prioritization or offer updated information about projects and methods.[337] Future studies may also affect prioritization as the roundtable updates and refines supplies, demands, or processes.

The roundtable created "Project Summary Sheets" in which it analyzed the Tier 1 projects and methods. These sheets provide a more in-depth look at the projects and methods, featuring information such as project yield, sponsor, and details about ways in which the project meets basin goals. A table briefly outlines projects the roundtable classified as Tiers 2 or 3. The table also features inventory projects, which will further examine regional projects and methods.

Projects and methods summary: The roundtable identified a total of 49 Tier 1 projects and methods meeting municipal, industrial, or agricultural needs.[338] Tier 1 projects were rated by their ability to meet basin goals:

- All 49 Tier 1 projects meet the overarching basin goal of "Protect existing water uses in the Gunnison Basin."
- 40 projects and methods seek to specifically "Improve agricultural water supplies to reduce shortages."
- 9 projects meet the basin goal of "Identify and address municipal and industrial water shortages."[339]

A great number of the Gunnison roundtable's identified projects have an agricultural benefit, as one would expect in this largely agricultural area.

North Platte Basin

Primary message: The basin goals the North Platte Basin Roundtable established are intended to maintain historical water uses within the basin, as well as provide a look forward at the future of development. Chief concerns in this particular basin are the equitable apportionment decree and the depletion allowance of the Three State Agreement.[340] Agricultural needs related to shortages, as well as infrastructural storage and water delivery concerns, are paramount. The roundtable created a list of "potential basin solutions," to include both structural projects and methods for water management.

NORTH PLATTE BASIN AT A GLANCE

52 total projects identified that meet municipal, industrial, or agricultural needs.

14 projects analyzed in summary sheets

12,197 acres of new irrigation for **9** projects

11,993 acre-feet of development identified for **5 projects**

Process: Similar to the Gunnison Basin roundtable, identification of projects, and a comparison of those projects to the basin goals, drove the North Platte process. The roundtable conducted targeted technical outreach to water managers and other stakeholders. The basin performed modeling analyses to identify challenges to implementation and to examine the effects of specific projects. As the roundtable reviewed projects, it highlighted potential multiple use projects, and called out potential water availability constraints. With the focus on agricultural needs, the roundtable conducted a shortage analysis to identify projects and methods that most effectively addressed shortages.

The roundtable prioritized the list of solutions by conformity with the basin goals, as well as in accordance with the timeline for potential implementation. It selected some projects that will receive additional analysis in the form of a project summary sheet, for these reasons:

- The project, and associated analysis herein, is representative of other projects on the list, such as the case with the Proposed Willow Creek Reservoir and the Hanson and Wattenberg Ditch Acreage;
- Implementation of the project is currently being pursued, such as the case with the Protocols and MacFarlane Reservoir; or
- Implementation of the project is potentially more feasible than projects on the following list because of limited constraints or challenges or more support from the Basin Roundtable, as with the Canal Maintenance and Improvements project.[341]

The project summary sheets provide a more extensive analysis of project or method information, including such details as "project constraints, implementation strategies and how well the project meets the Basin Goals."[342]

Projects and methods summary: The roundtable identified a total of 52 projects and methods that meet municipal, industrial, or agricultural needs.[343] The 14 projects that received additional analysis were compared with the basin goals:

- 13 projects met the basin goal to "Maintain and maximize the consumptive use of water permitted in the Equitable Apportionment Decree and the baseline depletion allowance of the Three State Agreement."
- 7 projects specifically addressed the basin goal to "Continue to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies."
- 3 projects met the basin goal to "Increase economic development and diversification through strategic water use and development."[344]

The majority of the projects and methods identified serve an agricultural benefit. The most numerous of projects are agricultural improvements, and many of the new storage projects will require further study to enable the roundtable to refine acre-feet projections.

Rio Grande Basin

Primary message: The Rio Grande Basin Roundtable identified 14 different goals, with central tenets being "a resilient agricultural economy, watershed and ecosystem health, sustainable groundwater resources, the encouragement of projects with multiple benefits, and the preservation of recreational activities."[345] Additionally, the roundtable identified preservation of the agricultural economy, which represents 99 percent of the basin's water use, as an overarching goal. Through public outreach and the work of roundtable subcommittees, the roundtable identified projects that met basin goals. It identified as desirable those projects and methods that meet multiple benefits and uses, and that stand a greater chance of receiving funding. In future planning efforts, the roundtable plans to develop project-ranking criteria, and to continue identifying projects and methods that meet basin goals.

RIO GRANDE BASIN AT A GLANCE

61 projects identified that meet municipal, industrial, or agricultural needs

$129,754,895 in costs identified for **29** projects

6,030 acre-feet of development identified for **2** projects

Process: Through the subcommittee and stakeholder outreach process, the roundtable selected 29 projects that would receive a more in-depth analysis through project fact sheets.[346] These fact sheets provided more information about each project, and featured the sponsor, location, estimated project costs, and a comparison of the project outcomes with basin goals. The roundtable also generated a matrix that displayed each project, the needs it met, and the basin goals its implementation would meet. Twenty-five of these projects were site-specific, and had associated cost estimates through the year 2020.[347]

The roundtable identified 21 additional projects and methods for future consideration and discussion. The roundtable did not analyze these projects at the fact-sheet level due to time constraints and available information, but the roundtable believes these projects could be beneficial to meeting basin needs and goals. The basin intends that this plan will remain dynamic, and will add projects and methods as it identifies additional needs, methodologies, and focus areas.

Projects and methods summary: The roundtable identified a total of 61 projects and methods meeting municipal, industrial, or agricultural needs.[348] It evaluated the projects and methods by their ability to meet basin goals. Within the 29 projects the fact sheets evaluated:

- 14 projects meet the goal of "Operate, maintain, rehabilitate, and create necessary infrastructure to meet the Basin's long-term water needs, including storage."
- 14 projects and methods seek to "Manage water use to sustain optimal agricultural economy throughout the Basin's communities."

- 24 projects and methods are identified as multi purpose, meeting the basin goal to "Support the development of projects and methods that have multiple benefits for agricultural, municipal and industrial, and environmental and recreational water needs."

South Platte Basin (Including Metro)

Primary message: The South Platte and Metro Basin Roundtables worked together on a joint BIP and sought water supply solutions that were "pragmatic, balanced, and consistent with Colorado water law and property rights."[349] The BIP emphasized multipurpose projects and specifically identified the following three objectives. "Projects and methods should be configured to meet multipurpose objectives that balance:

a. Consumptive with environmental and recreational needs;

b. Surface and groundwater utilization and storage; and

c. Current versus potential future needs and values."[350]

This BIP specifically referenced the "Four Legs of the Stool," a result of the IBCC's work that identifies four key tactics for meeting future water supply.

SOUTH PLATTE / METRO BASINS AT A GLANCE

63 projects identified that meet municipal, industrial, or agricultural needs

191,980 acre-feet of development identified for **23** projects

The South Platte/Metro Roundtable identified three categories of water development to meet future uses within the basin: 1) Water use efficiency improvements and water sharing strategies, including conservation, reuse, ATMs, and system integration; 2) Supply development involving new storage and conveyance systems and investigating, preserving, and developing Colorado River options; and 3) Watershed health and water quality management.[351] The roundtable examined both larger-scale concepts, such as TMDs, and smaller-scale projects and methods, such as storage and reuse projects. Project concepts the joint BIP identified are primarily geared toward meeting municipal, industrial, and agricultural needs. The BIP further divided these concepts into project categories such as reuse, agricultural transfers, ASR, and TMDs.

Process: Like some other basins, the South Platte/Metro joint effort began with the IPP list the SWSI 2010 process identified. The basin roundtable interviewed potential project sponsors (water conservancy districts, municipalities, and counties) via project summary sheets to gather basin project information, such as sponsor and estimated cost. The Metro Roundtable's executive committee and the South Platte's Rio Chato committee reviewed the project summary sheets gathered through the outreach process. Both roundtables then reviewed the projects and methods in full to consider them for inclusion in the BIP. Additionally, the roundtables considered three conceptual projects that were intended to demonstrate a collaborative approach to meeting basin needs moving forward.

Projects and methods summary: The basin roundtables identified a total of 63 projects and methods meeting municipal, industrial, or agricultural needs:[352]

- 13 projects identified as Reuse IPPs
- 8 Agricultural Transfer IPPs
- 17 In-Basin IPPs
- 5 Transbasin IPPs

Southwest Basin

Primary message: The Southwest Basin takes the approach that all needs should be viewed equally, be they agricultural, municipal, industrial, environmental, or recreational. The roundtable adopted 21 goals and 31 measurable outcomes in its BIP, with a focus on water supply needs.[353] Since SWSI 2010, the roundtable has identified the completion of 55 projects within the basin. Through the basin's outreach process, which it conducted in support of the BIP, the basin added more than 80 new projects to the list, totaling 164 IPPs. Of these identified projects and methods, "agricultural IPPs make up about 19 percent of the total IPPs on the list to date. Municipal and industrial IPPs make up about 29 percent of the total IPPs on the list to date."[354] The BIP serves as a living document that provides guidance for basin water supply planning, while continuing to refine projects, methods, and goals as needs evolve.

SOUTHWEST BASIN AT A GLANCE

117 projects identified that meet municipal, industrial, or agricultural needs

$60,000,000 in costs identified for **1** project

30,354 acre-feet of development identified for **8** projects

Process: The basin identified themes, goals, and measurable outcomes that are geared toward identifying and meeting water supply gaps. Themes B and C directly address the matter: "B) Maintain Agriculture Water Needs, C) Meet M&I Water Needs."[355] With these overarching themes in mind, the roundtable conducted outreach across the basin. In that outreach, it contacted water managers and other stakeholders to identify potential new projects and methods that had developed since SWSI 2010. Roundtable members and consultants also conducted public workshops members to inform the public about the BIP and Colorado's Water Plan process, and to elicit information about potential projects or methods. The listing of projects in the BIP began with the SWSI 2010 identified projects, and then roundtable members and consultants contacted potential project proponents to gather information in the form of a questionnaire. The roundtable vetted the project questionnaires, and adopted projects or methods by including them in the BIP.

Projects and methods summary: The roundtable identified a total of 117 projects and methods meeting municipal, industrial, or agricultural needs.[356] The BIP highlights some specific IPPs that meet basin goals and measurable outcomes, and that demonstrate the types of projects and methods the basin has planned:

- 8 multi-purpose, cooperative, and regional projects and processes such as renewable energy partnerships, water conservation and management plans, and optimization studies
- 5 potential IPPs related to hydropower
- 7 agricultural infrastructure improvements

The Southwest Basin Roundtable will continue to evaluate projects and methods. Additional refinement of project information will provide more detail about cost estimates and new acre-feet.

Yampa/White/Green Basin

Primary message: In the Yampa/White/Green BIP, the roundtable focused on two main concepts with regard to implementation of projects and methods for municipal, industrial, and agricultural uses. First, the roundtable sought to provide sufficient supply of "local water resources for existing uses and future development."[357] It also identified the need for implementation of projects and methods that are "appropriately located, sized, and operated…to protect important water uses and the environment."[358] The roundtable discussed the importance of the Colorado River Compact, and the need to keep compact concerns in mind when planning for the implementation of projects and methods. With these overarching themes in mind, the roundtable adopted eight primary basin goals, with chief concerns around meeting existing and anticipated future uses within the basin.

YAMPA/WHITE/GREEN BASIN AT A GLANCE

27 projects identified that meet municipal, industrial, or agricultural needs

$4,950,000 in costs identified for **3** projects

317,316 acre-feet of development identified for **12** projects

In consultation with basin water managers and other stakeholders, the roundtable developed a list of projects and processes. The roundtable intends the list to remain dynamic; it will update it as basin needs, the understanding of river operations, and potential project proponents are updated and refined. The projects and processes the roundtable identified stem from information basin studies provided. These include SWSI 2020 and the 2014 Project and Method Study, which the roundtable funded. The roundtable identified 21 projects as having met basin goals, and as being appropriate for implementation. The majority of the projects identified are new storage projects; implementation has met municipal, industrial, and agricultural needs.

TABLE 6.5.1-1	NO-AND-LOW-REGRETS ACTION PLAN SUMMARY TO HAVE A HIGH SUCCESS RATE FOR IDENTIFIED PROJECTS AND PROCESSES
COMPLETED, EXISTING, AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Make policy recommendations in support of IPP implementation through the 2010 "Letter to the Governors" • Establish the "Collaborative Approach to Water Supply Permit Evaluation" group to improve communication among state and federal agencies about permitting issues • Support key IPPs (e.g., the Chatfield Reallocation Project, WISE, CRCA. • Coordinate the DNR's responses to IPPs through the DNR Executive Director's Office • Provide technical and financial support to project proponents through WSRA grants	1. Support Local Implementation of IPPs a. Provide technical and financial support, including facilitation, to BIPs b. Support the conversion of single-purpose IPPs into multipurpose IPPs when a project proponent requests it c. Streamline state-permitting processes for IPPs that meet values of the CWP d. Continue state coordination with the federal permitting entities e. Encourage cooperative projects through BIPs f. Support local permitting authorities to identify, as requested, multipurpose components up front in project planning to incorporate county and local concerns 2. Update Tracking and Data Collection via the Basin Needs Decision Support System a. Support basin roundtables in providing updated IPP data as part of their BIPs b. Track and analyze effects of IPPs on the projected water supply gap 3. Optimize Funding Sources for IPPs a. Assess funding needs b. Target existing funding sources towards IPPs c. Identify new funding sources for IPPs 4. Generate Political Support for IPPs a. Facilitate and encourage regular, active communication about IPPs between the CWCB, the IBCC, and the basin roundtables b. Upon a project proponent's request, convene a facilitated dialogue among stakeholders, project proponents, and state agency representatives if there is disagreement about a proposed project or process c. Conduct outreach and education about IPPs and the state water-planning process d. Develop an approach for determining whether a project meets the values of the CWP and has broad stakeholder support e. Upon a project proponent's request, encourage legislative resolutions in support of IPPs that meet the values of the CWP f. Publicly advocate for IPPs that meet the values of the CWP and have stakeholder support

Process: Throughout the basin, the roundtable undertook a public outreach process to engage stakeholders and gather input about the BIP and Colorado's Water Plan. The roundtable updated projects and processes identified through SWSI 2010, and the 2014 P&M Study identified the most up-to-date project information.[359] With the basin goals in mind, the roundtable gathered information from project proponents and stakeholders. It distributed surveys throughout the basin at public information meetings or via individual BIP committee member contact. These surveys were intended to identify projects the SWSI and the P&M Study did not include.

Projects and methods summary: The BIP identified a total of 27 projects and methods meeting municipal, industrial, or agricultural needs.[360] Some representative projects and methods presented in the BIP are as follows:

- 9 projects identifying potential new storage sites
- 2 irrigation improvement projects
- 2 reservoir improvements or expansion

Ongoing studies in the basin will inform additional acre-feet yield, and project proponents can develop project costs during the permitting and financing stages.

IBCC No-and-Low-Regrets Identified Projects and Processes Actions

In 2014, the IBCC developed the No-and-Low-Regrets Action Plan to have a high success rate for identified projects and processes, and to implement and assess storage and other infrastructure. These strategies outline the minimum level of effort required regarding these topics on a statewide basis.

Table 6.5.1-1 explores potential future actions the IBCC agreed could generate a high success rate for identified projects and processes. Statewide, the No-and-Low-Regrets Action Plan indicates that on average, basins stakeholders need to implement 80 percent of the yield—equivalent to 350,000 acre-feet— identified in these projects. The BIP and Colorado's Water Plan processes are already addressing many of the IBCC's requests.

6.5.2 AGRICULTURAL VIABILITY

Governor Hickenlooper's executive order directed the CWCB to incorporate "a productive economy that supports vibrant and sustainable cities, viable and productive agriculture, and a robust skiing, recreation, and tourism industry" as key values Colorado's Water Plan is intended to reflect.[361] In every BIP, the roundtables identified the importance of agriculture as an economic driver and an overall community benefit to the basin landscapes. In discussing agricultural viability, the path forward is complicated; to some extent, hydrology, commodity prices, and federal programming dictate the landscape to farmers and ranchers.

Colorado's Water Plan sets an objective that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production. Though irrigated acreage has declined by 338,000 acres statewide, agricultural productivity has increased.

The following table shows an estimate of irrigated lands that have been taken out of production in Colorado over the past several decades. Although the CWCB made an attempt to present agricultural statistics from the USDA, the unreliable nature of the data and the mix of available data through the years made estimates loose at best. Instead, the CWCB used CDSS GIS data gathered during the various DSS projects statewide. Estimates were derived by determining which parcels from past datasets were no longer catalogued in the CWCB's "master" parcel files of irrigable lands for each division. The exception to this was Division 3, where the 1998 dataset (which had greatest total lands) was compared to 2012 (which had the lowest total lands). It should be noted that the CWCB has not determined permanent loss of agricultural lands due to urbanization or permanent dry-up; such a determination would require a more laborious process.

Also included is a chart (Figure 6.5.2-1, page 6-139) of total irrigated lands for the state, as reported by the USDA Census of Agriculture.

In order to meet the objective to maintain agricultural economic productivity, innovation and technological improvements will be integral to future agricultural water management. As the CWCB advances future funding initiatives and technical support, support for viable agriculture will remain a key consideration. Section 9.2 more thoroughly explores the role of future funding for agriculture. Potential long-term funding sources for agricultural viability could support the following endeavors:

- Exploring conservation easements for irrigation water.
- Developing incentives to keep water in irrigated agriculture, in addition to developing alternative methods for urban transfer.
- Upgrading irrigation and diversion systems.
- Purchasing water rights specifically to create an "agricultural water bank" for water sharing.
- Providing adequate staff resources to manage and coordinate an Agricultural Water Program.

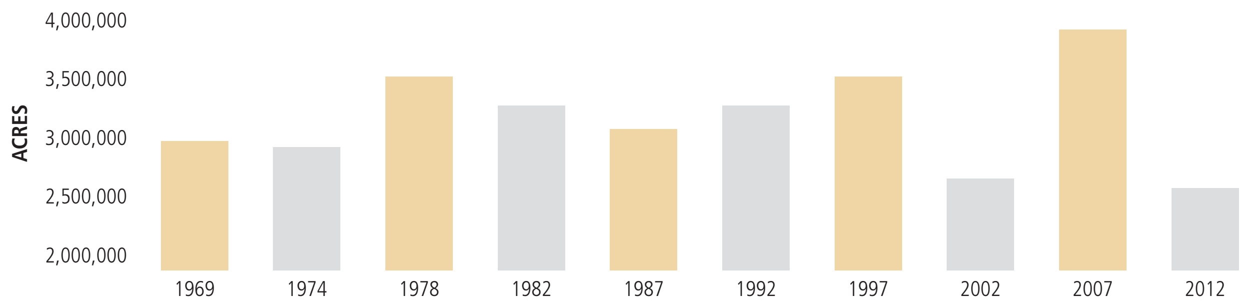
TABLE 6.5.2-1 IRRIGATED LANDS TAKEN OUT OF PRODUCTION

	Div 1	Div 2**	Div 3*	Div 4	Div 5	Div 6	Div 7
No longer Irrigated	136,760	115,630	13,882	13,573	38,476	7,359	13,140
Total irrigated lands in Div	998,214	~	585,457	311,659	235,240	116,380	205,645
% of total	13.7%		2.4%	4.4%	16.4%	6.3%	6.4%

**Permanent dry-up acres from Div 2 staff

*See note above

FIGURE 6.5.2-1 STATEWIDE IRRIGATED ACRES



The basin roundtables proposed solutions, stakeholders submitted comments to the CWCB, and the IBCC convened a subcommittee with the express purpose of exploring policies and concepts—with a goal to maintain viable agriculture in light of future water supply-and-demand challenges. The roundtables summarized these initiatives with the acknowledgement that agricultural viability is an ongoing matter that will require greater study, collaboration, and action items moving forward.

Basin Implementation Plans and Agricultural Viability

Arkansas Basin

In its BIP, the Arkansas Basin Roundtable proposes an economic measure of agricultural benefit. Members of the roundtable worked with a team from Colorado State University to establish a baseline for agricultural production at $1.5 billion annually.[362] Given the constraints of water management within the Arkansas Basin, including the Arkansas River Compact, the roundtable seeks to maintain or increase this baseline by identifying and implementing sources of augmentation water, supporting the development of leasing/fallowing programming within the basin, and further exploring the nexus between agricultural and environmental and recreational uses.[363]

> "The preservation of irrigated agriculture in the Arkansas Basin shall be given a high priority in the state water plan. It is too important to tourism, the preservation of food production, recreation, the environment and the health and well-being of our citizens as well as the economy of the State of Colorado to be ignored."
>
> — *Arkansas BIP*

Colorado Basin

In assessing the future of agriculture in the Colorado Basin, the roundtable first articulated concerns regarding development of a new TMD from the Colorado main-stem, citing existing diversions and the effect that further development could have on the agricultural economy.[364] The roundtable prioritized agriculture in one of six basin themes, and established the following guiding principles for the Colorado BIP: "Sustain, Protect, and Promote Agriculture." The BIP cites the importance of return flows to other economic drivers in the basin, such as recreation and tourism, and points to the 100,000 acre-feet in shortages the SWSI 2010 estimated.[365] The roundtable identified four goals to support this basin theme:

- Reduce agricultural water shortages
- Minimize potential for transfer of agricultural water rights to municipal uses (within private property rights)
- Develop incentives to support agricultural production
- Increase education among the agricultural community about Colorado River Basin water issues

The BIP articulates in greater detail measureable outcomes, short-term needs, long-term needs, and projects and methods in support of each goal.[366]

Gunnison Basin

Under the umbrella goal of "Protect existing water uses in the Gunnison Basin," the Gunnison roundtable also identified three basin goals centered on agricultural viability:

- Discourage the conversion of productive agricultural land to all other uses within the context of private property rights.
- Improve agricultural water rights to reduce shortages.
- Describe and encourage the beneficial relationship between agricultural and environmental recreational water uses.

> "Traditional agricultural water uses not only provide direct economic benefits but also help to drive the recreational economy by preserving the beautiful landscape enjoyed by the Basin's inhabitants and visitors."
>
> — *Gunnison BIP*

In the inventory of projects and methods, the Gunnison Roundtable identified projects that specifically seek to advance these three basin goals.[367] The roundtable discussed each goal in detail, proposed a process to achieve each goal, and defined a measurable outcome that often included a quantifiable target. For example, in discussions about the first bulleted basin goal, the roundtable hopes to achieve the following measurable outcome: "Preserve the current baseline of about 183,000 protected acres in the Gunnison Basin and expand the participation in conservation easements by 5 percent by 2030 through programs like the Gunnison Ranchland Conservation Legacy."[368] The roundtable also includes implementation goals, which may include a number of projects it will develop in accordance with a certain benchmark, or the completion of a study to assess infrastructural needs. The BIP further explores specific processes and measurable outcomes.

North Platte Basin

The North Platte Basin Roundtable identified in its BIP agricultural shortages and issues related to infrastructure as priority needs, along with concerns regarding long-term implications of the equitable apportionment decree.[369] Similar to the Gunnison BIP, one basin goal in the North Platte seeks to "describe and quantify the nonconsumptive benefits of agricultural use."[370] Moving forward, the roundtable hopes to complete further study of this relationship by quantifying the benefits and their overall effect on water management within the basin. Measurably, the roundtable seeks to complete at least two multipurpose projects in the basin meeting multiple needs.[371] The BIP identifies four specific projects by directly addressing this multipurpose-projects goal.

The roundtable also described shortages in the basin and the causes of these shortages, which fall into three categories: physical, legal, and irrigation-practice related.[372] Other basin goals seek to resolve identified issues with water availability under the decree, and address issues related to aging or non-functional infrastructure. Detailed project information is available for projects that address agricultural needs for multipurpose benefits.

Rio Grande Basin

The Rio Grande BIP begins by recognizing the importance of agriculture to the basin economy. Agriculture accounts for approximately 99 percent of the basin's water use.[373] The challenges inherent in compliance with the Rio Grande Compact and the basin's Well Rules and Regulations make viability of agricultural production a major concern for basin stakeholders. Twelve of the 14 basin goals include an agricultural consideration, ranging from compliance with legal mechanisms to optimal management of agricultural and environmental water uses.[374]

The BIP discusses the role of innovations in agriculture, and examines the future roles of strategic crop development and irrigation improvements as potential water management strategies.[375] Additionally, the BIP includes a summary of current approaches within the basin to improve soil health as a component of improved water management as it relates to agricultural production.[376] The roundtable took a closer look at 29 projects and methods identified to meet future needs within the basin. Of those 29 projects, 24 meet identified agricultural needs.[377] Beyond the projects and methods the project sheets explored in further detail, the BIP identifies 18 additional projects and methods with an agricultural nexus. These range from specific improvements, to agricultural infrastructure, to an "Alternative Cropping Education and Promotion Program."[378]

South Platte Basin (Including Metro)

> "The importance of agricultural production in the South Platte and Republican River Basins should not be overlooked. It is a major factor in the State's economy and includes processing of food and livestock from the entire state."
>
> — *South Platte BIP*

In proposing strategies to meet the projected water supply gap in the South Platte and Metro Basins, the roundtables set guidelines recognizing the importance of agriculture to the basin economy, and encouraging multipurpose projects with a minimal effect on agricultural uses.[379] In planning for the future of water within the basin, the roundtable set a basin goal to "Minimize traditional agricultural "buy and dry" and maximize use of ATMs to extent practical and reliable."[380] Specific recommendations for achieving this goal include further support of water-sharing methods and improvements to the water court process, with an acknowledgement of the importance of vested rights to water-rights holders.

The BIP discusses the benefits and challenges associated with the implementation of ATM projects, and identifies some lessons learned from previous and ongoing ATM projects within the basin. The roundtables also provided some strategies at the local level to minimize agricultural dry-up, such as switching to cool-weather crops, deficit irrigation, and dry-year leasing. The BIP emphasizes continuation of state pilot programs for water sharing, as well as collaborative solutions such as the coupling of agricultural easements with municipal lease options.[381]

Southwest Basin

Similar to other western slope basins, the Southwest Basin expresses concerns about the Colorado River Compact, and the influence future development of Colorado River supplies may have on basin agriculture, given downstream obligations. To that end, the roundtable proposed that proponents of a new TMD, or water providers that are utilizing agricultural dry-up to meet demands, should meet a 70:30 ratio of inside-to-outside use of municipal water by 2030.[382] In assembling the BIP, the roundtable identified 21 goals, three of which specifically address the theme of "Meet Agricultural Needs."[383] In addition to the proposed municipal-use ratio, the roundtable recommended implementation of ATM and efficiency projects, strategies to discourage permanent dry-up, and the implementation of at least 10 agricultural water efficiency projects identified as IPPs by 2050.[384]

The Southwest BIP also presents the challenges inherent in achieving these measurable outcomes, such as potential opposition to a statewide conservation ratio, and the difficulties in ATM implementation under water-rights administration within the basin.[385] In compiling the Southwest BIP, the roundtable conducted extensive outreach to update the IPP list. Of the total IPPs listed, agricultural projects and methods total about 19 percent, while 17 percent are multipurpose and may have an agricultural component.[386]

Yampa/White/Green Basin

The Yampa/White/Green Basin Roundtable identified eight goals, two of which specifically mention agricultural uses of water:

- Protect and encourage agricultural uses of water in the Yampa/White/Green Basin within the context of private property rights.
- Improve agricultural water supplies to increase irrigated land and reduce shortages.[387]

In looking to the future of the basin, the roundtable undertook a modeling exercise that demonstrated agricultural shortages under a baseline scenario, and substantial shortages under a dry-future scenario.[388] The roundtable projected the addition of up to 14,805 irrigated acres within the basin. As a result of the exercise, roundtable members determined their priority to be the identification of timing and location of shortages. In the context of private property rights, the BIP proposes potential cooperative programs to reduce shortages, while encouraging multipurpose projects with a benefit to agricultural uses.[389] With this closer study of shortages, and the encouragement of policies and programming to benefit agriculture, the roundtable has identified some quantifiable outcomes:

- Preserve the current baseline of approximately 119,000 irrigated acres and expand by 12 percent by 2030.
- Reduce agricultural shortages basin-wide by 10 percent by the year 2030.[390]

Additionally, the roundtable identified several processes related to improving agricultural infrastructure. These processes involve collaboration and more in-depth analysis of potential for improvements, taking into account the effects on other water uses.

BIPs and Agriculture Summary

The roundtables are exemplary in their detailed accounting of projects and methods, with the goal of achieving agricultural viability. In their BIPs, they establish and inventory these projects and methods at the grassroots level, incorporating policy suggestions from the stakeholders who are actively involved at the local basin level. Local stakeholders, water managers, and water users know what sorts of practices are actionable, and what will work in their area. Moving beyond an acknowledgement of the importance of agriculture to the economy and communities, the roundtables make a series of bold steps toward actionable and measurable strategies that seek to maintain the viability of agriculture across the basins. The IBCC Agricultural Viability Actions and Strategies section summarizes work occurring at the IBCC level, and highlights policies and strategies that have statewide applicability. The roundtables strive to measurably and meaningfully encourage the viability of agriculture around the state through a series of action items, and they also take a broader approach by seeking actions that may provide a benefit.

Effects of Agricultural Dry-Up

As basin roundtables and stakeholders statewide seek to identify projects and methods that promote agricultural viability, a greater understanding of the relationship between irrigated agriculture and the surrounding communities and ecosystems should be encouraged. Governor Hickenlooper's executive order and the work of the IBCC and CWCB support creative alternatives to traditional "buy-and-dry," while respecting the private property rights involved.

Return flows must be maintained in the case of an agricultural water rights transfer. However, reduction in use of an agricultural irrigation water right may still result in impacts on wetlands associated with agricultural dry-up, the loss of open space and wildlife habitat, and to local businesses and economies that depend on agricultural industry within a community.

These sorts of impacts merit further exploration, but not in a way that affects private property rights, increases uncertainty, or unduly burdens water users seeking to enter into a transaction. As with other action items in Colorado's Water Plan, the purpose of this effort should not be to increase red tape or create regulatory hoops, but foster a greater understanding of the role of viable agriculture in local communities, given the water supply challenges identified in other chapters and sections of this plan.

Moving forward, the CWCB should provide technical work and financial support of grassroots efforts to clarify the effects of transfers and to understand the relationship between irrigated agriculture and the surrounding communities and ecosystems. Entities in the Arkansas and Yampa/White/Green have applied for WSRA funds in this vein, and the IBCC Agricultural Viability subcommittee has suggested a potential "Framework for evaluations of agricultural transfers," described below. Such efforts should strive to include potential proponents of a water use change, as well as community members who would potentially be affected. These efforts would ideally lead to a greater understanding between members of the community regarding the effects of transfers.

IBCC Agricultural Viability Actions and Strategies

To inform the ongoing statewide discussion about agricultural viability, the IBCC assembled a subcommittee in 2015. The intent of the subcommittee was to propose specific concepts and strategies to attain the IBCC's support and achieve potential short-term implementation. The committee presented to the IBCC draft concepts for discussion, and the IBCC approved the pursuit of further work and implementation of those action items. Moving forward, the CWCB's members and staff will work with stakeholders and other interested parties to implement these action items, while recognizing the challenges and opportunities each presents. The following summary briefly describes each of the IBCC concepts.

Agricultural viability long-term goal: The IBCC asked the subcommittee to craft a long-term goal that would be closely tied to continued, long-term viability for agricultural uses, and to reflect the broad need to educate Coloradans about the importance of agriculture. Ideally, the goal should be measurable.

Program to facilitate agricultural opportunities: The state needs to provide additional education and assistance to farmers and ranchers to help realize more transactions that allow for ATMs, and to enable new Colorado farmers to successfully enter the agricultural industry. This assistance may include financial and other support for land links, land trusts, and conservation easements that protect working farmland and make irrigated land affordable for the next generation of farmers and ranchers. The program should include education on and assistance with the following:

- Deals, contracts, and other options for sharing agricultural water.
- Strategies to remain market competitive.
- Ways to achieve long-term certainty for both water lessors and lessees.
- ATMs that allow the farmer to continue owning the land.
- Opportunities to overcome entry barriers for young growers (in collaboration with such entities as Land Link, Farm Bureau's Young Farmer Group, and Colorado State University Extension).
- Perpetual agricultural agreements, such as conservation easements (such as those demonstrated by entities like the Lower Arkansas Valley Water Conservancy District).
- Other similar contractual agreements that allow for more long-term flexibility (an example is the purchase of water rights in the Arkansas Basin by Aurora Water).
- Funding opportunities for agricultural producers.

Proponents need to create the program's scope of work, goals, geographic range, and responsibilities, as well as measurements for success. Because many aspects of the program relate to agreements between municipalities and agricultural producers, program sponsors should involve both sectors in the development of the program and solicit their continued input.

Enforcement of minimum standard for water-rights applications: The court should be diligent in enforcing the minimum water-rights application requirements, which are already in existence, and should standardize these requirements statewide. Better guidance should be provided and advertised for applicants who do not have legal counsel or engineering consultants.

Incentives to reduce urbanization and fragmentation of agricultural lands: Colorado's Water Plan should indicate that current land-use incentives it describes would also help to keep agricultural lands in production. The CWCB should review these incentives to determine whether more incentives will be needed to further encourage local governments and land owners to reduce fragmentation and urbanization of agricultural lands. The CWCB's intent is that the incentives will provide additional options, but not infringe upon private property rights.

Addressing barriers to keeping agricultural land and water ownership when water sharing: Members of the IBCC will work with BRTs to apply for a multi-basin WSRA grant in order to compile ATM data, identify areas that will encourage irrigators to enter agreements, analyze barriers (beyond law review), and bring in municipalities' perspectives to understand both buyers' and sellers' viewpoints. CWCB will develop next steps once it has compiled and reviewed this data.

Framework for evaluations of agricultural transfers: More transparency with regard to agricultural transfer transactions is needed to help agriculture producers and the general public understand the effects of agricultural transfers to agriculture, the local community, and the environment. An evaluation of agricultural transfers could help, but several concerns and details that would need to be determined. An evaluation of agricultural transfers could encroach on private property rights, stall operations, and create a permitting hurdle, thereby functioning like an environmental impact statement (EIS). The end goal of such an evaluation would not be to create another hurdle in the permitting or water court process, but to provide transparency for the cumulative effects of such a transfer. Other remaining details to determine include the party responsible for conducting the evaluation, the evaluation's end goal, the evaluation's effect on agricultural viability, and timing of such an evaluation in the water-rights transaction process. The CWCB will host a stakeholder group comprising landowner and water provider participants to develop a framework for an evaluation of agricultural transfers to determine whether such a framework is appropriate from a technical, legal, and policy perspective.

Agricultural-to-agriculture, -environment, or -industry sharing pilot: In 2015 Governor Hickenlooper signed Senate Bill 198 into law, allowing pilot projects to share water among agricultural entities and industrial or nonconsumptive uses. To implement this program, the CWCB should encourage a pilot project to test the concept, and should educate ditch companies about this opportunity. Some ditch companies may need to change their bylaws to allow for water sharing.

Updates and improvements to Colorado's aging infrastructure: For many agriculture producers, building new storage and other infrastructure, and updating aging infrastructure, is too expensive and difficult due to the myriad regulations, permits, and costs. Storage both benefits and supports all uses and all sectors. Therefore, the CWCB encourages additional work to improve the permitting, system, water administration review, court system, and law, as well as work to increase funding for aging infrastructure and identified agricultural projects.

Regulations that increase costs for growers, and how to modify them: The agricultural community needs relief from increased government regulations across sectors. Stakeholders must address these mounting regulations as one of agriculture's top priority issues for the future, especially when encouraging young agriculturalists to continue farming.

Additional recommendations: The IBCC discussed the need for two additional points that focus on funding agricultural infrastructure and agricultural IPPs. The latter recommendation will support agricultural and municipal IPPs that reduce reliance on agricultural dry-up.

ROBERT T. SAKATA

SOUTH PLATTE RIVER BASIN

Robert is a vegetable farmer in Brighton and served on the Water Quality Control Commission, Metro Roundtable, and several other boards where he's demonstrated leadership statewide in the agriculture and water community. Robert is pictured on his farm.

One of my favorite quotes is from Albert Einstein who said, "We cannot solve our problems with the same thinking we used when we created them." And yet change is never easy. But I will need to change the way that I farm if I'm going to stay in business. Everybody is going to have to change the way we think about water in the world we live in. The Colorado Water Plan can be a first step. It outlines the parameters of how water administration works, it states the need, and it develops a basic action plan…but to carry out the outlined actions will require the state to provide the leadership to facilitate and minimize...

CONTINUED AT END OF CHAPTER

PROFILE

6.5.3 STORAGE

The implementation of projects and methods with a storage component will play a crucial role in meeting Colorado's water supply needs. Basin roundtables have identified storage as an important element of the BIPs, and have highlighted the necessity for storage through basin goals and measurable outcomes, or identified specific projects and methods with a storage component, as discussed in the BIP summaries above. Additionally, the IBCC has called attention to the future role of storage through the No-and-Low Regrets Action Plan, as summarized in Table 6.5.3-1 (page 6-152).

These types of projects and methods are identified in every BIP, which point out the many benefits that can be realized from new or reoperated storage projects. In establishing goals and measurable outcomes for the BIPs, basin roundtables universally expressed a preference for multipurpose storage projects moving forward. These projects can potentially meet multiple needs and serve multiple beneficiaries. This more inclusive model of collaboration in project planning may lead to more diverse funding models for project financing, and reduce hurdles to project implementation by working with a diverse set of users.

While new storage projects will certainly play a role in meeting the state's water needs, the enlargement and rehabilitation of existing dams and reservoirs will provide more options for the path forward, as Chapter 4 discussed. Additionally, options for storage in alluvial and bedrock aquifers provide another solution to supply challenges.

Colorado's Water Plan sets a measurable objective of attaining 400,000 acre-feet of water storage in order to manage and share conserved water and the yield of IPPs by 2050. This objective equates to an 80 percent success rate for these planned projects.

Extreme weather events and conditions such as those in 2013 and 2015 have precipitated discussion statewide and at the basin roundtable level regarding the benefits of storage for an array of purposes. Storage vessels can meet a variety of needs beyond water conservation, including but not limited to:

- **Flood Control:** In spring 2015, a "Miracle May" of late season snow and rain fell statewide, bringing Colorado's various regions out of drought classifications. Chatfield Reservoir south of Denver was one of many storage projects used statewide to control flows, which avoided property damage and unsafe river conditions.
- **Compact Compliance:** In recent years, discussions among Upper Basin states have focused on drought contingency planning, as discussed in Chapter 2. Upper Basin reservoirs have been key to the discussion of reoperation, with the intent of keeping levels in Lake Powell above minimum power pool. Reservoirs that could conceptually be used in a drought contingency planning reoperation strategy include Flaming Gorge, Navajo, and the Aspinall Unit. Reservoirs are also critical to meeting compliance with compact obligations; and example is the role of John Martin Reservoir with respect to the Arkansas River Compact.

- **Drought Mitigation:** The Soil Conservation Service (now the NRCS) and the Colorado DWR originally developed the Surface Water Supply Index. The purpose of the index is to describe drought severity in regions where water availability is driven by winter snow accumulation and subsequent melt. The index is comprised of four elements: snowpack, streamflow, precipitation, and reservoir storage. As a part of state and local planning and mitigation for drought, the inclusion of reservoir storage in this tool demonstrates the importance of this resource for water managers and resource officials around the state.[391] As climate change affects supplies, storage vessels also afford more flexibility to water managers planning for associated effects.
- **Crop Protection**: The Division 2 office of the DWR administers the Winter Water Storage Program, and the Southeastern Colorado Water Conservancy District coordinates it. This program allows agricultural users on the Arkansas River to store flows, which had historically been diverted onto their lands during the winter, in Pueblo Reservoir. With this reservoir in place, the stored water can be released during the irrigation season, allowing for better water usage by the farming and ranching communities in the Lower Arkansas Valley.[392]
- **Minimizing Buy and Dry:** The Southern Water Supply Project operated by Northern Colorado Water Conservancy District (NCWCD) provides water from Carter Lake to several northeastern Colorado communities. Rapidly growing communities such as Broomfield, Louisville, and Superior are project beneficiaries. These communities needed a year-round water supply, and the ability to contract with NCWCD for this water provided a solution, without needing to purchase agricultural water rights and converting these to municipal use.[393]
- **Ecosystem Health:** In August 2015, the CWCB entered into an agreement with the Ute Water Conservancy District to supplement flows in the Colorado River with water stored in Ruedi Reservoir. This agreement allows the CWCB to lease between 6,000 and 12,000 acre-feet of water for instream flow use on the "15-Mile Reach" of the river, which provides critical spawning habitat for endangered fish species.[394]
- **Environmental and Recreational Enhancements:** In 2012, 2013, and 2015, the Colorado Water Trust entered into an agreement with multiple partners to boost summer flows in the Yampa River upstream of Steamboat Springs by releasing water from Stagecoach Reservoir. This purchase of water from the Upper Yampa Water Conservancy District augments stream health and provides recreational opportunities in this area.[395]

BIPs and the Role of Storage

Every BIP addresses the role of storage within the roundtable's planning horizon. Addressing storage is accomplished in two different ways statewide: through the establishment of goals or measurable outcomes that relate to the future of storage within the basin, or through the identification of proposed projects and methods with a storage component. Some basin roundtables established a policy-based goal by stating the importance of storage to future needs within the basin and listing roundtable action items as a means to further such a goal. Other roundtables set a numerical measurable outcome by establishing a benchmark of new storage (in acre-feet) to be achieved by a certain time. Roundtables that chose to list proposed projects and methods within the basin boundaries included specific information, such as project proponents, estimated project yield, or timeline for project completion. Below is a summary of each BIP, specifically outlining how each roundtable addressed the matter of storage.

Arkansas Basin

The Arkansas Basin Roundtable identified three broad themes to guide the Arkansas BIP. The first theme directly addresses storage:

- *Increased water storage and preservation of existing water storage capacity is critical to all solutions.*[396]

This theme is echoed in a series of "Storage Goals," which the basin roundtable developed based on input basin stakeholders provided during the BIP public outreach process. These storage goals include a numerical acre-feet goal to be accomplished by 2020, and three goals that are action items the basin roundtable and basin stakeholders to implement. These three action items reflect the general sentiment statewide, emphasizing the importance of multipurpose projects and the exploration of a variety of storage options:

1. *Increase surface storage available within the basin by 70,000 acre-feet (AF) by the year 2020;*
2. *Develop alluvial and designated storage in gap areas within the basin;*
3. *Support multiple uses at existing and new storage facilities; and*
4. *Identify storage facilities that can be renovated, restored, or enhanced for additional storage.*[397]

The roundtable also identified a set of specific actions needed to accomplish these goals. It explored potential rehabilitation of nonfederal reservoirs, and listed action items such as implementation of IPPs and funding plans.

Colorado Basin

The Colorado Basin Roundtable discussed storage chiefly in two different sections of the BIP: storage as identified through the public input process, and the role of storage in meeting identified basinwide themes. The roundtable undertook an ambitious public outreach and input process for the BIP, and that led to the development of six major basin themes. While conservation was the most frequently advocated solution for meeting future water supply gaps, respondents also discussed increased water storage.

The roundtable also identified basin goals that correspond to the six basinwide themes. It mentioned storage as part of several action items in support of basin themes. For example:

- ***Basin Goal:*** *Develop a basinwide funding system to meet basin environmental and recreational needs.*
  - ***Long Term Needs:*** *Evaluate future storage projects in-basin and the potential impacts to nonconsumptive values.*[398]
- ***Basin Goal:*** *Reduce agricultural water shortages.*
  - ***Measurable Outcomes:*** *Identify multipurpose storage projects and methods that address the annual 100,000 acre-feet agricultural shortage.*
  - ***Short Term Needs:*** *Expand the storage capacity in existing reservoirs.*[399]
- ***Basin Goal:*** *Secure growing water demand by developing in-basin supplies and expanding raw water storage supply.*[400]
- ***Basin Goal:*** *Expand regional cooperation efforts to improve efficiency, provide water supply flexibility, and enhance environmental and recreational amenities.*
  - ***Long Term Needs:*** *Expand scope of smaller water providers to proceed on needed water storage projects as multi-beneficial projects.*[401]

Lake San Cristobal near Lake City is the second largest natural lake in Colorado.

The goals and actions the basin roundtable identified are consistent with statewide themes: addressing multiple beneficiaries through implementation of multipurpose projects and exploring multiple types of storage projects including new storage and rehabilitation of existing projects. The roundtable also discussed the role of storage across the different regions of the basin; it identified storage as a solution to regional concerns, and identified specific proposed projects as a solution to water supply concerns by region.

Gunnison Basin

The Gunnison Basin Roundtable identified a set of basin goals and a set of statewide principles. In discussion of these goals and principles, the roundtable identified storage in established processes as a way to achieve basin goals, and as a measurable outcome for implementation. As a result of conversations with water providers and proponents within the basin, the roundtable also compiled an extensive list of proposed projects, methods, and basin needs. Many of these specifically identified projects and methods include a storage component.

The primary goal the roundtable identified is to "Protect existing water uses in the Gunnison Basin."[402] Complementary basin goals seek to improve water supplies to reduce municipal, industrial, and agricultural shortages. In proposed processes to achieve these goals, the roundtable identified a common action item:

- *Recommend potential solutions in collaboration with local water users. Recommendations could include an initial analysis of hydrology (water variability), cost, financing, and permitting. Such projects could include new storage, water right exchanges, efficiency measures, operational optimization, etc.*[403]

The roundtable also identifies the benefits of projects and methods that meet multiple objectives. Basin measurable outcomes also directly address implementation of multi-purpose storage projects, geared to exploration of the beneficial relationship between agricultural and environmental and recreational water uses:

- *Complete at least five new multi-purpose water projects, including two storage projects, in the Gunnison Basin by 2025 that demonstrate the beneficial relationship between agricultural, environmental, and recreational uses.*
- *Explore and develop recommendations on alternative sources of funding from recreational users within the Basin to support development of those multi-purpose water projects.*[404]

Similar to the Colorado Basin Roundtable, the Gunnison Roundtable identified situations in which storage is a part of the solution to regional water supply challenges, and highlighted the role of storage in addressing environmental and recreational needs.

North Platte Basin

The North Platte Basin Roundtable also focused on the role of storage in meeting identified basin goals, most noticeably through measurable outcomes. The BIP focuses on maximizing the beneficial water use in the North Platte Basin within the limitations of the Equitable Apportionment Decree and the Three State Agreement.[405] The roundtable proposed an action item to meet this goal, with a storage component:

- *Recommend potential solutions in collaboration with local water users. Recommendations should include an initial analysis of hydrology (water availability), cost, financing, and permitting. Solutions will include storage and supplemental supplies (e.g. augmentation plans) to mitigate late season shortages.*[406]

The roundtable identified three measureable outcomes associated with this basin goal, which include development of projects and methods, as well as a numerical acre-feet goal for storage:

- *Develop three projects from the list of recommended solutions by 2020.*
- *Incrementally bring up to 17,000 additional acres under irrigation by 2050.*
- *Develop 37,000 AF of additional storage (doubling of current storage) by 2050.*[407]

Projects the basin roundtable identified include an array of solutions including "both structural solutions such as reservoirs and irrigation ditches, and nonstructural solutions such as protocols for the Colorado Division of Water Resources (storage, irrigated acreage, irrigation season)."[408] The list of proposed projects, methods, and actions the roundtable provided include a compilation of project summaries, some of which include a storage component.

Rio Grande Basin

The Rio Grande Compact affects the implementation of storage within the basin, limiting storage potential in post-Compact reservoirs. The Rio Grande Basin Roundtable identified a series of basin goals, some of which directly involve the development of storage, and also highlight the importance to the roundtable of multipurpose projects and methods:

- *Operate, maintain, rehabilitate, and create necessary infrastructure to meet the Basin's long-term water needs, including storage.*
- *Support the development of projects and methods that have multiple benefits for agricultural, municipal and industrial, and environmental and recreational water needs.*[409]

The Rio Grande BIP discussed a multi-pronged approach to storage concerns, including the rehabilitation of existing reservoirs, augmentation of water sources, and acquisition of storage or recharge necessary to replace well pumping depletions.[410] Aquifer sustainability is a primary concern within this basin, and the roundtable described declining levels of aquifer storage as a major need to be addressed with projects and methods within the BIP. The basin roundtable identified 29 primary projects and methods which are examined in further detail in Project Fact Sheets. Of those 29 projects, 14 address the first basin goal relating to storage, and 24 address the basin goal relating to the implementation of multipurpose projects.[411]

South Platte Basin (Including Metro)

The South Platte and Metro Roundtables collaborated on this BIP, which emphasizes the importance and benefits of multipurpose projects, and advocates for balanced approaches to the implementation of storage projects. In the list of elements needed to address South Platte water supply challenges, the roundtables emphasize the role storage must play in meeting current and future needs through this specific action:

- *Promote multi-purpose storage projects that enhance other South Platte basin solutions.*

The roundtables established a list of "South Platte Solutions" which seek to provide the water needed for current and future uses. The solutions are categorized into three groups, one of which addresses storage:

- *Supply development involving new storage and conveyance systems and investigating, preserving, and developing Colorado River options.*

With regard to this solution, the roundtables developed two goals that directly address the implementation and development of storage. These goals are supported by associated measurable outcomes, noted below.

- ***IPP Implementation***
  - ***Goal:*** *Bring a high percentage of entries in the updated IPP list on-line as a key strategy consistent with the "no/low regrets" scenario planning approach.*
  - ***Measurable Outcome:*** *Maximize implementation of the updated IPP list.*
  - ***Environmental and Recreational Measurable Outcome:*** *Encourage multi-purpose projects that also provide environmental and recreational considerations.*
  - ***Environmental and Recreational Measurable Outcome:*** Foster opportunities to improve environment and recreation conditions of affected watersheds in association with IPPs.
- ***South Platte Storage and Other Infrastructure***
  - ***Goal:*** *To the extent possible, develop multipurpose storage, conveyance, system interconnections and other infrastructure projects to take advantage of limited remaining South Platte supplies and enhance water use efficiencies and supply reliability.*
  - ***Measurable Outcome:*** *Explore opportunities to maximize yield from additional South Platte Basin strategic and multipurpose storage and other infrastructure including collaborative inter-connections between water supply systems and including both above ground and groundwater (e.g. ASR and alluvial recharge) storage.*
  - ***Environmental and Recreational Measurable Outcome:*** *Encourage multipurpose projects that provide environmental and recreational considerations.*
  - ***Environmental and Recreational Measurable Outcome:*** *Take into consideration environmental and recreational attributes when considering Storage and Other Infrastructure projects and methods.*

These themes, goals, and measurable outcomes reflect the ongoing statewide discussion regarding storage. The roundtable emphasized multipurpose projects and the implementation of varied storage options, including implementation of new projects, maximization of yield from existing projects, and the incorporation of ASR and alluvial storage strategies.

Southwest Basin

In its BIP, the Southwest Basin Roundtable established seven primary themes, and 21 total goals to address those themes. The roundtable also identified 31 measurable outcomes, many of which relate to the implementation of IPPs that may have a storage component. The Southwest Roundtable also expressed support for multipurpose projects "when possible and when they can be accomplished in a manner that is protective of the values present."[412]

The first theme identified by the roundtable is "Balance all Needs and Reduce Conflict" is, with the following goals and measurable outcomes related to the implementation of IPPs:

- ***Goal:*** *Pursue a high success rate for identified specific and unique IPPs to meet identified gaps and to address all water needs and values.*
- ***Goal:*** *Support specific and unique new IPPs important to maintaining the quality of life in this region, and to address multiple purposes including municipal, industrial, environmental, recreational, agricultural, risk management, and compact compliance needs.*
- ***Goal:*** *Implement multi-purpose IPPs (including the creative management of existing facilities and the development of new storage as needed).*

These goals address identified gaps by seeking IPP implementation, with a focus on projects that serve multiple purposes and multiple uses. Measurable outcomes for the basin also focus on a quantified goal for implementation:

- ***Measurable Outcome:*** *Complete 27 multipurpose IPPs to meet identified gaps.*
- ***Measurable Outcome:*** *Complete 40 IPPs aimed at meeting municipal water needs.*

Through public and stakeholder outreach, the Southwest Basin Roundtable also compiled a list of projects and methods, many of which feature a storage component. The BIP details some of these projects, and provides project information and the water supply needs they will address.

Yampa/White/Green Basin

The Yampa/White/Green Basin Roundtable begins by addressing the relative underdevelopment of the basin drainages in as comparison to other basins within the state. Storage in the Yampa/White/Green area is limited, and the majority of existing storage serves current municipal and industrial needs.[413]

The roundtable adopted eight goals and associated measurable outcomes to meet current and future YWG Basin needs. Two of those goals directly address the role of storage within the basin:

- *Restore, maintain, and modernize water storage and distribution infrastructure.*
- *Develop an integrated system of water use, storage, administration and delivery to reduce water shortages and meet environmental and recreational needs.*[414]

The roundtable established a series of processes to accomplish these two goals, and outlined measurable outcomes as benchmarks for each goal moving forward. Processes include identification of basin infrastructure that requires improvement or replacement, identification of potential locations for small scale water storage projects, and opportunities for collaborative partnerships for improvements with multiple benefits.[415] Given the existing and proposed storage options within the basin, the roundtable also plans to complete modeling to evaluate storage operations and explore contracting possibilities. Basin measurable outcomes with a potential storage component include:

- *Implement at least one project every year in the YWG Basin focusing on the restoration, maintenance, and modernization of existing water infrastructure.*
- *Administration and infrastructure improvements making decreed amounts of water available to diversion structures with less need for seasonal gravel dams in the river.*[416]

The Yampa/White/Green Roundtable also compiled a summary of current IPPs, several of which have a storage component. IPPs are identified by location, proponent, and primary purpose of project, though consideration is given to potential multiple benefits and to uses of each project or method.[417]

TABLE 6.5.3-1 NO-AND-LOW-REGRETS ACTION PLAN SUMMARY TO IMPLEMENT AND ASSESS STORAGE AND OTHER INFRASTRUCTURE

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Identify needed storage	1. Manage and Develop Strategic Storage and Infrastructure a. Identify storage and other infrastructure opportunities through BIPs b. Manage and improve storage and infrastructure to effectively use conserved water c. Prepare for uncertainty in hydrology and climate change d. Explore and implement ASR e. Explore and implement storage and other infrastructure to support meeting Colorado's compact obligations 2. Identify and Prioritize Multipurpose Storage and Infrastructure Opportunities a. Manage and improve storage, infrastructure, and reservoir operations to benefit environmental and recreational values b. Support basin roundtables in identifying feasible multipurpose projects c. Prioritize implementation of multipurpose projects that meet values of the Colorado Water Plan d. Identify partners for permitting, funding, and constructing multipurpose projects e. Manage and improve storage, infrastructure, and reservoir operations to benefit agriculture f. Manage and improve storage, infrastructure, and reservoir operations to benefit M&I uses g. Manage and improve storage, infrastructure, and reservoir operations to support hydropower production 3. Analyze Infrastructure Needs for Storage of ATM water a. Analyze existing storage and infrastructure for opportunities to increase exchange capacity b. Develop water-quality treatment infrastructure c. Manage and improve agricultural storage and infrastructure, including support of single-purpose projects as needed

IBCC No-and-Low-Regrets Storage Actions and Strategies

The IBCC has defined storage and other infrastructure as a critical cross-cutting topic. Storage can help water users maximize supplies by re-timing water availability. This allows users to capitalize on average and wet years, and may increase the possibility of sharing water resources when possible. Storage and infrastructure are also important for minimizing agricultural losses, maximizing the use of conservation and reuse savings, and allowing for additional new supplies. In addition, storage can play a critical role in supporting the environment, particularly in support of endangered- and threatened-species recovery programs. Moreover, storage is an important element in protecting Colorado's interstate water rights, pursuant to the State's compacts and equitable apportionment decrees.

As Colorado plans for its water future and looks ahead to a projected 2050 supply gap, it will need new storage and infrastructure to share, transfer, store, and convey water for the benefit of all. Additionally, the State should explore new opportunities for existing storage and infrastructure to provide maximum utilization for all purposes and to ensure compact compliance.

STORAGE GOALS AT A GLANCE

The **IBCC No-and-Low-Regrets Action Plan** identifies a goal of **80 percent yield** of IPP implementation.

This equates to **70,000 acre feet** of additional yield per year for the western slope and **280,000 acre-feet** of additional yield per year for the eastern slope.

This goal is based on implementation of IPPs as enumerated in SWSI 2010 and **does not include** additional projects and methods identified by roundtables during the BIP process.

While this section discusses new storage, it is not meant to include storage that would increase transbasin diversions. Therefore, this section does not include concerns related to new-supply development.

6.5.4 MAINTENANCE OF EXISTING PROJECTS AND METHODS

New projects and methods will be critical to Colorado's ability to meet its water supply needs. However, existing infrastructure and currently operational projects and methods require maintenance and upkeep, which are equally important to bringing new methods online. In evaluating funding mechanisms for future projects, many proponents will include operations and maintenance costs within the proposed budget. Many federal projects include maintenance costs in repayment contracts, or associate costs with power revenues. Many municipal projects pass maintenance costs on to the ratepayer. Funding mechanisms through entities such as the CWCB, as Section 9.2 discusses, are available for costs associated with maintenance, repair, and improvements.

Every BIP includes goals to modernize water infrastructure or improve agricultural efficiencies. Through the BIP process, many basins also identified operations, maintenance, and improvements as part of their plan for future needs. For example, 10 of the North Platte Basin's projects identified ditch and diversion improvements as their primary benefit. In these agriculturally focused basins, improvements to conveyance systems will be of high importance when planning for future needs.[418] The Gunnison Basin Roundtable classified 22 projects as storage improvements and expansion—which either maintain existing reservoirs or plan for more storage.[419] Similarly, the Colorado Basin listed many projects associated with storage expansion, as well as plans for improving or updating existing municipal infrastructure.[420] In this manner, the basins are preparing for new projects and methods while maintaining the existing supply systems.

Working on ultraviolet oxidation reactors at the Peter D. Binney Purification Facility. The reactors help remove substances such as pharmaceuticals and personal care products, part of the multibarrier treatment process used before water reaches Aurora residents. Courtesy of Havey Productions.

ACTIONS

Colorado's Water Plan sets a 2050 measurable objective to attain 400,000 acre-feet of innovative storage in order to manage and share conserved water and the yield of IPPs. This objective equates to an 80 percent success rate for these planned projects, as stated in the IBCC's No-and-Low Regrets Portfolio.

While the right to buy or sell private property water rights must not be infringed upon, the State will encourage innovation and creativity by agricultural producers and research institutions to maximize the productivity of every drop of water. Colorado's Water Plan sets an objective that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production.

To support projects and methods that meet future municipal, industrial, and agricultural needs, several next-steps are necessary.

1. **BIP project support:** The CWCB will continue to support and assist the basin roundtables in moving forward the municipal, industrial, and agricultural projects and methods they identified in their BIPs. It will accomplish this through technical, financial, and facilitation support when a project proponent requests it.

2. **Climate change incorporation:** The CWCB will work with the basin roundtables and, upon request, work with project proponents, to incorporate the potential effects of climate change on municipal, industrial, and agricultural projects and methods.

3. **Expansion of projects to be multipurpose:** The CWCB will prioritize funding to the basin roundtables to support an integrated approach to understanding the ways in which environmental and recreational projects and methods may interact with municipal, agricultural, and industrial projects and methods. As part of this task, basin roundtables will work with local stakeholders and project proponents to explore multipurpose projects and convert existing and planned single-purpose projects and methods into those that are multipurpose.

4. **Project tracking:** In partnership with the basin roundtables, the CWCB will continue to track municipal, industrial, and agricultural projects and methods.

5. **Project support:** The CWCB will continue to support and implement State programs that contribute to implementing municipal, industrial, and agricultural projects and methods. These include loan and grant programs, as well as ongoing studies, such as the SWSI.

6. **Project funding:** As Section 9.2 discusses, the CWCB will work with partners to strengthen funding opportunities for municipal, industrial, and agricultural projects and methods by:

   a. Coordinating current funding

   b. Assessing funding needs

   c. Exploring additional funding opportunities

7. **Storage opportunity assessment:** As part of the next version of SWSI, the CWCB will work with the DWR and local partners to assess storage opportunities to determine where existing storage can and should be expanded, where it is needed to prepare for climate change, where it can help to better improve sharing and use of conserved water, and where it can help meet Colorado's compact obligations. Furthermore, the CWCB will provide financial support to technical and practical innovations in the use of aquifer storage and recharge where it is practicable.

8. **Multipurpose project funding:** The CWCB will prioritize support for multipurpose projects and those that modernize, make more efficient, or lead to the building of new critical infrastructure for agriculture purposes, M&I uses, and hydropower production. Section 9.2 explores these programs.

9. **Permitting:** As Section 9.4 discusses, the CWCB will refine the permitting process to make it more effective and efficient.

10. **Technical and financial support of efforts to understand impacts to agricultural viability:** The CWCB and IBCC will work with stakeholders to provide grassroots-level support for efforts that foster a greater understanding of the effects of reductions in agricultural use on communities.
11. **Facilitation of agricultural opportunities:** The CWCB and the CDA will establish an education and assistance program for farmers and ranchers to help realize more transactions that allow for ATMs, and to enable new Colorado farmers to successfully enter the agricultural industry. This assistance may include financial and other support for land links, land trusts, and conservation easements that protect working farmland and make irrigated land affordable for the next generation of farmers and ranchers. The CWCB will need to create the program's scope of work, goals, geographic range, and responsibilities, in addition to measurements for success. Because many aspects of the program relate to agreements between municipalities and agricultural producers, the CWCB should involve both sectors in the development of the program, and should provide continued input.
12. **Enforcement of minimum standard for water-rights applications:** The court should be diligent in enforcing the minimum water-rights application requirements, which are already in existence, and should standardize these requirements statewide. Better guidance for applicants who do not have legal counsel or engineering consultants should be provided and advertised.
13. **Framework for evaluations of agricultural transfers:** The CWCB will develop a technical and legal framework for an evaluation of agricultural transfers before considering the requirement of such an evaluation. To help produce such a framework, the CWCB will host a stakeholder group, which will include local government, agricultural producers, municipalities, water providers, landowners, and environmental interests.
14. **Update and improve Colorado's aging agricultural infrastructure:** Over the next five years, the CWCB will work with the basin roundtables and agricultural partners to further identify and prioritize aging infrastructure projects, especially where there can be a large effect on or multiple benefits to other sectors. The CWCB will coordinate funding opportunities to address these needs.
15. **Encourage ditch-wide and regional planning:** Over the next two years, the CWCB will work with agricultural partners to explore opportunities to conduct ditch-wide and regional planning, such as the planning that is occurring in the Uncompahgre. These plans will explore system-wide conservation and efficiency opportunities, explore the potential for water sharing, and develop a long-term infrastructure-maintenance and upgrade plan.

ENVIRONMENTAL AND RECREATIONAL PROJECTS AND METHODS

GOAL

The policy of the State of Colorado is to identify and implement environmental and recreational projects and methods to achieve the following statewide long-term goals:

- Promote restoration, recovery, sustainability, and resiliency of endangered, threatened, and imperiled aquatic- and riparian-dependent species and plant communities.
- Protect and enhance economic values to local and statewide economies that rely on environmental and recreational water uses, such as fishing, boating, waterfowl hunting, wildlife watching, camping, and hiking.
- Support the development of multipurpose projects and methods that benefit environmental and recreational water needs as well as water needs for communities or agriculture.
- Understand, protect, maintain, and improve conditions of streams, lakes, wetlands, and riparian areas to promote self-sustaining fisheries and functional riparian and wetland habitat to promote long-term sustainability and resiliency.
- Maintain watershed health by protecting or restoring watersheds that could affect critical infrastructure and/or environmental and recreational areas.

One cannot overstate the importance of Colorado's natural environment and recreational opportunities to its quality of life and to its economy. Outdoor recreation—including hunting, fishing, biking, hiking, skiing, golfing, wildlife watching, and many other types of outdoor activities—significantly contributes to Colorado's economy, and nonconsumptive water-based recreation is an important part of that economy. Healthy watersheds, rivers and streams, and wildlife are vital to maintaining Colorado's quality of life and a robust economy. Section 5 of Colorado's Water Plan contains more information about the economic benefits recreational activities provide to the state.

This section details the projects and methods by which Colorado has protected nonconsumptive, river-based environmental and recreational water needs in the past, as well as how the State may maintain these values in the future. To that end, this section will describe the benefits of such projects and methods, and will illustrate existing examples. The section contains several subparts: 1) An overview of existing tools for assessing environmental and recreational needs; 2) an account of knowledge gaps; 3) an overview of environmental and recreational statutes and recent legislation; and 4) a description of projects and methods the eight BIPs contain.

While water is vital to many types of recreational activities, including skiing and sports that require grassy areas, such as soccer, golf, and baseball, this section focuses on recreational uses of water in Colorado's streams and rivers, which roundtables define as primarily nonconsumptive. Section 5 of Colorado's Water Plan addresses the importance of recreational water needs that involve consumptive uses of water that are primarily associated with municipal or SSI uses (for example, irrigation of parks and golf courses and snowmaking).

Overview

Water is a crucial element in the maintenance of environmental and recreational values that are important to Coloradans. Adequate streamflows support the outstanding fisheries in the upper Arkansas River, rafting activities in Glenwood Canyon, snowmaking at world-class ski areas, and habitat maintenance for the water-dependent natural environment. A healthy environment depends upon good water quality, connectivity of streams, and robust instream and riparian habitats. Careful water management and dedication of significant resources have also led to progress toward recovering threatened and endangered species.[421]

Comprehensive water planning must include meeting environmental and recreational needs, in addition to meeting agricultural, municipal, and industrial needs. The IBCC's conceptual agreement supports this concept and states:

> "Colorado's Water Plan, BIPs, and stakeholder groups across the state should identify, secure funding for, and implement projects that help recover imperiled species and enhance ecological resiliency whether or not a new [TMD] is built. This could create conditions under which future projects may be possible. . . . These existing environmental and recreational gaps should be meaningfully addressed in the near term."[422]

Projects and methods that maintain or improve Colorado's environmental and recreational values, and that achieve long-term sustainability and environmental resiliency, are an important part of Colorado's water future. An ecosystem's resilience is a measure of its ability to absorb changes and return to similar levels after disturbance.[423] According to Principle 7 of the IBCC Draft Conceptual Agreement, resilience of a stream or watershed can be measured as an ecosystem's ability to recover functionality after an acute or chronic disturbance. Resilient river systems require seasonal flow fluctuations and provide complex and connected aquatic and riparian habitats in order to sustain stable, diverse, abundant, and reproducing populations of aquatic and riparian species.[424]

To determine resiliency levels, it is necessary to identify the baseline status of these characteristics and to monitor stream ecological functions and watershed processes on an ongoing basis.[425] o promote environmental resiliency, planned projects and methods should incorporate the potential stressors of drought and climate change, including decreased supply, changes in water temperature, and changes in runoff magnitude, duration, frequency, rate of change, and timing.[426]

The challenges environmental and recreational project proponents face in the future include learning how to make the most of limited funding opportunities.

JACKIE BROWN

YAMPA RIVER BASIN

Jackie is the Natural Resource Policy Advisor to Tri-State Generation and Transmission and has been a leader in environmental stewardship in the Yampa Valley and on the Yampa-White-Green Basin Roundtable. Jackie is pictured next to the Yampa River.

I am most proud of working on collaborations. Whether it is an improvement project, our Yampa White Green Basin Implementation Plan goals and measurable outcomes, or a slow compromise, collaboration is the key to our water future. My hope for the future is that we begin to realize how adaptable we actually are as humans and continue carefully researching our trade-offs. Long term, big picture planning is difficult in natural resources, but we cannot exhaust our supplies and resources prematurely nor can we pick every battle. Careful and thoughtful implementation is of the utmost importance. I commit to staying at the table, listening, learning and collaborating. When the Colorado Compact was negotiated, it was...

CONTINUED AT END OF CHAPTER

PROFILE

There is a host of nongovernmental proponents of environmental and recreational needs; however, funding opportunities are scarce when one compares them with existing programs for municipal, industrial, or agricultural uses.[427] In addition to strengthening existing and exploring additional funding opportunities for environmental and recreational projects and methods, strategic partnerships will play an important role. Those seeking to fund additional storage or a new diversion may find that working with a diverse group of stakeholders from the beginning will make the process more successful.

In their BIPs, the roundtables have identified new multipurpose projects or methods as desirable, and by working to associate a project with an environmental or recreational use, project proponents will garner support from a wider range of stakeholders. For example, if the proponent can associate a new storage project with a potential recreational opportunity, such as boating or fishing, the proponent can count on a greater range of advocates to support the project through permitting and financing. As another example, a proponent can include a project component that focuses on habitat or flow restoration to address environmental and recreational needs. Proponents can leverage restoration projects and methods, and coordination of water uses among water users, to address the effects of traditional consumptive water uses on water quality and habitat degradation. Such balanced approaches to meeting future water needs could accomplish multiple objectives.

Strategic cooperation on environmental and recreational projects and methods has proven to be a successful mechanism in the past, as Section 9.3 will examine and discuss. In planning for multipurpose projects or methods, proponents should take into account the watershed nature of projects and methods, and the manner by which they influence more than one particular stream reach.[428] With an eye toward serving multiple purposes, proponents may also consider a project or method that meets multiple environmental and recreational purposes in a reach where the project or method leads to the most beneficial outcome.

With multipurpose projects and methods in mind, it is important to note that many environmental and recreational attributes benefit from more traditional existing consumptive uses. Although municipal or agricultural projects can affect environmental and recreational interests, these uses can also provide benefits. A reservoir provides wildlife and fish habitat as well as recreational opportunities for visitors, and provides a mechanism for beneficial management of streamflows. Agricultural water uses also provide these types of benefits. Crop cultivation around the state provides habitat and open space for many species, and the agricultural tourism sector has boomed in Colorado: wineries and orchards are bringing visitors and development to agriculturally centered communities. While these direct benefits are obvious, agricultural diversions also offer some indirect benefits. Diversions that occur in the irrigation season come back to the stream in the form of return flows. These late-season return flows that occur in early fall provide a boost to streamflows that would otherwise not be present. These re-timed flows benefit riparian health and provide instream habitat.

Existing Environmental and Recreational Projects & Methods

Recognizing the value of a robust recreational economy and the obvious benefits of healthy ecosystems, Colorado has implemented programs and invested in projects to protect and improve these attributes. Below are some examples.

Colorado's Instream Flow and Natural Lake Level Program

In 1973, the Colorado Legislature recognized the need to "correlate the activities of mankind with some reasonable preservation of the natural environment" and passed Senate Bill 73-097, leading to the creation of the CWCB's Instream Flow and Natural Lake Level Program.[429] This program, one of the nation's first, vested the CWCB with exclusive authority to protect streamflow through a reach of a stream, rather than just at a point, and to protect levels in natural lakes. Before Colorado passed this law, all appropriations of water in the state were required to divert water from its natural course in the stream.[430] Senate Bill 73-097 removed the diversion requirement for the CWCB and allowed it to appropriate water instream between specific points on a stream, and for levels on natural lakes.[431]

Any person or entity may recommend streams and lakes for appropriation in order to preserve the natural environment. The law also requires CWCB to request recommendations from CPW, the U.S. Department of Agriculture, and the U.S. Department of the Interior.[432]

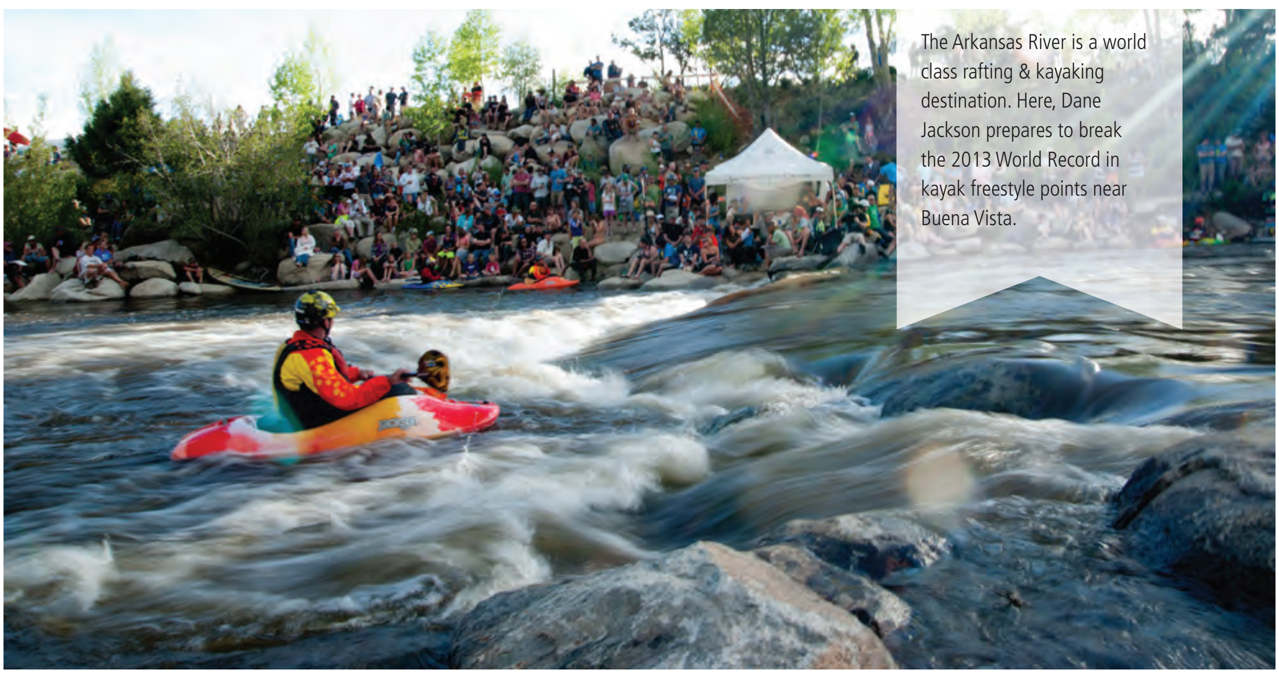
The CWCB uses a public notice and comment procedure to determine whether to appropriate instream flow water rights.[433] Before applying to water court for an instream flow water right, the CWCB must determine that: (1) There is a natural environment that can be preserved to a reasonable degree with the instream flow water right; (2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation; and (3) such environment can exist without material injury to water rights.[434] Once the water court decrees instream flow water rights, the DWR administers those rights through the State's water rights priority system, like it does with any other water right in the state. The CWCB has legal standing in water court to protect instream flow water rights from injury at any point within an instream flow reach.

The CWCB can also acquire water, water rights, and interests in water to preserve and improve the natural environment, on a permanent or temporary basis, from willing water rights owners. The acquisition process involves a biological analysis by CPW, the CWCB's consideration of several factors related to the transaction, and opportunity for public input.[435]

Since 1973, Colorado has appropriated instream flow water rights covering more than 9,200 miles of stream, and natural lake-level water rights on 480 natural lakes.[436] This protection represents approximately 23 percent of the perennial stream miles in the state.

Instream flow water rights appropriations: (1) Protect healthy native- and sport-fish populations, aquatic insects, and rare and distinctive riparian-vegetation communities; (2) achieve federal agencies' resource protection goals through a state-held water right; (3) are a key element of a management plan a diverse stakeholder group developed as an alternative to suitability for Wild and Scenic designation for three reaches of the Colorado River; and (4) provide numerous other benefits to Colorado citizens. Appendix C contains specific examples of instream flow water right appropriations. The CWCB has encouraged entities that recommend instream flow appropriations to focus on streams that provide habitat for threatened, endangered, and imperiled native species.

In 2002, the General Assembly passed Senate Bill 156, authorizing the CWCB to use acquired water to improve the natural environment to a reasonable degree.[437] The CWCB has completed 26 water acquisition transactions. These include acquisitions to protect critical habitat for endangered species on the Yampa River; improve the natural environment of the Blue River downstream from Dillon Reservoir; restore native flows to a degraded stream system near Silverton, Colorado; and re-water a historically dried-up stream near Crested Butte, Colorado.[438] Appendix C contains specific examples of water acquisitions for instream flow use.



The Arkansas River is a world class rafting & kayaking destination. Here, Dane Jackson prepares to break the 2013 World Record in kayak freestyle points near Buena Vista.

RICDs

Colorado is one of several states that authorize the appropriation of water rights for recreational boating purposes within a natural stream. However, Colorado is the only state that allows for the appropriation of water rights for recreational boating uses associated with man-made whitewater parks—specifically requiring structures in the stream that create recreational experiences. These water rights are known in Colorado as RICDs, and the holders of such rights can call water for recreational boating purposes when in priority. Depending on their location, the size and the magnitude of river flows called by some RICD water rights potentially restrict future upstream development potential, and may reduce the flexibility Colorado has in managing its water resources. Colorado law limits RICDs to the minimum streamflow necessary for a reasonable recreational experience, and RICD water rights holders must divert this water through a control structure, often a whitewater park itself.[439] Section 37-92-103(10.1), C.R.S. (2015) defines "reasonable recreation experience" as "the use of a recreational in-channel diversion for, and limited to, nonmotorized boating." Only a local governmental entity may apply for an RICD.[440] The statutes require that the CWCB must consider any water court application for an RICD after deliberation takes place in a public meeting to determine whether the proposed RICD will:

1. Promote the maximum beneficial use of waters of the state;
2. Not impair Colorado's ability to fully develop and use its compact entitlements; and
3. Not cause material injury to the CWCB's instream flow water rights.[441]

To ensure that a proposed RICD adequately meets these requirements, the CWCB has encouraged applicants to include specific provisions within their proposed water court decrees. These specific provisions have included concepts such as "carve-outs" and "no-call provisions." Examples of specific provisions of the CWCB's past findings of facts are available here.[442]

The CWCB then provides its findings to the water court for consideration. The water courts must also consider whether:

1. The water right sought is the minimum necessary for a reasonable recreational experience;
2. The RICD is accessible to the public; and
3. The RICD includes only that stream reach that is appropriate for the intended use.[443]

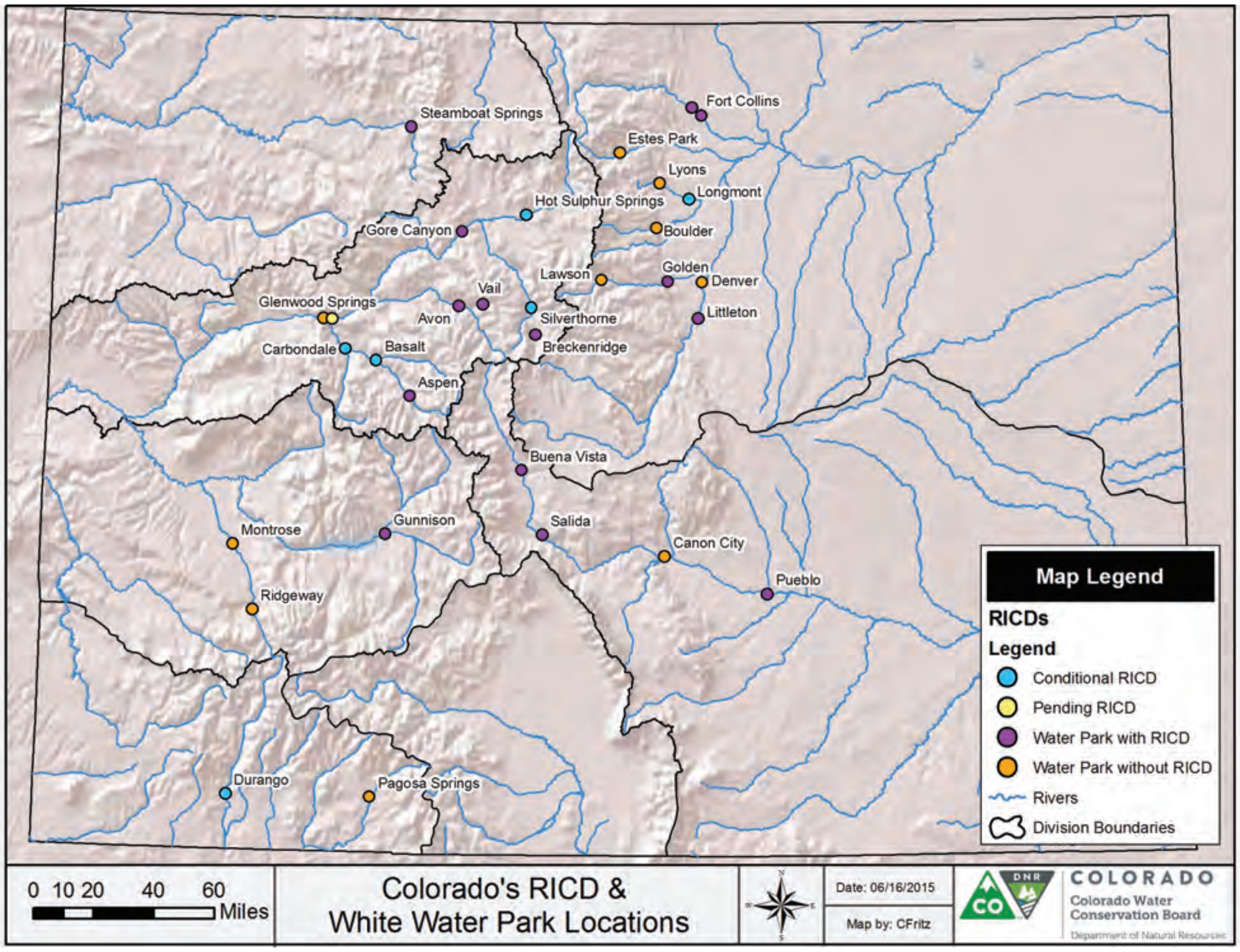
In Colorado, 15 existing whitewater parks have RICD water rights, and eight existing whitewater parks operate without an RICD water right. The map on the opposite page (Figure 6.6-1) illustrates Colorado's existing and planned whitewater parks.

Endangered Species Recovery Programs

Many of Colorado's water projects are likely to have what is known as a "federal nexus." A water project is considered to have a federal nexus if it involves federal funding, federal permitting or licensing, use of federal lands, or a federal program. The existence of a federal nexus often triggers the need for consultation under Section 7 of the ESA.[444] The result of a Section 7 consultation is a biological opinion that states whether a project is likely to jeopardize the continued existence of listed threatened or endangered species, or result in the destruction or adverse modification of critical habitat.

To mitigate these effects, Colorado participates in three cooperative programs designed to protect and recover stream-dependent species in various river basins. The Upper Colorado, San Juan, and Platte River Recovery Programs provide organized collaboration among states, federal agencies, local agencies, water users, water providers, power providers, and environmental organizations. These programs differ from the Three Species Agreement, as described below. These programs' goal is to recover the endangered species while allowing water use and development to continue in compliance with all applicable state and federal laws and interstate compacts.

FIGURE 6.6-1 COLORADO'S RECREATIONAL IN-CHANNEL DIVERSIONS & WHITEWATER PARK LOCATIONS



Funding and resources from participants are dedicated to activities that benefit the species.

Collaboration and a focus on recovery activities are intended to:

- Maximize benefit to the species and the environment by leveraging funding and resources expended.
- Minimize resources spent on adversarial activities, including litigation.
- Provide ESA compliance for water users.
- Streamline Section 7 consultations for water users and federal agencies.
- Reduce uncertainty and delays in planning and permitting processes.
- Reduce likelihood of jeopardy opinions.

Upper Colorado River Endangered-Fish Recovery Program

In 1988, various interests in Colorado, Wyoming, and Utah established the Upper Colorado River Endangered Fish Recovery Program. These interests formed the program as a unique partnership of groups working toward recovery of four endangered fish species: Humpback chub, bonytail, razorback sucker, and Colorado pikeminnow. These species are long-lived, warm-water fish and are endemic to the Colorado River Basin. Recovery efforts focus on creating self-sustaining populations of native fish through restoration and management of habitat, propagation and stocking of hatchery-raised fish, and management of certain deleterious non-native fish species throughout the mainstem Colorado, Gunnison, Yampa/White/Green River Basins.

Outdoor recreation, such as fishing and other water-related activities, highlight some of the quality experiences that tourists and Coloradans enjoy statewide.

The Upper Colorado Endangered Fish River Recovery Program provides ESA compliance for more than 2,050 water projects, encompassing more than 2.5 million acre-feet of existing water use and more than 300,000 acre-feet of new development. No entities have filed lawsuits regarding these projects' compliance with the ESA. The program has established procedures, projects, and agreements to provide streamflow protection, voluntary flow augmentation during critical spring peak and late summer time periods, habitat management and improved habitat access, genetic propagation, hatchery and stocking operations, non-native fish-control efforts, and research and monitoring. The cooperative nature of the program has led to multiple successes and cost efficiency, and the program has become a model for other endangered-species recovery programs.[445]

San Juan River Basin Recovery Implementation Program

A group of federal, state, and tribal agencies established the San Juan River Recovery Implementation Program in 1992 for the San Juan River Basin, a major tributary to the Colorado River. The Navajo Nation, Jicarilla Apache Nation, Southern Ute Indian Tribe, and Ute Mountain Ute Indian Tribe and other stakeholders are active partners in this collaborative effort to recover the razorback sucker and Colorado pikeminnow within the San Juan River Basin in Colorado and New Mexico.

The San Juan River Basin Recovery Implementation Program provides ESA compliance for more than 340 water projects using more than 880,000 acre-feet of water in the San Juan River Basin. Major accomplishments include extensive research in biology and geomorphology, and the establishment of procedures and agreements to provide streamflow augmentation and protection, habitat management and improvement, genetic propagation, hatchery and stocking operations, non-native fish control, and continued research and monitoring.[446]

Platte River Recovery Implementation Program

During the early 1990s, all ESA Section 7 consultations that were conducted on Platte River projects received jeopardy biological opinions, which meant that these water projects could not proceed. In response, Colorado, Nebraska, Wyoming, and the Department of the Interior entered into a collaborative conservation partnership with many other stakeholders. That partnership is now known as the Platte River Recovery Implementation Program.[447]

The Platte River Recovery Implementation Program is now working to recover four threatened and endangered species—the whooping crane, interior least tern, piping plover, and pallid sturgeon—in Nebraska. This allows water use and development to continue on the Platte River. With the current involvement of Wyoming, Nebraska, and Colorado; federal agencies; and many water, power, and environmental interests, the program provides ESA compliance for water projects and fully complies with the participating states' water law as well as existing interstate river compacts and decrees. The partnership is implementing the program in an incremental manner; the first incremental, programmatic biological opinion covers the 13-year period from 2007 through 2019.

Officially in place since 2007, the Platte River Recovery Implementation Program has provided 237 successful, streamlined Section 7 consultations using the programmatic biological opinion for every Colorado entity that has joined the South Platte Water-Related Activities Program. The preceding Cooperative Agreement, signed in 1997, resulted in bridge measures to allow for ESA compliance for approximately 120 Platte River Basin consultations while negotiations were underway.

Through 2019, South Platte water users will pay more than $13 million, and the State of Colorado will pay $24 million (based on 2005 inflation rates), for the Platte River Recovery Implementation Program. Water users and the public view the program to be well worth the cost in comparison to the untold costs water users would likely face without the program, including:

- ❖ Needing to undergo uncertain, individual Section 7 consultations, including bearing the risk of receiving jeopardy biological opinions.
- ❖ Potentially being required to replace past and future depletions on a one-to-one basis, which would likely add additional pressure to dry-up agriculture.
- ❖ Facing delays in the planning and permitting process.
- ❖ Risking court challenges to existing programmatic biological opinions.

Three Species Agreement

The CPW, five other Colorado River Basin state wildlife agencies, the USFS, the BLM, the BOR, and sovereign tribes are parties to a multi-state, multi-agency, range-wide conservation and strategy agreement that provides the framework for conservation actions designed to preserve three declining native fish species across their historic range. These species are the roundtail chub, bluehead sucker, and flannelmouth sucker.[448] Noting range-wide declines of these species, the Three Species Agreement addresses the species' potential for a USFWS listing as threatened or endangered under the ESA of 1973, as amended. The USFWS relies on implementation of the multi-state Three Species Agreement to protect and conserve these three native warm-water species.

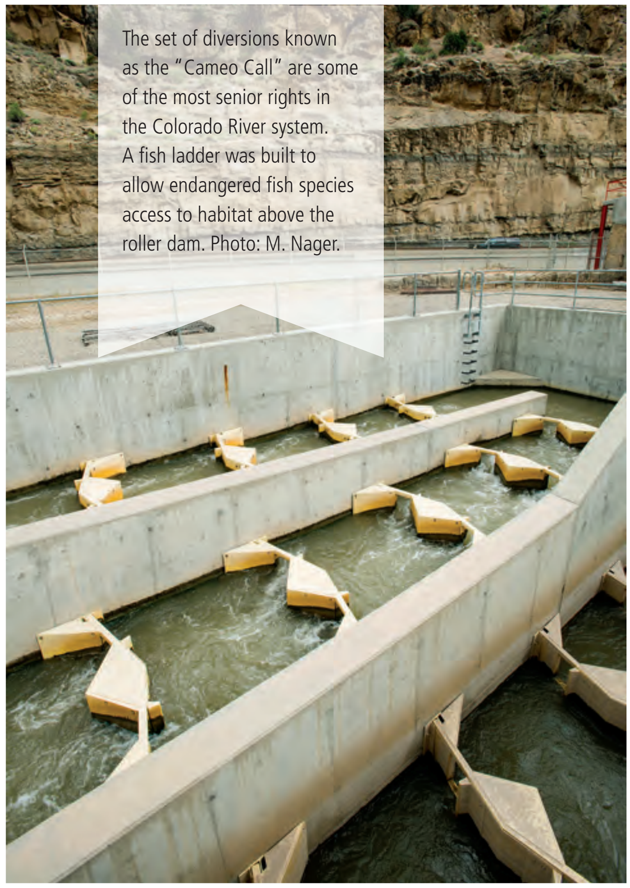
The Three Species Agreement provides that within their jurisdictional authorities, signatories are responsible for taking action to conserve native fish, coordinating status assessments, developing and maintaining data sets on occupancy and genetics, and documenting conservation measures taken on behalf of the three species. The agreement is predicated on the concept that collectively, local, state, and federal agencies, and other willing partners, can work together with communities that are most affected by a potential listing. It encourages all signatories to cooperate on science, research, education, and outreach to send a clear and consistent message about the conservation of these species. One of the agreement's goals is to develop and implement voluntary actions that pre-empt the need for federal listing of any of these species under the ESA. The agreement also prioritizes the establishment of instream flow protection for streams known to provide habitat for the three species. CPW and the BLM have recommended that the CWCB appropriate instream flow water rights to preserve the habitat of the three species. A recent example of such an appropriation is an instream flow water right on the San Miguel River from Calamity Draw to the confluence with the Dolores River. The water court decreed this water right in May 2013.

Colorado River Cutthroat Trout Conservation Strategy

Colorado River cutthroat trout (CRCT) is a state-listed species of special concern in Colorado, Wyoming, and Utah. Federal land management agencies—particularly the BLM and the USFS—that manage habitats where CRCT is present also characterize it as a sensitive species. CPW works closely with Utah, Wyoming, and federal land managers to manage the recovery and persistence of CRCT throughout their historic range. The Conservation Strategy for Colorado River cutthroat trout guides this work. It is a multi-pronged strategy that articulates steps that, if implemented, would be most likely to preserve CRCT in perpetuity.[449] Implementation of the CRCT Conservation Strategy, and an ability to show progress on measurable benchmarks, has allowed the USFWS to maintain its opinion that CRCT is "not warranted" for listing under the ESA of 1973, as amended.[450] This finding has been beneficial to state wildlife-management agencies to maintain state-management authority for this species. Based on this finding, Section 7 of the ESA does not require consultation with the USFWS for projects in CRCT-occupied waters, which is also critically important to water managers.

In general, the CRCT Conservation Strategy focuses on the following objectives:

- Identify populations of CRCT and characterize the level of genetic introgression;
- Secure "conservation" and "core conservation" populations from further genetic dilution (from non-CRCT salmonids) or inter-specific competition (e.g., barrier construction, reclamation, stocking restrictions);
- Maintain and enhance watershed conditions, including streamflow protection, riparian buffers, and habitat projects;
- Public outreach and education;
- Monitoring and data exchange among state fish managers and federal land management agencies; and
- Coordination of all CRCT activities among the same agencies and non-governmental organization partners.[451]



The set of diversions known as the "Cameo Call" are some of the most senior rights in the Colorado River system. A fish ladder was built to allow endangered fish species access to habitat above the roller dam. Photo: M. Nager.

As the CRCT Conservation Strategy outlines, the partnership is continually updating maps, regulations, and the list of CRCT conservation waters as new monitoring data and research unfold. Of current interest is the further delineation of historic, native cutthroat trout into two distinct lineages. These lineages reflect pre-settlement occupation endemic to the Yampa/White/Green River Basins ("blue" lineage) and the Colorado-Gunnison-Dolores River Basins ("green" lineage).[452] Regardless of the nomenclature for particular genotypes of native cutthroat trout, the CRCT Conservation Strategy partners will continue to evolve their management strategies to address new challenges, such as climate change, and research findings.

Wild and Scenic Rivers

The National Wild and Scenic Rivers Act requires federal land agencies—including the BLM, the National Park Service, the USFS, and the USFWS—to use their land and resource management planning processes to identify and evaluate rivers that may be "eligible" and "suitable" for designation as Wild and Scenic rivers.[453]

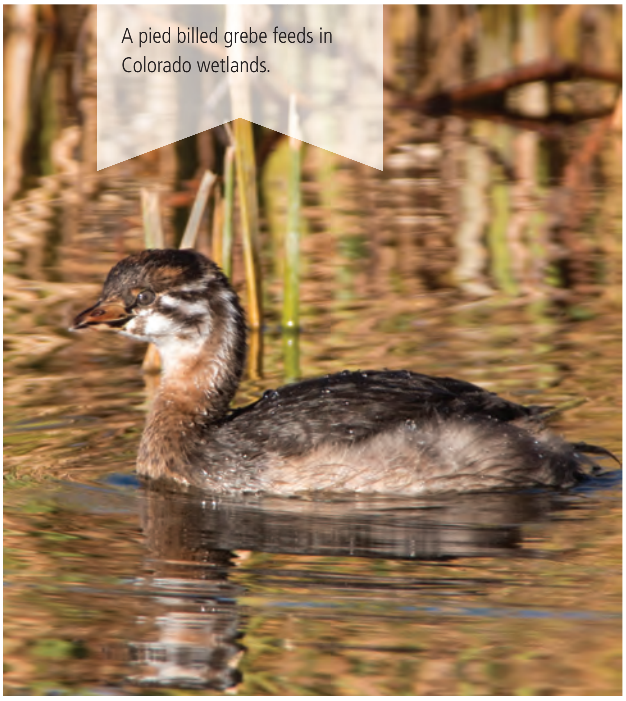
To be eligible, a river, stream, or segment must be free-flowing and must possess at least one Outstandingly Remarkable Value (ORV). ORVs include scenic, recreational, geologic, fish and wildlife, historic, cultural, or similar values. Once a federal agency establishes eligibility, it evaluates that river or river segment for its suitability for designation as a Wild and Scenic river.[454] Agencies consider many factors in the suitability evaluation, including whether nonfederal entities that may implement protective management demonstrate a commitment to protect the river and its ORVs.

Agencies that find a specific river segment suitable may recommend that segment for designation as a Wild and Scenic river. Only an act of the Secretary of the Interior (upon the governor's request) or an act of Congress may make the designation. The USFS, NPS, and the BLM have determined many river segments in Colorado to be suitable for designation since passage of the original Wild and Scenic Rivers Act in 1968.

If the Secretary of the Interior or an act of Congress designates a river as a Wild and Scenic river, that designation may include a federal reserved water right for a quantity of water necessary to achieve the Act's purposes—including protecting the ORVs for which a river is designated. However, the managing agency has discretion about whether to quantify, adjudicate, or request enforcement of the federal water right. In this context, Colorado can work with local managing agencies to protect flows that can support ORVs using Colorado's Instream Flow Program. Additionally, federal land management agencies may impose conditions on permits or other federal land management decisions to protect the free-flowing nature, water quality, and classification associated with ORVs for candidate (eligible and suitable) Wild and Scenic rivers. Federal land management agencies review proposed projects in, above, or below a designated reach to determine if "they would invade the area or unreasonably diminish the Outstandingly Remarkable Values."[455] If so, the agency may request that project proponents modify the project to avoid adverse effects. If proponents cannot modify the proposed project, the permitting agency may deny the request for a federal permit or assistance. While federal agencies have determined that several rivers in Colorado (for example, the Dolores and Arkansas Rivers) are suitable for designation, and manage them as suitable in the absence of congressional designation, water development and management have proceeded.

In 2009, Colorado's General Assembly established the CWCB Wild and Scenic Rivers Act Alternatives Fund to support cooperative and collaborative processes that are committed to exploring alternative avenues for resource protection.[456] These processes typically consist of stakeholder groups aimed at protecting the ORVs associated with rivers within Colorado, while protecting Colorado's ability to fully use its compact and decree entitlements. The goal of such processes is to find alternatives to Wild and Scenic designation that satisfy the federal agencies' requirements to protect the ORVs. Representatives of diverse interests—including state agencies, local governments, conservation groups, recreation groups, and individuals—participate in these stakeholder groups, and each brings a different perspective to the group's work.

The Cache la Poudre River is the only river in Colorado that is currently designated as a Wild and Scenic river.[457] However, the BLM and the USFS are currently evaluating several river segments in Colorado for Wild and Scenic eligibility and suitability as part of their current land and resource management planning processes. Some NPS units have evaluated their resources for Wild and Scenic eligibility; however, most of those units have not evaluated their resources for suitability. Currently, three active stakeholder groups are using the Wild and Scenic Fund to discuss the merits of suitability findings and, in most cases, to develop alternative ways of protecting the ORVs several federal agencies identified. Stakeholder groups include the Upper Colorado River Wild and Scenic Stakeholder Group, the River Protection Workgroup (working in southwest Colorado), and the Dolores River Dialogue's Lower Dolores Plan Working Group. Additionally, since 1997, the South Platte Enhancement Board has been actively implementing its alternative plan to a possible designation under the Wild and Scenic Rivers Act.[458]



A pied billed grebe feeds in Colorado wetlands.

State of Knowledge

As part of the process the Colorado Water for the 21st Century Act established in 2005, the nine basin roundtables and the CWCB have worked to identify Colorado's environmental and recreational water needs, also referred to as nonconsumptive needs. Below is a brief description of some resources the roundtables and the CWCB have developed so far. Still, it is apparent that these groups can do additional work to develop common metrics for environmental and recreational attributes and to develop focused, basin-specific knowledge of environmental and recreational needs.

SWSI Phase 1—Nonconsumptive Mapping (2010)

As part of the nonconsumptive needs assessments, each basin roundtable mapped out the locations of important nonconsumptive attributes. These reaches or watersheds are known as "focus areas." Each focus area is associated with one or more attributes, such as imperiled fish species, important boating and fishing areas, and important waterfowl hunting areas, among others.[459] Environmental attributes the roundtables identified include federal and state threatened, endangered, and imperiled species (e.g. piping plover, greenback cutthroat trout, boreal toad, bluehead sucker); significant riparian-wetland plant communities; and special-value waters (e.g. the CWCB's instream flow water rights, eligible Wild and Scenic rivers).[460] Recreational attributes the roundtables identified include whitewater and flatwater boating; cold- and warm-water fish species; Audubon important bird areas; waterfowl hunting; and wildlife viewing.

SWSI Phase 2—Nonconsumptive Projects and Methods (2010)

In Phase 2, basin roundtables determined the locations of planned and existing nonconsumptive projects and methods, also known as identified projects and processes, in relation to the focus areas they developed in Phase 1. This information can help determine where known, nonconsumptive identified projects and processes offer direct or indirect protection for a specific attribute. Equally important, it can help determine where there are no known protections for a given focus area. For example, important riparian and wetland areas cover 18,767 stream-miles statewide.[461] Of those miles, existing and planned projects and processes provide or will provide direct protection to 2 percent, a combination of direct and indirect protection to 2 percent, and indirect protection to 23 percent. Of those stream-miles, 73 percent currently have no known protection. The CWCB organized the survey information in a database with Phase 1 information, and summarized it in maps created using GIS.[462] The maps include a list of planned nonconsumptive projects and methods, and show:

1) Where planned and existing projects and methods overlap with the nonconsumptive focus areas, and
2) Where there are no known projects that support those reaches.

Watershed Flow Evaluation Tool

The CWCB partnered with The Nature Conservancy and CDM Smith to pilot a tool known as the Watershed Flow Evaluation Tool (WFET). The WFET provides a framework for examining the risk of ecological change as it relates to streamflow alteration at a watershed or regional level. By contrast, site-specific quantification applies standard techniques to develop reach-based flow quantification based on historic data collection efforts. The WFET can help identify reaches where the historical alteration of streamflow has either increased or decreased risk to a given attribute, such as a cold-water fishery, a warm-water fishery, and riparian vegetation. The WFET can also help project ecological responses to future streamflow scenarios that result from new water development projects, a compact call, or climate change. To date, the Colorado and Yampa/White/Green Basin Roundtables have applied the WFET to their basins.

It is important to note that the WFET and site-specific flow-quantification techniques possess different capabilities and limitations, and therefore complement each other. For example, the WFET can help target areas that may need further site-specific studies to quantify flow needs, and site-specific quantification can help refine risk-level categories the WFET identifies.[463]

Stream Management Plans

Stream management plans can play an important role in identifying both the needs of environmental attributes, and the projects and methods that will benefit those attributes. For example, the Grand County Stream Management Plan examined approximately 30 stream reaches in the Upper Colorado River Basin to "provide a framework for maintaining a healthy stream system in Grand County, Colorado, through the protection and enhancement of aquatic habitat while at the same time protecting local water uses, and retaining flexibility for future water operations."[464] or each stream reach, the plan includes a reach description, study methodology and results, recommendations for environmental target flows, review of existing temperature and water quality data, monitoring guidelines, unique features and issues, and supporting data.[465] Action items the plan identified include restoration opportunities and monitoring recommendations by stream reach, and the "Learning by Doing" process (similar to adaptive management). Learning by Doing includes monitoring, evaluation, and adjustment of restoration opportunities—including flow enhancements—for the purpose of meeting pre-established goals.[466]

Well-developed stream management plans should be grounded in the complex interplay of biology, hydrology, channel morphology, and alternative water use and management strategies. They should also consider the flow and other structural or management conditions needed to support both recreational uses and ecosystem function. A stream management plan should: (1) Involve stakeholders to ensure their acceptance of the plan; (2) assess existing biological, hydrological, and geomorphological conditions at a reach scale; (3) identify flows and other physical conditions needed to support environmental and recreational water uses; (4) incorporate environmental and recreational values and goals identified both locally and in a basin roundtable's BIP; and (5) identify and prioritize alternative management actions to achieve measurable progress toward maintaining or improving flow regimes and other physical conditions. For basin roundtables, local stakeholder groups, and decision makers, such plans can provide a framework for decision making and project implementation related to environmental and recreational water needs.[a]

The necessary steps for the development of a stream management plan include: (1) Gathering stakeholders to participate in plan development; (2) identifying the plan's objectives; (3) identifying and prioritizing ecological and recreational values; (4) establishing goals for flows and other physical conditions in order to protect or enhance environmental and recreational attributes on streams and rivers within a given watershed; (5) collecting and synthesizing existing data describing flows for river ecosystems, boating, or other needs in the watershed; (6) assessing existing physical conditions of stream reaches, including geomorphological and riparian conditions; (7) selecting quantitative measures that can be used to assess progress made toward articulated goals; (8) determining what new information is needed and the best methods for obtaining that information; (9) quantifying specific numeric flow recommendations (or ranges of flow) and physical conditions and assessing the potential for channel reconfiguration to support environmental and recreational values; (10) identifying temporal, geographical, legal, or administrative constraints and opportunities that may limit or assist in the basin's ability to meet environmental and recreational goals; and (11) implementing a stakeholder-driven process to identify and prioritize environmental and recreational projects and methods. Stream management plans should provide data-driven recommendations that have a high probability of protecting or enhancing environmental and recreational values on streams and rivers.[b]

[a] This summary of the elements of a stream management plan is based upon public comments that incorporated information the Colorado River basin roundtable compiled, and upon comments that the Northwest Colorado Council of Governments Water Quality/Quantity Committee submitted.

[b] This description of the steps to develop a stream management plan is based upon public comments that incorporated information from the Grand County Stream Management Plan and upon comments that the Northwest Colorado Council of Governments Water Quality/Quantity Committee submitted.

Section 7.1's recommendation for a collaborative approach to watershed planning is one that includes stakeholder involvement and management actions supported by sound science—and it applies equally to stream management plans. An inclusive stakeholder approach expedites cooperative and integrated project planning, which leads to successful implementation of measures that will meet the needs the stream management plan identified.

Additionally, while stakeholders can develop stream management plans independently of watershed master plans, a stronger stream management plan will result if the basin conducts it as part of, or in conjunction with, watershed master plans. Numerous watershed master plans incorporate important components of stream management plans. Future stream management plans should build off of existing watershed plans and other available studies.

Conclusion

While this body of work represents an increase in the understanding of Colorado's nonconsumptive needs, more work is required to understand and quantify recreational and environmental needs. Additionally, the roundtables need information about whether existing nonconsumptive identified projects and processes are sufficient to protect the environmental and recreational attributes the projects and processes target. Based upon the above-described information and information the basin roundtables, stakeholder groups, and others are developing, Colorado can develop a strategic approach to meeting its nonconsumptive needs and provide meaningful protection to environmental and recreational attributes.

Existing Environmental and Recreational Legislation

Instream Flow Legislation

Colorado's General Assembly established the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment."[467] This legislation vested the CWCB with exclusive authority "on behalf of the people of the state of Colorado, to appropriate or acquire...such waters of natural streams and lakes as may be required to preserve the natural environment to a reasonable degree."[468] Over the years, the General Assembly has amended and clarified aspects of this legislation. Highlights of recent legislation are presented below.

In 2002, Senate Bill 02-156 authorized the CWCB to use acquired water rights to improve the natural environment to a reasonable degree.[469] In 2003 and 2005, the General Assembly responded to the 2002 drought conditions by allowing temporary changes of water rights to instream flow purposes, with DWR approval.[470] In 2007 and 2008, the General Assembly established protections for water rights owners that lease water to the CWCB for instream flow use. These protections provide that a lease to the CWCB will not reduce the historical consumptive use of a water right. It also eliminates the legal presumption of abandonment for water rights that the CWCB has used nonconsumptively.[471]

In 2008, the General Assembly authorized an annual appropriation of $1 million from the CWCB Construction Fund for costs of acquiring water for instream flow use.[472] That same year, the General Assembly authorized an annual appropriation of $500,000 from the Species Conservation Trust Fund for the costs of acquiring water for instream flow use to preserve or improve the natural environment of species that have been listed as threatened or endangered under state or federal law, or are candidate species, or are likely to become candidate species.[473] In 2009, the General Assembly established a tax credit that created a market-based incentive for voluntary donation of water rights to the CWCB for instream flow use.[474]

Recreational In-Channel Diversion Legislation

In 2001, the General Assembly established authority and procedures for local government entities to apply for and hold in-channel water rights for recreational uses, referred to as RICDs.[475] The legislation charged the CWCB with making findings of fact and submitting recommendations to the water court regarding RICD water court applications. It also authorized the CWCB to hold hearings on such applications if any party requested it. In 2006, the General Assembly updated the procedures for RICD water rights applications. It also clarified the role of the CWCB's administrative process as well as its determination of findings of fact to submit to the water court.[476]

BIP-Identified Environmental & Recreational Projects & Methods

As part of the BIP process, the basin roundtables identified projects and methods that could assist in meeting environmental and recreational needs within their basins. The process for identifying these projects and methods was unique to each basin; roundtables collected and organized information through public outreach, input solicitation, and review by committees or the full roundtable. As a result, because these processes were different in each basin, the manner in which the BIPs presented these projects and methods varied. Some basins identified reaches of concern, and others consolidated existing compilations of project information.

A lake near Boulder with views of the Flatirons.

This section examines and summarizes the work of the basin roundtables. It focuses on a brief description of the process each basin used, a general overview of projects and methods identified, and the path forward as basins move to meet their goals and measurable outcomes. More information on the BIP process and how each basin collected and organized its environmental and recreational projects is available in the individual BIPs, which are available on the Colorado's Water Plan website.[477]

Arkansas River Basin

The Arkansas Basin Roundtable undertook an ambitious public outreach process by hosting meetings around the basin to gather input and suggestions from residents. One of the hallmarks of this process was the input form the roundtable designed. The input form encouraged basin residents to submit ideas and projects for the roundtable's consideration. The roundtable also considered the list of IPPs from SWSI 2010, as well as focus areas or areas of concern the Nonconsumptive Needs Committee identified.[478]

ARKANSAS BASIN AT A GLANCE

135 projects identified on the IPP List that meet environmental or recreational needs

$345,230,000 in costs identified for **2** projects

382 stream-miles identified for protection by **15** projects

The roundtable has gathered project lists from several sources, including SWSI 2010, The Nature Conservancy, CPW, and others. The BIP also identifies projects the roundtable funded through the WSRA program, and projects or methods the public input process helped identify and the roundtable undertook. Through this inventory of potential projects, the roundtable seeks to prioritize available WSRA funding, and to demonstrate the types of projects it believes conform to the basin's goals and measurable outcomes.[479]

The BIP Project Database includes environmental and recreational projects, classifying them by definitions of Master Needs, Preliminary Needs, and IPPs. These projects line up with the basin's environmental and recreational goals of maintaining and improving key attributes. Many of the identified projects concentrate on the protection and restoration of key habitat through diversion replacement, wetland improvement, and reoperation of currently existing storage rights. Three of the identified projects are associated with some aspect of instream habitat restoration. Two projects identified by the Committee focus on recreational needs through activities such as boat chute improvement, campsite restoration, and reservoir renovation with recreational needs in mind.

Moving forward, the Arkansas Basin Roundtable plans to delve deeper into the public input it received through its outreach program. For projects that meet basin goals, proponents may be invited to a roundtable meeting to present on their projects, and to potentially work with the roundtable to meet funding needs. As it moves forward to maintain an updated inventory of activities within the basin, the roundtable plans to take a holistic view of projects and methods, exploring concepts such as watershed health. GIS mapping of needs and identifying areas of concern is a roundtable priority, and supports the BIP's efforts. The roundtable plans to complement this path forward with the pending revised edition of the SWSI, with specific identification of projects and methods that meet the definition of an IPP.

Colorado River Basin

The Colorado Basin Roundtable also began with an extensive public outreach campaign in which consultants interviewed water providers throughout the basin and hosted many town hall meetings and opportunities for gathering BIP input. This outreach process yielded a comprehensive list of projects, organized by basin themes and geographical location. Similar to the Arkansas Basin approach, the roundtable believed that a comprehensive inventory of projects and methods would serve the basin well as a suite of options for moving forward and for meeting its future water supply needs. The basin also compiled projects and methods from existing sources, such as SWSI 2010, into this inventory. Roundtable members took a closer look at the list of projects and methods. Then, in each basin sub-region, they identified representative

COLORADO BASIN AT A GLANCE

27 projects identified on the Top Projects list that meet environmental or recreational needs

$117,500,000 - $152,500,000 in costs identified for **13** projects

24,082 acre-feet of development for environmental or recreational needs identified by **3 top** projects

projects that met basin themes and sub-region goals. These projects were designated "Top Projects" and represent important needs at both the basin-wide and sub-region levels.

The Colorado Basin Roundtable established several themes to sum up and organize the input it received from basin stakeholders. Theme #1 is: "Protect and Restore Healthy Streams, Rivers, Lakes, and Riparian Areas."[480] In its identification of Top Projects, the roundtable identified several projects that complement this basin-wide theme. Central to this theme is the roundtable's goal of establishing a basin-wide stream management plan. Data gaps for environmental and recreational needs are a key issue of concern for this basin. The roundtable would like to see more progress statewide in scientifically quantifying the amounts of water necessary to maintain or improve these attributes.

Many of the roundtable's identified Top Projects and methods have an environmental or recreational focus. Many include the acquisition of water rights to restore or protect streamflow, or flow-related recreational protection. The needs of endangered species in the Colorado Basin are highlighted in the BIP's goals and measurable outcomes; species recovery is a measurable outcome to be achieved through habitat improvement and addressing invasive species.

Moving forward, the roundtable plans to begin organizing the inventory of projects for potential implementation. To prioritize the projects and methods, the roundtable will examine each through the lens of the basin-wide themes, and will identify projects that may serve multiple purposes or meet basin goals. Many of the water management-related projects and methods may already be in the planning stages. Some of these may be associated with the CRCA, and some may be roundtable-funded projects that anticipate multiple phases.[481]

Gunnison River Basin

The Gunnison Basin Roundtable identified two basin goals that address environmental and recreational water needs, and then identified projects and methods within the basin that could assist in meeting those needs.[482] The roundtable compiled this inventory of projects and methods through outreach within the basin and through stakeholder participation in the BIP process. The roundtable also convened a group of environmental and recreational advocates, including staff from state and federal agencies, to provide input and assist in identifying focus reaches. As part of the BIP process, the roundtable approved the use of "project summary sheets," which help break down elements of projects and methods such as project proponent, project cost, and effectiveness in meeting basin goals.[483]

GUNNISON BASIN AT A GLANCE

30 projects identified that meet environmental or recreational needs

$427,848,100 in costs identified for **23** projects

21,472 acre-feet of development for environmental or recreational needs identified by **10** projects

In organizing its projects and methods inventory, the roundtable established three tiers of projects. The tiering criteria were the timeline and the effectiveness in meeting basin goals. The basin roundtable also identified 29 target stream reaches within the basin as areas where environmental and recreational projects and methods could be beneficial. While identifying potential projects and methods, the roundtable highlighted a series of ongoing efforts involving environmental protections and monitoring that help to maintain these attributes within the basin.

The Gunnison Basin Roundtable defined Tier 1 projects and methods as those whose implementation is likely feasible by 2025 and that do an excellent job of meeting basin goals.[484] Of the 49 projects classified as Tier 1, 18 are associated with Basin Goal #5: "quantify and protect environmental and recreational water uses."[485] These projects mostly focus on improving or restoring stream channels within the aforementioned target stream reaches, or on improving native trout populations. Many projects identified as Tier 1 are multipurpose projects that include an environmental or recreational benefit. The roundtable also identified 22 projects as meeting Basin Goal #7: "Describe and encourage the beneficial relationship between agricultural and environmental and recreational water uses."[486] These projects are chiefly multipurpose projects for agricultural uses with environmental and recreational benefits identified, making them in-line with the basin goal.

For its environmental and recreational goals, the Gunnison Roundtable also established some measurable outcomes that are based in project implementation. Moving forward, the roundtable aspires to develop 10 projects from the list of recommended solutions by 2030. Additionally, the roundtable included a more comprehensive inventory of environmental and recreational projects as a method in the list of recommended solutions, and hopes to see completion of this "Identification and Inventory" by 2020.[487]

North Platte River Basin

The North Platte Basin also had two primary goals related to environmental and recreational uses and needs.[488] The public outreach and education process the roundtable had been doing up to that point informed the BIP process. The public outreach and education process engaged stakeholders within the basin and also included more technically oriented outreach to identify specific projects and methods. Similar to the Gunnison BIP, the North Platte Basin Roundtable identified one goal associated with the maintenance of healthy rivers and wetlands, and one goal geared toward the nexus with agricultural water use. For both of these goals, the BIP's measurable outcomes are based on project implementation, with an inventory of potential projects and methods that serve as "recommended solutions."[489]

NORTH PLATTE BASIN AT A GLANCE

55 projects identified that meet environmental or recreational needs

6,226 acre-feet of development for environmental or recreational needs identified by **3** projects

The projects and methods the BIP identified complement the roundtable's previous work, which prioritized environmental and recreational attributes within the basin. The roundtable applied the previous prioritization of attributes to the inventory of recommended solutions, and established a process for identifying locations where these needs are not being met, and for finding solutions. Measurably, the roundtable plans to develop three projects from the inventory of solutions by 2020.[490] Regarding the goal of supporting environmental and recreational benefits through agricultural projects, the roundtable plans to complete at least two multipurpose projects by 2025.[491]

In its inventory of recommended solutions, the roundtable identified 50 environmental and recreational projects.[492] Of these projects, 37 are classified as restoration of wetlands, riparian, or stream projects. These projects identify specific species for protection and habitat restoration, and many are also associated with water quality or watershed health. The North Platte Basin Roundtable particularly emphasizes wetlands protection and restoration, so it identified amphibians and waterfowl as direct beneficiaries of implementation projects. Ten of the basin projects are focused on habitat restoration through projects that will improve livestock-grazing management through fencing. The focus in this basin, as is evident by its goals and implementation-based outcomes, is on multipurpose projects and methods.

Through implementation of these projects and methods, the roundtable hopes to accomplish incremental increases in recreational activities within the basin. Specifically, the basin aspires to a 5 percent increase in waterfowl hunting and viewing days by 2020, as well as a 5 percent increase in fishing user-days in the same time period.[493] Moving forward, the basin will use its existing prioritization system to evaluate funding for projects and methods in this inventory of recommended solutions.

The Rio Grande River flows from high mountain peaks in southern Colorado.

Rio Grande River Basin

The Rio Grande Basin Roundtable, like others around the state, established a set of basin goals, and then examined potential projects and methods with these goals in mind. The roundtable compared its basin goals with basin needs, and developed a multipurpose focus, since all basin goals had a nexus with environmental and recreational needs.[494] The roundtable gathered and consolidated projects and methods through its public outreach process, and through the work of subcommittees the BIP Steering Committee led. To date, the roundtable has identified 29 projects and methods, which were preliminarily evaluated in accordance with basin goals. The "Project Fact Sheets" describe these in detail.[495]

The roundtable assessed the projects and methods the BIP identified as multipurpose projects. Of those, 28 identify some nexus with environmental and recreational needs.[496] Additionally, the basin compiled a list of additional projects and methods that may merit future consideration, but that the BIP did not consider in this iteration due to time constraints. This additional section identified 19 projects and methods that would meet an environmental or recreational need, often as part of a multipurpose project.[497]

RIO GRANDE BASIN AT A GLANCE

58 projects identified that meet environmental or recreational needs

$129,674,531 in costs identified for **24** projects

4 stream-miles of protection for environmental or recreational needs identified by **3** projects

In keeping with this roundtable's goals and measurable outcomes, many of the identified projects and methods focus on riparian restoration and watershed health. Projects that fall into these categories include those intended to improve fish habitat, restore headwaters, and result in comprehensive watershed planning. Identified storage projects are potential sites for wildlife habitat and recreational opportunities, such as angling and boating. Other projects and methods fall into the category of water management, with plans to study hydrology within the basin, examine post-fire conditions, and potentially optimize streamflow.

Moving forward, the roundtable has estimated costs for 25 of the 29 projects the Project Fact Sheets examined. These 25 projects total an estimated financial need of more than $218 million through the year 2020.[498] As the roundtable moves forward with the basin planning effort, it will explore funding avenues, and may refine the list of identified projects and methods. The roundtable will do additional analysis of the supplementary list of projects and methods, and as it measures these potential recommendations against basin goals, may prioritize some of them. Similar to the Colorado Basin Roundtable, the Rio Grande Roundtable has identified the need to fill information gaps regarding environmental and recreational needs, and to find ways to better understand how water may be managed to maintain and protect these attributes. The BIP provides a list of projects and methods that would address these information gaps, and provides guidance to the roundtable as it moves forward on project funding and implementation.[499]

South Platte River Basin (Including Metro)

The joint BIP the South Platte Basin and Metro Roundtables prepared required a large amount of outreach throughout the basin, as these comprise the most populous areas in Colorado. The roundtables chose "Protect and enhance environmental and recreation attributes" as an area of focus when looking to future water needs in the basin. In addition, the roundtable identified a series of measurable outcomes to meet the basin's environmental and recreational goal: "Fully recognize the importance of, and support the development of environmental and recreational projects and multipurpose projects that support water availability for ecologically and economically important habitats and focus areas."[500]

SOUTH PLATTE/METRO BASIN AT A GLANCE

75 projects identified that meet environmental or recreational needs

The South Platte/Metro BIP highlights examples of projects throughout the basin that are consistent with the above environmental and recreational goal. It lists these examples by basin sub-region, and provides mapping and analysis that demonstrates key attributes in those areas. The South Platte/Metro team, similar to other basins, chose to create an inventory of projects and methods to serve as a suite of options for fulfilling these nonconsumptive measurable outcomes. A great deal of the projects listed for environmental and recreational projects came from the SWSI 2010 nonconsumptive needs assessment, and many of those projects have been completed. Beyond these identified projects, the roundtables also created an inventory of "Additional Identified Environmental and Recreational Projects."[501] The roundtables identified these projects through the public outreach process or through proponent submission, or identified them as active, in-progress projects the roundtables chose to identify as steps toward meeting the nonconsumptive measurable outcomes.

Beyond the inventory of SWSI and additional environmental and recreational projects, the roundtables identified specific examples of projects they believe meet their measurable outcomes, and would be good models to follow in the future. The roundtables specifically highlighted existing multipurpose projects throughout the basin that were in line with goals and measurable outcomes. These goals focus on endangered and threatened species, the economic value of environmental and recreational uses, and the sustainability of water-dependent areas. Following these goals, the roundtables categorized many projects that were identified beyond the SWSI needs assessment as wetlands restoration, riparian restoration, and stream habitat projects. Measurably, the roundtables identified the recovery of key species of trout and native plains fish as important. Serving as a snapshot of the current state of affairs in the basin, this list identified projects that are proposed, planned, completed, and ongoing.

The BIP also included an analysis of the benefits to environmental and recreational needs that multipurpose projects can provide. Examples include the potential for installation of environmentally friendly passages after flood events, coordinated reservoir operations, and recharge projects.[502] Moving forward, the roundtables will continue to identify projects and methods that match up with their identified measurable outcomes, and seek to identify projects that may meet multiple needs.

Southwest Basin

The Southwest Basin Roundtable completed an extensive public outreach process to provide a comprehensive update to the SWSI 2010 IPP list. Through a series of public meetings, newspaper articles, and conversations with water management entities within the basin, the roundtable created a complete inventory of new IPPs within the basin. Additionally, the roundtable identified "Conceptual IPPs," which have no active sponsor, but are ideas for projects and methods within the basin that may conform to basin goals and measurable outcomes.[503] The Southwest Basin Roundtable, similar to the Rio Grande, evaluates any project or method for potential multiple uses and benefits. Approximately 50 percent of the IPPs are primarily meeting potential environmental and recreational needs.[504]

SOUTHWEST BASIN AT A GLANCE

72 projects identified that meet environmental or recreational needs

$30,000 in costs identified for **1** project

202 stream-miles of protection for environmental or recreational needs identified by **9** projects

The goals the roundtable identified specifically recognized the benefit environmental and recreational values provide to statewide and local economies. The roundtable's measurable outcomes include the maintenance, protection, and enhancement of these uses, as well as species recovery and watershed health. The inventory of projects and methods listed 67 environmental and recreational projects.[505] The inventory identified projects that pertain to invasive species removal, native revegetation, hydroelectric projects, natural disaster mitigation, habitat protection and restoration for trout and warm-water fish, appropriation of instream flows, habitat assessments, and fish passage projects.

Within the text of the BIP, the roundtable identified representative environmental and recreational IPPs. These example projects provided a look at the type of implementation of environmental project and method implementation that is planned or ongoing within the multiple sub-basins of the southwest. In line with the basin's measurable outcomes relating to the "condition and natural function of streams, lakes, wetlands, and riparian areas," the basin plans riparian restoration projects for key reaches of the La Plata, Dolores, Navajo, and San Juan Rivers.[506] On the Florida River, the basin identified livestock fencing as a means to protect a riparian buffer zone.

Moving forward, the basin will continue to consider all proposed IPPs equally, and will evaluate each one for potential multiple uses and benefits. In the BIP text, the roundtable considered opportunities for funding availability. It also explored the concept of "bundling" a package of proposals, and ways in which such an approach may help make the most of limited funding.[507] The Southwest Basin Roundtable, similar to the Rio Grande and Colorado, identified the data gaps in environmental and recreational water needs as a priority moving forward. The roundtable discussed identification and evaluation of gaps in this body of knowledge, and believes that by addressing these gaps, it can accomplish more reliable planning for the water supply future of the basin, and can make project implementation more efficient.

Yampa/White/Green River Basin

The Yampa/White/Green Basin Roundtable drew from two different sources to compile an inventory of projects and methods within the basin. First, the roundtable conducted an extensive outreach process, including holding several public meetings, publishing information in local publications, and issuing surveys. Also, the roundtable had previously begun the Projects and Methods Study, which identified projects and methods within the basin, as well as compared certain IPPs against potential future hydrological scenarios.[508]

YAMPA/WHITE/GREEN BASIN AT A GLANCE

22 projects identified that meet environmental or recreational needs

$5,050,000 in costs identified for **4** projects

371 stream-miles of protection for environmental or recreational needs identified by **16** projects

The roundtable identified two main inventories of projects with an environmental and recreational nexus. Many of the projects and methods listed in the inventory of "Current M&I, SSI, Agriculture, and Multipurpose IPPs" have an identified or potential benefit for environmental and recreational needs, some of which were modeled.[509] Additionally, some of the identified projects are the subject of ongoing feasibility studies that could potentially identify environmental and recreational benefits that project implementation can help realize. Drawing from interviews and information basin stakeholders provided, the roundtable identified a collection of projects with primarily environmental and recreational benefits. Most of these projects and methods are located within focus areas the roundtable identified. This collection identifies 18 projects and methods. Several of these projects have a completion date before 2020, while others are classified as ongoing through 2020.[510]

The list of Environmental and Recreational Identified Projects and Processes focuses heavily on the improvement of existing river conditions to restore and improve environmental and recreational attributes. Several projects identified the modification of specific reaches for the benefit of endangered fish or for recreational access. Other projects seek to restore and preserve the natural state of the river for watershed health and erosion control. Other proposed methods would study potential solutions to identified challenges, such as flow regimes for endangered fish, or potential augmentation of instream flow shortages. However, the roundtable emphasized that the current inventory is not exhaustive, and that other projects and methods will be necessary to fully address the environmental and recreational needs located within focus segments or otherwise. As planning efforts continue within the basin, the roundtable will identify additional projects and methods to meet these needs.

Like other basin roundtables, the Yampa/White/Green BIP stressed the need for accurate information and analysis of data gaps for environmental and recreational needs. To that end, and to fully assess the

TABLE 6.6-1 COMPLETED, ONGOING, AND POTENTIAL FUTURE ACTIONS

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTION
• Implement ESA recovery programs • Implement basin nonconsumptive projects • Develop draft Nonconsumptive Toolbox • Put Wild and Scenic alternatives in place • Implement the CWCB Instream Flow Program • Implement Colorado Watershed Restoration Program • Implement Species Conservation Trust Fund • Implement CPW Management Plans	1. Develop statewide goals and measurable outcomes to be considered for incorporation into BIPs a. Develop goals and measurable outcomes for federally listed endangered and threatened species b. Develop goals and measurable outcomes for imperiled species c. Develop goals and measurable outcomes for economically important nonconsumptive uses d. Develop goals and measurable outcomes for multipurpose projects and methods 2. Pursue projects and methods to meet nonconsumptive needs as part of the BIPs a. Develop basin-wide goals b. Develop measurable outcomes c. Identify needs and opportunities d. Use the decision process to determine projects and methods 3. Track nonconsumptive projects and methods a. Conduct nonconsumptive surveys and analysis b. Create web portal c. Use existing database d. Use the Basin Needs Decision Support System 4. Develop incentives, including funding for projects and methods in the nonconsumptive focus areas a. Assess funding needs b. Target existing funding sources and programs to provide enhanced levels of support for implementation of nonconsumptive needs c. Explore additional incentives, including funding options 5. Develop environmental metrics that can help evaluate future projects (to be considered in the new supply discussions) Manage and improve storage, infrastructure, and reservoir operations to benefit environmental and recreational values [Section 6.5]

effects of projects and methods, the roundtable plans to use studies and modeling efforts that are already completed or underway. The roundtable will use these analyses to determine which type of project or location would be the most beneficial regarding stream conditions and hydrologic impact.

IBCC Actions

In 2013, the IBCC developed the No-and-Low-Regrets Action Plan to implement environmental and recreational projects and methods. This strategy outlines what should be carried out in the near term statewide. The IBCC reached consensus on the need to implement the actions, regardless of the future scenario. Table 6.6-1 summarizes these actions.

ACTIONS

A strong Colorado environment is critical to the state's economy and way of life. Colorado's Water Plan sets a measurable objective to cover 80 percent of the locally prioritized lists of rivers with stream management plans, and 80 percent of critical watersheds with watershed protection plans, all by 2030.

To support a strong environment that includes healthy watersheds, rivers and streams, and wildlife, as well as a robust recreation and tourism industry, several actions are necessary:

1. **Technical work:** As part of the next version of SWSI, the CWCB, in consultation with the basin roundtables, will conduct additional technical work associated with the environmental and recreational focus areas to better determine the levels of existing protections, and where additional projects and methods should focus.
2. **Near-term projects and methods to address high-priority needs:** The CWCB will work with CPW, the basin roundtables, and other relevant agencies to establish and achieve measurable outcomes for (a) federally and state-listed endangered and threatened species, and imperiled species; and (b) economically important water-based recreational uses. It will accomplish this by developing a plan within the next three years that compiles and develops near-term projects and methods that address these high-priority needs, including projects the BIPs identified. This work will build on the work of the basin roundtables and the SWSI, including the work done in Action 1 above. At the same time, the CWCB will continue to provide technical and financial assistance to support the strategic implementation of currently identified projects.
3. **Common metrics:** In coordination with other state agencies, basin roundtables, and other stakeholders, the CWCB will develop common metrics for assessing the health and resiliency of watersheds, rivers, and streams.
4. **Watershed master plans:** As Section 7.1 indicates, the CWCB will work with watershed and other stakeholder groups toward a long-term goal of developing watershed master plans for every large watershed area to maintain watershed health. The CWCB will encourage and support capacity in areas that currently do not have watershed groups or other broad, local stakeholder groups.
5. **Stream management plans:** To promote healthy watersheds, rivers, streams, and wildlife, the CWCB encourages and will work with basin roundtables and other stakeholder groups to develop stream management plans for priority streams identified in a BIP, or otherwise identified as having environmental or recreational value. As part of this work, the CWCB will provide guidelines and templates for developing stream management plans, and will conduct ongoing analyses through the SWSI. To ensure continued planning and implementation in this context, the CWCB will explore additional funding sources, in addition to funding sources the 2015 CWCB Projects Bill provides.
6. **Incorporation of drought and climate change:** The basin roundtables and the CWCB will incorporate into the BIPs and the next update of the SWSI the potential effects of drought and climate change on environmental and recreational attributes.
7. **Multipurpose projects:** To support the development of multipurpose projects and methods, the CWCB will work with the basin roundtables and other stakeholders on an integrated approach to understanding how environmental and recreational projects and methods can interact with municipal,

agricultural, and industrial projects and methods to achieve multiple benefits. The CWCB will strategically support the implementation of BIP-identified multipurpose, projects, and methods that help meet environmental, recreational, agricultural and community water needs. It will accomplish this with state financial and technical resources, taking into consideration locally identified geographic and/or seasonal gaps. This will include establishing priorities in Colorado's grant and loan programs for multipurpose projects and methods. Working with the basin roundtables and BIPs, the CWCB will also coordinate with project sponsors to explore and support opportunities to increase benefits to environmental and recreational values associated with existing and planned storage and infrastructure.

8. **Proactive implementation of existing programs:** The CWCB, other state agencies, basin roundtables, and other interested stakeholders will continue to support and implement state programs that benefit environmental and recreational attributes, such as the Colorado Watershed Restoration Program, Instream Flow and Natural Lake Level Program, Wild and Scenic Rivers Act Alternatives Fund, and CPW's Wetlands for Wildlife Program. The DNR and its agencies will institute policies, criteria, and programmatic approaches to proactively developing projects and methods that strategically address important aquatic, riparian, and wetland habitats.

9. **Continued support of ESA activities:** The CWCB, CPW, and water users will continue to support and participate in collaborative approaches to ESA issues, including recovery programs, cooperative agreements, and other efforts to prevent listings and promote the sustainability of endangered, threatened, and imperiled aquatic- and riparian-dependent species and plant communities.

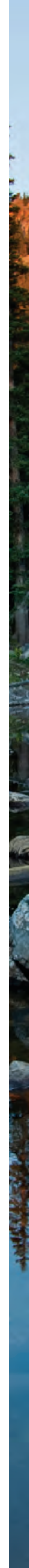
10. **Broadened support of recreational uses:** The CWCB will support local governments with water recreation opportunities through continued technical consultation and funding, where appropriate. To assist with water project planning, the CWCB will support the development of tools that can be used to better understand the relationship between stream flows and recreational water uses. Additionally, the DNR will explore opportunities to protect instream flows for recreational uses without the requirement of a control structure.

11. **Funding:** As Section 9.2 discusses, the CWCB will work with appropriate entities to strengthen funding opportunities for environmental and recreational projects, including funding for long-term monitoring and maintenance of such projects, by:

    a. Coordinating current funding

    b. Assessing funding needs

    c. Exploring additional funding opportunities



Sunrise reflection of Hallet Peak on Dream Lake, Rocky Mountain National Park.

A LOOK AT HISTORY

Construction of the Alva B. Adams Tunnel, a feature of the C-BT Project, began in 1940. The tunnel drops 109 feet in elevation over its 13.1 mile length and is 3,800 feet below the Continental Divide at its deepest point. The tunnel transfers water from the Colorado River drainage to Colorado's Front Range. Construction was suspended in 1943 for nearly a year due to WWII, but was completed on March 31, 1944. When the tunnel was holed through, NBC Radio broadcast the event live throughout the United States.

SOURCE: Bureau of Reclamation.

CAPTION: Thomas V. Cech, J William McDonald, Defened and Develop: *A Brief History of the Colorado Water Conservation Board's First 75 Years,* [Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

A LOOK AT HISTORY

Increasing demand for municipal water supplies along the Front Range, symbolized here by the growth of subdivisions on former farmlands, was one of the issues which prompted the creation of the IBCC process.

Courtesy of the Northern Colorado Water Conservancy District.

CAPTION: Thomas V. Cech, J William McDonald, Defened and Develop: *A Brief History of the Colorado Water Conservation Board's First 75 Years,* [Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

A LOOK AT HISTORY

Boy irrigating alfalfa, date unknown.

Courtesy of City of Greeley Museums, Permanent Collection. source: Bureau of Reclamation.

MARK MARLOWE, CONTINUED FROM PAGE 6-68

operations and lead a team of 79 employees in their mission of providing excellent service to over 55,000 residents. I also serve on a number of regional water boards including the South Metro Water Supply Authority and the WISE Authority. Prior to becoming the Utilities Director for the Town in March of 2013, I spent 10 years with Dalton (GA) Utilities most recently as the Senior Vice President of Watershed Services. In this position, I was responsible for running the water, wastewater, and stormwater business unit, an award winning full service utility that provided water service to approximately 100,000 people in Northwest Georgia. My career also includes experience working for General Electric as a project manager as well as several regional consulting/engineering firms in the Southeast over approximately a 10 year period before joining Dalton Utilities.

I earned a Bachelor of Arts (Russian Studies and Mathematics) from the University of North Carolina at Chapel Hill and a Bachelor of Science in Civil Engineering from the Georgia Institute of Technology. I also hold a Master of Environmental Engineering from the Georgia Institute of Technology and am a licensed professional Engineer in Colorado and Georgia. I have been a Rotarian since 2005 and served as the President of the Rotary Club of Dalton during the 2011 to 2012 Rotary year.

I am currently a member of the Rotary Club of Castle Rock. I live in Castle Rock with my wife and two children, Brett and Cecilia. I am an avid soccer fan, and coach my daughters in my spare time. My family supported my desire to come to Castle Rock to join Castle Rock Water because water is recognized by the community as the most important thing for the long term success of the community. I loved the idea of being a part of a community where the importance of water was recognized.

I spent the early part of my career searching for meaning in my life. First, I started searching in the environmental industry, but when I took a position with a water utility and became part of the mission of providing clean water and sanitation, I found my calling. In addition to loving water for all kinds of reasons (you need water for coffee and even more importantly hot showers a.k.a. heaven on earth), I quickly realized that it is the people in this "water" industry that make it so fulfilling. The people are servants of society in the truest sense of the word. Generally, they do what they do out of the sheer caring and loving of the communities they serve, not for money or recognition or any other reason. I cherish working with these people.

I am most proud of being selected and given the opportunity to work with the Castle Rock water team to secure the communities long term renewable water future. Castle Rock has a top notch team and has been a statewide leader in water conservation and long term water planning for many years. To get the opportunity to come from a utility in Georgia, and help lead this amazing team's efforts in Colorado, where water is king, is nothing short of a great honor.

My hope for water supply for the future is that we reach a point on earth where all human beings get to enjoy a hot shower, a clean bathroom, a cool glass of crystal clear tap water, and clean/safe natural water bodies for their beauty and recreational value. Of course, my other hope and quite honestly mission in life is to teach the world about the value of tap water, the best deal on the planet, a value thousands of times better than bottled water or anything else you can buy anywhere with money. I love spending my time working towards that future for my local community and when I get the opportunity, for others across the globe. I will work towards this future till I drop dead or am otherwise required by circumstances to retire from this mission.

HAROLD GRIFFITH, CONTINUED FROM PAGE 6-118

Born and raised in Fort Morgan, graduating from Fort Morgan High School in 1958, me and my late wife, Karenjo, owned Griffith Dairy in Morgan County where I milked Grade A cows for more than 50 years. We have nine children, 3 boys and 6 girls, as well as 22 grandchildren.

Passionate about water concerns in eastern Colorado, I spent much of my time as a farmer negotiating water agreements for Morgan County and beyond. I became a member of the Board of Directors for Fort Morgan Irrigation and Reservoir Company in 1977, became president in 1979 and helped with the establishment of the water court filing standards. also helped create a cadillac water plan for Morgan County residents. During my tenure with the commonly known Morgan Ditch Company, I was able to negotiate agreements with the City of Fort Morgan for parks and golf course water use and city of Brush for their municipal wells. One of my biggest accomplishments was the agreement with Public Service Company of Colorado, which created a 40 year lease for the water and sprinkler market.

Why did I do this? I am passionate about negotiating solutions so that farmers can continue to farm and do not run out of water. I am proud of the work I've done for the ditch system. These agreements have boosted the local economy for the Fort Morgan and Brush communities.

I am perhaps most proud of being part of and helping to create the Morgan County Dairy Calf Catch-it program. When participation dwindled to just a few students, I joined with other dairy farmers, and together created the Dairy Calf Catch-it program. A two-year program, students are given a dairy heifer to raise and care for before showing at the County Fair. The average price for the champion Dairy Heifer in the last two years has been $5,000. And in 2015, the Catch-It program had 12 participants. Although it is sponsored by local dairy farmers, veterinarians, and citizens, I believe it is about the students, not the sponsors.

In my youth, I was president of a Future Farmers of America chapter and head of the parliamentary procedure team (a skill I still use today). And I still use my Ag Work Manual on a regular basis – refer to it all the time.

ROBERT T. SAKATA, CONTINUED FROM PAGE 6-144

the risk associated with new inventive approaches and change.

I am a Colorado native, born and raised in Brighton Colorado on a family farm started by my fathe Bob Sakata. Currently, my parents, Joanna and Bob, and I are one of the largest fresh market sweet corn growers in Colorado. We also grow broccoli, cabbage, dry bulb onions, pinto beans, field corn, wheat, and barley. My father taught me the importance of investing in good land with good water and to care for those resources like family. With that upbringing, my interest has always been in science, and I worked for AmGen before going back to the farm. I served on the Colorado Water Quality Control Commission for 15 years, was a member of the Metro Basin Roundtable since its inception, and serve on the board of directors for several of the mutual ditch companies that my family farm receives irrigation water from.

Brighton, CO is where I was born and raised and now find myself growing old! Being just north of the Denver metropolitan area I have seen lots of changes but I couldn't ask for a better place to live. Once strictly a farming community, we still have a Cabbage Avenue na, which has grown to include many different industries. We maintain that small community feel…but it's great that we are only minutes away from all of the big city activities that the Denver metropolitan area has to offer.

It was such an honor to serve the citizens of Colorado on the Colorado Water Quality Control Commission for 15 years. In the semi-arid climate that we live in I think most people are keenly aware of water quantity issues but often as a headwaters state we take for granted water quality. In the past there has been a distinct division between water quantity and quality but as the resource becomes more limited the linkage between the two will mandate cooperative management discussions in order to meet both needs.

The Colorado Water Plan along with the Statewide Water Supply Initiative have highlighted the demands that will be placed on our water resources and my hope is simply that we don't end having water wars… like the song says, can't we just all get along? There will have to be a lot of creative minds that develop some unique partnerships to share this limited resource. To grow hig quality, nutritious fresh vegetables we need good soil, a good climate and a reliable supply of high quality irrigation water - it's as simple as that - no water-no food.

To be a farmer requires a person to have a lot of faith and belief that what you are doing is going to all work out. When you prepare the soil in the spring, plant the seed, irrigate and nurture it through the summer you are hoping that after months of dedication, you will finally be able to harvest your crop. No different than that, Coloradoans need to step up and know that planning for tomorrow is more important than what we may desire for today. I truly believe that locally grown fresh nutritious vegetables are an important piece of the overall well being of our society. When I went off to college the last thing I wanted to be was a farmer because watching how hard my parents worked when I grew up I knew that there had to be an easier way to earn a living. My goal was to get into molecular cellular research and to find the cure for cancer…little did I realize then that as a vegetable farmer I was already providing the cure…and now as a farmer I feel I am doing more than I ever could in oncology research. I am committed to ensure that I can continue to play an important role in being a part of creating my hope for the future… as a farmer.

JACKIE BROWN, CONTINUED FROM PAGE 6-158

done wisely in a manner that allowed slower growing basins to develop in their own time. I hope to see SB1177 continue, which supports collaboration.

I grew up in Steamboat Springs, Colorado. I am a self-proclaimed lifelong learner who has studied at Boston University, the University of Colorado and Colorado State University. I have a diverse career background spanning project and business management, natural resources, and of course, water in the west. I am currently the Natural Resource Policy Advisor to Tri-State Generation and Transmission. I live in the mountains with a fantastic husband, a four-year old son, and a stubborn black lab puppy who all remind me constantly of the important things in life – not cleanliness.

I became addicted to water at a young age – constantly drenched in fluid or frozen water. My interest in policy came about in 1999 on a trip through the Grand Canyon. As a water rat once said, "there is nothing – absolutely nothing – half so much worth doing as simply messing about in boats" (*Wind in the Willows* by Kenneth Grahame). Living in Steamboat Springs in 2008, I began attending Basin Roundtable Meetings and the rest is history. It gives me great pleasure to work with people and the resource that sustains us.

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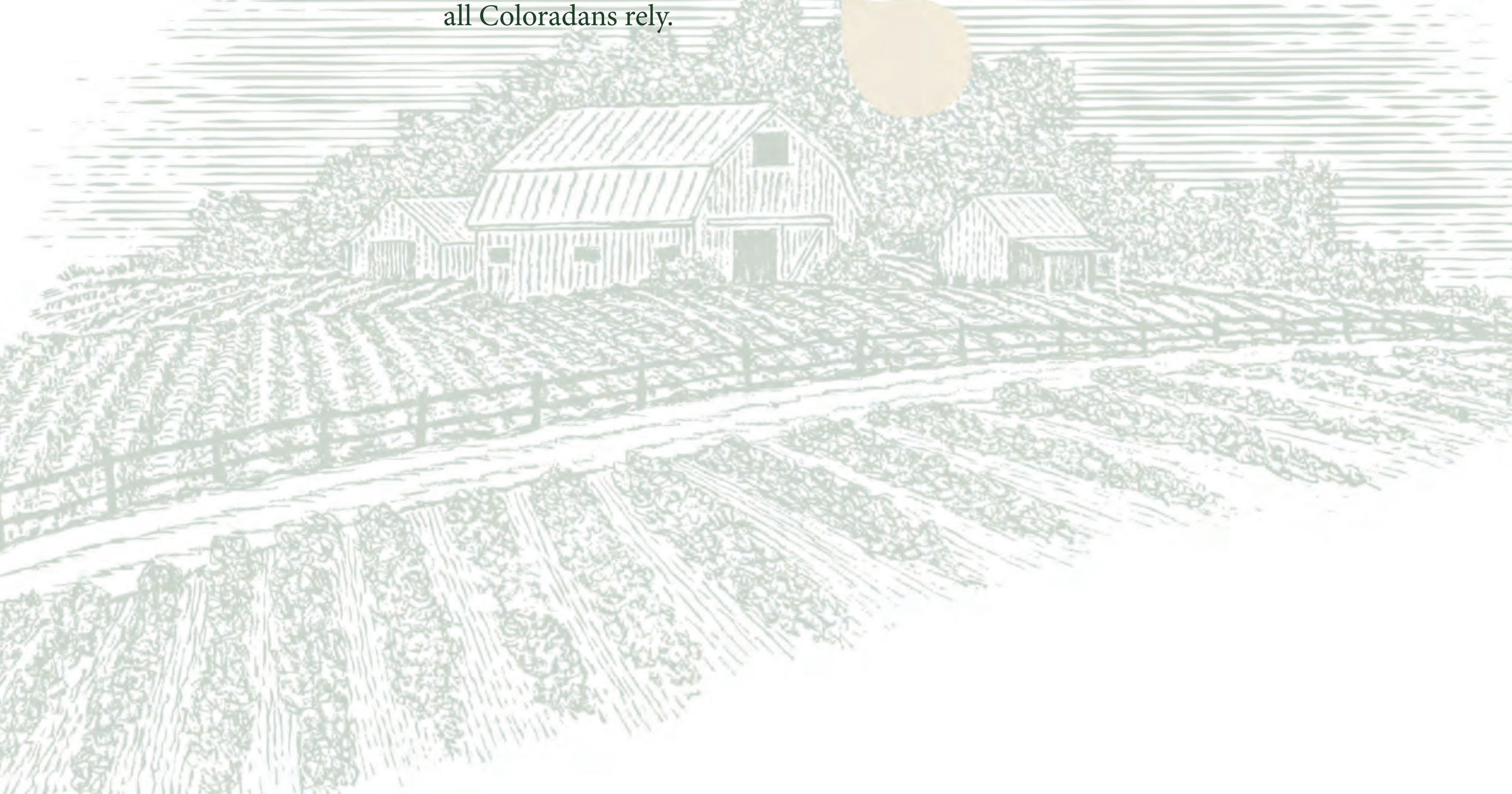
Water Resource Management and Protection

Chapter 7 examines factors beyond supply and demand that affect water availability, such as natural hazards, watershed health, and water quality. Section 7.1 delves further into watershed health, including the effect of natural disasters on watershed health, management strategies, and the critical role watershed health plays in ensuring Colorado's water future. In particular, this section, emphasizes the ways stakeholders can work together through collaboration and information-sharing. Section 7.2 provides an overview of natural hazards, which can result in serious consequences for our state's watersheds, drive up demands for water, and influence water quality. Natural hazards and watershed health influence water quality, which is of utmost importance to water providers, and Colorado's wildlife, which depends on healthy streams. Section 7.3 provides a detailed exploration of watershed management, watershed quality and quantity, and the organizations and regulations that are charged with watershed protection. Together, these three elements help to ensure that Colorado is adequately prepared to not only manage, but to protect, the water resources upon which all Coloradans rely.



Fires can seriously degrade the water quality and capacity of reservoirs for years to come. Flash flooding can carry burnt earth and debris into them. This underscores the need for healthy watersheds and natural disaster preparedness and recovery.
High Park Fire, 2012.

7.1 WATERSHED HEALTH AND MANAGEMENT

GOAL

Colorado's Water Plan promotes watershed health and supports the development of watershed coalitions and watershed master plans that address the needs of a diverse set of local stakeholders.

Introduction

Watersheds connect terrestrial, freshwater, and coastal ecosystems. They also provide ecosystem services, such as carbon sequestration, water supply, filtration, and purification.[1] Colorado watersheds support multi-objective uses for both consumptive and nonconsumptive water supply. Approximately 80 percent of Colorado's population relies on forested watersheds to deliver municipal water supplies.[2] Watershed health management strategies that protect this domestic supply will also protect other uses in the watershed.

Colorado's mountain watersheds have a strong influence on the quality and quantity of water. Watershed geography includes physical aspects, such as climate and geology, and ecological aspects, such as stream biology; but it also examines the relationships between humans, land and water. Healthy watersheds provide ecosystem services that benefit ecological processes, local and state economies, and social stability. Ecosystem services include flow regulation, flood attenuation, water purification, erosion control, dilution and flushing of contaminants, and habitat protection.

This section begins by defining the physical processes that influence watershed health, and then discusses recommended strategies for successful stewardship of watersheds and water supply. It concludes with a summary of the roundtables' watershed health strategies.

Watershed Health Science

A watershed is an area of land in which all water drains to a common point. Watersheds exist at all spatial scales, from the tiniest of tributaries to the largest rivers on earth. John Wesley Powell defined a watershed as "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community." Headwater areas include forested watersheds, intermountain wetland complexes (parks), and the riparian corridors of stream valleys, and are the natural forebays of Colorado's water supply. As water from snowmelt and rain travels down-gradient to reach rivers, it must move through varying terrain, interacting with the watershed's biology and physical environment. This is the watershed's ecosystem. Water quality and quantity are intimately linked to watershed health.

Broadly defined, watershed health is a measure of ecosystem structure and function. Structure refers to species richness (characterized by abundance and diversity), inorganic and organic resources, and physical attributes (including habitat complexity). Function refers to ecosystem processes such as the hydrologic cycle, nutrient cycling, energy flow, and succession.[3] A critical component of the hydrologic cycle is flow regime. Flow regime defines the magnitude, duration, frequency, rate of change, and timing of flows in stream systems. Magnitude refers to a river's discharge. Duration describes the period of time during which a river experiences a given discharge. The frequency at which a river experiences a given discharge and the rate at which discharges increase and decrease (i.e. change), also characterizes flow regime. Finally, a watershed's hydrologic function influences the timing of discharges, or seasonality. Figure 7.1-1 represents an annual median-flow hydrograph for a snowmelt-driven stream. This figure describes the different elements of flow regimes. Society has adapted its water supply infrastructure to the flow regime of its watersheds. Changes in ecosystem structure and function have direct and indirect effects on a stream's flow regime.

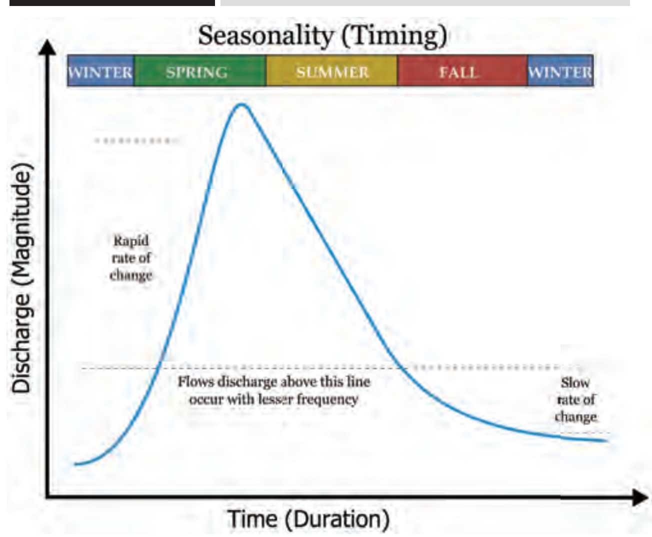
Watersheds support dynamic ecosystems that are subject to natural perturbations, such as fire, flood, and drought.[4] Resilient ecosystems exist in a state of dynamic equilibrium (for example, the flow regime may deviate around a mean while still maintaining its function). These watersheds experience natural disturbances with little effect on function. Often, anthropogenic, or human-induced, activities exacerbate the impacts resulting from fire, flood, and drought. For example, watersheds that have historically been managed to suppress fires have changed ecosystem structure and productivity. This results in fires that burn with greater intensity and leads to soil hydrophobicity, which in turn increases runoff and erosion. When natural ecosystem functions are altered, a watershed may no longer exist in equilibrium. The resultant changes to hydrologic function and water quality may have direct effects on water supply and infrastructure.

Sediment is the most concerning non-point source pollutant our forested lands contribute.[5] An accelerated delivery of sediment in rivers has negative effects on both consumptive and nonconsumptive water uses. Sediment flows into river systems through natural processes that connect land and water. High- to moderate-severity fires, forest roads with failing stormwater management infrastructure, and other processes in which humans or natural causes alter the landscape cause erosion, which increases the volumes of sediment in river systems.

Forests and riparian corridors provide ecosystem services for watersheds that help protect, restore, and sustain water quality and quantity. Healthy, forested watersheds absorb rainfall and snowmelt and allow it to runoff slowly, recharge aquifers, sustain streamflows, and filter pollutants. Healthy forest ecosystems largely protect watersheds because they protect soil, thereby preventing erosion, promoting soil-moisture storage, and allowing groundwater recharge.[6] These services can offset natural hazards by reducing floods, maintaining plant communities, and reducing contaminants. Present-day forest-health concerns are largely attributed to climate change and forest-stand density, ecosystem productivity.[7] Climate change has the potential to affect watershed health by increasing temperatures, altering precipitation patterns, and causing earlier snowmelt. This results in potential increases in stream temperatures, increased pollutant concentrations, reduced quality of aquatic habitats, and loss of wetlands. Conversely, healthy watersheds may increase climate change resiliency and provide natural carbon sequestration.[8]

While forests are vital to overall watershed health, lower elevation rangelands comprise the remaining lands in the watershed. Rangelands, wetlands, and riparian corridors play a substantial role in water storage, transport, sediment control, water quality,

FIGURE 7.1-1 STREAM HYDROGRAPH



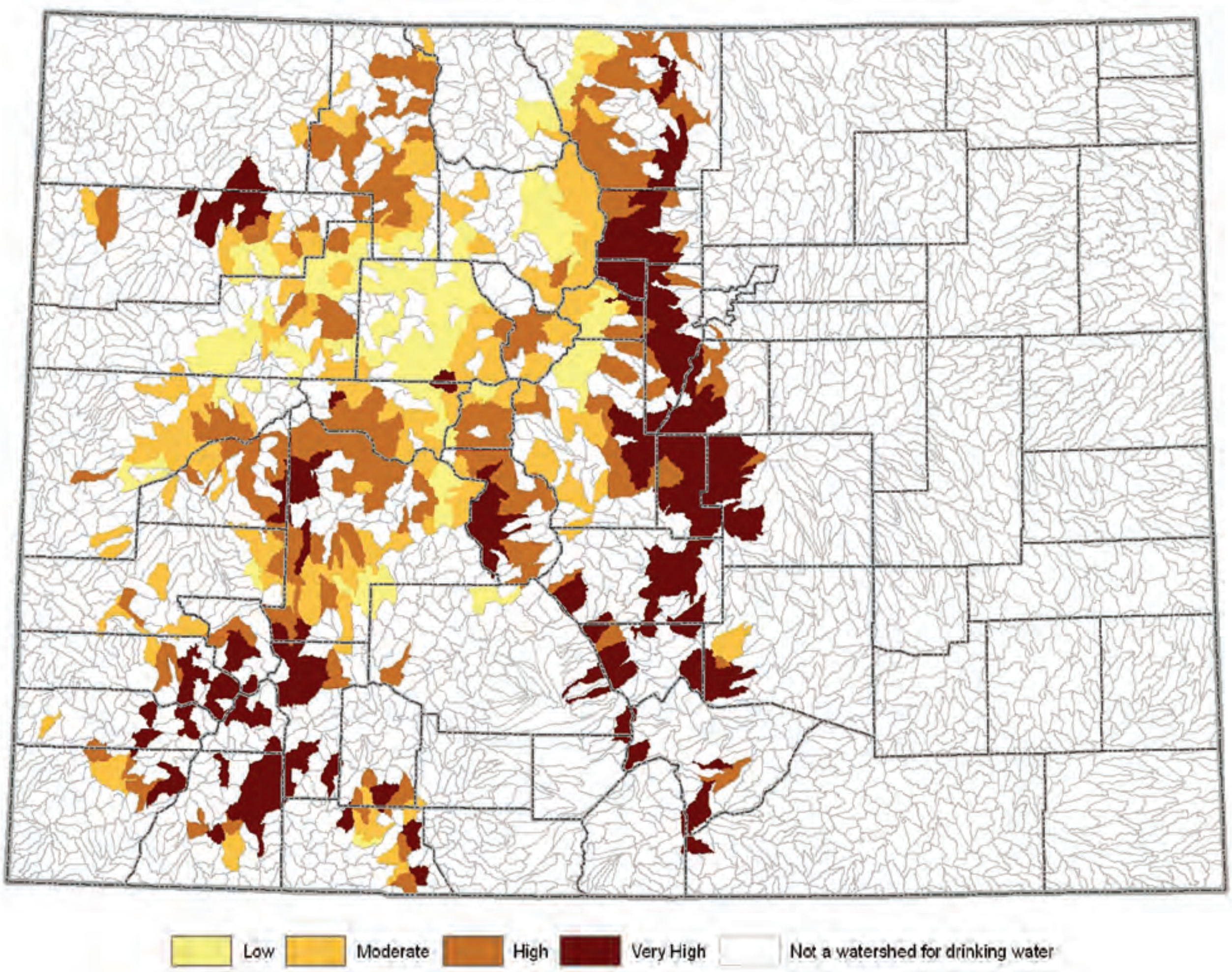
wildlife habitat, and streamflows. The presence of wetland complexes and optimal agricultural practices may favorably influence lower-elevation watershed health.

Watershed Partnerships

Watershed management for healthy ecosystem structure and function can provide a unique opportunity for watershed stakeholders. Successful watershed management necessitates a pragmatic approach that includes coalition-building, data collection, planning, prioritization, implementation, and monitoring. This is a cyclical process, and each phase requires continued efforts. Watersheds span across political boundaries, and watershed health management involves collaboration among many interested entities. Natural resource management may be the driver that catalyzes a need for collaboration, but social, political, and economic interests must be represented as well.

A watershed approach is a flexible framework for managing water-resource quality and quantity within specified drainage areas, or watersheds. This approach includes stakeholder involvement and management

FIGURE 7.1-2 COLORADO STATE FOREST SERVICE RISK OF POST-FIRE EROSION IN WATERSHEDS THAT ARE IMPORTANT SOURCES OF DRINKING WATER




Healthy watersheds are critical not only for wildlife and streams, but also water quality and water infrastructure.

actions supported by sound science and appropriate technology. Coalition-building typically starts when interested parties come together to discuss a watershed health concern. For example, Colorado identifies many watersheds as having a high post-fire erosion risk as well as being a critical watershed for water supply (Figure 7.1-2).[9] This is an example in which concerned stakeholders can engage in collaborative dialogues to address very real watershed health concerns. Coalitions form to address a variety of concerns, including pre- and post-fire mitigation, forest mortality, water quality impairments, potential impacts of abandoned mines, flood mitigation and recovery, aquatic and riparian habitat enhancement, and land-use change. In September 2013, flooding in the Front Range resulted in the formation of 10 new watershed coalitions that developed master plans focusing on stream restoration. Other groups may come together to discuss watershed protection in well functioning ecosystems. Collaboration before a threshold-crossing disturbance takes place sets the stage for faster and more resilient recovery measures.

The State of Colorado recommends that partnerships form an organizational structure consisting of a diverse stakeholder group and a coordinator. The State recommends this structure whether or not the coalition chooses to become incorporated. The coalition should be open to diverse interests within the watershed, as well as to interests the watershed outputs directly affect. Diverse stakeholder input at the beginning stages of coalition-building increases the likelihood that actions to improve watershed health will succeed. Engaged community members are more likely to participate in building political will, developing management options, and supporting project implementation. Stakeholder representation includes all levels of government, special districts, private landowners, businesses, citizens, nonprofits, educators, recreational interests, agricultural interests, grantors, and conservationists. A paid watershed coordinator improves the chances for continued coalition success by servicing all coalition stakeholders equally and by representing the interests of all coalition members. They are the unifying body, the moderator, the facilitator, and the manager. It is helpful for this person to have a background in both nonprofit and governmental work.[10]

Ideally, partnerships work to develop a watershed plan. A watershed plan is a strategy that defines a coalition's mission, goals, and objectives, along with assessment and management information, for a geographically defined watershed. The strategy should include the analyses, actions, participants, and resources related to developing and implementing the plan. It may include or be informed by a streamflow management plan (which Chapter 6.6 defines). The plan may serve as a guide for mitigation of fires and floods, or for the development of new infrastructure. It can also offer a holistic approach for the rehabilitation of stream systems. The watershed plan development process will require a leader with a certain level of technical expertise, and the participation of a variety of stakeholders with diverse skills and knowledge. These participants will aid in the assemblage and assimilation of watershed information—including geographic information systems data, maps, monitoring reports, risk analysis, and existing assessments.

A holistic watershed planning approach will provide the most technically sound and economically efficient means of addressing watershed health concerns. The involvement of stakeholders strengthens the process. This approach will address all of the beneficial uses of the water that the watershed supplies, the criteria needed to protect the uses, and the strategies required to restore or protect ecosystem processes. This approach also expedites cooperative and integrated water-supply planning, which leads to successful implementation of watershed health management strategies. Examples of partnerships formed to address these issues are detailed below.

Forest Health Partnerships

Fires are a part of Colorado's forest ecosystems. Forest management for fire prevention has proven to exacerbate burn intensity.[11] Many stakeholders have come together to address forest health through fire mitigation strategies. The USFS has partnered with Colorado's municipal water providers, state agencies, and private interests through the Rocky Mountain Protection Partnership. This partnership functions to preserve water quality by mitigating the effects of forest-landscape change that severe fires and pine beetles have caused.[12] It is also a venue to strategize post-fire restoration in critical watersheds on public and private lands. Key municipal water providers include Denver Water, Aurora Water, Colorado Springs Utilities, Northern Water Conservancy District, and the Pueblo Board of Water Works. The National Forest Foundation and the Coalition for the Upper South Platte are nonprofit organizations that play a critical role in the partnership. Federal and state funds are leveraging partner funds to plant trees, treat hazardous fuels, restore riparian and wetland areas, treat invasive species, restore trails, decommission roads, restore stream channels, and engage volunteers.

Federal, state, and local governments and private partners formed the Watershed Wildfire Protection Group in 2007. The group's vision "is to protect Colorado water supplies and critical infrastructure from catastrophic wildfire and other threats by maintaining healthy, resilient watersheds through collaboration, implementation, leveraging, and education." Core members of this group include the CWCB, the Colorado State Forest Service, the USFS, Denver Water, Aurora Water, the Coalition for the Upper South Platte, and J.W. Associates. The group provides education and outreach activities statewide and connects practitioners with funders.

The CWCB recommends that those who are considering the formation of forest-health partnerships read the Forest Land and Resource Management Plan for their national forest, as well as consult the entities above. These partnerships have explored and prioritized strategies to implement pre- and post-fire mitigation projects for the improvement of forest health and protection of critical water supplies. Existing forest health partnerships are adept at leveraging funds and resources from federal, state, and local government agencies as well as from private companies, foundations, and nonprofits. The CWCB has leveraged funds from various grant programs to improve forest health. These include the Colorado Healthy Rivers Fund, the Colorado Watershed Restoration Program, the Fish and Wildlife Resources Fund, and the Water Supply Reserve Account. The success of the Watershed Wildfire Protection Group helps showcase it as an example for other watershed partnerships, as it is exemplary in its efforts to build consensus among diverse stakeholders and implement cost-effective strategies that benefit all interests.

Basin Implementation Plan Strategies

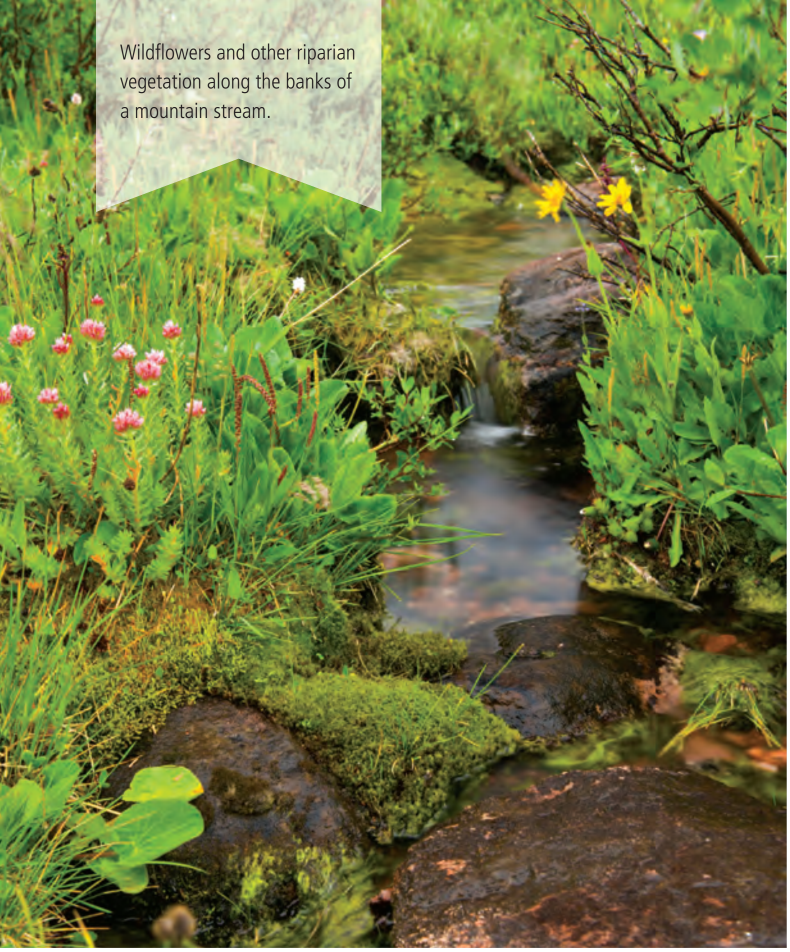
With the roundtables' guidance and CWCB's recommendation, watershed health for individual basins largely focuses on forest-health concerns. Forest health concerns center on wildfire, flooding, and sedimentation. The CWCB asked basins to identify projects and methods that would protect critical water supplies and the environment in the event of a natural disaster at the watershed scale. The CWCB recommended that basins assemble or develop existing watershed assessments. It also recommended that basins begin collaborative discussions on managing forests to benefit water supply. The CWCB encouraged basins with water supplies originating in another basin to work collaboratively.

FIGURE 7.1-3	COALITION STAKEHOLDER FIGURE

> The Arkansas Basin illustrates a process with a strong emphasis on pre-disaster preparedness through collaborative dialogues with potentially affected parties.

All of the basin roundtables identify wildfire as a watershed-health concern. This includes recovery from existing fires and identification of pre-fire mitigation strategies. The Arkansas Basin illustrates a process with a strong emphasis on pre-disaster preparedness through collaborative dialogues with potentially affected parties. Figure 7.1-3 outlines the Watershed Health and Emergency Event Life Cycle and the role of stakeholders.[13]

The Rio Grande Basin contributed to the Arkansas Basin's watershed health planning process and closely aligns with that of the Arkansas Basin's approach to watershed health. The primary goal of the basin is to "protect, preserve and/or restore the sustainability of the Rio Grande Basin watershed by focusing on the watershed health and ecosystem function." The basin developed a collaborative watershed coalition during the 2013 West Fork Fire, and discovered the benefits of such a group for restoration and protection of forested watersheds. The coalition known as the Rio Grande Watershed Emergency Action Coordination Team (known as RWEACT) has modeled post-fire hydrology, improved its ability to forecast storms, identified flood potential, and developed post-wildfire flood-risk analysis maps. The basin's watershed health


Wildflowers and other riparian vegetation along the banks of a mountain stream.

actions emphasize forest management and stakeholder coordination. Methods to improve forest health include forest thinning and prescribed burning. In addition, the Rio Grande Basin included soil health for agricultural lands as a key action in its plan.[14]

> "The basin [Rio Grande] developed a collaborative watershed coalition during the 2013 West Fork Fire, and discovered the benefits of such a group for restoration and protection of forested watersheds."

The South Platte and Metro Basins also participated in the Arkansas Basin's watershed-health planning process. They propose a collaborative dialogue that focuses on post-fire mitigation across watershed (basin) boundaries. Deliverables resulting from this process will include the development of forest-health manuals at a statewide level. The basin watershed-health section in this plan also discusses insect infestations, but concludes that insects have little direct influence on water quality and quantity.[15]

The Southwest Basin has a history of collaborative watershed groups focused on watershed-health topics. This includes forest health and resiliency planning for the San Juan and Piedra watersheds; water quality monitoring and action on the Animas River; watershed health assessments for the Mancos, Dolores, and San Miguel watersheds; and development of Source Water Protection Plans for 23 public water suppliers. A Source Water Protection Plan inventories potential sources of drinking-water contamination in a defined watershed. These efforts have fostered dialogue and action that can help protect critical water supplies from fire risk, contaminants, and other hazards.[16]

> "The South Platte and Metro Basins also participated in the Arkansas Basin's watershed-health planning process."

The Yampa, White, and Green Basin states that more than one-third of its jobs are dependent on water quality, which is influenced by watershed health. They acknowledge that communities in the basin are susceptible to water quality issues that severe wildfires cause. The basin references a Critical Community Watershed Wildfire Protection Plan entitled, "Upper Yampa Phase I Watershed Assessment: Prioritization of Watershed Base Hazards to Water Supply." The plan frequently recommends watershed-wildfire planning for watersheds that are critical to water supply, and provides composite hazard rankings for wildfire hazards, flooding/debris flow-risk, and soil erodibility. These data are combined with Source Water Assessment and Protection data to prioritize critical watersheds.[17] Presently, the Watershed Wildfire Protection Plan prioritizes forest-health treatments for watersheds that are critical to drinking water supply; however, the basins could apply these treatments to any prioritized water use.[18]

> "The Yampa, White, and Green Basin states that more than one-third of its jobs are dependent on water quality, which is influenced by watershed health."

The Gunnison Basin is addressing forest-health concerns by partnering with the Colorado State and USFS to manage forests, insects, and wildfire. The basin also expects to conduct education and outreach associated with this effort. It did not participate in the Arkansas Basin's watershed-health planning process, but does plan to reference produced materials for future watershed-health projects. That said, several local watershed groups are working in the Gunnison Basin to address general watershed health and specific water quality challenges. These groups have developed comprehensive watershed plans.[19]

> "The Gunnison Basin is addressing forest-health concerns by partnering with the Colorado State and USFS to manage forests, insects, and wildfire."

A goal of the North Platte Basin is to enhance forest health and management efforts for wildfire protection and beetle-kill effects on watershed health. To reach this goal, the basin has funded a major study that monitors forest beetle-kill, wildfire potential, and effects on water quality and quantity. It also looks at management alternatives in the post-beetle kill forest environment. The study is nearing completion, and the basin intends to review, disseminate, and implement recommendations the study identifies.[20]

> "A goal of the North Platte Basin is to enhance forest health and management efforts for wildfire protection and beetle-kill effects on watershed health. To reach this goal, the basin has funded a major study that monitors forest beetle-kill, wildfire potential, and effects on water quality and quantity."

The Colorado Basin identifies 14 collaborative watershed groups that are actively engaged in improving watershed health. Primary watershed-health concerns in the basin include wildfire risk and the evolving forest landscape; both have the potential to impair water supply. The basin supports watershed wildfire assessments, and there are currently 18 Community Wildfire Protection Plans within the basin.[21]

ACTIONS

To better understand and promote watershed health, it is important to support the development of watershed coalitions and watershed master plans that address needs from a diverse set of local stakeholders. The parties responsible for implementing action plans should be watershed coalitions and forest partnerships. Water-supply stakeholders should participate in the development of effective watershed coalitions. The Watershed Wildfire Protection Group, other watershed groups with a state- or region-wide geographic scope, and state agencies focusing on watershed health should manage coordination across watershed divides. State agencies include CPW, the CDPHE, and the CWCB.

Actions include:

1. Identify existing watershed coalitions and existing watershed plans and assessments, including source-water protection plans.
2. Encourage and support capacity in many areas that currently do not have watershed groups or other groups that work with a broad set of local stakeholders
3. Assist stakeholders in existing watershed groups to identify tools and resources that address gaps and build capacity in existing plans.
4. Identify public and private funding sources that together can support watershed- and forest-health projects.
5. Identify watersheds that are critical to water supply.
6. Work toward a long-term goal of developing watershed master plans for watersheds critical to consumptive and nonconsumptive water supply.
7. Prioritize and implement projects identified in master planning.
8. Monitor projects to ensure that objectives are met and maintained.
9. Conduct adaptive management as necessary.
10. Coordinate statewide watershed-coalition and partnership plans, projects, monitoring, and adaptive management strategies.
11. Watershed management plans may include potential impacts to the environment, public water supplies, and agricultural production from abandoned mines, and a strategy for addressing these impacts. CDPHE and DRMS are potential partners in developing a prioritized list of mines which could impact streams.

7.2

NATURAL DISASTER MANAGEMENT

GOAL

Colorado's Water Plan promotes water resource resilience from natural disasters through strategic preparedness and response.

Natural disasters are potentially devastating natural events that may have detrimental effects on the state and its economy. In Colorado, we are prone to droughts, floods, earthquakes, tornados, and wildfires. Since the turn of the current century, Colorado has experienced many record-breaking natural disasters. These have included our most intense single-year drought in 2002; our most expensive wildfire, the Waldo Canyon Fire of 2012; our most destructive wildfire, the Black Forest Fire of 2013; our most expensive winter storm in 2003; and our most expensive summer storm in 2009. In fact, 54 percent of all homeowner insurance claims between 2009.[22] and 2013 were a result of catastrophe, more than double the rate for the previous 12 years.[23] Natural disasters do not only affect people and property; they may also have serious negative effects on our water systems and on the amount of water that is available for meeting the needs of Coloradans. Additionally, climate change has the potential to influence the frequency and severity of these events in the future.

The Effects of Climate Change on Natural Disasters

In 9 out of every 10 years, a portion of the state experiences some level of drought conditions.[24] As Chapter 4 discusses, droughts and floods that make our water availability so variable may also bring devastating economic and natural consequences to Colorado. The State has invested heavily in developing both structural and nonstructural flood mitigation activities, and leads the nation in innovative drought preparedness planning. Although we cannot avoid or prevent natural disasters, investments in planning and preparedness can help reduce adverse effects.

Given that water influences nearly all sectors of Colorado's economy, and that too little or too much water can have a substantial effect on the environment and the economy, it is important to understand how climate change may affect the frequency, duration, and intensity of natural disasters. The CWCB has conducted several studies to examine the ways in which climate change will affect water resources. These studies include Climate Change in Colorado, The Colorado River Water Availability Study, The Joint Front Range Climate Change Vulnerability Study, the Colorado Drought Mitigation and Response Plan, and the Colorado River Basin Water Supply and Demand Study.[25]

The most likely effect of future climate change on water supplies is a shift in the timing of runoff. Projections indicate that runoff timing will shift one to three weeks earlier by mid-century due to increased temperatures.[26] This shift may affect water rights holders that are only permitted to withdraw their allocation during specific timeframes, and those with limited storage. It is also likely to result in decreased late-summer streamflow due to both increased temperatures, and the projection that precipitation will generally increase in the winter months and decrease in the summer months.[27] At the same time, increased population and higher crop irrigation requirements will put additional pressure on a changing water supply.[28]

Although precipitation trends are far less clear than temperature trends, some studies have examined what floods and droughts might look like under an altered climate. Colorado's paleoclimate record shows droughts that are longer-lasting and more intense than those experienced in the 20th and early 21st centuries.[29] That said, there is much variability across the state. For instance, in the Yampa/White River Basin, the hydrologic paleo record shows that streamflows are variable enough to capture all but the wettest projected flows under various climate change conditions. Conversely, in the Arkansas River Basin, paleo flows accurately represent only one of the climate projections, and none of the driest.[30] These records reinforce that the past may not be a good predictor of the future.

When one directly examines flood and drought extremes under projected future climate conditions, substantial variability exists across the state. On the Colorado River at Cameo, the average intensity for droughts was somewhat greater than the historical intensity (-24 percent versus -19 percent), while the intensity of surplus, or flood spells, was considerably lower than the historical surplus (27 percent versus 46 percent). When one takes into account climate projections, future projected drought intensities for the same-length event range from -19 percent to -32 percent, while surplus intensities range from 17 percent to 38 percent. The frequency of such events depends on which climate projections one uses.[31]

The frequency and intensity of wildfire may also change under a warmer climate, and will continue to affect watersheds and ecosystems. While it is understood that variability in Colorado's climate will continue long into the future and will include wildfires, drought, and floods, the influence of climate change on these events is less certain. The use of scenario planning enables the State to modify and adapt planning processes as new information becomes available, which will increase flexibility and resiliency in planning.

SEAN CRONIN

SOUTH PLATTE RIVER BASIN

Sean is the Executive Director for the St. Vrain and Left Hand Water Conservancy District in Longmont and was involved in the flood recovery efforts during the 2013 floods that ravaged northeast Colorado. He also chaired the South Platte Basin Roundtable during the creation of the South Platte Basin Implementation Plan and Colorado's Water Plan.

I believe Colorado's future depends on the same vision, drive, and selflessness possessed by past water leaders. I am confident that today's water professionals have those same qualities to "pay it forward" to the next generation. I believe this because Colorado's Water Plan has evolved the water community and enabled it to better appreciate diverse perspectives, openly discuss once-taboo topics, and gather some of the most visionary, driven, selfless, and passionate professionals our state has to offer. I view Colorado's Water Plan as the ultimate in paying...

CONTINUED AT END OF CHAPTER

PROFILE

Historic floods in 2013 damaged several portions of Highway 36 between Estes Park and Lyons.

Preparedness and Response

Looking back at Colorado's recent history, the last few years have demonstrated the extreme variability Colorado faces. The year 2011 was historically wet, 2012 was historically dry, and 2013 was both historically dry and wet. This variability presents immense challenges to water supply management and planning in Colorado.

The State gathered stories about the flood of 2013 illustrating water infrastructure and diversion structures that were damaged, facilities that were severely disconnected from stream and river channels, streams and rivers that substantially changed course, homes and businesses that were damaged or washed away, watersheds that were affected by fire followed by flood, and thousands of agricultural acres that became at risk of damage. The State and other agencies across Colorado responded expediently with grant and loan resources. This level of response teaches two things:

1. Coloradans know how to face and recover from disasters. People came together to support their neighbors, and thousands of unknown heroes made a huge difference in the lives of their neighbors and communities.
2. Even when people come together to face catastrophe, having a plan and sufficient resources in place ahead of time makes both the immediate response and the long recovery effort easier and less costly. In fact, studies have shown that for every one dollar of investment in natural hazard mitigation, society saves four dollars in response costs.[32]

Following the 2013 floods, the United States Department of Housing and Urban Development approved Colorado's Community Development Block Grant – Disaster Recovery to include the Watershed Resilience Pilot Program. The CWCB and the DOLA jointly developed this innovative holistic program to provide watershed restoration, risk mitigation, and community and economic development using a collaborative, coalition-of-partners approach. The program identifies an immediate need to focus on capacity-building, comprehensive watershed planning, and project implementation to address long-term catalytic watershed system improvements. The program will support capacity-building; additional watershed master planning and conceptual design activities (including modeling and mapping); planning for multi-objective uses such as green infrastructure, greenways, recreation, transportation, and recreation; and funding for the implementation of projects that result from cooperative planning efforts. This pilot program will receive an allocation of $25 million. The U.S. Department of Housing and Urban Development has never-before approved a watershed resilience pilot program.

The 2013 floods did result in an opportunity to implement various resiliency projects during the recovery period, which may continue in the event of future floods within the state. As an example, the 2013 flood resulted in unprecedented levels of damage to water supply infrastructure, creating the need to quickly rebuild in order to restore water management capabilities. The CWCB, CPW, and other partners encouraged water providers to consider multiple-objective designs when repairing diversion structures and other damaged infrastructure. These multiple-objective designs encourage processes that can enhance fish passage, recreational uses, and movement of sediment. Many rebuilt structures incorporated these design elements. Nevertheless, as the 2013 flood recovery demonstrated, current levels of funding and the need for quick rebuilding often hampered well-intentioned efforts to incorporate these new features. New or enhanced funding sources for these activities must continue to grow in order to be readily available and implemented into this infrastructure at key times.

Agencies successfully implemented other processes during the recovery from the 2013 floods. For example, the CWCB and the Colorado Department of Transportation (CDOT) have begun a very successful partnership to incorporate design principles for stream restoration and highway-rebuilding into a complementary, holistic process. The process has resulted in more-resilient stream and highway corridors and has saved money during the construction process. The State must continue this model in road and stream alignments, especially in the steep-canyon environments.

Damaged streams resulting from the 2013 floods highlighted the need for updated floodplain mapping that more accurately reflects post-flood conditions. A re-study of the hydrology of the flood-affected areas indicated that in many of the damaged watersheds, the regulatory flood hydrology that had been in place for as long as 40 years understated the flood risk. Senate Bill 15-245 put into place State-funded mapping processes that will accurately reflect this higher level of risk. Nevertheless, this process underscored the point that updated, statewide studies based on modern methods are necessary to ensure that the State adequately convey flood risk to landowners, and that important land-use decisions will rely on accurate information.

As Section 6.1 describes, the future is uncertain. While Section 6.1 describes the types of projects and methods the State generally needs for scenario planning and adaptive strategies for average conditions, this section focuses on variability from year to year. In any given year, Colorado must be prepared to respond adequately to the extremes of flood, drought, and fire. To support local communities and prepare for disasters that affect our water supply, the State's many agencies and programs work to both prepare for and respond to extreme events, and will continue these efforts into the future.

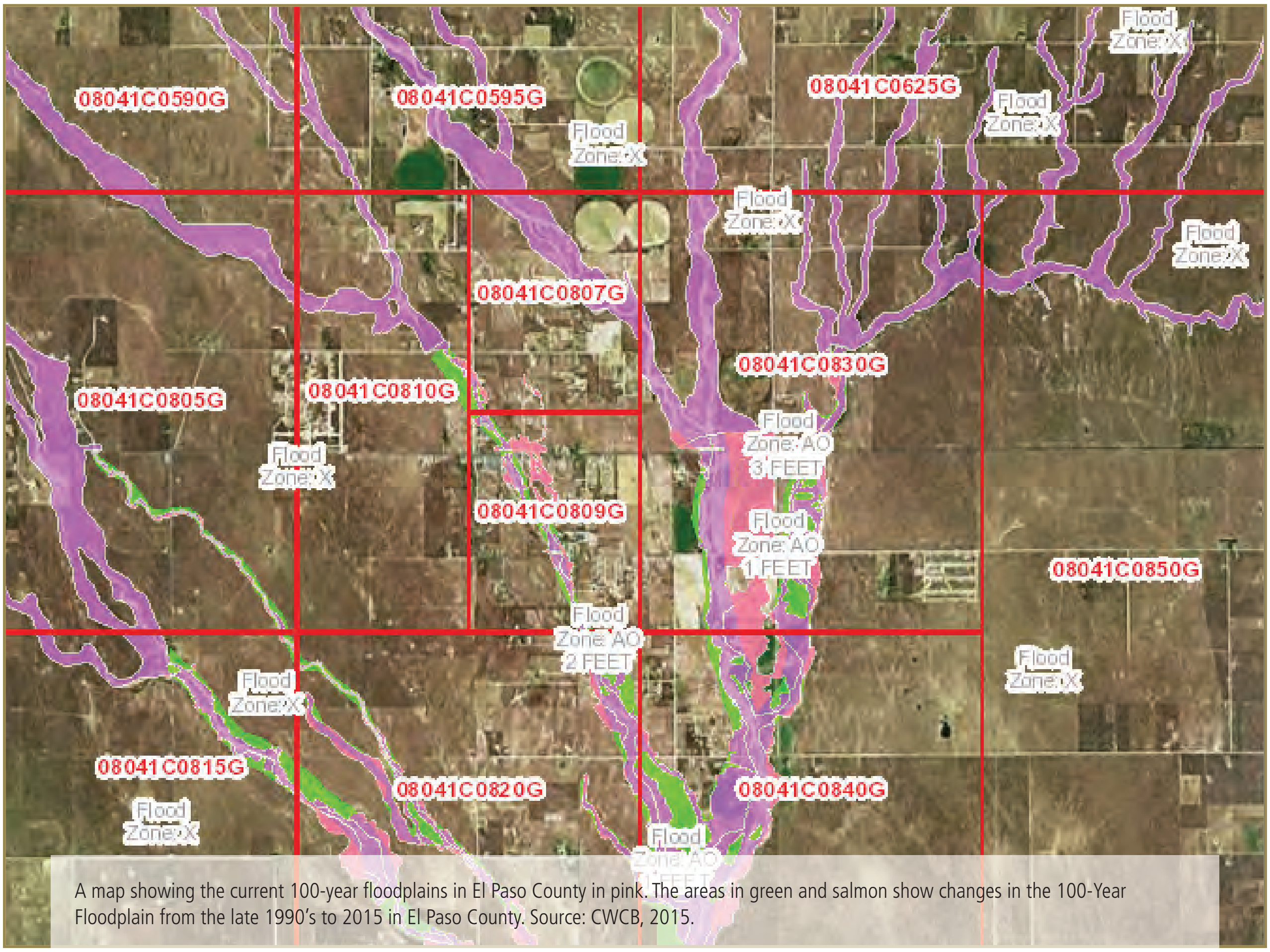
Colorado communities have a responsibility under the State's floodplain management standards— floodplain rules and regulations that meet or exceed the Federal Emergency Management Agency (FEMA) minimum requirements—to foster community resiliency and to develop wisely in light of flood events. The CWCB works with the Colorado Office of Emergency Management and FEMA to provide technical and financial support for these activities. In recent years, Colorado has improved its flood regulations by increasing freeboard requirements for homes and businesses, with additional protection for critical infrastructure such as hospitals, fire stations, and nursing homes. Colorado's Flood Hazard Mitigation Plan also helps the State and local communities better prepare for these events.[33]

The Colorado Drought Mitigation and Response Plan outlines the monitoring, mitigation, and response actions necessary to adequately prepare Colorado for drought.[34] The Water Availability Task Force brings together state, local, and federal agencies to monitor conditions on a monthly basis. Once an event occurs, the State activates the Drought Task Force, bringing together a multitude of state agencies to collaboratively address issues that arise.

The State projects that droughts will increase in frequency and severity. At the local level, the development of drought management plans can help communities prepare for those future conditions.[35] Furthermore, planning and preparedness before the onset of an event can reduce both physical and economic drought-related effects. The CWCB has developed many tools and resources to aid in this process and has made them accessible through the Drought Planning Toolbox.[36] Additionally, through the Water Efficiency Grant Fund, the CWCB is able to provide grant funding for up to 80 percent of the cost of both developing a plan and implementing proposed measures. Currently, mid-sized communities including the Town of Firestone, Pagosa Water and Sanitation District, and the Town of Erie have sought the CWCB's funding for plan development and approval. Larger providers, such as Denver Water and the City of Aurora, have current drought management plans, but have not sought State assistance or approval. If the number of communities that have active drought management plans in place increases, Colorado's overall resilience to drought will increase.

Technical and financial support is also available for healthy watersheds, which can help reduce the risk of catastrophic fires and buffer against the effects of other natural disasters. Section 7.1 further describes this. State agencies work closely with local and federal agencies on fire mitigation, response, and recovery. Because many watersheds are located on federal lands, intergovernmental collaboration is vital for protecting those resources. Additionally, Colorado is a headwaters state, and our downstream neighbors have a vested interest in maintaining healthy watersheds that contribute to their water quantity and quality. Building on these relationships may also contribute to better long-term protection of the resource.

Although Colorado has greatly prepared for the eventualities of floods, drought, and wildfires, these events rarely unfold exactly as predicted. That is why flexibility is critical in fostering effective and



A map showing the current 100-year floodplains in El Paso County in pink. The areas in green and salmon show changes in the 100-Year Floodplain from the late 1990's to 2015 in El Paso County. Source: CWCB, 2015.

efficient response to natural disasters. To that end, Colorado regularly updates its flood, drought, and wildfire plans. These plans comprise part of the State's Natural Hazard Mitigation Plan, which both the Colorado governor and FEMA approve. The updates incorporate lessons learned, new policies, and updated program information and, together with the working partnerships, will enable Colorado to respond better to future natural disasters. Existing technical tools, such as Colorado's Flood Threat Bulletin, are useful for helping state agencies and affected communities prepare for substantial precipitation events. Future enhancements to these and other tools may provide even further benefits.

ACTIONS

1. Where appropriate, the State of Colorado will continue to support and expand drought, flood, and wildfire-preparedness and response programs.
2. The State of Colorado will actively encourage local communities to develop drought preparedness plans by providing tools and resources for development and implementation.
3. The CWCB and the Colorado Recovery and Resiliency Office will implement the actions identified in the Colorado Resiliency Framework to build communities that are more resilient to natural disasters.
4. The CWCB and CDPHE will work with utilities, federal agencies, and others to proactively identify and address regulatory barriers to climate preparedness and adaptation

7.3

WATER QUALITY

GOAL

Colorado's Water Plan promotes waters that fully support their classified uses by 2050 through strategies designed to meet Colorado's current and future consumptive, recreational, and environmental water needs. These strategies incorporate the protection and restoration of water quality as a key objective.

Coloradans have a strong connection to water. The State and water managers need to protect quality of water, and in some cases, restore quality to support Colorado's heritage, communities, and way of life, now and into the future. Executive Order D 2013-005 recognizes this by stating, "Colorado's water quantity and quality questions can no longer be thought of separately. Each impacts the other and our state water policy should address them conjunctively." The executive order also lists "a strong environment that includes healthy watersheds, rivers and streams and wildlife" as one of three core Colorado values. In addition, recent public survey results highlight the value Coloradans place on safe, clean water. This survey indicates that Coloradans believe the quality of both surface and groundwater is very important as a source of drinking water. Coloradans also believe the quality of water in streams and lakes is very important to support recreational uses. The survey shows that public health, followed by wildlife and fish habitat, are the most compelling reasons to improve water quality.[37, 38]

As Colorado plans for its water future, it will be critical to better integrate water quality and quantity planning and management activities. To ensure that Coloradans continue to have access to safe and clean water, the State must prioritize opportunities to address existing water quality effects and minimize future effects. Creating a balance between increasing quantity demands and water quality protection and restoration requires on-going dialogue with all Coloradans and collaboration at all levels of government. Colorado's Water Plan offers a framework for moving forward with the quality and quantity conversations.

The following information is a starting point for an ongoing conversation. To create a foundation for understanding this complex subject, the conversation describes how quality and quantity are related. It also identifies an integration goal geared to improve relationships in support of protecting and restoring water quality. The conversation describes current water quality management as a context for identifying ways to improve coordination, and makes recommendations for moving forward with initiatives that meet the integration goal. The water quality foundation for this conversation is included in Colorado legislation, and the Water Quality Control Commission (WQCC) and the Water Quality Control Division (WQCD) established goals to meet the intent of this legislation.

Water Quality and Quantity Relationships

State and associated federal statutes, as well as local, state and federal regulations, protect water quality in Colorado. The WQCC adopts regulations, guidance, and policies required by the federal Clean Water Act (CWA), the federal Safe Drinking Water Act, and the Colorado Water Quality Control Act. The CDPHE Water Quality Control Division is the primary agency that implements these regulations, guidance, and policies. This water quality management structure is different from that which is in place for water-quantity management. Understanding the existing relationships between these distinct management frameworks, and looking for opportunities to improve coordination and integration, are important for protecting the state's water resources.

Water Quality and Quantity Connections

Managing water quantity may cause a change in water quality. When entities divert water to farms or cities, store it for future use or flood control, or manage it as return-flows to address downstream water rights, water quality can change. For example:

- Recreational fishing is a way of life in Colorado and is important to local and state economies. Deep reservoirs tend to thermally stratify in summer, when cold water settles to the bottom. Many reservoirs release water downstream from the bottom, where the stratified water is very cold. In some places, cold-water releases from the bottom of reservoirs have affected downstream native fish and aquatic life. Most of Colorado's Gold Medal Fisheries, which CPW manages, are located downstream of

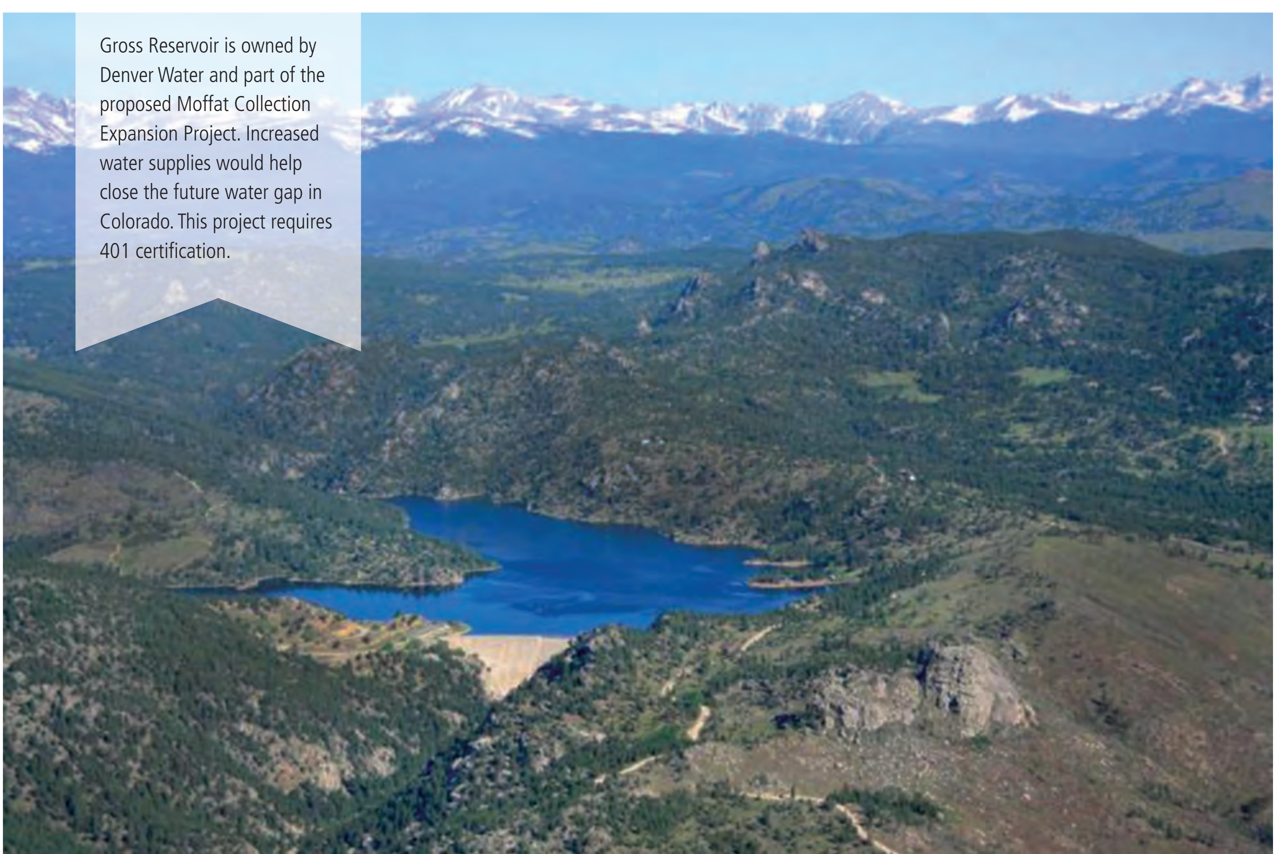
Black Lake No. 1 and No. 2. The lakes were enlarged so that stream flows could be maintained during snowmaking season.

dams. Other surface-water structures, such as diversions to canals and off-stream reservoirs, can also affect water quality and fisheries. Such modifications can result in low streamflows and cause low oxygen concentrations, high water temperatures, and higher concentrations of pollutants. In Colorado, the State is exploring solutions during project planning to address these types of water quality effects that surface-water modifications can cause.

- One option for addressing future municipal-water supply needs is the use of alternative agricultural transfers, such as rotational fallowing and interruptible supply options. High concentration of salts and other pollutants from this source water, however, may require advanced water-treatment technologies, such as reverse osmosis, to make the water usable for communities. The waste product 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. For example, Aurora Water recently completed the Prairie Waters Project in which both natural and constructed treatment allow potable water reuse—without requiring new CWA permits.

- The implementation and maintenance of drinking water and wastewater treatment in a semi-arid environment is a challenge today, and will continue to be in the future. Treatment infrastructure is critical to protecting public health and the environment. The capacity of the stream to accept wastewater pollutants without a negative effect on quality depends on the amount of water flowing in the stream. Water diversions upstream can result in fluctuating stream levels, and therefore affect water quality. Changes in treatment processes that are necessary to meet new, more stringent discharge limits, or upgrades to aging infrastructure, can increase operational costs for wastewater treatment facilities. However, protecting water quality through wastewater treatment and other measures can result in cost savings for downstream drinking water treatment facilities, because such protection results in higher-quality source water that could require less treatment in the future.

- The CWCB is responsible for the appropriation, acquisition, protection, and monitoring of instream flow and natural lake level water rights in order to preserve and improve the natural environment to a reasonable degree. The CWCB



Gross Reservoir is owned by Denver Water and part of the proposed Moffat Collection Expansion Project. Increased water supplies would help close the future water gap in Colorado. This project requires 401 certification.

exclusively established these water rights for nonconsumptive, in-channel, or in-lake water uses to support minimum flows between specific points on a stream, or minimum levels in natural lakes. The State's water right priority system administers the rights. While Colorado law explicitly prohibits the WQCC and the WQCD from taking any action that requires minimum instream flows, the program has provided tangible water quality benefits specifically for aquatic life classified uses across the state.

Cause-and-effect connections related to water quality and quantity are integral to the State's ability to make sound water management decisions. The State considers these connections during decision-making processes that are dependent on statutory, regulatory and management relationships related to water quality and quantity.

Statutory and Regulatory Relationships

The State manages water quality and quantity separately based on different constitutional, statutory, and regulatory provisions. That said, state and federal statutes that protect instream water quality recognize the importance of protecting water rights while providing the authority to impose water-pollution controls. The federal statute that protects drinking water quality also recognizes integration with water quantity by including source-water protections that reduce treatment costs.

Many state and federal water quality-specific regulations intersect with quantity management. Establishing water quality standards and ensuring that entities attain these standards as required in state and associated federal water quality regulations is connected to the amount of water available in streams. State regulations also recognize water quality by addressing the quality of substitute water supplies used in exchanges and in substitute water supply plans. Regulations governing reuse also support integration between water quality and quantity management.

One of the primary examples of the regulatory quality and quantity relationship is the WQCD's water quality certification of federal permits and licenses under Section 401 of the CWA. WQCC Regulation No. 82 implements this certification, known as 401 certification. Section 401 of the CWA directs states to certify that activities needing federal permits and licenses, including many water development projects, must comply with the applicable provisions of the State's water quality use classifications, standards, and designation program during both construction and operation over time. WQCC Regulation No. 82 gives the WQCD three certification options for federal permits or licenses. These include the ability to certify, conditionally certify through identified mitigation measures, or deny certification. WQCD certification signifies that when the proposed project implements the federal permit or license, the project will comply with applicable surface and groundwater standards regulations, classifications, and all other applicable water quality requirements for the affected waters. For example, if a project requires a CWA Section 404 individual permit from the Army Corps of Engineers, it also requires a WQCD 401 water quality certification. Section 9.4 discusses the 401 water quality certification in more detail.

The WQCC's adoption of site-specific standards and designations is another example of a quantity-and-quality regulatory relationship. Site-specific standards and designations may reflect a lower level of water quality than would have been present before exercised water rights resulted in a hydrologic modification such as a dam, diversion, or return flows.

The WQCC is solely responsible for the adoption of water quality standards and classifications; however, local government regulations can also have a water quality and -quantity connection. For example, the State gives local governments permit authority over certain matters under the Areas and Activities of State Interest Act. Under the act, local governments can adopt regulations that address the effect of municipal and industrial water projects. These regulations, referred to as 1041 regulations, often require mitigation of water quality effects from water projects. Associations of local governments also prepare Regional Water Quality Management Plans that establish water quality goals and recommendations for regional water quality management. Typically, local 1041 regulations require new water projects to comply with these plans.

Water Management Relationships

Statutes and regulations define roles and responsibilities that many entities share, creating a complex system for overseeing Colorado's water resources. At the state level alone, many entities are involved with protecting water quality, which requires coordination and integration to ensure that they appropriate manage water resources.

The Colorado Water Quality Control Act defines water quality roles and responsibilities for the WQCC and the WQCD. The Act also identifies several additional water quality implementing agencies, including:

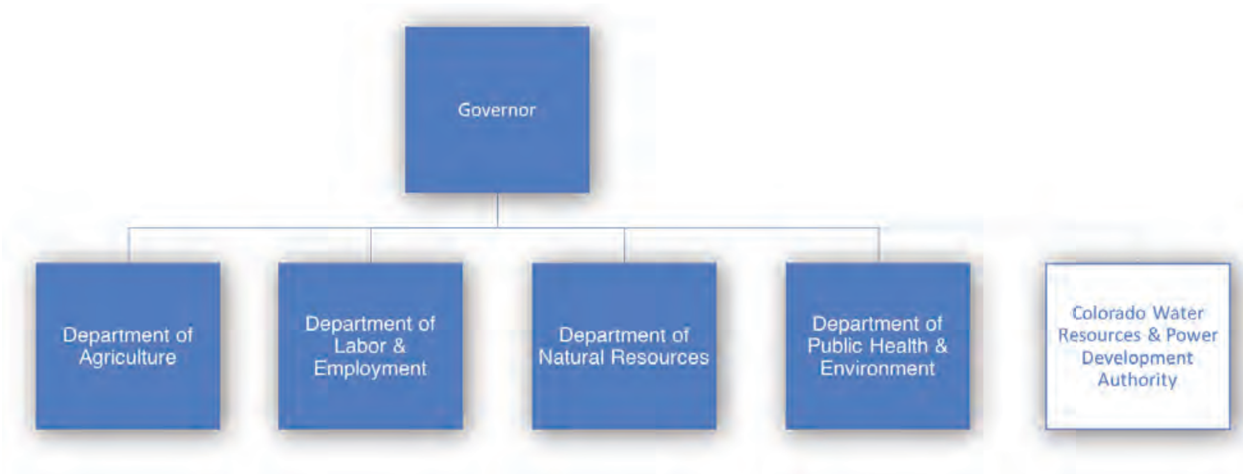
- Division of Reclamation, Mining and Safety
- DWR
- Oil and Gas Conservation Commission
- CDPHE Hazardous Materials and Waste Management Division
- Division of Oil and Public Safety at the Department of Labor and Employment

These agencies have initial responsibility for implementing groundwater quality classifications and standards the WQCC adopts. A Memorandum of Agreement defines these implementing relationships. The WQCC can intervene in the event that it determines an implementing agency is not assuring compliance with water quality classifications and standards.

The DNR plays a critical role in managing water quantity in the state. The DWR within the DNR is responsible for water administration, while the CWCB, another DNR division, sets water policy, completes water planning, and reviews state wildlife-mitigation plans. The DNR's CPW develops state wildlife-mitigation plans, which address fish and wildlife resources that the construction, operation, or maintenance of water diversion, delivery, or storage facilities affect.

The Colorado Water Quality Control Act requires the WQCC and the WQCD to consult with the CWCB before making any decisions or adopting any rules or policies that have the potential to cause material injury to water rights. The CWCB receives copies of all WQCC rulemaking hearing notices, and all notices include a provision requesting information from the public regarding potential effects on water rights.

FIGURE 7.3-1 COLORADO STATE AGENCIES AND QUASI-GOVERNMENTAL ORGANIZATIONS WITH QUANTITY AND QUALITY RESPONSIBILITIES



Water Quality- and Quantity-Integration Goal

Executive Order D 2013-005 states, "Colorado's water quantity and quality questions can no longer be thought of separately. Each impacts the other and our state water policy should address them conjunctively." To this end, it is important to establish a goal related to quantity and quality integration between now and 2050. To develop this goal, the CWCB reviewed many documents, including the CWA, the federal Safe Drinking Water Act, the U.S. EPA's strategic plan, Colorado's Water Quality Control Act, the WQCD's strategic goals, the WQCC's strategic water quality goals, and the BIPs. These laws, goals, and plans focus on broader actions than quality and quantity integration, yet they provide important insight for developing a quality- and quantity-integration goal as part of Colorado's Water Plan.

> It is important to establish a goal related to quantity and quality integration between now and 2050.

The CWA sets a national goal "to restore and maintain the chemical, physical, and biological integrity of the nation's waters," with interim goals that all waters be fishable and swimmable where possible. The federal Safe Drinking Water Act authorizes the EPA to set national health-based standards for drinking water in order to protect against both naturally occurring and man-made contaminants in drinking water. The EPA and water systems work together to make sure states meet these standards. The EPA's current strategic plan has a goal regarding protecting America's waters to "protect and restore waters to ensure that drinking water is safe and sustainably managed, and that aquatic ecosystems sustain fish, plants, wildlife, and other biota, as well as economic, recreational, and subsistence activities."

The legislative declaration of the Colorado Water Quality Control Act includes the following goals:

- Achieve the maximum practical degree of water quality in the waters of the state.
- Provide that no pollutant be released into any state waters without first receiving treatment or other corrective action necessary to reasonably protect the legitimate and beneficial uses of such waters; to provide for the prevention, abatement, and control of new or existing water pollution; and to cooperate with other states and the federal government in carrying out these objectives.

In addition, there are several Colorado Water Quality Control Act provisions related to water quantity and water rights:

- A primary goal of the Water Quality Control Act is to protect, maintain, and improve the quality of state waters for beneficial uses, including domestic, wildlife, and aquatic life; and agricultural, industrial, and recreational uses.
- Dischargers of pollutants may be required to meet a high degree of treatment to protect water rights.
- The WQCC and the WQCD must consult with the CWCB before making any decisions or adopting any rules or policies that have the potential to cause material injury to water rights.
- Nothing in the state act is to be construed or applied to cause or result in material injury to water rights.
- The WQCC and WQCD shall not require an instream flow for any purpose.

The WQCD's mission is to protect and restore water quality for Colorado's public health and the environment. The WQCD's strategic plan states that it will achieve its mission by pursing the following goals:

- Prevent waterborne disease and reduce chronic public-health risks from drinking water through improved implementation of the federal Safe Drinking Water Act and Colorado's drinking water statutes and regulations.
- Protect all designated uses by attaining water quality standards through improved implementation of the CWA and the Colorado Water Quality Control Act and associated regulations.
- Restore impaired water quality to attainable standards through improved implementation of the CWA and the Colorado Water Quality Control Act and associated regulations.

Finally, the WQCC's strategic water quality goal: By 2050, Colorado's waters will fully support their classified uses, which may include drinking water, agriculture, recreation, aquatic life, and wetlands.

The State will require better integration of water quality and quantity in order to address the WQCC's overall goal for water quality. Based on review of the laws, goals, and plans summarized above, the WQCC developed a quality- and quantity-integration goal:

> Recognizing the inter-relationships between quality and quantity, strategies designed to meet Colorado's current and future consumptive, recreational, and environmental water needs will incorporate, as a key objective, the protection and restoration of water quality.

The following steps further refine and advance this goal:

- The State encourages the basin roundtables to actively incorporate water quality into decision-making processes for consumptive, recreational, and environmental projects. To help facilitate this effort, the WQCD will provide basin-scale water quality information to the basin roundtables for their use in updating their future BIPs. The WQCD originally developed this information as part of the Statewide Water Quality Management Plan.
- Project proponents must understand the nexus between water quality and quantity, and must work to avoid or mitigate water quality effects of a project through the implementation of best management practices, whether associated with 401 water quality certifications or otherwise. The WQCD will support this effort by developing guidance on the 401 water quality certification process and identifying best management practices.
- The WQCD, in concert with other stakeholders, including watershed groups and those with point and nonpoint discharges, will continue to employ available programs to maintain, and in some cases, improve water quality at a basin-scale. The WQCD will document progress over time in the WQCD's Integrated Report and WQCD's Statewide Water quality Management Plan. The WQCD typically updates the Integrated Report every two years and uses it to track progress on the quality portion of the integration goal over time.
- The CWCB will use information from the WQCD's Integrated Report in its scenario-planning efforts when evaluating the status of future *signposts* (see Chapter 6.1). By tracking this information through time, water quality and quantity managers will know whether efforts to integrate water quantity and quality are successful, and can make course corrections as part of adaptive management plan efforts.

A hiker takes a break to drink some crisp mountain water.

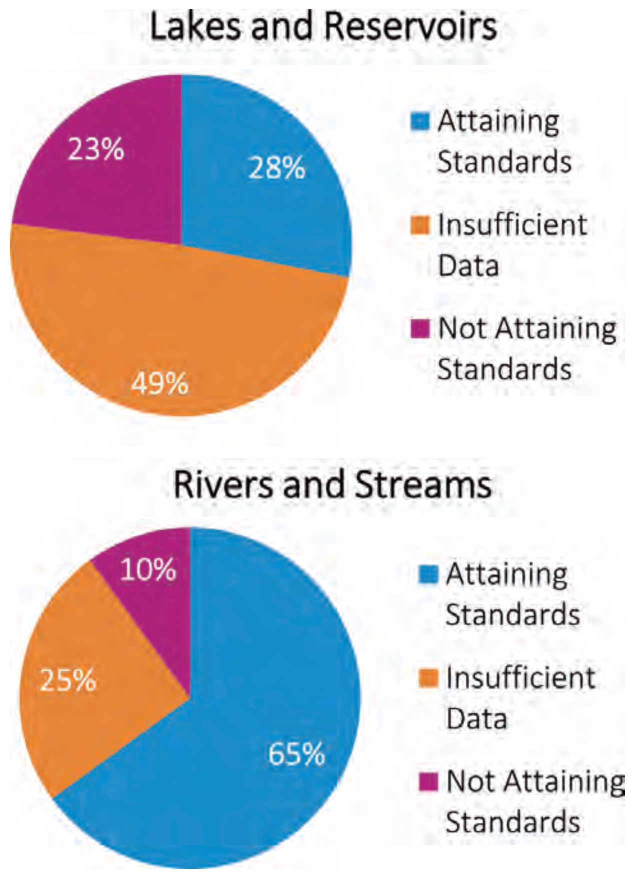
Current Water Quality Conditions

As state water managers and stakeholders produce plans for meeting consumptive, recreational, and environmental needs in ways that recognize the many interactions of statute, regulation, and management activities, it will be important to understand current water quality conditions in the state. Understanding current water quality conditions is also fundamental for ensuring compliance with water quality regulations as they pertain to water-supply planning and implementation activities.

The ability to evaluate the status of surface-water quality in Colorado requires an understanding of the classified uses for waterbodies throughout the state. A classified use is a specific type of use for an identified waterbody and can include domestic water supply, agriculture, recreation, aquatic life, and wetlands. With an aim to protect these waterbody-specific uses, the WQCC assigns classified uses to stream and lake segments and adopts water quality standards for many different pollutants.

The state also must have an antidegradation policy as part of its water quality standards. Antidegradation protects the value of high-quality surface waters. Colorado's antidegradation policy establishes that, at a minimum, the State and water managers must maintain existing classified uses for all surface waters, and the water quality necessary to protect those uses; these waters are *use-protected waters.* The antidegradation policy also provides extra levels of protection for two other types of waters the commission designates. *Outstanding waters* receive the highest level of protection and require that quality must be maintained at current levels (with no degradation). *Reviewable waters* are high-quality waters that receive an intermediate level of protection. The rules for antidegradation review require a public process. This must occur before the natural capacity of a waterbody to dilute and absorb pollutants and prevent harmful effects is completely allocated to a project or permit under which a new or increased impact is proposed. The State allows use of such capacity if the review shows that it would accommodate important economic or social development for the area in which the waters are located.

FIGURE 7.3-2 CURRENT WATER QUALITY CONDITIONS[39]



Standards are the basis for evaluating the status of water quality for each waterbody. When available data show that a waterbody is not meeting water quality standards, state regulation identifies the waterbody as impaired. A biennial report to the EPA (Integrated Water Quality Monitoring and Assessment Report, or Integrated Report) must identify these impaired waterbodies, as well as other information about water quality in the state.

For waters that attain water quality standards, the challenge is to maintain the existing good water quality in order to protect classified uses, such as drinking water supplies, robust fisheries, and recreational opportunities.

The Paradox Valley salinity control unit is located along the Dolores River in the Paradox Valley near the Utah border. The unit injects collected brine into deep geologic formations, and is one of the most effective salinity control projects in the Colorado River Basin, accounting for about ten percent of total salinity control reductions in the Colorado River.

The most common causes of river and stream impairments in waters that are not meeting water quality standards are selenium, pathogens such as E. coli, and iron. In lakes and reservoirs, the most common causes of impairment are selenium, mercury, and dissolved oxygen saturation. Waters that do not attain water quality standards affect the ability of water users to use water for domestic water supply, agriculture, aquatic life, and recreation.

As shown on previous page, Figure 7.3-2 presents statewide information and is based on available water quality data. Different regions or basins within the state have varying water quality conditions and may have unique water quality challenges. Water quality impairments may also exist in streams or lakes that have either little or no available data, or that the Integrated Report process has not yet assessed.

Future Water Quality Conditions

Over the next 35 years, many changes will occur that have the potential to affect both regional and statewide water quality. Understanding these changes is important as the State, water managers and stakeholders develop plans for addressing the municipal and industrial supply gap and for meeting recreational and environmental needs.

Water-quantity decisions will affect future water quality conditions, but changing water quality regulations will also influence these decisions. Currently, several additional proposed regulations are designed to further protect and restore water quality. Examples of proposed regulations include increased nutrient controls, more stringent arsenic standards, and a revised selenium standard. There is also renewed emphasis on implementing actions that will produce measureable, positive changes in water quality. Recognizing the possibilities associated with potential change, both water- quantity and -quality managers must seek opportunities to protect and enhance water quality in the future.

Other factors affecting future water quality conditions are also important to consider. As the economy and population grow and land uses change, water-quantity demands will increase and additional stressors on water quality will come into play. Future land-use decisions are a substantial factor, as increased urbanization and associated stormwater runoff, higher volumes of discharged municipal wastewater, and industrial discharges—including those from the energy sector—can affect water quality. As additional diversions deplete streams, existing concentrations of pollutants will increase, and water treatment and wastewater-treatment processes that rely on those streams will become more difficult and expensive. New issues may also arise from emerging contaminants or from interactions among different constituents. These potential effects could be negative; however, there may also be opportunities for positive change. These variables reinforce the critical nature of informed and integrated water-resource management decisions.

Climate change further compounds the potential for positive or negative effects on water quality in the future. Predicted effects of a changing climate on water quality include:[40]

- Potential streamflow volume will decrease in the Rockies and interior southwest, and increase in the east and southeast coasts.
- Higher peak streamflow will increase erosion and sediment transport, and loads of nitrogen and phosphorus are also likely to increase in many watersheds.
- Many watersheds are likely to experience substantial changes in the timing of streamflow and pollutant delivery. In particular, there will be a tendency to shift from snowmelt-dominated spring runoff systems to rain-dominated systems with greater winter runoff.
- Nutrient and sediment loads will change, as they are generally correlated with changes in hydrology.
- Warming air temperature will cause stream and lake temperatures to rise, which can harm aquatic organisms—such as trout—that live in cold-water habitats. Additionally, warmer water can increase the range of non-native fish species, permitting them to move into previously cold-water streams. The population of native fish species often decreases as non-native fish prey on and compete with them for food.

Planning for water quality changes based on these potential fundamental system-shifts is challenging, and highlights the need to make measurable progress on the water quality and -quantity integration goal.

Water Quality Management

The WQCD and WQCC currently make water quality decisions in the context of a management system based on statutes, regulations, and implementation processes. This system defines boundaries needed to protect and restore water quality, and also offers opportunities for flexible, integrated approaches for meeting consumptive, recreational, and environmental needs. The existing water quality management system is a starting point for finding opportunities and maximizing them to facilitate improved, integrated water-resource management decisions.

Section 2.4 and in Section 7.3 discuss the statutory and regulatory framework for water quality. The framework establishes the requirements for protecting and restoring water quality in the state, and processes at the state and local level implement the framework. The chapters also discuss classified uses and the water quality standards established to protect those uses. Both are critical to protecting and restoring water quality in the state; with public input, WQCC processes establish those uses and standards.

Water quality management processes also include monitoring, data assessment, and reporting. Monitoring and data assessment are essential to identifying and characterizing water quality problems, revising water quality standards, and developing and evaluating the results of control programs. Many statewide partners aid in completing the monitoring. The WQCD uses its own data and partners' data in evaluating the status of statewide and basin-scale water quality with respect to meeting water quality standards. Information about attainment of water quality standards is available in the Integrated Report discussed in 7.3.2. WQCC Regulation No. 93, Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List also identify the information. The WQCC has used public processes to adopt both of these.

When streams and lakes do not meet water quality standards, WQCD produces a restoration plan called a Total Maximum Daily Load (TMDL). The TMDL defines how much of the pollutant causing the impairment is allowed in the stream or lake while still ensuring high water quality standards. The allowable amount of the pollutant is then divided among all the different sources of the pollutant—including both point and nonpoint sources. A point source is a sewage treatment plant or industrial facility discharge. Nonpoint sources are diffuse sources of pollution, such as runoff from agricultural fields or abandoned mines.

As the WQCD produces the restoration plan, public notice process provides the opportunity for gathering input. Once the EPA approves the TMDL, the TMDL becomes the basis for implementing necessary actions to bring the stream or lake back into attainment. As an alternative to implementing controls to meet existing water quality standards, TMDLs can result in a re-evaluation of standards and sometimes a re-evaluation of classifications. A TMDL implementation plan can define implementation actions in a locally driven watershed plan or in a locally driven, regional water quality management plan (208 plan). Watershed plans and 208 plans identify stressors to water quality and address other water quality improvement and protection activities necessary to meet local and regional goals. The WQCD works with local partners and local plans to implement priority projects in order to restore and maintain water quality at a watershed or regional scale.

The WQCD also actively engages in promoting and supporting source-water protection planning across Colorado through the Source Water Assessment and Protection (SWAP) Program. The program is designed to define drinking water supply areas and identify potential water quality and contaminant risks to drinking water systems. The SWAP program, in collaboration with the Colorado Rural Water Association, provides technical and financial support to encourage voluntary local planning efforts and the implementation of best management practices to minimize source-water quality effects. This effort is a collaborative stakeholder process that contributes to protecting and restoring water quality in the state.

The WQCD uses information from all of these local plans to support its own planning efforts. For example, the WQCD produces a Statewide Water Quality Management Plan for approval by the WQCC. The Statewide Water Quality Management Plan compiles water quality information in support of implementation activities at a statewide and basin-wide scale. This compilation, in addition to the Integrated Report, WQCC policies, and other WQCD documents, supports the WQCD's strategic planning—while promoting progress toward national water quality goals and providing specific metrics for measuring that progress.

The purpose of these plans, which exist at different scales with the support of numerous partners, is to define and prioritize actions for the improvement, restoration, and protection of water quality. The WQCD uses several implementation tools, including Section 401 water quality certifications (which Section 9.3 discusses), permits that allow discharges to streams and lakes (provided they meet certain limits or control measures), and funding support for partners. The federal CWA prohibits the discharge of pollutants from a point source to surface water without a permit. Because the State has developed a program that meets the requirements of the federal CWA, the WQCD, rather than the EPA, administers the primary discharge permit program in Colorado. The permits the WQCD issues to point sources specify the limits or controls required to meet Colorado's water quality standards.

Implementation tools often require the development of strategies or best management practices that, when completed, result in the improvement, restoration, and protection of water quality. Strategies also address consumptive and nonconsumptive needs. Sections 6.3 through 6.6 summarize these strategies. Examples of strategies that have a quality and quantity nexus include, but are not limited to:

- CDPHE regulates non-potable water reuse and graywater use. Section 6.3 further describes these strategies.
- Storage, including reservoirs and aquifer storage and recovery can impact the amount of water available in streams, which may impact water quality.
- Source-water protection best management practices, such as proper storage and disposal of pesticides and proper management of septic systems can improve the quality of drinking water supplies.
- Stormwater best management practices, including retention and detention, can improve the quality and quantity of the supply, and water management practices could incorporate these practices. Colorado has not typically considered stormwater to be a source of supply, but may explore this in the future.
- Nonpoint-source best management practices will be critical to improving water quality for recreational, environmental, and consumptive needs in the future. Examples of nonpoint-source best management practices include mine tailings removal, riparian buffer creation, wetlands construction, and habitat restoration.
- Green infrastructure is taking place at a national level and Colorado is exploring application of this concept. The focus of the green infrastructure concept is to weave natural processes into the built environment, which can provide stormwater management, flood mitigation, air quality management, and riparian zone restoration.
- Water quality trading is based on the fact that sources in a watershed can face very different costs and regulatory requirements when under the control of the same pollutant. Trading programs allow facilities that are facing higher pollution-control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at a lower cost, thus achieving the same water quality improvement at a lower overall cost.

Chapter 9 discusses funding and financing in detail; however, the WQCD provides various financial assistance opportunities to aid with efforts geared to protect public health and the environment. The WQCD administers the following financial assistance programs:

- State revolving funds provide low-interest loans to government entities for drinking water and water quality improvement projects.
- The Water Quality Improvement Fund provides grant funds for water quality improvement projects using civil penalties from water quality violations. State House Bill 11-1026 amended the statute to authorize grants for stormwater management training and best-practices training to prevent or reduce the pollution of state waters.
- Source-water protection grants provide funding for pilot planning projects as well as development and implementation projects.
- The small-system training and technical assistance set-aside provides grant funding to assist with the costs of planning and design for small drinking-water systems serving fewer than 10,000 people.
- State statutes 25-8-703 and 25-1.5-201 authorize funding, when the legislature appropriates it, for small-community domestic wastewater and drinking water projects. These programs provide grants to municipalities for costs associated with planning, design, and construction of drinking water and wastewater treatment plants.

- Through a competitive process, the WQCD distributes nonpoint-source grant funds to local project sponsors to implement projects that restore impaired waters, prevent future impairments, or raise public awareness.

In addition, the CWCB administers the Water Supply Reserve Account as another financial tool. This tool provides grants to assist Colorado water users in addressing their critical water-supply issues and interests. The funds help eligible entities complete water activities, which may include competitive grants for:

- Technical assistance regarding permitting, feasibility studies, and environmental compliance.
- Studies or analysis of structural, nonstructural, consumptive, and nonconsumptive water needs, projects, or activities.
- Implementation of structural and nonstructural water projects or activities.

Water Quality and BIPs

The various basin roundtables have addressed water quality in the BIPs in two major ways: Through quality-related basin goals and measurable outcomes, and through identification of projects and methods with a water quality nexus. In many basins across the state, public water systems, municipal governments, and communities have developed source-water protection plans with specific water quality protection strategies. Many basins also have watershed plans in place that identify priority actions necessary to both protect and restore water quality. Basin roundtables should consider these prevention, protection, and restoration strategies and actions during the project development and prioritization stage. The WQCD can provide information about in-progress or completed protection and watershed plans.

Every basin roundtable has addressed water quality in goals and measurable outcomes. Several basins have addressed water quality issues in the context of greater watershed health, while others look to established water quality standards as a potential measureable outcome. The Rio Grande Basin Roundtable established the following goal: "Make progress toward meeting applicable water quality standards throughout the basin."[41] This approach demonstrates ways in which the basin may use the planning process to work closer with the CDPHE and make progress toward meeting established standards.

In its goals, the Yampa/White/Green Basin Roundtable references water quality as it relates to uses within the basin: "Maintain and consider the existing natural range of water quality that is necessary for current and anticipated water uses."[42] Recognizing the importance of both quality and quantity, this water quality-centric goal follows the strong BIP theme of protecting existing uses within the basin and providing for future development. This type of goal seeks to establish how water quality fits within the basin's vision of its future.

Basin roundtables have also addressed water quality issues through identification of projects and methods that have a water quality nexus. For example, the South Platte/Metro BIP identifies 18 projects with a connection to water quality, ranging from assessment of wildfire restoration, to sediment mitigation projects, to mine remediation.[43] These projects seek to leverage implementation to address water quality issues at the source.

The Gunnison Basin has identified currently ongoing projects and methods that address water quality issues. These include several programs related to Colorado River water quality, such as the Gunnison Basin Selenium Management Plan, and projects funded through the Colorado River Basin Salinity Control Forum.[44] Additional localized projects for improving municipal infrastructure also have benefits for water quality.

Through these goals, outcomes, and identified projects and methods, the basins seek to address water quality concerns at a more local level. Future roundtable efforts will prioritize projects and methods according to basin goals, and this incorporation of quality concerns into the goals-and-outcomes framework will benefit water quality overall.

ACTIONS

The WQCD worked with the Colorado Water Quality Forum and the WQCC to develop recommendations. As the CWCB updates the Colorado's Water Plan in the future, these recommendations will serve as a starting point for implementation efforts focused on:

A. Integrated water quality and -quantity management.

B. Policy considerations.

C. Financial considerations.

D. Stakeholder and public outreach.

In addition, the State will assign these recommendations to a responsible party and prioritize them for implementation over time.

Water for agricultural use needs to be free from contamination. Depicted here are siphon tubes on the Sakata farm in Brighton.

A. Integrated Water Quality and -Quantity Management Actions

Recommendations to promote increased integration of water quality and -quantity management include:

1. Evaluate the water quality effects associated with the proposed solutions and scenarios the BIPs and Colorado's Water Plan (Sections 6.3 through 6.6) have presented. Identification of those effects will help define the scope of strategies that entities need to explore to protect and restore water quality. The State will share information about these effects among all involved parties.

2. In cooperation with basin roundtables, the CWCB, and others, define opportunities for projects or processes that restore and enhance existing water quality conditions, with an aim of addressing potential water quality effects resulting from water-quantity solution implementation. An initial step will be to assist the basin roundtables in developing water quality goals, objectives, and measurable outcomes based on current water quality information; each basin will be able to use this information when updating its BIP. This collaboration supports the basin roundtables in identifying projects and methods that integrate water quality and -quantity management to protect and restore water quality.

3. Define green-infrastructure approaches for the arid West, and explore ways in which entities can use green infrastructure to address Colorado's consumptive and nonconsumptive gaps. For example, green infrastructure in the arid West can go beyond stormwater management activities and low-impact development methods by including landscape-scale land-use planning that identifies where activities should occur in order to meet dynamic goals, including protecting and restoring water quality. Green-building and stormwater management groups have developed information that provides a starting point for developing and maintaining a library of green-infrastructure options.

4. Evaluate new water-supply projects and the potential for multiple benefits, including water quality protection and enhancement. Strive to ensure that project plans incorporate all water quality benefits.
5. Examine ways to design and operate new or existing supply projects to advance water quality objectives. Actively pursue incorporation of these design and operation considerations into proposed projects.
6. Identify the role of reuse by developing a library of reuse examples, such as direct potable reuse, indirect potable reuse, non-potable reuse, graywater use, and the associated water quality issues for each type of reuse. Ensure that any initiative that desires to use these resources addresses the issues. Section 6.3 further discusses reuse and identified actions.
7. Promote the use of aquifer storage and recovery, since water quality effects associated with this storage strategy are minimal.
8. Explore the role of stormwater management from both a quality and a quantity perspective in order to determine whether stormwater is a viable additional source of supply to address consumptive needs.
9. Address nonpoint sources through ongoing management activities, which play an important role in protecting and restoring water quality for the benefit of future water uses. These activities should include cataloguing and evaluating local-government land-use planning tools that minimize nonpoint-source pollution associated with development. Entities should also explore a comprehensive approach to nonpoint-source management, including water- quality trading.
10. Identify the risks of climate change as they relate to integrated water quality and water-quantity management. Develop specific recommendations for addressing these risks.
11. Explore how entities can most efficiently and cost-effectively integrate the CWA requirements and Safe Drinking Water Act requirements. Develop specific implementation recommendations.

B. Policy Considerations

Policy considerations related to quality and quantity integration include:

1. Continue to engage in creative, solution-oriented actions, such as implementing site-specific standards, temporary modifications, discharger-specific variances, pollutant trading, and conditional 401 water quality certifications. Use all available means to improve water quality and protect the high-quality waters that are considered better-than-necessary for supporting classified uses. Maintain ongoing, non-regulatory programs, including nonpoint-source management and source-water protection planning. These solution-oriented actions will also be necessary for addressing the effects of climate change.
2. As entities continue to maximize wastewater reuse in Colorado, establish a more complete understanding of the concept of "net environmental benefit." This concept demonstrates that the ecological value of using effluent to support riparian and aquatic habitats exceeds the ecological benefits of removing the discharge from the waterbody.
3. Review and appropriately modify existing regulations, guidance, and policy documents for new types of wastewater reuse so that revisions will protect public health and the environment, while also providing sufficient flexibility for water suppliers to develop new water-reuse projects across the state.
4. Consider and document the water-rights implications of water quality strategies and the water quality implications of water development strategies as they both pertain to integrated water quality and -quantity management. For example, integrated stormwater management may have effects on downstream flows, and entities would have to understand and address possible water-rights effects before implementing such a strategy.
5. Continue to work with neighboring states to address interstate water quality and quantity-issues to protect Colorado's compact entitlements.
6. Continue statewide monitoring that supports assessment of the quality- and quantity-integration goals and measures.

C. Financial Considerations

Future efforts to integrate water quality and quantity will require funding. Chapters 9 and 10 of Colorado's Water Plan further detail the recommendations outlined below.

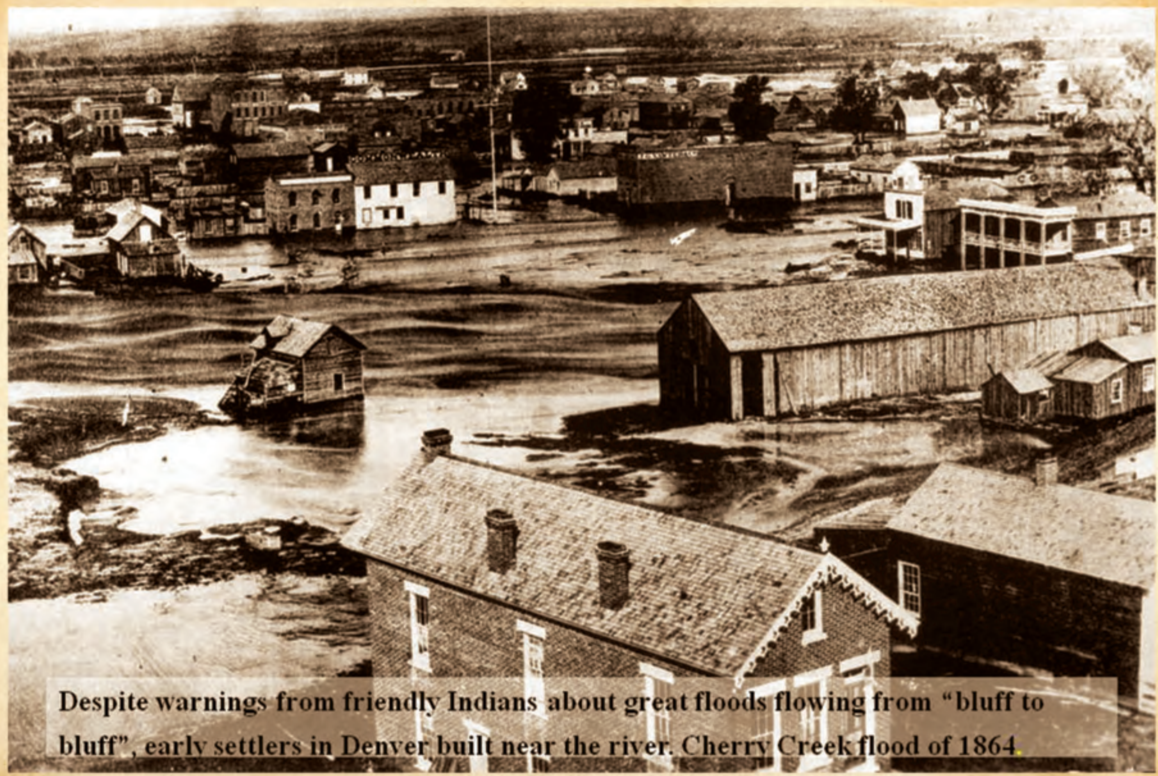
1. Continue to fund nonpoint-source pollution management efforts. Identify new funding opportunities and nonpoint-source pollution-control strategies.
2. Identify costs and funding sources forimplementation of green infrastructure and reuse.
3. Pursue state funding of regional watershed-based water quality planning to better integrate current and future water-quantity efforts.
4. Develop and implement State funding mechanisms for future water projects that implement consumptive and nonconsumptive strategies in ways that are consistent with Colorado's Water Plan. Plans should emphasize funding portions of projects that result in a public benefit.
5. Develop and implement State funding mechanisms for the implementation of mitigation activities required either under a state water-court water-rights decision, or under a federal or state water quality protection regulatory action.
6. Develop and implement funding mechanisms for the protection, restoration, or enhancement of water quality values in river or stream reaches.
7. Explore ways to facilitate innovative treatment and engineering solutions through technology transfer and liability management techniques.

D. Stakeholder and Public Outreach

Stakeholder and public outreach is critical to meeting the water quality and -quantity integration goal. Chapter 9.5 of Colorado's Water Plan further details the recommendations outlined below.

1. Use a watershed approach for outreach and community engagement around water quality, ways to protect water quality, and solutions to water quality issues. Colorado's many watershed groups already use this approach to effectively plan for and implement actions that protect and restore water quality. The approach can be used when developing and implementing strategies that integrate water quality and -quantity management.
2. Refine future water quality goals and measurable outcomes by monitoring public attitudes and opinions about water quality as it relates to domestic water supply as well as environmental and recreational uses of water.
3. Develop additional water quality goals and performance measures based on the completed BIPs from the basin roundtables.
4. Conduct joint CWCB and WQCC meetings at least annually to discuss water quality and water quantity integration issues.
5. Consider holding workshops as part of WQCC's annual basin rulemaking process. To gather input and share information related to progress on water quality and quantity integration efforts, workshops should include participation from basin roundtable representatives for the basin that is the subject of the annual rulemaking hearing.
6. As the CWCB updates or implements the water plan in the future, it will participate in the Colorado Water Quality Forum's process and working groups which provide stakeholder input on water quality issues.

Trappers Lake, the headwaters of the White River, in the Flat Tops Wilderness.



Despite warnings from friendly Indians about great floods flowing from "bluff to bluff", early settlers in Denver built near the river. Cherry Creek flood of 1864.

A LOOK AT HISTORY

Despite being warned by friendly Native Americans, pioneers in Denver settled along the banks of the South Platteand its tributaries. They suffered the consequences in the Cherry Creek flood of 1864.

source: Colorado Water Conservation Board.

caption: Thomas V. Cech, J William McDonald, Defened and Develop:
A Brief History of the Colorado Water Conservation Board's First 75 Years,
[Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

SEAN T. CRONIN, CONTINUED FROM PAGE 7-12

it forward - a gift that is opened when the next generation turns on a tap, fishes a stream, shops at a farmers' market, plays ball in the backyard, or goes downtown for a cold beer.

I live in my adopted home of Colorado with my wife and two children. I remember in 1997 moving to Colorado as entering nirvana -- spectacular weather, world-class recreation opportunities, high employment, and darn tasty beer. My first water job evoked a "water awakening". It suddenly became abundantly clear that this nirvana did not exist by chance. It was instead very deliberately engineered, and all connected by a common thread - water.

Prior to moving to Colorado, I lived in North Carolina where I obtained a degree in environmental science from the University of North Carolina at Charlotte and worked for the North Carolina Cooperative Extension Service. I grew up in Massachusetts on the South Shore of Boston where as a young kid witnessed human-caused degradation of local waterways. Those were defining moments that inspired me to obtain the rank of Eagle Scout and pursue my chosen field of study.

After working in the water industry for over 20 years, what I most enjoy is the opportunity to serve the greater good. A service that started at the Extension where I lead a partnership with farmers and non-profits to implement best management practices to protect water quality; then to a municipality providing a clean, reliable water supply to residents; and most recently with the District assisting property owners and ditch companies with flood recovery efforts. I consider myself fortunate to be part of a community of stewards for this life giving natural resource.

Section 7.1: Watershed Health and Management

[1] Sandra L. Postel and Barton H. Thompson, Jr., "Watershed Protection: Capturing the Benefits of Nature's Water Supply Services," Natural Resources Forum 29 (2005): 98-108.

[2] Richard M. Edwards and Greg Sundstrom, *Colorado Forestry Best Management Practices, Forest Stewardship Guildlines for Water Quality Protection, 2012 Field Audit Report* (Colorado State Forest Service, 2013), 2, http://static.colostate.edu/client-files/csfs/pdfs/BestMgmtPractices2012FieldAuditReport_www.pdf

[3] J.E. Williams, C. A. Wood, and M.P. Dombeck, *Watershed Restoration: Principles and Practices* (Bethesda, MD: American Fisheries Society, 1997), 2-3.

[4] Williams, Wood, and Dombeck, *Watershed Restoration: Principles and Practices,* 5.

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Interbasin Projects and Agreements

People often refer to Colorado as "the headwaters state" because it is the only state in which every major river system starts within the state and exits to downstream states. Colorado stakeholders created intrastate agreements to help align key parties' interests and understandings; as a result, Colorado has a united voice when dealing with interstate and federal negotiations and litigation about water exiting the state. This chapter describes some recent examples of intrastate agreements, including the basin roundtables and the IBCC process. This chapter also examines the next steps and a path forward for these critical agreements.

Two men surveying the view after climbing to the top of Colorado's Continental Divide. Photo taken between 1900 and 1923. Courtesy of the Denver Public Library.

GOAL

Colorado's Water Plan promotes statewide cooperation for water supply planning with the following long-term goals:

A. Protect Colorado's ability to fully develop compact entitlements, and continue to support agreements that strengthen Colorado's position in interstate negotiations, while ensuring the long-term viability of Colorado's interstate compacts and relationships. Colorado will focus planning efforts on maintaining healthy systems and avoiding a Colorado River Compact deficit, rather than focusing on its response to compact curtailment.

B. Encourage multi-partner, multipurpose, cooperative projects through financial incentives and technical support.

C. Use the conceptual framework as an integrated package of concepts to:
   - Encourage environmental resiliency;
   - Set high conservation standards;
   - Develop stakeholder support for interstate cooperative solutions; and
   - Establish conditions for a new multi-purpose and cooperative transmountain diversion (TMD) project if proposed in the future.

Existing Stakeholder Agreements and Projects

Colorado has many intrastate agreements among diverse and disparate stakeholders. These agreements benefit the individual stakeholders, but also equip the State to effectively protect its interests in interstate matters. The following are recent examples of intrastate agreements that model a collaborative process for future agreements.

Arkansas River Voluntary Flow Agreement

A voluntary flow management program is a unique arrangement between state and federal agencies, nonprofits, water management organizations, and commercial rafting organizations. Because these agreements are voluntary, the parties are under minimal obligation to participate, but they remain involved because the agreement is successful year after year. The Upper Arkansas River voluntary program, which the water users established in 1990, is a partnership among Colorado Parks and Wildlife, Southeastern Colorado Water Conservancy District, Pueblo Board of Water Works, Trout Unlimited, the Arkansas River Outfitters Association, and the BOR.

The Arkansas River voluntary flow agreement helps meet the environmental and recreational needs of the Upper Arkansas Basin by providing increased recreational flows on the river and beneficial flows for wildlife. From July 1 to August 15, the BOR's Fryingpan-Arkansas Project facilities provide a flow of at least 700 cubic feet per second at the Wellsville gage, greatly benefiting recreation in the Arkansas River. In addition, during the spring and fall months, the facilities provide optimal conditions for a healthy brown trout fishery. These efforts bolster the recreational economy and attract tourists from all over the world.

Colorado River Cooperative Agreement

In fall 2013, 18 parties that are reliant on water from the Colorado River completed the Colorado River Cooperative Agreement (CRCA). The CRCA represents the culmination of years' worth of negotiation between Denver Water and several western slope entities. The goal of the CRCA is to protect Colorado River watersheds while allowing Denver Water to develop future supplies. More than 40 stakeholders, including water providers, county commissioners, local municipalities, ski resorts, and environmental groups, participated in the process alongside the 18 signatories.

On a river system as complicated as the Colorado, the CRCA represents a new way of looking at water management by considering the interests of as many parties as possible, while encouraging collaboration and innovation. This type of process helps the counties and municipalities more effectively manage environmental and recreational flows. A few examples of cooperative operations under the CRCA are the following Denver Water and western slope facilities:

Dillon Reservoir, the Moffat Collection System, and the Shoshone power plant. Many basin roundtables have demonstrated concerns about local control and multipurpose collaboration, and the CRCA illustrates an effective way to address such concerns.

Colorado River System Conservation Pilot Program

Facing declining water levels in Lakes Mead and Powell, four of the largest water providers that depend on Colorado River System supplies have joined with the BOR in exploring potential long-term solutions. Denver Water, the Southern Nevada Water Authority, the Central Arizona Water Conservation District, and the Metropolitan Water District of Southern California have all contributed $2 million to a fund that will be used to finance pilot projects in the basin; in addition, the BOR is contributing $3 million. These pilot projects will pay municipalities, industries, and farmers to reduce their use of Colorado River System water, thereby potentially increasing levels in the basin's two largest reservoirs.

The Conservation Pilot Program intends to test and demonstrate the concept of "demand management" in both the Upper Basin and the Lower Basin. These cooperative projects may use such methods as temporary fallowing of agricultural endeavors, upgrading to more efficient irrigation practices, reusing self supplied industrial water, recycling municipal supplies to lessen consumptive use, and other possible methods geared to leave more water in the Colorado River.

The Colorado River Cooperative Agreement involved signatories and interested parties from both sides of the Continental Divide. This goal of this historic agreement is to benefit watersheds in the Colorado River basin while allowing Denver Water to develop future water supplies.

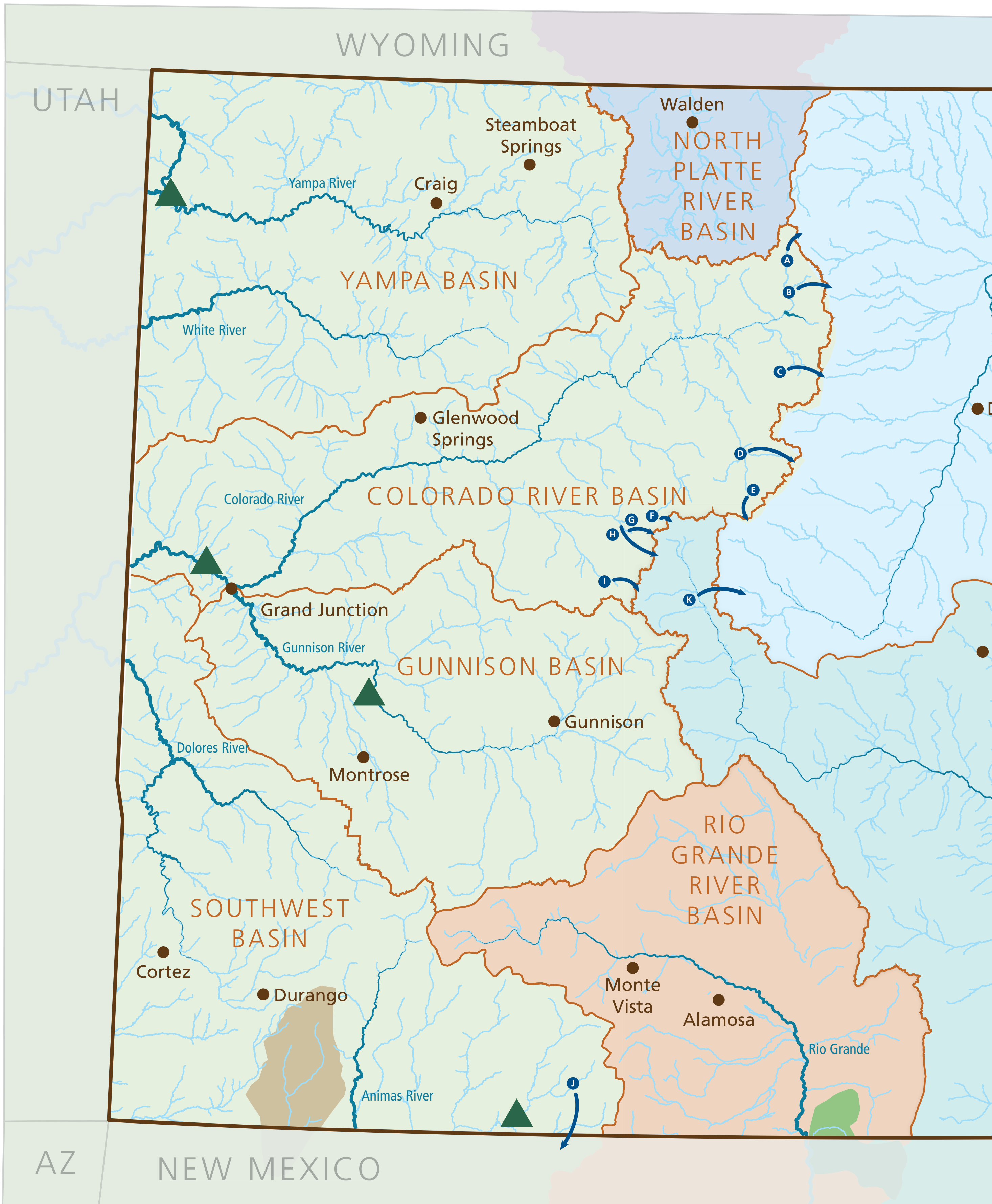
The program supports concepts the Upper Basin states are exploring under the current drought contingency planning effort, which Chapter 2.2 of this plan describes. The drought contingency planning effort in the Upper Division states (Colorado, Wyoming, Utah, and New Mexico) names demand management as a key strategy for keeping the Lake Powell reservoir level above critically low levels. While the conservation program is not specifically tied to the drought contingency planning effort, it may provide critically important information related to demand management concepts the drought contingency planning effort is exploring.

The program will provide funding for the pilot projects in 2015 and 2016. It considers several factors when choosing a pilot project, including geographic diversity, the implementation schedule, ease of administration, environmental benefits, and, for Upper Basin projects, the potential to interface with water users between the project and Lake Powell. As the river master, the BOR will handle program projects and management in the Lower Basin. In the Upper Basin, the Upper Division states, with assistance from the Upper Colorado River Commission, will oversee projects. In addition, a state's commissioner for the Upper Colorado River Commission may veto any project within an Upper Division state.

Elkhead Reservoir

The 2006 enlargement of Elkhead Reservoir is another example demonstrating the collaboration of multiple interests on a project. The City of Craig originally owned the Elkhead Reservoir; the City constructed it to provide energy to the Craig Station Power Plant and to support recreational sport fishing and boating.

Multiple stakeholders gathered together to plan an extensive $31-million, multipurpose expansion project that would enhance endangered fish and water flow management. As part of the project, the City of Craig, the Colorado River Water Conservation District (CRWCD), and Colorado Parks and Wildlife formed a joint management of the reservoir. A combination of state funds and stakeholder cost-sharing funded the project. The Upper Colorado River Recovery Program contributed $13.6 million; the State of Colorado Species Conservation Trust Fund contributed $6.5 million; and the CWCB construction loan program and the CRWCD funded the remainder. All parties had an interest in the project because it has multiple purposes.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Colorado River
COLORADO RIVER BASIN
Grand Junction
Gunnison River
GUNNISON BASIN
Gunnison
Montrose
Dolores River
SOUTHWEST BASIN
Cortez
Durango
Animas River
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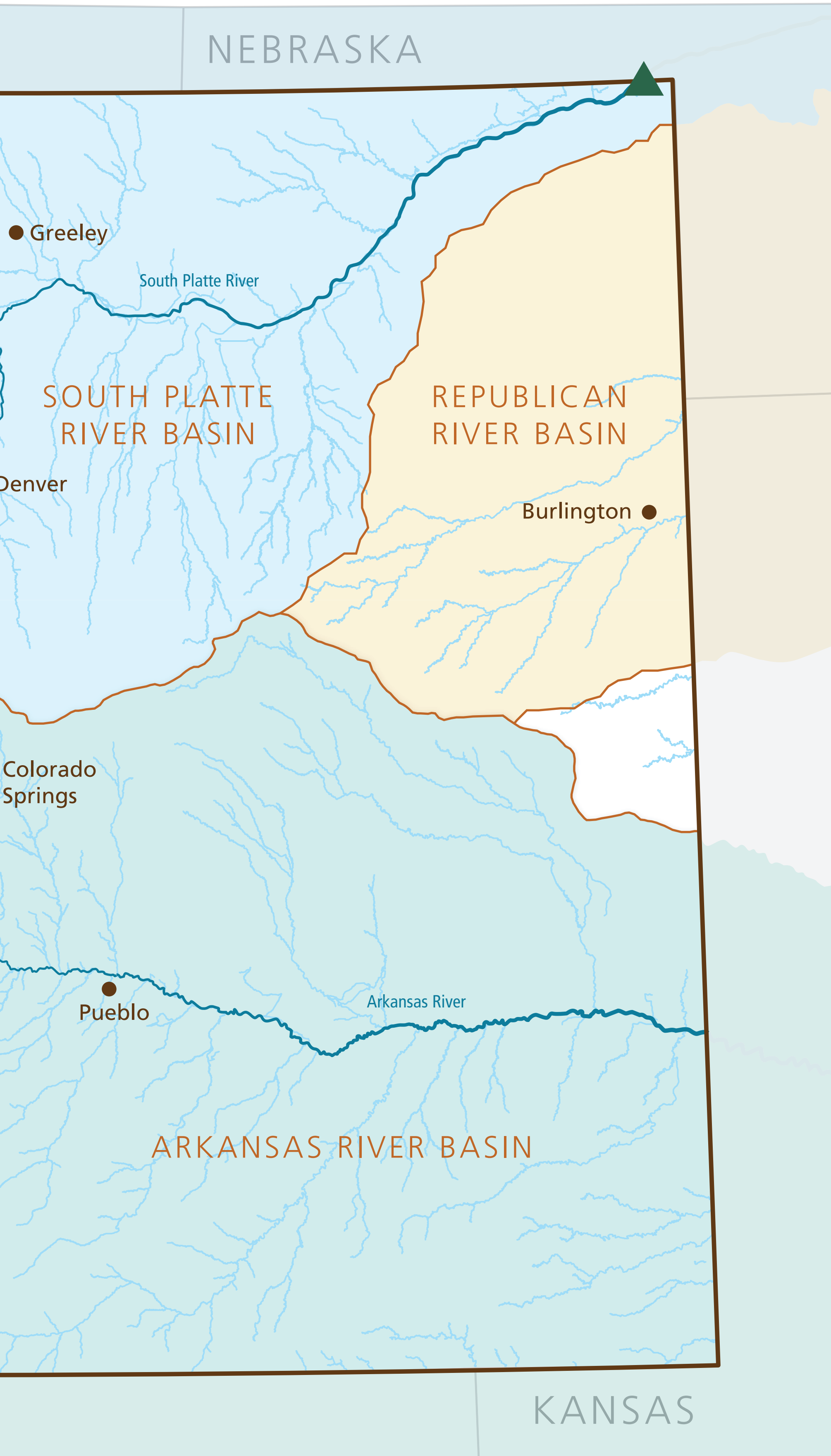


Major Interstate and Intrastate Agreements and Diversions

Interstate Compacts

- South Platte River Compact (1923)
- Republican River Compact (1942)
- Arkansas Compact (1948)
- Rio Grande Compact (1938)
- Costilla Creek Compact (1944, Revised 1963)
- La Plata River Compact (1922) & Animas–La Plata Project Compact (1948)
- Colorado River Compact (1922) & Upper Colorado River Compact (1948)
- North Platte (1945) & Laramie River (1957) U.S. Supreme Court Equitable Apportionments

Major Trans-Basin Diversions

A: Grand River Ditch *18,000 AFY*

B: Adams Tunnel *226,000 AFY*

C: Moffat Tunnel *55,000 AFY*

D: Roberts Tunnel *62,000 AFY*

E: Blue Mountain Project *9,000 AFY*

F: Homestake Tunnel *25,000 AFY*

G: Busk Ivanhoe Tunnel *5,100 AFY*

H: Boustead Tunnel *56,000 AFY*

I: Twin Lakes Tunnel *41,000 AFY*

J: San Juan-Chama Project *83,000 AFY*

K: Aurora Homestake Pipeline *16,000 AFY*

Endangered Species Flow Programs

Basin Boundaries

The multipurpose project allocated 5,000 acre-feet of storage for endangered fish management, which provided the Yampa Basin with water to enhance environmental flows. The stakeholders worked together to address the potential conflicts between sport fishing and the protection of endangered fish species; they resolved the issue by installing a fish screen. The CRWCD and the CWCB collaborated on an adjudicated water right in a critical habitat on the Yampa for "in-river fish habitat and river flow maintenance and enhancement uses, and uses in furtherance of the Recovery Program." In addition, the project updated existing facilities to meet new uses and needs.

Windy Gap Firming Project

The Windy Gap Firming Project is a collaboration among 13 northeastern Colorado providers to improve the reliability of water supplies from the Windy Gap Project. The original project began delivering water in 1985, and today the Northern Water's Municipal Subdistrict operates it. The firming project proposes to build a new reservoir called Chimney Hollow on the eastern slope. Chimney Hollow will provide dedicated storage to supply a reliable 30,000 acre-feet of water each year. This water will be supplied via the Colorado-Big Thompson Project, so the Bureau of Reclamation must approve a contract allowing use of federal facilities.

The firming project will cause environmental effects, which the 13 project participants are committed to addressing. On behalf of project participants, the subdistrict spent several years negotiating measures to mitigate environmental effects. The subdistrict worked with state wildlife biologists to develop the fish and wildlife mitigation plan, which operates to mitigate higher stream temperatures, increase flushing flows to clean sediment in the stream, and provide nutrient removal to offset water-quality effects on Grand Lake and the Colorado River. Federal reviewers incorporated the plan into the Final Environmental Impact Statement.

Project participants agreed to the implementation of voluntary enhancement measures to address concerns with the current condition of aquatic life in the Colorado River. The enhancements include a State-authorized plan to provide $4 million to fund future stream-restoration and habitat-related projects on the Colorado River, and $250,000 to study a stream bypass around Windy Gap Reservoir. As part of the 1041 permit Grand County approved, the subdistrict has entered into several agreements with local governments and environmental nonprofits to provide ecological enhancements. The Windy Gap Bypass Funding Agreement provides $2 million to construct a bypass around the reservoir, which the State matched with $2 million in funding. An intergovernmental agreement among the subdistrict, Grand County, CRWCD, Middle Park Water Conservancy District, and Northwest Colorado Council of Governments provides a reliable water supply to Middle Park. This supply will meet Middle Park's future water needs and provide additional water supplies that Grand County may use for environmental purposes.

The collaboration between eastern slope and western slope entities and state agencies will improve the conditions for aquatic life on the Colorado River, and also help the Windy Gap Firming Project progress toward meeting water supply needs on the eastern slope.

Water, Infrastructure, and Supply Efficiency Partnership

The Water, Infrastructure, and Supply Efficiency (WISE) Partnership serves as an example of the use of infrastructure to meet increasing water demands. The project brings together water providers in the Denver metropolitan area to meet challenges jointly, rather than individually. The WISE Partnership explores how water providers can use the existing provider infrastructure to the benefit of all cooperating partners.

In response to the drought of 2002, Aurora Water began construction on the Prairie Waters Project, an innovative supply and filtration system. The Prairie Waters Project stabilized Aurora's water supply and created a large system of treatment and water-transport infrastructure. Aurora now partners with Denver Water and the members of the South Metro Water Supply Authority on a project that couples the Prairie Waters infrastructure capacity with Denver and Aurora's unused supply and reusable flows. The partnership steadies water supply in times of drought for these providers, and administers the sale of water to South Metro as a new and sustainable supply.

The WISE Partnership creates flexibility in the face of hydrologic uncertainty and establishes triggers to modify yields based on available flows. In addition, South Metro Water Supply Authority members use back-up water supplies when WISE water is not available.

State Funding for Collaborative Projects

Funding for opportunities will become more competitive as Colorado moves from the planning phase to the project implementation phase. The basin roundtables state in the BIPs that the projects with multipurpose functions should be prioritized.

When examining appropriate projects to fund, the State looks for multiple stakeholder involvement and multiple project purposes. A few examples of State-funded projects are the Chatfield Reallocation project, the Wild and Scenic Alternatives processes, the Animas-La Plata Project, and a collaborative process to assess the best approaches to secure water for the Upper Colorado River Basin Recovery Implementation Program. In addition to providing funding, the State served as a partner in the planning, permitting, and development of operational procedures for the Chatfield Reallocation and Animas La-Plata projects.

These projects and processes represent the type of collaboration necessary for future water supply planning in Colorado. Local involvement, stakeholder consultation, innovative practices, and multiple uses will be integral to future successful projects and processes. The BIP and Colorado's Water Plan processes have engaged communities, stakeholders, and basin roundtables in an unprecedented way. Continuing this engagement will be important for next steps regarding project implementation.

Conceptual Intrastate Agreements and Points of Consensus

The drought in 2002 illustrated that Colorado had not brought together the necessary stakeholders and technical information to adequately plan for Colorado's future. In response, Colorado initiated three important efforts: the SWSI, the Colorado Water for the 21st Century Act, and the Water Supply Reserve Account Grant Program.

The SWSI (SB03-110) established the technical backbone for statewide planning.

The Colorado Water for the 21st Century Act (HB05-1177) created the basin roundtables and the IBCC. The basin roundtables consist of nine stakeholder groups, including those from the Metro Area, Arkansas, Colorado, Gunnison, North Platte, Rio Grande, South Platte, Southwest, and Yampa/White/Green River basins. Members include representatives for the environment, recreation, domestic water

MICHELLE PIERCE

GUNNISON RIVER BASIN

In her dual role as Lake City's Town Manager and chair of the Gunnison Basin Roundtable, Michelle cultivated the spirit of collaboration and cross-basin dialogue. She is now enjoying life as a full-time student after recently retiring. Michelle is pictured in front of Lake San Cristobal Dam.

Given the ever-increasing and diverse demands that are being placed on our water supplies statewide, I believe it's imperative that the Colorado Water Plan takes a realistic and holistic approach to establishing methods to secure Colorado's water future. Shortages in supplies must be acknowledged, and appropriate conservation measures must be taken, in order to sensibly allocate water for future needs and provide true security to all users.

My family and I moved to Lake City thirty years ago. I retired as Lake City's Town Manager in 2012 and am currently enrolled as a full time student at Western State Colorado University in Gunnison...

CONTINUED AT END OF CHAPTER

PROFILE

Blue Mesa Reservoir in the Gunnison River Basin is one of the reservoirs built under the Colorado River Storage Project Act to help manage flows in the Upper Colorado River system. Photo: M. Nager.

suppliers, agriculture, and industry. Representatives from each county, municipalities within each county, and conservancy and conservation districts join these members. A basin roundtable may also vote in additional members, who may serve as voting or nonvoting members. The major charge of the basin roundtables is to determine their municipal, industrial, agricultural, environmental, and recreational needs, and identify projects and methods to meet those needs.

The IBCC comprises two representatives from each basin roundtable, six gubernatorial appointees, two legislative appointees, and the director of compact negotiations. The IBCC's main charge is to work with the basin roundtables to develop and ratify cross-basin agreements. A detailed list of the IBCC membership is available here.[1]

The basin roundtable and IBCC processes have evolved over the years, and the roundtable and the IBCC produced several work products to reach consensus across the state. These include:

- Statewide Basin Roundtable Summits and the roadmap documents.
- IBCC 2010 Letter to then-outgoing Governor Ritter and then Governor-elect Hickenlooper.
- IBCC Draft No-and-Low-Regrets Action Plan.
- Colorado's Conceptual Framework.

Statewide Basin Roundtable Summits

The three Statewide Basin Roundtable Summits have helped focus Colorado and the hundreds of stakeholders involved in water planning throughout the state. The summits provided an opportunity to learn across basins, ensure that statewide planning is heading in the right direction, and set the course forward.

IBCC 2010 Letter

In December 2010, the IBCC submitted a letter to the governor. This letter synthesized the IBCC's ideas and laid the foundation for establishing the No-and-Low-Regrets Action Plan and conceptual framework.

Much of this work remains relevant today and has helped guide the development of Colorado's Water Plan. The IBCC wrote, "The enormous challenge of meeting future water needs facing water users and the State requires the collective input of all stakeholders and a collaborative decision-making process that reaches common ground to plan a sustainable water future that meets our numerous and diverse needs… Our system of water allocation should be guided and supported by a comprehensive framework that will marshal ever-scarcer government resources in a manner that supports economic growth; protects our environment; provides for municipal, agricultural, and industrial needs; and supports rural, recreation, and ecotourism-based economies."

> The general consensus was that the status-quo scenario is not a desirable future for Colorado.

The IBCC highlighted that the current path was not sustainable for Colorado. The IBCC wrote, "Status quo will likely lead to large transfers of water out of agriculture resulting in significant loss of agricultural lands, more dried-up streams threatening ecosystems and recreation-based economies, water-inefficient land use decisions, and continued paralysis on water supply projects. We have discussed status quo as the default position--the results that will likely occur if we, the water community, allow current trends to continue unchanged. Inaction is a decision itself, a decision with significant consequences. The general consensus was the status quo scenario is not a desirable future for Colorado."

The IBCC also described the path forward regarding water supply options: "It is clear that no one strategy can meet Colorado's growing water needs without harming values important to all Coloradans. Therefore, a mix of solutions is needed. At the IBCC's August 2010 meeting, it agreed that a future mix of water supply solutions should include all four sources to meet the water supply gap in Colorado: conservation, IPPs, agricultural transfers, and new supply development, while also protecting Colorado's significant water-dependent ecological and recreational resources."

No-and-Low-Regrets Action Plan

Based on dialogue from the November 2012, March 2013, and June 2013 IBCC meetings, as well as numerous subcommittee meetings, the IBCC developed a draft No-and-Low-Regrets Action Plan. The draft document reflects 100 percent consensus by the IBCC members, and provides a menu of options the basin roundtables should consider for the BIPs; it also recommends that the CWCB consider the options as a component of Colorado's Water Plan and the SWSI.

Scenario planning is a critical part of the No-and-Low-Regrets Action Plan. Full implementation will occur within the next 10 to 15 years. Without full implementation of these foundational actions, the gap between water demand and water supply will be much greater than the State originally projected. This means that even under a weak-economy scenario, the State will need new water supplies. Under the scenarios in which demands for water are greater and supplies are lower, the State will need additional new supplies and agricultural transfers beyond what the basin roundtables envisioned.

The IBCC identified the following no-and-low-regrets goals:

- Minimize the transfer of statewide acres (per the basin goals) and implement agricultural sharing projects.
- Plan and preserve options for existing and new supply.
- Establish low- to medium-conservation strategies.
- Implement nonconsumptive projects.
- Have a high success rate for identified projects and processes.
- Implement storage and other infrastructure.
- Implement reuse strategies.

Colorado's Water Plan incorporates this Action Plan. It is also available here.[2]

Colorado's Conceptual Framework

A long-standing controversial issue in Colorado is the development of water supply from the Colorado River System for use on the eastern slope. It is controversial because of supply gaps, environmental health, compact compliance, and other issues. Table 8-1 demonstrates the variability in opinion on this issue, as articulated by the basin roundtables in the BIPs. Generally, eastern slope roundtables identify the need for a balanced program to preserve the option of future development of Colorado River System water. Western slope roundtables express concern regarding the impact on future development on the western slope, as well as the potential for overdevelopment related to both a Colorado River Compact deficit and critical levels for system reservoir storage, such as the minimum storage level necessary to reliably produce hydroelectric power at Glen Canyon Dam ("minimum power pool").

The Colorado and South Platte/Metro BIPs are the BIPs with the greatest divergence. In its BIP, the Colorado Basin Roundtable points out the variability in hydrology, stating that TMDs "should be the last 'tool' considered as a water supply solution, once the many and complex questions are addressed over hydrology."[3] In the South Platte/Metro BIP, the roundtable advocates to "simultaneously advance the consideration and preservation of new Colorado River supply options."[4] Both viewpoints recognize the constraints of water availability and Colorado water law, but differ in their beliefs about whether such a project fits into water supply planning.

Despite differences of opinion, the IBCC, basin roundtables, and CWCB reached consensus to support the conceptual framework, which seeks a path forward that considers the option of developing a new TMD and addresses the concerns of roundtables, stakeholders, and environmental groups. The conceptual framework presents seven principles to guide future negotiations between proponents of a new TMD, if it were to be built, and the communities it would affect. The principles identify areas of statewide concern, and state the issues and realities proponents of a new TMD should expect to address. Below is a brief summary of the path that led to this consensus:

1. **Initial discussions:** In 2013, the No-and-Low-Regrets Action Plan sparked discussion about preserving the option for a new TMD. The IBCC focused its discussion on a conceptual framework for future detailed negotiations about a potential new TMD.

2. **First draft:** In June 2014, the IBCC reached consensus that the draft conceptual framework was ready for public feedback, and submitted it to the CWCB for inclusion in the initial draft of Colorado's Water Plan.

Board members of the CWCB emphasize the geographical diversity Colorado's Water Plan seeks to accommodate, while Director Eklund works to balance these needs. Photo: J. Johnson.

3. **First round of input:** Following the publication of the first draft of Colorado's Water Plan in December 2014, basin roundtables discussed the conceptual framework. Roundtable members expressed concerns about terminology that addressed "firm yield" from a TMD, the triggers under which a new TMD would be managed, "environmental resiliency," an "insurance policy" in Principle 4, and language regarding conservation and the relationship to the conservation "stretch goal."
4. **IBCC subcommittee:** The IBCC tasked a subcommittee to address these concerns and make the document more concise. The subcommittee included representatives from every western slope basin, both eastern slope basins, and the metro area, and included IBCC members representing agricultural interests, municipal water providers, conservancy districts, and environmental interests. CWCB members also participated in the subcommittee's work. Informed by the discussion to this point, the subcommittee sought to clarify the conceptual framework based on roundtable and stakeholder feedback.
5. **Basin roundtable support:** Following extensive discussion, every basin roundtable supported the final draft of the conceptual framework. The Arkansas, Colorado, Gunnison, Metro, South Platte, and Yampa/White/Green roundtables passed motions supporting inclusion of the framework within Colorado's Water Plan, recognizing the evolving nature of the conversations initiated by the framework. The North Platte, Rio Grande, and Southwest roundtables expressed support for inclusion of the framework in Colorado's Water Plan through consensus or communication with the IBCC and CWCB staff.
6. **IBCC consensus:** At the August 2015 meeting, the IBCC made final modifications and voted unanimously to support the conceptual framework and forward the final draft on to the CWCB for inclusion in Colorado's Water Plan.
7. **CWCB adoption:** At its September 2015 meeting the CWCB adopted the conceptual framework for inclusion in the final draft of Colorado's Water Plan.

The conceptual framework reads as follows: Colorado's Conceptual Framework

In preparation for *Colorado's Water Plan,* the basin roundtables drafted Basin Implementation Plans (BIPs). Front Range roundtables declared a need for a balanced program to preserve options for future development of Colorado River System water, while western slope roundtables expressed great concern regarding additional development of Colorado System water involving a new transmountain diversion project (TMD). This document represents an IBCC consensus to address both Front Range and western slope concerns about a new TMD.

The *IBCC Conceptual Framework* (Framework) sets out seven principles to guide future negotiations between proponent(s) of a new TMD and those communities it may affect, were it to be built. The Framework reflects areas of statewide concern. In generating it, the IBCC's diverse stakeholders thoroughly explored the difficult issues that would surround a new TMD. As such, this Framework may help accelerate future negotiations. However, the Framework cannot take the place of specific negotiations and agreements.

The intent of the Conceptual Framework is to represent the evolving concepts that need to be addressed in the context of a new TMD, as well as the progress made to date in addressing those concepts. The Conceptual Framework refers to several topics that are not exclusively linked to a new TMD, but are related to Colorado's water future. These include conservation, storage, agricultural transfers, alternative transfer methods, environmental resiliency, a collaborative program to address Colorado River system shortages, already identified projects and processes (IPPs), additional Western Slope uses, and other topics. The Conceptual Framework, like the rest of Colorado's Water Plan, is a living document and is an integrated component of the plan. Many of these topics are further discussed in more detail in other sections of Colorado's Water Plan.

The IBCC acknowledges that overdevelopment of Colorado River System water is a serious risk that could result in a Colorado River Compact deficit[a]. All of Colorado's water planning efforts must recognize that risk. The Framework provides a way to think about how entities in Colorado might develop a future increment of Colorado River System water. The Framework states the realities and issues proponents for a new TMD should expect to address.

Principle 1: Eastern slope water providers are not looking for firm yield from a new[b] TMD and the project proponent would accept hydrologic risk for that project.

Water providers define firm yield differently, but the concept usually represents an estimate of the amount of water a system makes available during a representative hydrologic cycle. A proponent of a new TMD would not seek a firm yield from the Colorado River System, but instead would develop a project that could provide firm yield if operated in conjunction with eastern slope sources of supply, as Principle 2 describes.

Accepting hydrologic risk means that a new TMD would be administered under Colorado's priority system, diverting water only when it is physically and legally available in priority in the basin of origin, and in accordance with the triggers Principle 3 describes. Thus, a new TMD would avoid unacceptably increasing either the risk of a Compact deficit or the burden on existing uses in a demand management program, such as Principle 4 describes.

Principle 2: A new TMD would be used conjunctively with eastern slope supplies, such as interruptible supply agreements, Denver Basin Aquifer resources, carry-over storage, terminal storage, drought restriction savings, and other non-western slope water sources.

It is important for eastern slope parties to demonstrate to the western slope that structures, agreements, and frameworks are or will be in place for eastern slope backup water supplies during times when a new TMD would not be able to divert Colorado River System water. Interruptible supply agreements, Denver Basin Aquifer resources, carry-over and terminal storage, and drought-restriction savings are options for backup water supplies that eastern slope entities would use during years when a new TMD would not be able to divert Colorado River System water. Any entity interested in participating in a new TMD would prepare and share a detailed plan for firming the yield

[a] A Colorado River Compact deficit occurs when flows at Lee Ferry fall below the obligation of the Upper Division States contained in Article III of the Colorado River Compact.

[b] A "new" TMD means a transmountain diversion project that is not an identified project or process (IPP) in SWSI 2010.

of a new TMD in dry years using some or all of these options. The firming plans should include steps to replace water not available from the new TMD, as well as sufficient supplies to meet the entity's demands, including those that could be met with reuse of a new TMD's water. Each entity would tailor its firming plan to its system's unique strengths and constraints. The tools listed above are options, not requirements.

Principle 3: In order to manage when a new TMD would be able to divert, triggers are needed.

Triggers are operating parameters that determine when and how much water a potential new TMD could divert, based upon predetermined conditions within the Colorado River System. Such parameters include, but are not limited to, specific storage-elevation levels in one or more Colorado River System reservoirs, projected inflows at key Colorado River System locations, actual reservoir inflows over specific defined periods, snowpack levels, predictive models—or combinations of these—which would trigger certain actions and prevent others.

Triggers are needed to ensure that diversions by a new TMD do not unacceptably increase the risk to the yield of existing uses of a Compact deficit, or increase the amount of water existing users would have to provide through a demand-management program in order to maintain storage levels in Lake Powell.

Triggers would need to be adaptable as conditions within the Colorado River System change over time, and be legally enforceable by appropriate authorities. Triggers may also need to be modified to reflect the outcome of continuing negotiations among Colorado, other Colorado River Basin States, the federal government, and Mexico regarding the continuation of the 2007 Interim Shortage Guidelines, 1944 Mexican Water Treaty and related Minutes, and other Colorado River System issues. Colorado would modify the triggers over time, as these agreements will provide the ultimate parameters within which a new TMD would need to operate.

Principle 4: A collaborative program that protects against involuntary curtailment is needed for existing uses and some reasonable increment of future development in the Colorado River System, but it will not cover a new TMD.

A collaborative program that protects existing uses and an increment of future development is a necessary element of Colorado's water planning, regardless of whether a new TMD is developed. The Framework includes this principle to make clear that a collaborative program would not protect a new TMD.

The collaborative program should provide a programmatic approach to managing Upper Division consumptive uses, thus avoiding a Compact deficit and ensuring that system reservoir-storage remains above critical levels, such as the minimum storage level necessary to reliably produce hydroelectric power at Glen Canyon Dam (minimum power pool). A goal of the collaborative program is that protection of Colorado River system water users, projects, and flows would be voluntary and compensated, like a water bank. Such protection would NOT cover uses associated with a new TMD.

A second goal of the collaborative program is protection of the yield of the water supply systems in place in the Colorado River Basin from involuntary curtailment. To achieve this goal, the program would need to expand to accommodate future western slope growth and growth of existing water supply systems, the pace of which is not now known. Protecting additional consumptive uses will increase the program's scope and challenges. Some basins, such as the less-developed Southwest and Yampa/White/Green Basins, anticipate the need for future development and will seek terms to accommodate it in the collaborative program. Regardless of "when" a use develops, the program would strive to protect uses at the time of shortage, with the exception of a new TMD. By adapting to accommodate increased uses at any given time, the program should not lead to a rush to develop water rights. Section 9.1 of Colorado's Water Plan provides additional discussion of the collaborative program.

The collaborative program will develop in concert with intra- and interstate water policies. The IBCC and roundtables can provide an important forum for sharing the work of ongoing interstate negotiations, scoping technical analyses, and identifying issues of concern at the stakeholder level, as well as providing input to the CWCB as it manages and conducts the technical, legal, economic, and other studies necessary for implementation.

Principle 5: Future western slope needs should be accommodated as part of a new TMD project.

If a new TMD were to be built, this Framework assumes that proponents and affected parties would agree to its development as part of a package of cooperative projects and processes that benefit both the eastern and western slopes. The focus should be on pairing the potential new TMD described above with one or more of the following:

- Compensatory projects and methods (protecting and providing for both consumptive and nonconsumptive needs).
- A socio-economic compensation fund (as described in the 2010 IBCC "Letter to the Governors").
- Other requirements stated in the Conservancy District Act (C.R.S. § 37-45-118).

The parties would develop a new TMD and compensatory western slope project(s) and methods in concert to ensure sufficient funding and hydrology for the whole package. Such an arrangement would provide the necessary mutual assurance that a new TMD would move forward only as a package that also accommodates both the eastern and western slopes.

The increment of additional development Principle 4 discusses will meet some portion of future western slope needs. The purpose of Principle 5 is to indicate that a new TMD may be part of a package of other consumptive or nonconsumptive projects and methods that may need both eastern slope and western slope financial or infrastructural support. Discussion of future western slope needs in relation to a new TMD does not imply that western slope entities would not move forward with additional projects and methods in the absence of a new TMD.

This principle does not imply that the new TMD project proponent would pay all costs associated with providing the basin-of-origin benefits to the basin of origin, beyond those required to mitigate a new TMD's impacts identified in regulatory processes. Providing these benefits may require building coalitions and finding additional funding.

Principle 6: Colorado will continue its commitment to improve conservation and reuse.

Part A. Municipal & Industrial Conservation and Reuse

M&I conservation: Conservation actions defined in the No and Low Regrets Action Plan should be substantively completed prior to implementation of a new TMD project.

All M&I water providers that are covered entities should do integrated water resource planning that strives to meet the "conservation stretch goal" described in section 6.3.1 of Colorado's Water Plan. The stretch goal recognizes the need 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.

Water providers participating in a new TMD project should have active conservation plans and activities approved by the CWCB in place prior to implementation of the project, and high conservation levels, as defined in SWSI, should be reached for new growth relying on water that would be yielded from a new TMD. The active water conservation plans of providers participating in a new TMD should demonstrate a commitment to work toward achieving the conservation stretch goal. These plans should have measurable outcomes. Opportunities for conservation may vary from one community to another.

Reuse: Reuse actions defined in the No and Low Regrets Action Plan should also be substantively completed prior to the implementation of a new TMD project, given technical and regulatory feasibility at the time of proposed implementation. Such actions include improved tracking and quantification, development of a statewide reuse goal, development of new incentives for reuse, and education and outreach efforts.

Additionally, water providers that are participating in a new TMD project and that utilize other fully consumable water supplies should have a reuse program to recycle as much water as is technically and economically practical. Existing regulations and policies may limit such reuse, and the ability to make these changes may be beyond the control of the project proponent(s). The State should make every effort to allow for the reuse of these fully consumable water supplies in an appropriate and environmentally safe manner. Legislative and regulatory reform may be desirable to achieve these objectives. If such reform does not occur, key objectives of the water plan may not be realized. Section 6.3.2 of Colorado's Water Plan further discusses reuse.

Water & land use: Land-use practices that help reduce water consumption should be supported and encouraged, focusing as much as possible on incentives. Land use is an important component in water conservation; however, further work is needed to determine strategies and partners that can tackle this issue. In partnership with the Department of Local Affairs, the CWCB will initiate additional discussions on this issue along with municipalities, counties, local planning agencies, and elected officials at all levels. Trainings on this issue are forthcoming. Section 6.3.3 of Colorado's Water Plan further discusses land use.

Part B. Agricultural Conservation

When considering agricultural conservation strategies, it will be important to take a site-specific perspective and to consider the potentially negative consequences of altering the timing and the amount of return flows. While some locations lend themselves well to agricultural conservation practices, others do not, and a clear understanding of the affected systems is necessary.

Current Agricultural Uses: Many of the BIPs identified the explicit interconnections between agricultural and nonconsumptive uses. In addition, several BIPs are looking to decrease agricultural shortages. As part of this work, each basin should seek to reduce consumptive, non-beneficial use by following the guidelines in the Colorado Agricultural Water Alliance (CAWA) 2008 Agricultural Conservation Paper (e.g., reducing soil-moisture loss where practical through drip irrigation or mulching). Lining of high-priority ditches is another important tool in reducing seepage losses in appropriate areas. Phreatophyte control presents one of the largest opportunities for reducing non-beneficial consumptive use and should be pursued aggressively, although balancing this with nonconsumptive needs can be challenging. Additional incentives should be developed to assist basins in implementing, where appropriate, agricultural efficiency and conservation practices, supporting the ecosystem services agriculture can provide, and changing crop types to lower water-use crops.

Future Agricultural Uses: New, irrigated agricultural lands (currently identified in the North Platte, Yampa/White/Green, and Southwest Basins) should be designed to either use best practices with regard to agricultural conservation and efficiency, or be measurably and explicitly multipurpose by meeting identified nonconsumptive needs.

Principle 7: Environmental resiliency and recreational needs must be addressed both before and conjunctively with a new TMD.

Agriculture and Nonconsumptive Partnerships: Agricultural water can add flexibility and reliability to meet future water needs. The Framework encourages agricultural partnerships with environmental, recreational, and municipal groups to help sustain Colorado's diverse economic future and healthy environment. In addition, development of all new water projects should consider important agricultural and nonconsumptive gaps that basin roundtables have identified.

Environmental Resiliency:[c] Colorado's Water Plan, BIPs, and stakeholder groups across the state should identify, secure funding for, and implement projects that help recover imperiled species and enhance ecological resiliency, whether or not a new TMD is built. Doing so may create conditions that make a new TMD possible, but building environmental resiliency is not the sole responsibility of a new TMD proponent, since environmental and recreational gaps exist now. The Framework encourages addressing these existing gaps meaningfully in the near term as well as in any new TMD-affected areas in advance of building a new TMD. Sources of funding will likely include federal, state, foundation, corporate, and private money, but Colorado will likely need to develop additional funding sources. Colorado's Water Plan recommends actions that improve Colorado's environment, which will ultimately help Colorado achieve environmental resiliency.

[c] Resilience of a stream or watershed can be measured as an ecosystem's ability to recover function after a disturbance, whether acute or chronic.

Environmental and recreational needs in relation to a new TMD: In addition, a new, multipurpose TMD could potentially fill remaining environmental and recreational gaps as part of a package of compensatory projects. As Principle 5 discusses, a new TMD will be part of a package that also includes benefits or mitigation for environmental and recreational values. This principle encourages addressing environmental and recreational needs proactively and voluntarily, and up-front in project design. Proponents should include nonconsumptive partners to make the package of projects associated with the new TMD truly multipurpose. A new TMD proponent should avoid, minimize, or mitigate adverse environmental impacts where possible, and provide opportunities for environmental restoration and enhancement. Project proponents must mitigate impacts that result from a new TMD project, even if those impacts occur outside of Colorado. The financial burden of environmental and recreational enhancements, beyond the mitigation required to address the impacts of the new TMD project, will require funds in addition to those that the TMD proponent provides, and may require building coalitions and additional funding opportunities.

Appendix D[5] includes the complete first draft of the conceptual framework. Once the framework is complete, the points of consensus may serve as the foundation for any new future TMD projects seeking State support, and the framework's considerations will guide and move projects forward in conjunction with State support.

The 2015 Statewide Basin Roundtable Summit was held in Westminster. Attendees discussed the action items in Colorado's Water Plan and the interdependent nature of water uses across the state. Photo: J. Bornstein.

ACTIONS

The following next steps will support the policies, conceptual agreements, and points of consensus in the conceptual framework:

1. At the roundtable and IBCC levels, the CWCB will monitor ongoing discussions that involve the topics associated with the seven principles of the conceptual framework.
2. The CWCB will protect the ability to fully develop Colorado's compact entitlements and continue to support intrastate agreements that strengthen Colorado's position in interstate negotiations. The State of Colorado will support strategies to maximize the us of compact water while actively avoiding a Colorado River Compact deficit. Colorado will focus planning efforts on maintaining healthy systems and avoiding a Colorado River Compact deficit rather than on its response to compact curtailment.
3. The CWCB will help Colorado prepare for a future with more scarce water supplies; in other words, it will hope for the best and plan for the worst. Colorado will work with other states to evaluate options for sustainable water solutions that balance the development of Colorado's compact entitlements with the risk of a compact deficit in the Colorado River System. Colorado's conceptual framework, under Principle 4, and Section 9.1 in Colorado's Water Plan further describe this concept. The CWCB will also support continued outreach to stakeholders regarding interstate cooperative solutions.

TABLE 8-1 COLORADO RIVER DEVELOPMENT - DISCUSSION IN THE BASIN IMPLEMENTATION PLANS

River Basin	Compact Discussion	Transmountain Diversions (TMDs)
Arkansas	"As an importing and exporting basin, the future of the State's Colorado River Compact Entitlement directly affects all water uses in the Arkansas Basin;" "**Policy Statement:** The Arkansas Basin Roundtable supports the full development of Colorado's entitlement under the Colorado River Compact, for use in Colorado."[6]	"In particular, a future without New Supply, as that term is understood in the lexicon of the Statewide Water Supply Initiative 2010, is detrimental to the future of agriculture in the Arkansas Basin."[7]
Colorado	"Recent studies show that continued development from the Colorado River toward full Compact entitlement is simply unsustainable."[8]	"The core principle is that a TMD should be the last not the first tool out of the box to deal with water supply shortages statewide. This principle is equally applicable to any basin, including the Colorado Basin where the focus is on meeting the needs of the basin from resources within the basin.[9]
Gunnison	"The ultimate risk from new development of Colorado River System water is over development of Colorado's entitlement under the Colorado River Compact and Upper Colorado River Basin Compact, resulting in curtailment of water uses in Colorado. However, because Colorado River Storage Project reservoirs have provided drought protection for Upper Basin states, Compact curtailment is not a near term risk. Therefore, in preparing the 2015 Water Plan, new development planning should be focused on avoiding hydroelectric power disruption, a Colorado River Compact deficit, or development in excess of Colorado's allocation under the Upper Colorado River Basin Compact. The Gunnison Basin Roundtable believes that evaluating new development using this standard will leave Colorado well positioned to respond to the ultimate risk of over development."[10]	"1. Future supply of Colorado River water is highly variable and uncertain; therefore any proponent of a new supply project from the Colorado River System must accept the risk of a shortage of supply however the shortage occurs, strictly adhere to the prior appropriation doctrine, and protect existing water uses and communities from adverse impacts resulting from the new supply project. 2. It must be explicitly recognized that a new supply development from any location in the Colorado River System affects the entire West Slope, as well as the Front Range diverters. 3. Any new supply project from the Colorado River System must have specifically identified sponsors and beneficiaries, and meet certain minimum criteria 4. Local solutions must be utilized to meet Colorado's future water needs without a major state water project or related placeholder water right."[11]
North Platte	The BIP did not address Colorado Compact concerns.	The BIP took no position on TMDs.
Rio Grande	The BIP did not address Colorado Compact concerns.	The BIP took no position on TMDs.
South Platte/Metro	"The Metro and South Platte Roundtables encourage strong consideration and preservation of the ability to use Colorado's entitlement under the Colorado River Compact as we pursue other strategies to meet our water demands. Investigating, preserving, and developing Colorado's entitlement to Colorado River supplies is beneficial to the state's economic, social, political and environmental future. This may involve large state-level water projects, or small level projects, each with comprehensive West Slope water supply and environmental and recreational components. The Roundtables support the Conceptual Framework developed by the IBCC (and as outlined in Colorado's Water Plan) as the means whereby new Colorado River Basin supply options could be investigated and potentially developed."[12] "Additional amounts of Colorado River water supply may be developed within the State's Colorado River Compact entitlement, especially during wet years and wet cycles. Management techniques such as water banks and methods for temporarily reducing water use during dry conditions are available to manage a warmer and/or drier climate. However, artificially capping development due to a fear of a "compact call" merely shifts future risks to agriculture."[13]	"The South Platte and Metro Basin Roundtables are supportive of the on-going IBCC discussions and believe that a wide range of water supply solutions should be carefully considered including continued and expanded water conservation and reuse programs statewide. *All "four legs of the stool plus storage" need to be simultaneously considered as the development of Colorado's Water Plan continues."* "Ideally, a Colorado River supply project(s) would be multipurpose, with associated recreational and environmental benefits. Colorado River supply would be developed in a manner that does not exacerbate compact risks. East slope storage would come from enlarging existing reservoirs, building off-river storage, and using underground storage to minimize riparian impacts. Colorado River supply and east slope storage would form the base of the M&I supply. East slope Agricultural Transfers and conjunctive use of the Denver Basin Aquifer would be used primarily for droughts and drought recovery. Alternative agricultural transfer methods including land and water conservation easements could be used to help maintain agricultural production and the local economic benefits of agriculture."[14]

TABLE 8-1 CONTINUED COLORADO RIVER DEVELOPMENT - DISCUSSION IN THE BASIN IMPLEMENTATION PLANS

River Basin	Compact Discussion	Transmountain Diversions (TMDs)
Southwest	"The Roundtable is concerned about any new TMD. A new TMD would increase the risk of a Colorado River Compact call, as well as the risk of contingency measures to address serious conditions such as the inability to generate power from Lake Powell or levels of Lake Mead dropping below Las Vegas' intake. An increase in such risks jeopardizes the Southwest Basin's ability to develop water supplies to meet needs in the Southwest Basin and pits additional pressure on the basin's agriculture to meet downstream water needs for compact compliance and/or obligations. Therefore, the Roundtable agrees on eight factors to be addressed prior to considering a new TMD."[15]	"The Southwest Basin intends to continue its involvement in two current cross-basin cooperative efforts. One is the IBCC's effort to develop a conceptual agreement among roundtables regarding how to approach a potential future TMD from the west slope to the east, including the discussion of a possible future use allocation. The Southwest Basin is actively engaged in the West Slope Caucus discussions and supports further refinement of the seven points of framework (IBCC Draft Conceptual Agreement; July 2014). The Roundtable would like the opportunity to review and comment on any future refinements to said Framework. A new TMD must be considered in conjunction with alternative water sources that do not rely on the Colorado River Basin water supplies The Southwest Basin's cooperative effort is through the Southwestern Water Conservation District's participation as a member of the Water Bank Working Group to develop a Compact Water Bank."[16]
Yampa/ White/ Green	"How the Yampa/White/Green Basin fits into meeting Colorado's compact obligations within and beyond the state is a principal concern. The Yampa/White/Green Basin is part of Colorado River Basin, and is caught among the needs of the downstream states, the needs of the urbanized east slope of Colorado, and its own in-basin needs. The Yampa/White/Green Basin Roundtable must consider these competing needs in its water planning effort. In this regard, the Yampa/White/Green Basin Roundtable also recognizes that the overdevelopment of water in the Colorado River and its tributaries poses a serious risk that would impact all users of Colorado River Basin water"…" "The State of Colorado is party to the 1922 Colorado River Compact and the 1948 Upper Colorado River Compact. Currently, the state is discussing methods (e.g. contingency planning, demand management, water banking) to minimize the risk of a "call" under compact administration. The role of the Yampa/White/Green Basin flows in meeting the state's compact obligations is a central issue in the Yampa/White/Green BRT's planning efforts. In the event of a compact deficit, the State Engineer would have to develop rules by which to curtail Colorado River water users to remedy the condition. How the state administers a curtailment could greatly affect Colorado River water rights users across the state. If administration is based upon a statewide application of the prior appropriation system in the Colorado mainstem and tributary basins, the burden would likely fall disproportionately on the Yampa/White/Green Basin as its water rights are relatively junior to those of other Colorado River basins."[17]	"The Yampa/White/Green Basin Roundtable's position is that a negotiated equitable native flow allocation for all basins tributary to the Colorado River should be the basis for such a rulemaking. The Yampa/White/Green Basin Roundtable recognizes that negotiations for allocations of Colorado River water should include all users including TMDs that have historically diverted from Colorado River tributaries."[18]

A LOOK AT HISTORY

Signing of the Mexican Water Treaty in Washington, D.C. on February 3, 1944.
Secretary of State Cordell Hull, seated at the head of the table, is signing the treaty.
Mexican Foreign Relations Secretary F. Castillo Najera is seated to Secretary Hull's right.

source: Bureau of Reclamation.

caption: Thomas V. Cech, J William McDonald, Defened and Develop:
A Brief History of the Colorado Water Conservation Board's First 75 Years,
[Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

MICHELLE PIERCE, CONTINUED FROM PAGE 8-8.

Water first became important to me during my career with the Town of Lake City. The Town's water distribution system includes the operation of two wells and administration of their associated water rights. My work to help secure those water rights and to help with the development of an augmentation plan gave me a basic understanding of the prior appropriation doctrine and a mere glimpse into its complexities. It also opened my eyes to the fact that water is a scarce resource in Colorado and how what water we have serves many purposes.

In the few years leading up to my retirement, I had the complete pleasure of working with many dedicated folks to establish the Lake San Cristobal Water Activity Enterprise for the purpose of constructing and managing an outlet structure at Lake San Cristobal. The water stored behind this outlet structure not only augments the water rights for the Town of Lake City, it will also serve as augmentation water for future diversions in the Lake Fork Valley for many years to come. But, perhaps what I'm most proud of is my service over the past ten years on the Gunnison Basin Roundtable. Helping to create common understandings among extremely diversified interests on both sides of the Divide has been one of the most rewarding and challenging experiences of my life. While the planning processes that we've been immersed in have not solved our future water supply needs, we have successfully established the relationships that will be needed to do so. This is a huge accomplishment that has required tremendous effort by many dedicated people to achieve and one for which we should all be proud.

My hope for water supply for the future is that we can figure out a way to responsibly manage what little supply is left without sacrificing Colorado's agriculture and without sacrificing our environment. Although my term on the Gunnison Basin Roundtable expires in October, I plan to continue my work in water supply issues as a board member of the Upper Gunnison River Water Conservancy District.

[1] Colorado Water Conservation Board, "Interbasin Compact Committee Members," accessed July 2015, http://cwcb.state.co.us/about-us/about-the-ibcc-brts/Pages/InterbasinCompactCommitteeMembers.aspx

[2] Colorado Water Conservation Board, "No and Low Regrets Action Plan" (Colorado Water Conservation Board Meeting Agenda Item 24, September 24-25, 2013), accessed July 2015, http://cwcbweblink.state.co.us/WebLink/ElectronicFile.aspx?docid=172937&searchid=369b690c-638b-4207-9e92-efa1e6ff0e95&dbid=0

[3] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015), 45. http://coloradobip.sgm-inc.com/

[4] HDR, WestSage Water Consultants, *South Platte Basin Implementation Plan* (Denver: HDR, West Sage Water Consultants, 2015), 1-21. http://southplattebasin.com/

[5] Colorado Water Conservation Board, "Interbasin Compact Committee DRAFT Conceptual Agreement" (Colorado Water Conservation Board Meeting Agenda Item 13, July 16, 2014), accessed July 2015, http://cwcbweblink.state.co.us/WebLink/ElectronicFile.aspx?docid=191531&searchid=0e0a416b-3b1d-4d97-92ec-c12350d56016&&dbid=0.pdf

[6] CDM Smith, CH2M, Sustainable Practices, Peak Facilitation, G. Barber, Project Manager, 2015 Edition, *Arkansas Basin Implementation Plan,* (Pueblo: Arkansas Basin Roundtable, 2015), 166, http://www.arkansasbasin.com/arkansas-bip.html

[7] CDM Smith, CH2M, Sustainable Practices, Peak Facilitation, G. Barber, Project Manager, 2015 Edition, *Arkansas Basin Implementation Plan,* (Pueblo: Arkansas Basin Roundtable, 2015), 4-8. http://www.arkansasbasin.com/arkansas-bip.html

[8] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015) 136. http://coloradobip.sgm-inc.com/

[9] SGM, *Colorado Basin Implementation Plan* (Glenwood Springs: SGM, 2015) 14 http://coloradobip.sgm-inc.com/

[10] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015). 40. https://www.colorado.gov/pacific/cowaterplan/gunnison-river-basin

[11] Wilson Water Group, *Gunnison Basin Implementation Plan* (Denver: Wilson Water Group, 2015). 39-41. https://www.colorado.gov/pacific/cowaterplan/gunnison-river-basin

[12] HDR, WestSage Water Consultants, *South Platte Basin Implementation Plan* (Denver: HDR, West Sage Water Consultants, 2015) Section S-14. http://southplattebasin.com/

[13] HDR, WestSage Water Consultants, S*South Platte Basin Implementation Plan* (Denver: HDR, West Sage Water Consultants, 2015) 4-116. http://southplattebasin.com/

[14] HDR, WestSage Water Consultants, *South Platte Basin Implementation Plan* (Denver: HDR, West Sage Water Consultants, 2015) Section 4.8.2. http://southplattebasin.com/

[15] Harris Water Engineering, *Southwest Basin Implementation Plan* (Durango: Harris Water Engineering, 2015), 2. https://www.colorado.gov/pacific/cowaterplan/san-juan-and-dolores-river-basin

[16] Harris Water Engineering, *Southwest Basin Implementation Plan* (Durango: Harris Water Engineering, 2015) 106. https://www.colorado.gov/pacific/cowaterplan/san-juan-and-dolores-river-basin

[17] AMEC, *Yampa/White/Green Basin Implementation Plan* (Denver: AMEC, 2015) 1-2. https://www.colorado.gov/pacific/cowaterplan/yampa-white-green-river-basin

[18] AMEC, *Yampa/White/Green Basin Implementation Plan* (Denver: AMEC, 2015), 1-2. https://www.colorado.gov/pacific/cowaterplan/yampa-white-green-river-basin

Alignment of State Resources and Policies

Chapter 9 explores the mechanisms by which the State of Colorado can help implement the BIPs and address Colorado's critical water strategies discussed throughout Colorado's Water Plan.

As Section 9.1 describes, continuing to support the solid foundation of Colorado's prior appropriation system, maintaining interstate agreements and compacts, and retaining local control are all critical to keeping Colorado whole. These systems are flexible enough to move forward with the actions Colorado's Water Plan describes; however, many of the strategies this plan and the BIPs describe require additional or more coordinated funding. Section 9.2 explains imminent needs for project funding, along with options for new and existing funding mechanisms that will be necessary for meeting Colorado's water future.

The State of Colorado holds numerous water rights, many of which aim to protect the environment or recreational opportunities. In addition, Colorado has purchased water rights in important multi-purpose projects to help with implementation of these water projects. Section 9.3 illustrates ways to improve coordination among state agencies that own water rights, and describes the possible acquisition of new water rights that more strategically address the State's water values.

Many of the projects and methods this plan describes will require permitting, and if the State of Colorado is to be adaptive in its approach to water management, the permitting process needs to be as effective and efficient as possible. Section 9.4 discusses emerging concepts for a more efficient permitting process.

Lastly, an educated public is necessary to Colorado's ability to continue engaging stakeholders in developing grassroots solutions—and moving them forward. However, few resources are available to meet this important need. Section 9.5 discusses the unprecedented educational effort the CWCB has initiated to build the first draft of Colorado's Water Plan, and offers a vision of the ways the CWCB can implement education and outreach efforts in a more sustainable and robust fashion. Together, these state actions will help Colorado implement the water strategies described in Chapters 6 through 8.

Looking up into the State Capitol Dome. The state Capitol houses the Governor's office and both houses of the General Assembly.

9.1 PROTECTING COLORADO'S COMPACTS AND UPHOLDING COLORADO WATER LAW

GOAL

Colorado's Water Plan upholds Colorado's water law system, interstate water compacts and equitable apportionment decrees, and local control structures. Colorado will focus planning efforts on maintaining healthy systems and avoiding a Colorado River Compact deficit, rather than focusing on the State's response to a compact curtailment.

As Chapter 2 describes, Colorado has an intricate legal and institutional framework, and the institutional setting is the starting point for all other conversations regarding Colorado's water future. Colorado's Water Plan recognizes the prior appropriation doctrine as the foundation of Colorado's water law system, and respects the importance of Colorado's interstate water compacts and other interstate agreements.

Additionally, this plan maintains Colorado's water allocations by respecting the designated roles of the State of Colorado and the federal government regarding water management within Colorado. Colorado's Water Plan continues to support state-based solutions to needs federal agencies have identified in order to best balance water needs in Colorado and ensure that water rights for environmental purposes can be appropriately administered within Colorado's water law. These state and federal partnerships have been successful in several instances, and this plan describes them in more detail below. This plan also recognizes Colorado's history of local control regarding water development, and will continue to uphold Colorado's commitment to supporting tribal water settlements with the Ute Mountain Ute and Southern Ute Tribes.

Section 9.1 reaffirms Colorado's commitment to these fundamental tenets, while advancing strategies for future water management.

The State of Colorado Demand will continue to uphold the prior appropriation doctrine.

Colorado's prior appropriation doctrine is based on language within the Colorado Constitution. The doctrine requires that water be put to beneficial use, and also requires efficient use to ensure the greatest utilization of Colorado's water resources.[1] These concepts are ever-evolving and will need to adjust appropriately. Over time, the doctrine has proven to be remarkably flexible, and this flexibility has been demonstrated by the recognition of new beneficial uses, such as environmental and recreational uses, under the law. While Colorado's Water Plan affirms the prior appropriation doctrine, there is room for improving water management within this allocation system.

Colorado's water court system has often been criticized for being cumbersome and expensive.[2] Several years ago, a report from the Water Court Committee of the Colorado Supreme Court to the Chief Justice made recommendations to improve the efficiency and cost effectiveness of the water court system. The State has implemented most of these recommendations, but the Water Court Committee should assess whether these changes have had the desired effect of making the system more efficient and cost effective. In addition, the standing committee should explore whether additional recommendations could be made in the future.

The State of Colorado will continue to uphold and maximize the use of Colorado's water entitlements under Colorado's compacts, equitable apportionment decrees, and other interstate agreements.

For nearly a century, Colorado has led the development and protection of interstate water compacts as a method of allocating water on interstate streams and rivers. Colorado vigorously defended its water allocations when downstream states have alleged compact violations,[3] and has also been steadfast in defending water entitlements allocated to Colorado through equitable apportionment decrees.[4] Colorado's

Water Plan reaffirms Colorado's dedication to protecting its compact and decree entitlements.

Colorado has a litigation account that is available to the CWCB and the Office of the Attorney General for Colorado's defense of its water resources.[5] Importantly, this fund is available to: 1) Support water users whose water supply yield is or may be diminished as a result of conditions imposed, or that may be imposed, including but not limited to bypass flows by any agency of the United States on permits for existing or reconstructed water facilities located on federally owned lands; 2) oppose applications of a federal agency for an instream flow right that is not in compliance with Colorado law; 3) protect Colorado's allocations of water from interstate streams; and 4) ensure the maximum beneficial use of water for present and future generations by addressing important questions of federal law.[6] Colorado should continue to maintain a sufficient balance in this fund to ensure that the State has adequate resources to protect its water resources. In addition, Colorado should make every effort to comply with its compact and decree obligations. While interstate compacts have been a solid foundation upon which water allocation occurs, interstate compacts have also been flexible and are able to address issues in times of drought and other unforeseen circumstances.

The Republican River Compact Compliance Pipeline project delivers water from wells north of the North Fork of the Republican River, providing credit associated with the compact. Courtesy of the Republican River Water Conservation District.

In working to protect the state's valuable water resources, Colorado recognizes that federal agencies manage federal lands and have a role in managing water resources within the state. At the same time, the State of Colorado has vigorously defended Colorado's water allocation and management system. Colorado will continue to argue for an appropriate balance between state and federal roles in Colorado's water law and water management system. That said, it is important to balance and coordinate the state and federal agency roles and responsibilities in order to remain consistent with their respective authorities and obligations. Federal statutes such as the Wild and Scenic Rivers Act and the ESA may affect the ways in which water users develop Colorado's compact and decree entitlements. The State of Colorado is committed to working with federal agencies to fulfill their legal responsibilities in ways that respect Colorado's compact and decree entitlements, and authorities to administer waters within the state. An example of this type of compromise exists within the Upper Colorado River Endangered Fish Recovery Program, a multi-agency partnership that operates to help protect and recover endangered fish species while allowing water users to continue to develop the State's compact entitlements. The State of Colorado should continue to support such programs and explore ways to develop similar programs when appropriate.

In addition, Colorado's Instream Flow Program is an effective tool used in the Upper Colorado River Wild and Scenic Rivers Act Management Plan. This plan provides protection for flow-related "Outstandingly Remarkable Values" associated with the Upper Colorado River, while respecting the need for water managers to have flexibility in the future. It can also serve as a model for future endeavors in state and federal collaboration.

The State of Colorado will continue to ensure a proper balance between state and federal roles in Colorado's water law and water management system.

The State of Colorado has always vigorously defended Colorado's water allocation and management system, and is committed to ensuring that there remains an appropriate balance between federal and state roles in water management. Recently, certain federal agencies' decisions and proposed actions identified the need to improve communication and coordination among state and federal agencies to ensure mutual respect of state and federal roles. Some recent examples include the USFS' position on water rights associated with Colorado ski areas; the USFS' proposed groundwater directive; the BLM's resource management plans; and USFS' management plans. In the context of these and other federal water-related issues, Colorado must work proactively with federal agencies to ensure that resource protection needs required by federal law are met in a way that respects water rights decreed and administered by the state. To the extent that bypass flows interfere with and potentially undermine water rights as decreed and administered within the state, Colorado maintains that bypass flows should not be a preferred method for meeting aquatic resource protection objectives on federal lands. Rather, federal agencies and the State should work together, whenever possible, to meet their common water resource objectives.

The State of Colorado will continue to work within Colorado's local structure.

Colorado's local governments have considerable authority in making water development and management decisions, and counties and municipalities exercise a broad range of powers—explicitly conferred to them by state law—to address the needs of their constituents. The range of local authorities includes broadly authorizing counties and municipalities to balance environmental protection with the need to provide for planned and orderly land use. Counties and municipalities have several tools at their disposal to make this happen, including the ability to create special districts, require master plans for development, assess impact fees to offset new development on existing infrastructure, and exercise 1041 powers, which allow local governments to regulate construction or extensions of major new water and sewage treatment systems. The State of Colorado will work collaboratively with local governments within this existing framework, and Colorado's Water Plan is a valuable tool for both levels of government in that work. Section 2.3 discusses the local control structure within Colorado in more detail.

The State of Colorado will support strategies to maximize the use of compact water while actively avoiding a Colorado River Compact deficit.

All Colorado River system water users have an interest in the security of Colorado's compact entitlement. Basins using Colorado River system[a] water emphasized the need to protect existing uses, while proposing some increment of future development. Ongoing interstate discussions, such as those about the Colorado River drought contingency-planning efforts the Upper Division states are developing (which Chapter 2 discusses), will inevitably affect water management within Colorado. These efforts include weather modification, extended reservoir operations (the release of water from upper Colorado River Storage Project reservoirs to protect critical reservoir elevations at Lake Powell), and management of demands to influence Lake Powell elevations. Hydrologic conditions in the face of climate change and increased demands will require Colorado water users to creatively and collaboratively manage the resources at hand. Intrastate efforts will be distinct from, but necessarily informed by, ongoing interstate processes and negotiations.

[a] As defined in the Colorado River Compact of 1922: "that portion of the Colorado River and its tributaries within the United States of America."

In early drafts of the IBCC Conceptual Framework, the IBCC discussed the concept of a collaborative program to protect existing uses and some increment of statewide future use. The IBCC placed the highest priority on working on a collaborative, programmatic approach to managing consumptive uses moving forward, with the end goal of avoiding a compact deficit. This programmatic approach would ideally involve water banking concepts, although at present this approach has not been sufficiently developed to provide full coverage for protected uses. While water banking may be an important part of the programmatic approach, it will likely be one piece of a multifaceted program.

The programmatic approach involves augmentation and storage management as initial tools, and demand management as a tool of last resort. Demand management efforts would be based on voluntary, temporary, and compensated reductions in eastern and western slope consumptive use. Willing water users would be temporarily compensated for voluntary reductions of consumptive use, and such reductions in use would be monitored and verified to ensure a benefit to the Colorado River system.

By definition, pre- and post- compact water rights are subject to distinctive levels of risk in a compact curtailment situation, and though the purpose of a collaborative program would be to avoid curtailment entirely, it is important for program participants to recognize the potential impacts of a curtailment on these different types of water rights.

Lake Powell lies across the border between Utah and Arizona. This reservoir serves as the Upper Basin States' "bank account" with regard to the Colorado River Compact.

ACTIONS

The following actions will promote continued collaboration among the State of Colorado and federal, state, tribal, and local entities regarding interstate and intrastate water management issues. These actions seek to protect Colorado's compact entitlements while encouraging collaborative solutions to protect existing and future uses within the state.

A. **The State of Colorado will continue to uphold the prior appropriation doctrine.**
    1. The CWCB encourages ongoing efforts to make the water court system more efficient—including the work of the Water Court Committee of the Colorado Supreme Court. CWCB envisions that these efforts will make the prior appropriate doctrine process more efficient and easily navigated, while maintaining the protection of these important private property rights.
    2. The IBCC's work on potential legislative solutions suggests that broad stakeholder input is needed to garner support for achieving process improvements through the legislative process. The CWCB will explore potential avenues for broad input on improvements to the water court process, whether through the roundtable and the IBCC process, or other mechanisms.
    3. Using broad stakeholder input to garner support, the CWCB will explore potential avenues for achieving process improvements that will make Colorado's existing water law system more agile, effective, and efficient.

B. **The State of Colorado will continue to uphold Colorado's water entitlements under Colorado's compacts, equitable apportionment decrees, and other interstate agreements.**
    1. The CWCB will continue to maintain a sufficient balance in the litigation fund to ensure that the State has adequate resources to protect its water resources.
    2. The CWCB and the Division of Water Resources will continue to make every effort to comply with interstate compact and decree obligations.
    3. The CWCB will continue to work with federal agencies to ensure that their responsibilities are implemented in a way that respects Colorado's compact and decree entitlements, and respects the State's authorities to administer waters within the state.

C. **The State of Colorado will continue to ensure a proper balance between state and federal roles in Colorado's water law and water management system.**
    1. The CWCB will remain involved in maintaining the balance of state and federal roles within Colorado. As federal procedures and policies are developed and implemented, the State will defend Colorado's water allocation and management system to the extent that proposed federal actions may interfere with and potentially undermine water rights as decreed and administered within the state.

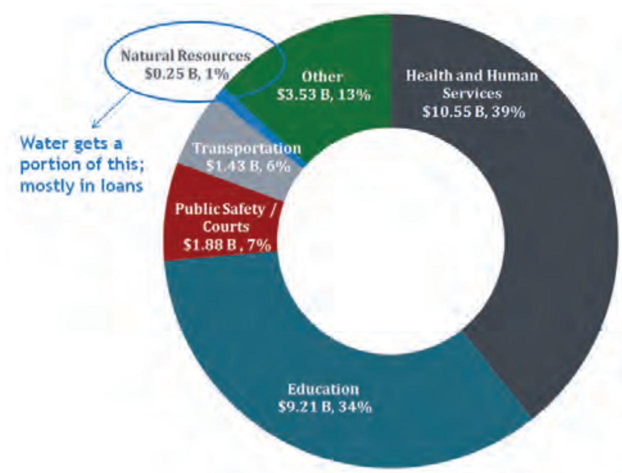
D. **The State of Colorado will continue to work within Colorado's local structure.**
    1. In proposing innovative strategies to meet Colorado's existing and future water needs, the CWCB will continue to work collaboratively with local governments, while recognizing the authority of counties and municipalities in making water development and management decisions.

E. The State of Colorado will support strategies to maximize use of compact water while actively avoiding a Colorado River Compact deficit.

1. The CWCB will continue to support water banking efforts and prioritize the development of the programmatic approach as described over the next several years. This development will require extensive statewide stakeholder participation and educational efforts.
2. The CWCB's future study and collection of collaborative stakeholder input will help the CWCB gauge the potential for a programmatic approach to meet existing and future needs, while maintaining equitable distribution of the reduced consumptive use. Multiple types of water users in locations on eastern and western slopes should share the burdens of demand management.
3. As the CWCB begins technical investigation of a potential collaborative program, a key issue to resolve will be the potential scope of demand management. The greater the number of existing uses such a collaborative program will cover, the greater the number of necessary voluntary reductions and amount of compensation.

9.2 ECONOMICS AND FUNDING

FIGURE 9.2-1 2015 COLORADO STATE BUDGET



GOAL

Colorado's Water Plan coordinates existing funding sources and explores additional funding opportunities.

Introduction

Investing in the long-term sustainable supply and delivery of water is critical to Colorado's future. Even in robust economic times, the difficulties inherent in financing large, long-term, sustainable water projects can create community apprehension and political controversy.

At the same time, the State of Colorado does not invest significant funds in water resources compared to other state priorities.[7] Figure 9.2-1 shows the State's overall natural resources budget compared to other state priorities.

Financing long-term, sustainable water supplies and infrastructure projects requires a collaborative effort involving water users and providers, as well as federal, state, and local entities. Over the years, the CWCB has partnered with various water providers throughout Colorado to conserve, develop, and protect Colorado's water for future generations. The CWCB has provided funding through grants and loans for critical multipurpose and multipartner projects, which have included the Chatfield Reallocation Project, the Animas-La Plata Project, the Rio Grande Cooperative Project, and the Elkhead Reservoir Enlargement Project. For these projects alone, the CWCB contributed over $200 million. These projects supplied over 100,000 acre-feet of water to help water providers meet their water supply and storage needs, while also improving stream health, promoting shared uses, sustaining agriculture, and providing long-term recreational benefits.[a]

To meet long-term water demands, Colorado will need to secure funding through a combination of legislation, partnerships, and state and federal grant and loan programs. It is the CWCB's intent to promote, and potentially financially and politically support, projects that evaluate water supply, storage, and conservation efforts on a regional, multipurpose, multi-partner, multi-benefit basis, and projects that evaluate the consolidation of services where practical, feasible, and acceptable. This section provides: 1)A description of existing financial need; 2) an overview of financial assistance programs; and 3) recommendations and suggested approaches for developing an integrated water infrastructure financing model that could assist in addressing Colorado's short- and long-term water needs.

[a] Chatfield Reallocation Project ($62 million CWCB investment, $80 million loans), Animas- La Plata Project ($37 million water purchase), Rio Grande Cooperative Project ($5 million grant, $15 million loan/grant), and Elkhead Enlargement Project ($11 million).

TABLE 9.2-1 **PROJECT COSTS IDENTIFIED IN THE BASIN IMPLEMENTATION PLANS***

BASIN	SINGLE-PURPOSE PROJECTS AND METHODS			MULTI-PURPOSE PROJECTS	TOTAL
	ENVIRONMENTAL, RECREATIONAL, OR WATER QUALITY	MUNICIPAL AND INDUSTRIAL	AGRICULTURAL		
Arkansas	$345,000,000	$270,000,000	$10,000,000	$792,000,000	$1,407,000,000
Colorado	$1,500,000	$4,000,000	Forthcoming	$132,000,000	$137,500,000
Gunnison	$8,000,000	$46,000,000	$9,000,000	$423,000,000	$486,000,000
North Platte	Forthcoming	Forthcoming	Forthcoming	Forthcoming	Forthcoming
Rio Grande	Forthcoming	Forthcoming	$80,000	$130,000,000	$131,080,000
South Platte / Metro	Forthcoming	Forthcoming	Forthcoming	Forthcoming	Forthcoming
Southwest	$60,000,000	Forthcoming	Forthcoming	Forthcoming	$60,000,000
Yampa/White/ Green	$5,000,000	Forthcoming	Forthcoming	Forthcoming	$5,000,000
TOTAL	**$419,500,000**	**$320,000,000**	**$19,080,000**	**$1,477,000,000**	**$2,235,580,000**

* Costs were rounded to three significant figures. Most identified projects did not have associated costs. Therefore, additional cost estimating and refinement of existing project costs will be forthcoming to develop an overall statewide summary of water project funding needs.

Statewide Water Infrastructure Financing Need

The BIPs for Colorado's major river basins are a critical component of Colorado's Water Plan. In general, each BIP looked at balancing long-term municipal, industrial, agricultural, environmental, and recreational needs within and among the respective basins. As part of the BIPs, the basin roundtables identified a list of projects and methods they believe address the long term needs of their basins.

Table 9.2-1 features an initial summary of the costs the BIPs identified. It must be emphasized that costs were not associated with the vast majority of projects identified. In addition to these projects, the BIPs included other activities that require financial support, including education, outreach, conservation programs, flow agreements, alternative agricultural transfer methods, important legal investigations, and programs that manage various risks and vulnerabilities throughout the state.

The SWSI estimated that by 2050, municipal and industrial water infrastructure improvements will require between $17 billion and $19 billion in funding.[8, b] In addition, approximately $150,000 is needed per mile of stream for smaller-scale river restoration work, but substantial structural changes or channel reconfiguration could cost $240,000 or even $500,000 per mile.[9] Up to 90 watershed or stream management plans, at an estimated cost of $18 million statewide, will be necessary to help CWCB and stakeholders better determine the amount of river restoration work and other similar types of work that may be required.[10]

As basins and stakeholders identify their environmental and recreational needs, the basins will need to develop and fund further projects and methods to meet those needs. For planning purposes, however, one could estimate a $2 billion to $3 billion environmental and recreational statewide need, equivalent to approximately 10 to 15 percent of the municipal and industrial water infrastructure cost

[b] This number is based on an estimated $14 billion to 16 billion of identified M&I needs calculated in the Portfolio and Trade-off tool (CWCB, 2011), plus an additional $3 billion estimated need for maintaining existing M&I infrastructure. The numbers, however, are being refined in accordance with the BIPs.

HEATHER DUTTON

RIO GRANDE RIVER BASIN

Heather works for the Rio Grande Headwaters Project and has become an expert at finding financial resources to implement collaborative and multi-purpose projects. She is a member of the Rio Grande Basin Roundtable. Heather is pictured standing next to old and new head gates at McDonald Ditch, outside of Monte Vista along the Rio Grande River.

My vision for Colorado's Water Plan is a living document that provides a baseline analysis of where we are and what is important to us as a State. The Water Planning Process has been eye opening and has provided a forum for people to come together and learn about each other. I hope the plan will be a springboard for action because I view the widening gaps in supply for agriculture, environment, and communities as the most urgent issue we are facing. One of our local water and wildlife managers said, "water is not life or death, it is more important than that…"

CONTINUED AT END OF CHAPTER

PROFILE

estimates. Additionally, basins will need to develop the long-term funding needed to support agricultural sustainability based on further identification of projects and methods. Funding for agriculture should not only include legal and engineering support alternatives to reduce agricultural dry-up, but also water infrastructure needed to deliver water from agricultural areas to urban areas on a shared basis.

As the State moves forward in improving Colorado's water infrastructure, it will need to further refine and identify water infrastructure financial needs through the BIP process. The CWCB will review the results of these efforts to develop a list of project priorities. For a project to be considered priority, the CWCB weighs several criteria—including the project's funding; whether it meets multiple purposes, has multiple partners, and provides multiple benefits; and whether it is regional in nature. The CWCB will identify projects that have the potential to move forward quickly, have cross-basin and statewide benefits, and have a possible funding plan, as further discussed below.

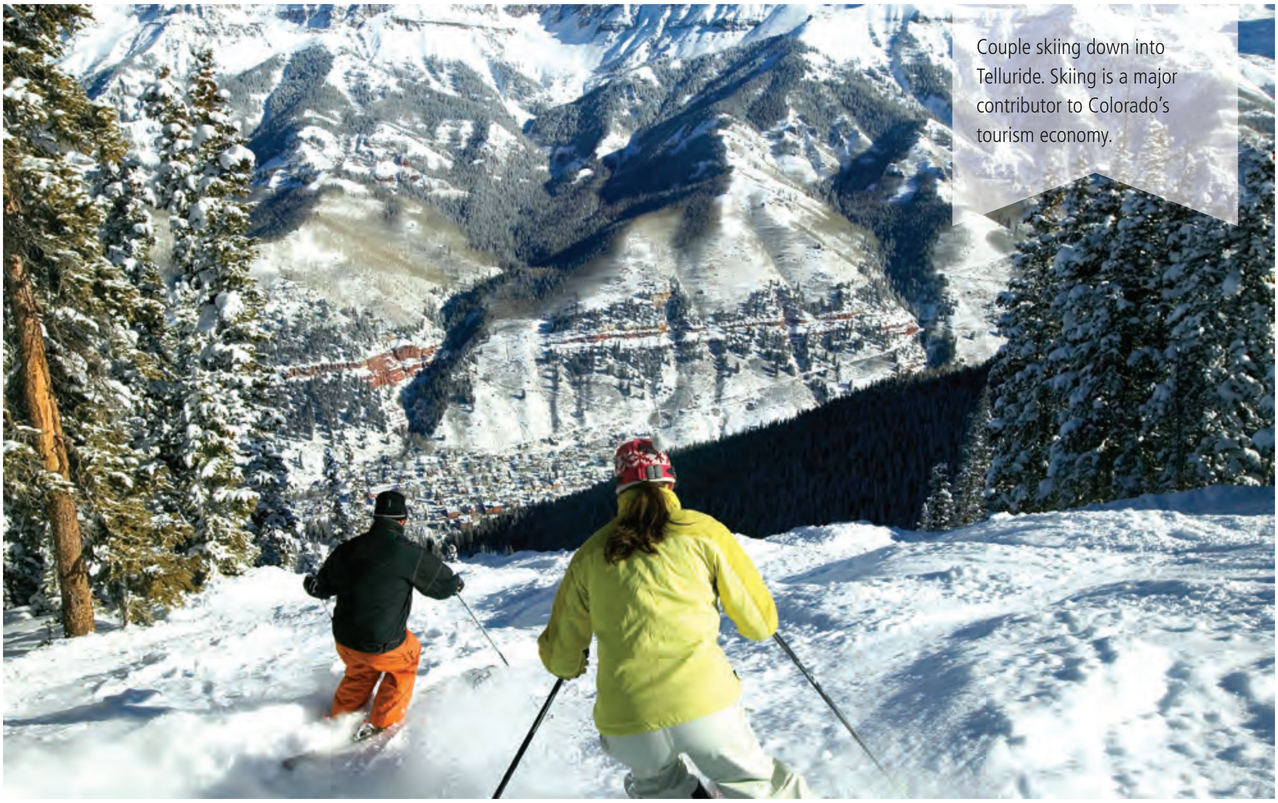
An estimated overall funding need of approximately $20 billion is associated with meeting the M&I gap and maintaining current infrastructure. Specifically, these funds would support:

1. The IPPs identified in the SWSI.
2. Short- and long-term maintenance needs of existing water delivery systems.
3. Alternatives to agricultural transfers.
4. Active water conservation.

Additionally, financial support is needed to address statewide environment and recreational needs and to support agricultural viability. And finally, the estimated $20 billion figure does not include treated water projects, such as drinking water treatment, distribution, and wastewater treatment.

Economics

When Colorado's land, labor, and capital assets combine with available water, the result is economic prosperity and opportunity. Nevertheless, managing water operations is challenging due to the wide variation in supply and demand. Water providers need to ensure the delivery of quality water to all customers as demand rises and falls, and they must do so at a cost people can afford and are willing to pay.



Couple skiing down into Telluride. Skiing is a major contributor to Colorado's tourism economy.

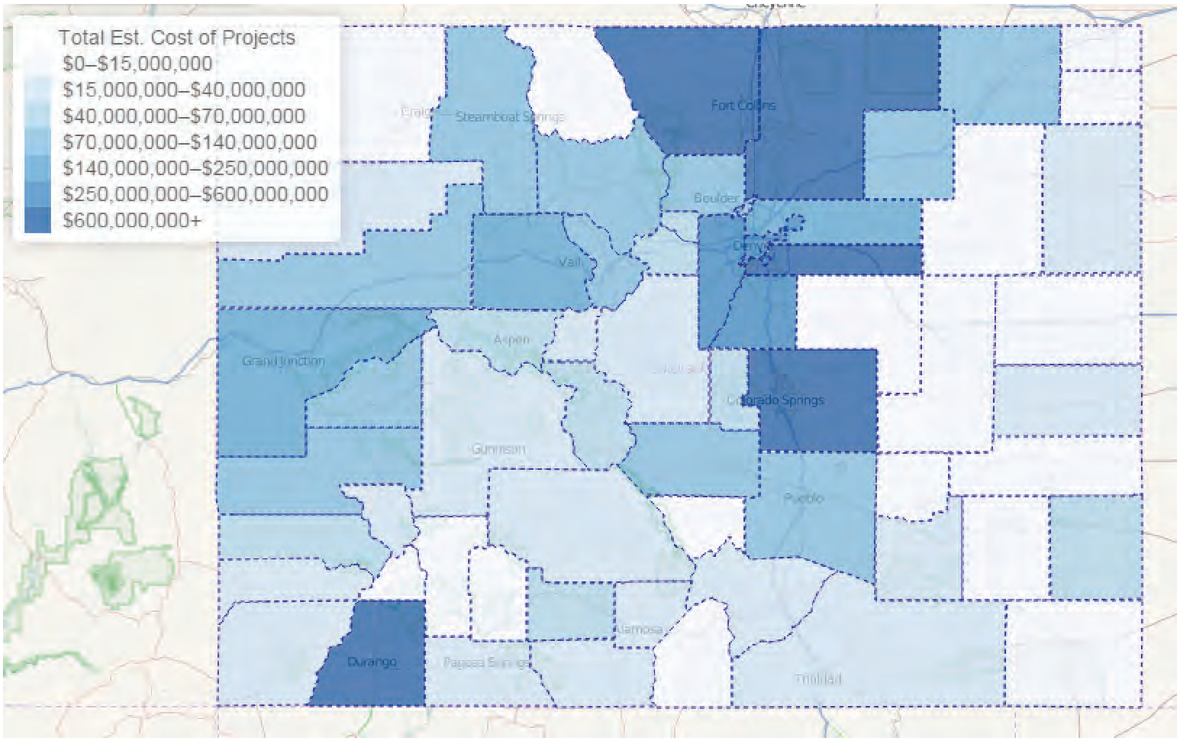
Water is also extremely mobile, and by the nature of its physical properties, it can move around in streams, seep into soils, move underground, evaporate, be stored in reservoirs, and even be bottled and transported. The inherent reality of mobility is that the same molecule of water can have many sequential uses, since it is rarely consumed fully by a particular user, and what is left is available for other uses. Water mobility is also described by its overall variability in terms of where it is located and for what duration, and its variability in quality and quantity. In Colorado, the mobility of water is very high, given that 89 percent of the state's population resides east of the Continental Divide, yet 70 percent of the state's water supply originates west of the Continental Divide.[11]

Water is considered both a private and a public good, making it difficult to assess its economic value. Compared to other public utilities such as natural gas and electricity, which are invisible and weightless, water is capital-intensive due to its weight, viscosity, and volume.[12] Despite being capital-intensive, the public perceives water as an affordable, accessible, and continually available resource.[13] On average, most families pay less than one percent of their household income for water, so many do not understand the true cost of water compared to other living expenses, such as fuel, electricity, and food.[14, c] Twelve ounces of bottled water at the store costs $1.00, but tap water that is treated and delivered across Colorado to a house costs approximately $3.00 per one-thousand gallons. The fact that the public is not willing to pay much for water could be a by-product of the lack of awareness about its true inherent value; alternatively, the lack of awareness about the true value of water could simply be a learned response to the historically low cost citizens have paid for treated water delivered to their homes.

Given the current demand and the increased future demands on water supplies, it is important to focus on education efforts. Water users need to be aware of the inherent true costs of providing water.

[c] Average household income in Colorado from 2008 to 2012 was $58,224. Based on 9,000-gallon monthly household water use (108,000 gallons/year) inside city limits, Denver paid $35/month, Longmont paid $22.50/month, and Ute Water Conservancy District paid $42.00/month in water bills. The combined average of the three entities equaled $33/month in water bills.

FIGURE 9.2-2 ESTIMATED NEAR-TERM INFRASTRUCTURE NEED[15]



State Funding Resources and Other Funding Opportunities

Current Funding Opportunities

Though the statewide funding need for both consumptive and nonconsumptive water projects is substantial, a planned, phased approach with existing and potential alternate funding sources could address a majority, if not all of the state's needs, depending on how aggressive and successful the approach is. The State recognizes that water providers are in control of their own short- and long-term capital investments, operation and maintenance costs, and customer base. Therefore, use rates and tap fees could be the primary source of funding where the end user is directly connected with the costs and investments. When broader public interests are in play, there are opportunities to combine financial resources and infrastructure in order to solve complex water supply challenges and accelerate the construction of a project. The WISE Project is a case that illustrates how several entities, including South Metro Water Supply Authority members, Denver Water, Aurora, and the CWCB, shared infrastructure, water, and financing to provide critical renewable water to offset well usage in Douglas County.[16]

Many existing state funding sources and programs can assist in meeting Colorado's long-term water infrastructure needs. These sources include the CWCB Water Project Loan Program, the CWCB's WSRA Fund, the Species Conservation Trust Fund, nonconsumptive funding programs as identified in SWSI 2010 Nonconsumptive Toolbox, and the Water Resources and Power Development Authority's Water Revenue Bond Program (WRBP). Although these programs cannot solely meet the state's financial water needs, they can assist in bridging funding gaps when combined with other funding sources.

The CWCB Water Project Loan Program

Recognizing the importance of funding raw water projects, the Colorado General Assembly in 1971 created the Water Project Loan Program. This program comprises two funds: the Construction Fund and the Severance Tax Trust Fund, codified at section 37-60-120 of the Colorado Revised Statutes.[17]

Annual revenues to the Construction Fund come from principal and interest (P&I) on existing loans and from a portion of federal mineral lease revenues that are paid to Colorado. Approximately $18 million to $20 million is available annually for water project loans from this fund.[18] In 1995, the Severance Tax Trust Fund was created under section 39-29-109, which directs 25 percent of the state's severance tax revenues into this fund. The fund is currently capped at $50 million annually,[19] and annual severance tax revenues provided to the CWCB range from $20 million to $50 million.[20] A portion of available Severance Tax Trust Fund revenues could be directed to assist in meeting investment return obligations on impact bonds issued in support of statewide environmental and recreation needs.

On average, the Water Project Loan Program has between $50 million and $60 million available annually for loans for various water projects throughout the state. The combined fund equity from the Construction Fund and Severance Tax Trust Fund exceeds $700 million.[21]

Water Supply Reserve Account

The WSRA grant program provides funding at the local basin level to address a variety of short- and long-term water needs. Current funding level is capped at $10 million annually, and is split between the statewide and basin WSRA accounts. Funding comes from annual severance tax revenues to the state, and has varied from $5.7 million to $10 million annually.[22] To date, this program has distributed over $40 million in grant funds for a variety of water-related studies and projects.[23]

The WSRA roundtable process has proven to be an effective grassroots platform for engaging local basin, regional, and cross-basin discussions on water issues. Continued support and additional funding should be considered to maintain and enhance this successful program. The existing process and structure of how the WSRA grant funds are distributed from the basin and statewide accounts should be reevaluated to encourage multi-benefit and multi-partnering projects, and to promote planning and technical support to smaller communities and water providers. A collaborative, regional approach should always be encouraged and considered in the planning process for projects that are funded through this program.

Watershed Restoration Program

The CWCB's Watershed Restoration Program provides grants for watershed and stream restoration and flood mitigation projects throughout the state. Over the years, the program has leveraged substantial outside-entity dollars to promote watershed health. While it has had an annual funding allocation of $250,000, it has recently seen a substantial increase in funding as a result of legislation approved for phreatophyte control and flood and fire mitigation. The 2015 CWCB Projects Bill also approved an additional $1 million in funding for this program to assist with funding stream management plans, as Section 6.6 discusses. If additional revenue sources are successfully developed to support environmental and recreational projects, this program can manage and disburse those funds.

Species Conservation Trust Fund

The Native Species Conservation Trust Fund was created in 1998 pursuant to HB98-1006. The CWCB and CPW use this fund for programs associated with recovering species listed as threatened and endangered under state law; recovering and protecting federal candidate species; conducting scientific studies related to the listing or delisting of any species; and evaluating genetic, habitat, and declining species baseline data. Through the annual Species Conservation Trust Fund legislation, the Species Conservation Trust Fund authorizes millions of dollars of work the CWCB and CPW conduct each year.

Water Resources and Power and Development Authority

The Water Resources and Power and Development Authority (Authority) is a quasi-governmental organization created by section 37-95-101 of the Colorado Revised Statutes to provide low-cost financing for water- and wastewater-related infrastructure projects to municipalities and special districts. The Authority has four main financing programs: the Drinking Water Revolving Fund, the Water Pollution Control Revolving Fund (WPCRF), the Small Hydropower Loan Program, and the WRBP.[24]

The WRBP provides funds up to $500 million for individual projects, without legislative review, to public entities for water and wastewater projects. The Authority's WRBP rates are consistent with private municipal bond market rates, with the distinction being that the WRBP rates provide bond issuance subsidies, up to a total of $250,000, for each of up to four projects in any given year. The WRBP can provide funding well above $500 million with legislative approval.[25]

The Drinking Water Revolving Fund and the WPCRF are both part of state revolving funds, which are operated in every state. These funds are primarily used for water quality projects, and are capitalized by state and federal funds whereby states contribute 20 cents for every federal dollar. Projects often use these funds to leverage other funds through the issuance of municipal bonds, and to finance the design and construction of water and water pollution control infrastructure. The Authority, the Colorado WQCD, and the DOLA jointly administer these funds.

The Small Hydropower Loan Program is a joint program operated in coordination with the CWCB. Loans from this program are limited to up to $2 million per governmental agency for eligible projects of five megawatts or less.[26] Agencies seeking more than the first $2 million available through the Authority can apply through the CWCB.

Additional Grant and Loan Programs

Water conservation system improvements, such as smart metering technology, more efficient cutomer billing and communication systems, and other related technologies used to influence behavior to achieve water conservation goals, are eligible for financial assistance from state revolving funds as part of a water system capital impreovement project.

The CWCB offers many grant programs for various water-related efforts, such as water efficiency, alternatives to agricultural transfers, emergency drought response, phreatophyte control, and others. Annual combined funding for these grant programs is in excess of $4 million.[27] A list of grant programs is available here.

The Nonconsumptive Toolbox contains a list of federal, state, and private funding opportunities for environmental and recreational needs.[28] The total amount of funds available from state resources dedicated to these efforts on an annual basis is approximately $11 million.[29] Some of these funds are extremely competitive, while others are hard to qualify for, and are therefore not fully utilized.

Currently, limited funding sources are available for education, outreach, environmental resource management, recreation, and other important water-related activities that do not involve construction of projects. Though these efforts have strong support from nongovernmental organizations, charitable donations (as opposed to tax revenue) typically fund them. Additionally, the WSRA program has funded much of this type of work, which requires approval by the basin roundtables and the CWCB. Therefore, it may be necessary to identify additional funding sources to fully meet the state's environmental and recreational water needs.

CWCB Program Overview

Initial estimates suggest that municipalities will primarily need state, federal, or bond market loans to fund their projects. Over the next 35 years, based on current funding levels, the State expects to have nearly $2 billion available in CWCB loans for municipal, industrial, and agricultural projects.[d] Compared to the statewide water infrastructure financing needs discussed above, this amount suggests a potential public financing gap. Consensus and additional state funds may be necessary to support innovative water projects, such as multi-use, alternative agricultural transfers, or a new TMD with a sufficient back-up supply on the eastern slope, as well as to support substantial environmental and recreational enhancements that meet the IBBC's criteria. Additionally, because environmental and recreational projects are not typically ratepayer-supported, they primarily rely on grants for financial support. Current capacity to fund environmental and recreational projects and methods over the next 35 years is $385 million, based on current funding levels.[e] This suggests

[d] $55 million average annual available CWCB loan funds x 35 years = $1.925 billion rounded to $2 billion.

that it may be difficult to fund projects that promote environmental and recreational interests. Beyond the CWCB loan programs, an additional $490 million is available from the WSRA and other grant programs for meeting future needs.[f]

Federal Funding Options

Federal funding options are a potential source for meeting financial needs. For scientific and research-based projects, the BOR's WaterSMART program, managed through Landscape Conservation Cooperatives, has funded several programs throughout the state. For certain agricultural efficiency projects, the Colorado River Basin Salinity Control Forum has brought a substantial amount of federal funding aimed at improving the water quality of the Colorado River.

In addition, the Upper Colorado River Basin Fund is a federal fund that comprises funds appropriated from the U.S. Treasury for capital projects, as well as proceeds from the sale of hydroelectric power, transmission services, and M&I water services. The Basin Fund funds important work associated with the Salinity Control Forum, the Upper Colorado River Basin and San Juan River Basin Endangered Fish Recovery Implementation Programs, and the Glen Canyon Dam Adaptive Management Working Group. These programs are described throughout Colorado's Water Plan.

A potential source of funding for future collaborative projects is the Regional Conservation Partnership Program (RCPP). This program of the Natural Resources Conservation Service (NRCS) encourages cooperation at the local level, and brings together multiple partners, such as local and tribal governments, nonprofit groups, farmers, ranchers, and landowners. In 2015 up to $235 million was made available nationwide for conservation projects that address local needs, focused on water quality, drought resiliency, enhanced soil health, wildlife habitat and agricultural viability.[30]

In addition, in 2011, the Upper Division Colorado River Basin states (Colorado, Wyoming, Utah, and New Mexico), BOR, the United States Department of Energy Western Area Power Administration, and the Colorado River Energy Distributors Association signed a memorandum of agreement (MOA). The MOA authorizes the use of the Basin Fund to further the purposes of the 1956 Colorado River Storage Project (CRSP) Act (Public Law 485) through fiscal year 2025. This MOA also authorizes additional uses for operational and maintenance on CRSP facilities, among other specified purposes, and provides more than $5 million that the CWCB can direct toward CRSP operation and maintenance activities.

Potential Future Funding Opportunities

Many stakeholder efforts, such as the IBCC, environmental groups, and the recently created Statewide Water Investment Funding Committee, have explored other avenues of funding to meet Colorado's future water needs. The IBCC explored several financial options in the No-and-Low-Regrets Action Plan. These are listed below:[31]

- A federal/state partnership similar to the Central Arizona Project.
- A state water project similar to the California State Water Project.
- A state/local partnership in which the State facilitates the project, but the end-users finance and manage it.
- A public/private partnership similar to those used to build transportation projects (e.g., E-470).
- Enactment of a "water" mill levy (the assessed property tax rate used to raise revenue).
- Additional bonding authority for the State of Colorado.
- Severance tax increases.
- A statewide sales tax.
- Federal loan guarantees.
- Expanded authority of Great Outdoors Colorado funding.
- Specific Farm Bill initiatives that appropriate funds for enhancing agricultural operations while supporting nonconsumptive needs.

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[e] $11million available x 35 years = $385 million.
[f] WSRA Funding at $10 million + $4 million in grant funding = $14 million x 35 years = $490 million.

- ❖ Regional taxing.
- ❖ Statewide user fee.
- ❖ Statewide tax on internet-based transactions.
- ❖ Debt financing (debt backed by existing or newly created revenue source).

In addition, The Nature Conservancy, Colorado Chapter, and the Tamarisk Coalition assessed funding sources for environmental needs.[32] When additional funding sources become needed, some potential investment opportunities include:

Legislation: Water providers, the CWCB's recently created Statewide Water Investment Funding Committee, elected officials, and community leaders can work to develop legislation to create effective and efficient funding processes that will maximize the use of water within the state. Some specific examples of legislation that could be considered include:

- ❖ Remove federal mineral lease and Severance Tax Trust Fund cap limits, which could generate an additional $10 million per year.
- ❖ Increase the funding cap on the WSRA Grant Program account, currently limited to $10 million per year. An additional $10 million could greatly assist in meeting environmental and recreational funding needs.
- ❖ Investigate extending instream flow tax credits for water rights donations to the instream flow program beyond 2015.[33]
- ❖ Expand the CWCB's authority to improve the management and distribution of existing funds, enabling the CWCB to fund treated water facilities. This could alleviate gaps in funding raw water projects with treated components that are not funded by other sources.
- ❖ Investigate the use of conservation tax credits as a potential funding source. This could support efficient outdoor irrigation systems and replacement of residential outdoor turf with plants that use less water.
- ❖ Amend governing statutes to water providers, granting them specific authority to use public/private partnerships.
- ❖ Explore broadening the statutory authority of the existing program to allow for the protection of watershed health, instream flow benefits, and alternative transfer methods to mitigate dry-up of agricultural lands.
- ❖ Return remaining $123 million in General Fund transfers back to the Severance Tax Trust Fund. A total of $163 million was transferred from the Construction Fund and the Severance Tax Trust Fund to the General Fund to help balance the state's budget from 2008 to 2011. To date, $40 million has been returned.[34] These funds could be directed to various water projects, environmental and recreational projects, watershed and stream management, project management, and other uses.

Public/Private Partnerships (P3s): Provide funding to create a State-sponsored Center of Excellence, research the pros and cons of P3s, and develop a preliminary water infrastructure P3 model. The Center of Excellence would be a centralized clearinghouse to allow water providers and other entities to talk with experts in the field and obtain information about working P3 models. Based on their expertise, the basin roundtables, through the WSRA process, should assist with this discussion to provide guidance to project proponents regarding the potential value of P3s for specific projects they are considering.

In general, P3s have the potential to reduce both capital investment and risk, while drawing on the respective strengths inherent in both the public and private sectors. Nevertheless, care must be taken to achieve an appropriate balance among public and private resources, costs, control, and long-term revenue streams. Lessons can be learned from the transportation sector, which used public/private funding for a toll road, and which had to balance several P3-related challenges and opportunities such as social perception, the interaction of state and private contracting policies, ratepayer concerns, and long-term sustainability of the partnership. P3s can offer a considerable amount of working capital which, in certain circumstances, can accelerate the delivery of costly, technically complex projects.[35]

State Repayment Guarantee Fund: For larger water projects with many participating entities, it has proven difficult to develop an overall project financing package that equitably distributes risk and repayment. The involvement in a bundled financing package of smaller participating entities with lower credit ratings, minimal revenue streams, and small service areas can create a disincentive for larger water providers to participate, given they would be subjected to higher interest rates, repayment, and risk. To address this obstacle, the State could develop a repayment guarantee fund that would act as an overall repayment guarantee to the financial entity that is issuing the bond for the project. Such a State-managed repayment guarantee would reduce the level of risk to the lender and participating entities, while providing a mechanism for smaller water providers to participate in regional water distribution and supply projects, without negatively affecting larger water providers.

The CWCB and the Statewide Water Investment Funding Committee would recommend that this fund develop with a starting balance of $300 million. Lenders typically require a 10 percent repayment guarantee on a bond issuance, which would therefore support $3 billion in water project construction. Given that the amount of repayment guarantee diminishes over time once bonds are issued, those funds that are no longer needed to guarantee repayment on the original total bond amount could then be reinvested into other needed environmental programs.

Impact Investment Capital (Green Bonds): If a State Repayment Guarantee Fund is successfully developed, it could potentially support $3 billion in water infrastructure projects throughout the State. To assist in providing funding for environment and recreational projects that may or may not be attached to a specific water infrastructure project, it is recommended that the CWCB work with specific environmental groups to secure private capital through the issuance of bonds (Green Bonds), to provide meaningful, immediate funding for environment and recreation projects throughout the state. The Green Bonds could be issued in incremental amounts over time to support projects that have been identified previously; this would minimize debt investment return costs under one large bond issuance. Only bonds that can actually be spent in a specified time frame should be issued. The CWCB recommends that these funds be managed and disbursed through the CWCB's Watershed Restoration Program, requiring substantial reorganization of that program.

The long-term obligation and repayment of green bonds could come from a combination of revenues from the CWCB's Severance Tax Perpetual Fund, or from public initiatives, as further discussed below.

State Referendum: Any taxpayer-supported effort and accompanying long-term debt needs to be approached with care and consideration. There should be a clear and concise reason for the need, a comprehensive plan for how and where the funds will be expended, defined oversight and accountability, and a plan that addresses long-term challenges.

In 2003, Coloradans voted on Colorado Water Projects Referendum A, a ballot initiative that would have allowed the CWCB to borrow up to $2 billion by issuing bonds to construct water projects throughout the state. This ballot initiative was soundly defeated, with 67 percent of Coloradans opposed and 33 percent in favor. Though Referendum A was initiated to resolve long-term water challenges in the state, it was not accompanied by a comprehensive plan outlining how to address that challenge, a quantification of the magnitude of financial need, or where and how the money would be spent.

Since 2003, a substantial amount of time and resources have been spent developing a comprehensive overview of the state's current and long-term water needs. In 2005, HB 1177 was passed creating the Inner Basin Compact Committee, the basin roundtables, and the WSRA. In 2010, the State completed the SWSI that provided a detailed assessment of the state's current and future water needs. In 2011, the Colorado River Water Availability Study (CRWAS) was completed, and in 2015 the basins completed the BIPs, which identified basin-specific needs, and projects and methods.

The BIPs provide an excellent roadmap for what the State of Colorado needs to accomplish to address its long-term water supply needs. The development of the BIPs is the result of decades of discussion, debate, and collaboration among water users, providers, and the Colorado General Assembly. With prioritization and refinement, the BIPs could provide a necessary framework for state referendum funding. A state referendum could generate hundreds of millions of dollars per year, phased over a defined period, generated from sale tax revenues, income tax, and other sources. Those funds could reside in a statewide water investment fund that would be distributed either as a loan, a grant, or a combination of the two, and managed and disbursed through the CWCB. A portion of the funds could also be reserved as repayment guarantees for water providers seeking bonds. Policy developed to manage and disburse money from this fund could include a zero-interest rate to market loans, security or repayment guarantees on bonds, environmental and recreational grants, permitting assistance, legal assistance, and expanded funding levels for existing programs. P&I returned to the fund would be invested in water projects or other areas of need within the state.

As a comparison, in 2013, the Texas Legislature authorized a transfer of $2 billion from the state's "Rainy Day Fund" to create a new loan program, later approved by Texas voters, to fund projects in the State Water Plan. This original investment in the State Water Implementation Fund for Texas (SWIFT) and the State Water Implementation Revenue Fund for Texas (SWIRFT) was designed to fund almost $27 billion in water supply projects over the next 50 years to ensure that Texas communities have adequate water supplies during drought. Additionally, in November 2014, the State of California approved Proposition No. 1, which allows the State to redirect $425 million in unsold bonds and sell $7.1 billion in additional bonds, for a total of $7.5 billion in general obligation bonds. The funds would be used to manage water supplies, protect and restore wetlands, improve water quality, and protect against floods.

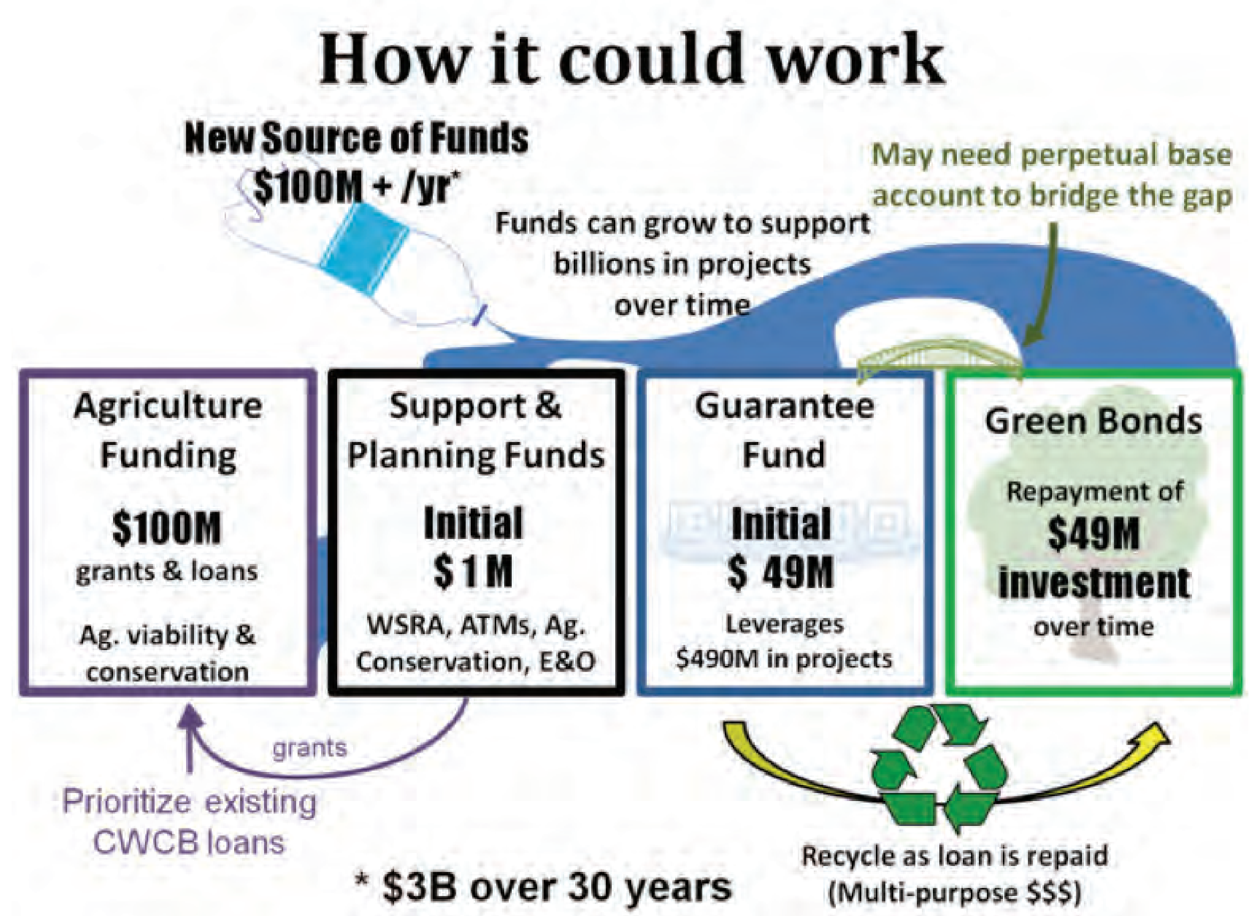
Mill Levy or Sales Tax: In lieu of a statewide referendum, a more targeted approach could help increase property or sales taxes in counties with large population bases along the Front Range—such as Adams, Arapahoe, Boulder, Denver, Douglas, El Paso, Jefferson, Weld, and Larimer Counties. These large population centers could be assessed an additional four to eight mills on their property taxes or increase sales tax to provide critical water project funding in their area and to offset distresses in other areas (for comparison, typical fire district revenues are based on eight mills). This could generate approximately an additional $215 million to $430 million dollars per year and reside in a water investment fund as described above.[g] This option might be better handled at local levels based on specific water provider needs within a given service area, although there may be a statewide option if benefits are spread across the state.

Container Fee Ballot: In 2010, two citizens filed a Ballot Initiative seeking a fee on beverages containers sold in Colorado. Unofficially captioned "Container Fee to Fund Water Preservation and Protection" by legislative staff for tracking purposes, the initiative was heard by the Ballot Title Setting Board in April 2010. The initiative title for the ballot was appealed to the Supreme Court on the basis that by naming the basin roundtables specifically the initiative was not a single subject. The Supreme Court granted the appeal and the initiative was dropped. This initiative has merit and should be reevaluated. It was estimated in 2010 that this initiative could generate in excess of $100 million per year and could finance water projects, environmental and recreational projects, and stream and watershed management efforts throughout the state.[36] It is an initiative that could help offset the negative environmental impact of plastic containers (i.e., bottled water). If the Container Fee Ballot were successful, it would play a key role in moving forward many of the funding issues identified in this section.

Securing additional funding to assist in the implementation of Colorado's Water Plan is one of the plan's most critical objectives. Colorado's Water Plan provides a realistic, achievable path forward to secure additional funds. First, the State plans to initiate the development of a Repayment Guarantee Fund and green bond program with an initial investment of $50 million from the Severance Tax Perpetual Fund. The Repayment Guarantee Fund would assist water providers in securing financing for regional multipartner and multipurpose projects guaranteeing repayment on bonds so that all the project participants can achieve financing, despite varying credit ratings. Issuance of green bonds would support large-scale environmental and recreational projects. These funds would be operated in a conjunctive manner, as funds would be released from the Repayment Guarantee Fund as debts on the project bonds are repaid. In

[g] Mill levy calculations based on 4 mills, Adams $18 million, Arapahoe $30.4 million, Boulder $22 million, Denver $40.4 million, Douglas $17.2 million, El Paso $23.2 million, Jefferson $28.8 million, Larimer $15.2 million, and Weld $18 million, approximate total = $215 million. Those figures are doubled for 8 mills or $430 million.

FIGURE 9.2-3 FRAMEWORK FOR HOW A NEW SOURCE OF FUNDING COULD BE MAXIMIZED



doing so, the initial $50 million investment would leverage half a billion dollars in regional projects and support nearly $50 million in environmental projects. In order to make this level of funding sustainable, the State will investigate options to raise an additional $100 million annually ($3 billion by 2050) to support implementation of the plan. Such funds would increase the Repayment Guarantee Fund and green bonds, while further supporting conservation, agricultural viability, alternative transfer methods, education and outreach, and other plan implementation priorities. Under a well-planned, phased approach, this investment could address a majority, if not all, of the funding needs described in Colorado's Water Plan, as Figure 9.2-3 further describes.

ACTIONS

According to studies conducted by the U.S. EPA, the Congressional Budget Office, and the Water Infrastructure Network, the cost of addressing our nation's clean water infrastructure needs over the next 20 years could exceed $400 billion, which amounts to roughly twice the current level of investment by all levels of government.[37] Colorado alone has nearly $20 billion in identified water project needs, including water supply and environmental and recreational projects.[38] While there is no easy or inexpensive way to provide Coloradans with a sustainable long-term water supply, the overarching goal is to provide clean, reliable water at an affordable price for many generations.

Action Summary

Realistic, long-term funding sources are essential to Colorado's ability to meet its future water funding needs. It cannot be assumed that existing programs and revenue streams are sufficient to address the state's long-term water supply and environmental needs, or to maintain existing water supply infrastructure. The actions and initiatives below could greatly assist in meeting Colorado's water funding needs over the next decade and in generating the momentum required to address long-term funding needs. The CWCB will work with the Statewide Water Investment Funding Committee to explore options for implementing these initiatives.

1. **Public funding sources:** Identify and determine a path to develop a new viable public source of funding (such as through a container fee ballot initiative) to support a repayment guarantee fund or green bonds, and to provide additional support grants and loans for the WSRA, education, alternative transfer methods, conservation, and agricultural viability.
2. **State repayment guarantee fund:** Establish a state repayment guarantee fund.
3. **Green bonds:** Develop issuance and repayment strategies needed to establish a green bond program to provide a funding source for large environmental and recreational projects.
4. **Water education and outreach:** Fund a water education and outreach grant program based on basin roundtable education action plans and the initiatives indicated in Colorado's Water Plan.
5. **WSRA:** Provide additional state account funds to the WSRA program.
6. **Public/Private Partnerships:** Modify Colorado's statutes to clearly allow for public/private partnerships for water projects.
7. **Conservation:** Explore a tax credit for home owners who install efficient outdoor landscapes and irrigation as part of the integrated funding plan.

Colorado's Water Plan identifies the following actions:

1. The CWCB will work with the Statewide Water Investment Funding Committee to develop a sustainable funding plan that integrates a repayment guarantee fund, green bonds, and additional support grants and loans for the WSRA, education, alternative transfer methods, conservation, and agricultural viability.
2. The CWCB will assess funding needs across multiple sectors using the BIPs and other resources as guides. Needs may include municipal, environmental, industrial, recreational, agricultural, conservation, and education and outreach, among others.
3. The CWCB will determine the economic benefits and effects of meeting or not meeting Colorado's future water needs.
4. The CWCB will work with the General Assembly and state agencies to align state funding policies and promote coordination among state agencies in order to strategically support the values Colorado's Water Plan identifies. These values include the need for multipurpose and multipartner projects and methods.

The State will take the following actions:

- ❖ Develop a common grant-inquiry process to be coordinated across funding agencies for each sector, including environmental, recreational, municipal, and agricultural project proponents. This will include revisiting and reorganizing how agencies conduct the current state funding coordinators meeting.
- ❖ Review the CWCB's financial policies, taking into consideration providing financial incentives to move projects and methods forward and assisting small water providers in addressing upfront planning costs. Such policies may include reduced interest-rate categories and extended terms (40 years).
- ❖ Pursue additional funds to support the WEGP, which provides financial incentives for implementing conservation programs and planning for drought; investigate expanding the program's authority to provide grant funds to municipalities for documented water conservation and savings to help offset the economic impact of lost revenue due to reduced water usage; and develop funding recommendations.

- Assess whether there are additional loan opportunities for municipal conservation practices.
- Pursue funding to establish a water education and outreach grant program, and develop funding recommendations.
- Assess opportunities for additional WSRA grant funds, and work to amend the WSRA guidelines on how additional funding is allocated, approved, and disbursed in order to prioritize projects that provide the greatest benefit to Colorado.
- Seek an amendment to statutory language to expand the CWCB's loan program's authority to fund treated water supply, reuse, conservation, and environmental and recreational projects and methods.
- Continue to provide $1 million or more if needed on an annual basis to support stream management and watershed plans, and develop an established funding source.
- In partnership with the Water Investment Funding Committee and in coordination with the basin roundtable representatives, review and prioritize BIP-identified water projects to develop a funding plan for those that could move forward. Based on the identified funding level, develop funding strategies that use existing and new funding sources to move high-priority projects forward in one to three years.
- Develop policies for how and when the CWCB becomes a project beneficiary through an arranged partnership for projects that are central to fulfilling the goals of Colorado's Water Plan.
- Identify and develop, in two years, a single multi-benefit, multi-partner, shared infrastructure pilot project that is funded through a joint revenue stream of public and private funding. From this pilot project, develop a framework for how future water public/private partnership projects will move forward, taking into consideration best procurement practices, maintenance and operation, water administration and management, and other factors.

Downtown Manitou Springs. The town was established for its mineral springs and beautiful setting, and bounced back from the economic disruption of the Waldo Canyon Fire in 2012 and the related flash flood in 2013.

- ❖ Continue to use the Water Investment Funding Committee—comprising representatives from each basin, the CWCB, the Water and Power Authority, the Executive Director's Office, large water providers, and the private sector— to evaluate funding recommendations contained within Colorado's Water Plan and other plans. The goal of such evaluation will be to develop a well-planned, phased approach to provide funding for water projects, environmental projects, recreational projects, and stream and watershed management throughout the state. This committee met over the course of 2015 and will continue to meet to provide funding and implementation recommendations to the CWCB.
- ❖ Over the next year, continue to develop and fund a modern method for determining probable maximum precipitation for spillway sizing for dams in Colorado, with the intent to provide additional storage while minimizing capital investment.
- ❖ Consider allocating all or a portion of any surplus in the DNR's severance tax operational account revenues to efforts prioritized in Colorado's Water Plan.

5. The State will explore near-term opportunities to increase funding resources by implementing the following actions:
   - ❖ Develop preliminary support data for various public funding options, such as state referendums, individual county mill levy increases, insurance tax premiums, user fees, and other potential funding mechanisms.
   - ❖ Explore implementation of a Center of Excellence to create a working model of public/private partnerships for water projects and methods.
   - ❖ Explore how a water investment (public tax) fund could be created, managed, and disbursed.
   - ❖ Work with other applicable state agencies to develop a reserve fund that would act as a security or repayment guarantee by the State to water providers seeking bond funds through the Authority.
   - ❖ Explore the concept of a container fee ballot initiative.
   - ❖ Develop issuance and repayment strategies in issuing green bonds as early as 2016 for environmental and recreational projects. CWCB recommends that green bonds be issued incrementally, based on identified need, to minimize repayment costs.
   - ❖ Reassess the Instream Flow Tax Credit program to determine how to make it more usable.
   - ❖ Work with various stakeholders, the Department of Real Estate, the Department of Revenue, and appropriate legislative committees to develop strategies that maximize the conservation tax credit program.
   - ❖ Explore potential uses of conservation tax credit revenues for stream and watershed restoration.
   - ❖ Explore with water providers the possibility of issuing a state tap fee for future taps installed statewide. Funds developed could be used to support the CWCB Water Efficiency Grant Program and/or water education. The amount assessed per tap would be determined based on the estimated number of new taps issued statewide, and target revenue.
   - ❖ Assess funding and loan opportunities from the Water Infrastructure Finance and Innovation Authority (WIFIA) and the Rural Infrastructure Fund to rebuild aging water infrastructure. Encourage the U.S. Department of Transportation and other agencies to share lessons learned regarding innovative financing programs with the Army Corps of Engineers (Corps) and the EPA as they implement WIFIA.
   - ❖ Work collaboratively with foundations and nonprofits to support the environment, recreation, and education priorities through philanthropy.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9.3 STATE WATER RIGHTS AND ALIGNMENT

GOAL

Colorado's Water Plan ensures that state agencies coordinate the uses of their current and future water rights and that they will uphold Colorado's water values, as Chapter 1 discusses.

Several Colorado state agencies hold and exercise water rights for various beneficial uses authorized by Colorado's constitution and statutes, and by permits and water court decrees. The DWR administers water rights, including state-held water rights, within the State's priority system; it does not own any water rights. As part of developing Colorado's Water Plan, the CWCB asked each state agency to develop an inventory of its water rights to the extent that it had not already developed one.

This section describes state agencies that hold water rights, including each agency's mission and the legal basis for each agency's water rights and their uses. It also summarizes the agencies' water rights inventories and describes how the State is aligning its water rights with the water values identified in Chapter 1 of Colorado's Water Plan. Finally, this section describes how state agencies will work to maximize the use of their water rights to realize the greatest benefits to the state as a whole. The inventory process is ongoing, and the CWCB will continue to incorporate information as it becomes available.

Inventory of State Agencies' Water Rights

The CWCB

Mission and Statutory Authorities

Colorado established the CWCB in 1937 with the mission *to conserve, develop, protect, and manage Colorado's water for present and future generations.*[39] Section 37-92-102(3), C.R.S. (2014) authorizes the CWCB to appropriate and to acquire water for instream flow water rights and natural lake level water rights to preserve and improve the natural environment to a reasonable degree. Section 37-60-106(n) authorizes the CWCB to take actions necessary to acquire or perfect water rights for projects it sponsors.

The CWCB Water Rights Inventory

The CWCB currently holds 1,595 decreed instream flow water rights that protect approximately 9,180 stream miles and 480 decreed natural lake-level rights.[40] The CWCB has also entered into 30 transactions by which it has acquired water, water rights, or contractual interests in water for instream flow use.[41] Pursuant to an agreement with the Corps, the CWCB owns two storage rights in Bear Creek Lake in Jefferson County. The storage rights equate to approximately 2,000 acre-feet, decreed absolute for piscatorial and recreational purposes, and conditional for municipal, domestic, industrial, and irrigation.[42] In 2012, the CWCB exercised its right to acquire its project water allocation of 10,460 acre-feet (supply) and 5,230 acre-feet (depletions) in the Animas-La Plata Project. Currently, the project is decreed for municipal and industrial uses only, but the CWCB may use this water for compact compliance, endangered species, and instream flow purposes.[43] The CWCB intends to sell or lease its water allocation to local water providers in southwest Colorado as demands dictate.

Finally, the CWCB is an active partner in the Chatfield Reservoir Reallocation Project. Its multiple roles include feasibility study sponsor, storage space shareholder, and financial lender for low-interest project loans. Furthermore, the Colorado General Assembly appropriated funding within two consecutive legislative cycles enabling the CWCB to hold, and later disperse for investment recovery, a certain percentage of unused storage space commonly referred to as "orphan shares." In October 2014, following an approval letter and federal Record of Decision (ROD), the Colorado DNR executed a storage contract with the Corps to use up to 20,600 acre-feet of additional storage space in the reservoir.[44] The new space will be used to store water supply for multiple uses.

Uses of the CWCB's Water Rights

The CWCB uses its instream flow and natural lake-level water rights to preserve the natural environment to a reasonable degree. In some cases, the CWCB uses water acquired for instream flow use to improve the natural environment to a reasonable degree. These uses enhance healthy watersheds, rivers and streams, and wildlife. Additionally, through its water acquisitions, the CWCB can work with other entities on multipurpose projects, aligning water rights to meet consumptive and nonconsumptive needs.

One such example of a multipurpose project is the CWCB's acquisition, in partnership with the Colorado Water Trust and Skyland Metropolitan District, of an interest in the Breem Ditch in the Gunnison River Basin. The project resulted in multiple uses of the acquired water right. Those uses included preserving and improving the natural environment on Washington Gulch and the Slate River, with subsequent municipal use by the Skyland Metropolitan District to meet the needs of its constituents. In partnership with the Colorado Water Trust, the CWCB has also acquired an interest in the McKinley Ditch, located in the Gunnison River Basin. The CWCB will use the water in a split-season arrangement, under which a lessee will use the water to irrigate in the early season and the CWCB will use the water for instream flow use for the remainder of the irrigation season.

These creative and flexible approaches enable the CWCB to work with its partners to protect Colorado's streams (and the species that rely on them), sustain agriculture, and maximize beneficial uses of Colorado's water. The CWCB will use this water rights inventory process as a starting point for increased coordination with other state agencies to explore opportunities for sharing water.

Maroon Creek, in the White River National Forest. CWCB acquired a water right on this creek for the purposes of instream flows.

The legislation that authorized the CWCB to appropriate and acquire water for instream flow and natural lake level water rights recognized the need to "correlate the activities of mankind with some reasonable preservation of the natural environment."[45] The General Assembly imposed that balance by limiting instream flow appropriations to amounts the CWCB determines are "required for minimum stream flows to preserve the natural environment to a reasonable degree."[46]

The multipurpose projects described above are an innovative and important means of benefiting the natural environment while maintaining other uses of water. The CWCB acknowledges the many competing needs for water in Colorado, and will continue to work closely with stakeholders to ensure that instream flow protection and other water uses coexist harmoniously in order to achieve the balance needed to uphold the Colorado Water Plan water values.

Colorado Parks and Wildlife

Mission and Statutory Authorities

A merger of the Division of Parks and Recreation and the Division of Wildlife in 2011 created the CPW,[a] responsible for conservation, outdoor recreation, and wildlife management on behalf of current and future Coloradans.[47] CPW's mission statement is: "To perpetuate the wildlife resources of the state, provide a quality state parks system, and provide enjoyable and sustainable outdoor recreation opportunities that educate and inspire current and future generations to serve as active stewards of Colorado's natural resources."[48] CPW is authorized to acquire land and water—or interests in land and water—for wildlife, parks, and outdoor recreation purposes.[49]

CPW Water Rights Inventory

At present, CPW holds or manages approximately 1,320 decreed water rights. These were acquired primarily using sportspersons' dollars dedicated to preserving wildlife habitat, providing public access, and producing fish to stock state waters. Using general descriptors of these water rights, roughly 620 are direct-flow surface-water rights, 270 are groundwater rights, 220 are spring rights, and 210 are storage rights. The water rights are decreed for irrigation, piscatorial uses, direct flow for fish propagation, wildlife and recreation, and domestic rights. Domestic rights apply to employee housing and water supply for drinking and sanitary purposes at state parks. These numbers do not include some permitted wells, other water interests not associated with court decrees, and various other agreements.

Uses of CPW Water Rights

Through an executive order, Governor Hickenlooper required that Colorado's Water Plan reflect Colorado's water values (which Chapter 1 outlines).

CPW is the state agency charged with protecting wildlife and natural resources and providing recreation now and for future generations. Nearly all of the water rights the CPW owns or leases are dedicated to this purpose,[b] directly supporting the governor's goals and the agency's constitutional and statutory obligation to protect, preserve, enhance, and manage wildlife and recreation for the use, benefit, and enjoyment of the people of this state and its visitors.

There is statewide acknowledgement that supporting environmental and recreational attributes is vital to local economies and Coloradans' quality of life. The continued statewide environmental and economic benefits derived from Colorado's streams and lakes requires that the State protect environmental, wildlife, and recreational water needs. For example, endangered or threatened species and species of concern exist throughout Colorado; so, the State must ensure that there is water available to support these species. Conversely, while there are hotspots for recreation—such as rafting on the Upper Arkansas River and fishing on the Colorado River—the State benefits by supporting healthy multifaceted recreational economies on both the Front Range and on the western slope.

[a] House Bill 11-208 established the merger of the Division of Parks and Recreation and the Division of Wildlife. House Bill 12-1317 established the composition of the new Parks and Wildlife Commission.

[b] The 'Parks' side of CPW has some domestic water rights that provide water for bathing and drinking at state parks. These are the only rights that are not dedicated to protection and preservation of wildlife and natural resources.

Elk standing in shallow water. Colorado Parks and Wildlife is the state agency responsible for ensuring that wildlife in Colorado have the water resources they need.

CPW provides outdoor recreation, hunting, and fishing opportunities for more than 12 million state park visitors, 284,000 licensed hunters, and 733,000 licensed anglers. About 45 percent of Coloradans report that they regularly visit state parks. Recent studies indicate that roughly 18 percent of Coloradans are anglers and almost 5 percent of Coloradans hunt. Additionally, over 80 percent of all Coloradans use trails and over 50 percent participate in water sports. Overall, activities the CPW supports result in over 24 million recreation days per year in Colorado.

CPW's water use supports:

- Fisheries (rivers, reservoirs)
- Fish stocking (hatcheries)
- Recreation (fishing, boating, hunting, wildlife viewing)
- Habitat
  - Instream flows
  - Conservation pools in reservoirs
  - Wetlands, riparian habitat
  - Forage production, terrestrial habitat through irrigation
- Threatened and endangered species protection, recovery, and propagation
- Groundwater recharge
- Drinking water for visitors to state parks and wildlife areas

Partnerships are critical to CPW's mission. CPW works extensively with private landowners; local, state, and federal agencies; other public entities, such as water districts and municipalities; and nongovernmental organizations (NGOs) on a number of wildlife- and recreation-related projects. Some of the water-related projects include:

- Partnerships for protecting and restoring species of concern, such as the Colorado River cutthroat trout, roundtail chub, bluehead sucker, and flannelmouth sucker.
- General fishery management strategies regarding management classifications for all waters in the state. One example of such a strategy is the Basin Aquatic Wildlife Management Plan.
- Partnerships with agricultural water users to share and coordinate the use of water resources. Examples include the Rio Grande cooperative agreement and the Tamarack Ranch groundwater recharge project.
- Development of data to understand water quality issues and to support wise water quality management.
- Collaboration with the Habitat Partnership Program. This program is funded by revenue from the sale of big game licenses, and develops partnerships among landowners, land managers, sportsmen, the public, and CPW to reduce wildlife conflict—particularly conflict associated with forage and fencing. Habitat Partnership Program committees are responsible for finding local solutions to local problems. The program works with public and private landowners to develop distributed water features statewide, such as stock ponds, solar wells, and springs, that improve livestock or game distribution on the landscape and minimize riparian damage.

- Protection of water-dependent conservation values on easement properties, which helps to minimize agricultural dry-up and provide long-term benefits to wildlife and landowners.
- Investments that provide public access and recreational opportunities to and on otherwise private land and water rights.
- Continued work with the CWCB to protect and enhance streams and lakes through the Instream Flow Program. For example, in 2012, CPW loaned water to the CWCB from Lake Avery for instream flow use on Big Beaver Creek and the White River.
- Continued work with the CDPHE to ensure protection of water quality for fish, amphibians, wildlife, plants, and people.
- Provision of water to enhance wetlands on Natural Resource Conservation Service Wetlands Reserve Program easements in the San Luis Valley, benefiting both wildlife and agricultural operations.

CPW is committed to developing positive relationships in every area of the state. There is also potential to bolster CPW's work with other state agencies in order to develop and realize additional benefits from water assets. For example, CPW looks forward to working more closely with the State Land Board (SLB) to develop ways to use water assets that enhance wildlife habitat on state trust lands.

While some examples of projects with multiple benefits are listed above, the ability to use any particular water right for multiple purposes is generally a function of the individual water rights decree. CPW's water is first and foremost dedicated to environmental, wildlife, and recreational uses, as most of CPW's water rights are decreed for these uses. However, CPW actively works within the water basins to find opportunities to optimize the use of water to benefit Coloradans, without diminishing the protection of wildlife, habitat, and recreational facilities.

Colorado State Land Board of Commissioners

Mission and Constitutional/Statutory Authorities

The SLB protects, enhances, and manages Colorado's permanent endowments of assets to generate revenue for Colorado's public schools and public facilities. The SLB believes that economic productivity in perpetuity is dependent on sound stewardship, which includes the protection and enhancement of the beauty, natural values, open space, and wildlife habitat of those lands. Amendment 16 of the Colorado Constitution and Section 36-1-118, C.R.S. govern the SLB's management of its assets.

SLB Water Rights Inventory

The majority of the SLB's water assets consist of agricultural stock wells. Table 9.3-1 summarizes the water assets the SLB identified and verified.

TABLE 9.3-1 STATE LAND BOARD WATER ASSETS

TYPE OF WATER ASSET	QUANTITY	COMMENTS
Ownership Shares in Ditch Companies	9	Used to support agricultural leases located on state trust land.
Decreed Surface Water Structures	17	
Decreed Groundwater Structures	117	
Permitted Structures	55	
Agricultural Stock Wells (estimated)	3,000	Stock wells located on state trust land, used to support grazing leases and permitted at less than 15gpm.

Uses of SLB Water Rights

All water rights the SLB currently owns help support agricultural production on state trust lands. This directly supports the agency's constitutional and statutory obligation to "protect and enhance the long-term productivity and sound stewardship of state trust land held by the board" by promoting sound land management practices, long-term agricultural productivity, and community stability. This use of the SLB's water rights also supports Colorado's Water Plan goal to maintain viable and productive agricultural lands.

There are additional opportunities for the SLB to work with other state agencies to develop and maximize benefits from its water assets. These include:

- Leasing existing water assets to CPW or the CWCB to support projects that enhance wildlife habitat on state trust lands.
- Selling or leasing land to other agencies for the development of new water projects.
- Purchasing new water assets that the SLB can hold and lease to other state agencies.

History Colorado

Established in 1879, History Colorado is both a state agency under the Department of Higher Education and a 501(c)(3) charitable organization.[50] History Colorado is a trustee of the State and holds property on its behalf.[51]

History Colorado Water Rights Inventory

History Colorado's water assets are a mix of surface water, ground water, and leased storage rights. The decreed uses of these rights include domestic, irrigation, commercial, and industrial.

TABLE 9.3-2 HISTORY COLORADO WATER ASSETS

TYPE OF WATER ASSET	QUANTITY	USES
Leased Water Rights	2	Commercial, Domestic, Storage
Decreed Surface Water Structures	2	Augmentation
Decreed Groundwater Structures	7	Commercial, Domestic, Industrial, Irrigation, Geothermal

Uses of History Colorado's Water Rights

History Colorado uses its water rights in connection with the operation and maintenance of its museums and historic sites.

Colorado Department of Corrections

Mission and Statutory Authorities

The Colorado Department of Corrections (DOC) is governed by Article 17, C.R.S. (2014). The DOC's mission is "To protect the citizens of Colorado by holding offenders accountable and engaging them in opportunities to make positive behavioral changes and become law-abiding, productive citizens."[52] Section 37-88-101 authorizes the DOC to own ditches, canals, and reservoirs for irrigation and domestic purposes.[53] Section 17-24-106 authorizes the Division of Correctional Industries to own real and personal property, which includes water rights.[54]

The DOC Water Rights Inventory

The DOC owns a number of water rights, including surface and groundwater rights and one storage right, located in Water Divisions 2, 4, and 5. The decreed uses of these water rights include irrigation (including irrigation by reuse and successive use of treated wastewater), domestic, exchange, augmentation and recreational (including fish and wildlife), storage and subsequent application to beneficial uses, sanitary, commercial, industrial, stock watering, mechanical, horticultural, fire protection, and manufacturing.

Uses of the DOC's Water Rights

Currently, the DOC uses most of its water rights for landscape irrigation and to support the Division of Correctional Industries' agribusiness program—for example, for raising pasture grass and hay to support cow-calf dairy herd development. The DOC uses the wells and reservoir associated with the Rifle Correctional Center in Garfield County to support all functions at the facility, including irrigation needs.

ACTIONS

Based on the information compiled in the state agency water rights inventory process, the state agencies this section discusses are currently using their water rights in ways that accomplish their respective missions, benefit the state, and further the water values underlying Colorado's Water Plan. To further align state water rights with these values, and to maximize the use of these water rights to realize all possible benefits to the state, the following actions are necessary:

1. The CWCB will continue to work with state agencies to compile and update inventories of their water rights.
2. The CWCB and other state agencies will use the information resulting from the inventory as a basis for coordinating agencies' water right uses and potentially sharing water to provide additional benefits to the state. To accomplish this, the CWCB and other state agencies will:
    a. Convene work groups comprising multiple agencies' staff members. These work groups will identify opportunities to align the agencies' water rights to achieve additional benefits and, where feasible, use those water rights to meet identified needs. For example, the CWCB and CPW can identify opportunities for releases from CPW reservoirs to be protected under Colorado's Instream Flow Program.
    b. Encourage sharing and optimal use of water among state agencies where efficiency savings might be realized.
    c. Conduct technical and legal feasibility analyses of identified opportunities for aligning or sharing agency water rights, and advance feasible projects in a timely manner.
3. The CWCB will identify State-owned water rights within the Colorado River Basin and evaluate opportunities for these rights to assist with Colorado River Compact compliance. For example, the Animas-La Plata Project contract between the BOR and the CWCB recognizes that the State's stored water rights in the project could be used for compact compliance purposes. There may be other state resources that could assist in complying with the State's obligations under the Colorado River Compact.
4. The CWCB will continue to schedule joint meetings with local governmental water management agencies around the state to facilitate information sharing and coordination on common water rights issues.
5. The CWCB will work with local stakeholder groups to determine where instream flow water rights could provide the greatest benefits, and assist such groups with the instream flow recommendation process.
6. The CWCB will partner in the early stages of future multipurpose projects as a water rights holder when such partnership is needed to ensure the success of the project, minimize environmental impacts of a project, or otherwise further the water values Chapter 1 outlines.
7. In coordination with the CWCB and interested stakeholders, CPW will take the lead on identifying opportunities to use CPW's water rights to help fill environmental and recreational gaps while maintaining consistency with its mission, statutory mandate, and rules/policies governing the use of CPW property.[c]

[c] CPW is funded primarily through the sale of hunting and fishing licenses, parks passes and permits, and the receipt of associated federal parks and wildlife funds. All real property interests, including water rights, purchased with wildlife cash, parks cash, or associated federal funds, are required to be used only for parks and wildlife purposes. See sections 33-1-112(1), 117, 118, and 119, 33-9-107 and 109, 33-10-108(1), 111, 112, and 113, C.R.S.; see also 16 U.S.C. 669 to 669i, 16 U.S.C. 777 to 777l, and 16 U.S.C. 460l-4 to 460l-11. As such, there is limited ability to use such water rights for any purpose other than the originally intended parks and wildlife purposes. Any secondary or shared uses must be consistent with, and not otherwise impair, the water rights' originally intended parks and wildlife purposes.

Sun sets near Fort Collins over Horsetooth Reservoir, part of the Colorado-Big Thompson Project. The reservoir provides drinking water, irrigation, recreational opportunities and hydropower generation to east slope communities and is jointly operated by the Bureau of Reclamation and the Northern Colorado Water Conservancy District.

9.4 FRAMEWORK FOR A MORE EFFICIENT PERMITTING PROCESS

GOAL

Colorado's Water Plan advocates for effective and efficient permitting in which State of Colorado agencies work together to complete their work early in the permitting process. This will provide the opportunity for State support without being pre-decisional.

Introduction

Governor Hickenlooper's May 2013 executive order reiterated that the gap between Colorado's water supply and water demand is real and looming. While conservation is a key strategy to narrowing the gap across the state, it alone cannot solve the problem. Scenario planning indicates that at least 80 percent (350,000 acre-feet) of already-planned projects need to be implemented, and many of these still need to go through the permitting process.[55] Ideally, the permitting process ensures the implementation of projects that best meet Colorado's water values—which are to support vibrant and sustainable cities, viable and productive agriculture, a robust tourism industry, efficient and effective infrastructure, and a strong environment. The current permitting process needs review, and the executive order directed the CWCB to "streamline the State role in the approval and regulatory processes regarding water projects."[56]

The objective of this section of Colorado's Water Plan is to explore how permitting in Colorado can be more effective and efficient. Tackling permitting is extremely difficult due to the complexity of the projects, the challenges in understanding and reducing environmental impacts, and the condition of many of the aquatic systems. This section describes the current permitting and licensing processes, challenges that arise during the process, and reforms that could make the process more efficient and effective for all parties involved. The solutions the CWCB proposes focus on how the State can be more effective and eliminate and reduce redundancies. This section also touches on the benefits of cooperation among federal agencies, local governments, and stakeholders. Finally, this section describes an approach that allows the State to support a project without predetermining the outcome of an environmental permit, certification, or mitigation plan.

Summary of Each Process Within Water Permitting

This section briefly explains the state and federal process that project proponents are required to follow in completing a project. Section 2.4 contains a description of entities involved in permitting.

National Environmental Policy Act Process

NEPA is a federal law that establishes and requires a structured planning and decision-making framework for any federal decision that has the potential to significantly impact the human environment. NEPA requires federal agencies to assess the environmental effects of their proposed actions before decision making. Importantly, NEPA provides opportunities for citizen involvement in government decision making through public disclosure, and formal opportunities for public input as the environmental effects of a project are evaluated.[57]

There are three situations in which a water supply project may trigger NEPA's procedural requirements:

- One or more project components will occur on federal lands, such as national forest or BLM lands.
- The project or its components will be funded in part or whole by federal funds.
- The project will require a federal permit or license.

For water projects in Colorado, the most common federal actions that lead to a NEPA environmental review are a BOR contract for storage of water in a facility managed by that agency, a Corps CWA Section 404 permit, a project component that will be built on federal land, or a FERC hydropower license.[58]

The NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences, and take actions that protect, restore, and enhance the environment.[59] Regulations instruct federal agencies to use the NEPA planning process "to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment" and to use all practicable means "to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions."[60] It is with public and agency input that these goals are to be achieved.

The NEPA process begins when the federal agency determines that there is a need to take action. The federal agency that needs to take action is the lead agency and is responsible for compliance with NEPA. Depending on the circumstances, a joint lead agency and/or cooperating agencies can be identified to share in the responsibilities of completing NEPA environmental review. For many state water projects that may have significant environmental impacts, an EIS process is required.[61]

To the fullest extent possible, NEPA regulations direct federal agencies to integrate NEPA requirements with other planning and environmental review procedures required by law or by agency practice, so that all such procedures run concurrently rather than consecutively.[62] Agencies often do not meet this goal and instead run consecutive permitting processes. This, in addition to other factors, often leads to an extended planning process. To successfully achieve the goal of concurrent planning, the NEPA process must start at the earliest possible time within the water supply project planning process and involve all interested parties in a meaningful way. Proponents should assess whether a project proposal is likely to trigger NEPA planning requirements at the start of planning, and immediately engage the relevant federal and state agencies, as well as local governments and other interested parties. Early involvement of all such parties may also avoid extended planning processes by reducing the need for supplemental NEPA documents.

Clean Water Act Section 404

Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Activities this program regulates include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States, unless the activity is exempt from Section 404 regulation (for example, certain farming and forestry activities).

In summary, the Code of Federal Regulations (CFR) 40 Part 230 Section 404(b)(1)(Guidelines) states that no discharge of dredged or fill material may be permitted if:

- A practicable alternative that is less damaging to the aquatic environment exists.
- It causes or contributes to violations of any applicable state water quality standard.
- It violates any applicable toxic effluent standard.
- It jeopardizes the continued existence of species listed as endangered or threatened under the ESA.
- The nation's water would be substantially degraded, and unless steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

Like NEPA, Section 404 requires that a program address specific, structured planning steps and information at the initial stages of project planning and development in order to increase efficiencies. Various federal agencies have different Section 404 roles and responsibilities.

The Corps administers the day-to-day permitting program, including individual and general permit decisions. The Corps issues individual permits and evaluates applications under a public interest review, as well as evaluates the environmental criteria defined in the guidelines and NEPA regulations, if they are applicable. For most discharges that have only minimal adverse effects, the Corps issues a general permit. It issues general permits on a nationwide, regional, or state basis for particular categories of activities. Large-scale water projects require an individual Section 404 permit.[63] The Corps also conducts or verifies jurisdictional determinations, develops policy and guidance, and enforces Section 404 provisions.

The EPA develops and interprets policy, guidance, and environmental criteria used in evaluating permit applications. The EPA also determines the scope of geographic jurisdiction and evaluates the applicability of any exemptions, approves and oversees state and tribal assumptions, and reviews and comments on individual permit applications. The EPA has the authority to prohibit, deny, or restrict the use of any defined area as a disposal site under section 404(c), may elevate specific cases for further evaluation under Section 404(q), and enforces Section 404 provisions.

The USFWS evaluates the impacts of all new federal projects and federally permitted projects on fish and wildlife, including projects subject to the requirements of Section 404. The USFWS also elevates specific cases or policy issues about an individual permit that is required for activities that have potentially significant impacts.

401 Water Quality Certification

Under Section 401 of the CWA, if an activity that requires a federal license or permit may cause any discharge into navigable waters, the applicant for the federal license or permit must obtain a 401 certification to protect water quality. The WQCD is required by Colorado statute (C.R.S., §25-8-302(1)(f)) to review federal licenses and permits under Section 401 of the CWA. Regulation No. 82 (5 CCR 1002-82) authorizes the division to certify, conditionally certify, or deny certification of federal licenses. It also sets forth best management practices applicable to all certifications, with one exception.[64] Regulation No. 82 applies to division certification of CWA 404 permits issued by the Corps, licenses for hydropower projects issued by the FERC, and other federal permits involving a discharge, including CWA Section 402 discharge permits issued by the EPA.[65] The 401 certification process includes an antidegradation analysis as described in Chapter 7.3.

Exceptions apply to 402 discharge permits the EPA issues for facilities on tribal lands, Section 404 permits the Corps issues on tribal lands, and 402 permits the

LURLINE UNDERBRINK CURRAN

COLORADO RIVER BASIN

Lurline was the county manager for Grand County and currently serves as the vice chair of the Colorado Basin Roundtable. As the County's lead negotiator for recent transmountain diversion agreements associated with the county's 1041 permitting authority, she demonstrated that cooperation can be accomplished even in the most contentious of circumstances. She is pictured by the bridge at Grand Lake near the headwaters of the Colorado River.

Colorado's Water Plan will provide a template for cooperation and thoughtful decisions as demands increase on the waters originating in Colorado. There are many struggles to overcome between the East and West slopes, but the plan...

CONTINUED AT END OF CHAPTER

PROFILE

EPA issues for federally owned facilities on federal lands. For these facilities, the EPA issues the 401 certification.[66] Individual certification review is not required for Section 404 general or nationwide permits the Corps issues, except for activities covered by certain nationwide permits on tribal lands. Except for the activities on tribal lands, general or nationwide permits are certified under statute (C.R.S., §25-8-302(1)(f)) without additional conditions.

The WQCD issues a Section 401 water quality certification when it determines reasonable assurance that both the construction and the operation of the project will comply with state surface and groundwater water quality standards and requirements. If the WQCD concludes that the project will comply with the water quality standards and requirements, and if one or more conditions are placed on the license or permit, it will issue the certification with the necessary conditions included.

House Bill 15-1249 passed during the 2015 legislative session. It repeals and reenacts statutory fees for clean water and drinking water programs in the WQCD of the CDPHE. One of the many provisions of the bill authorized new fees for the CDPHE certifications related to projects affecting regulated water quality standards in jurisdictional waters of the United States; these are known as 401 certifications. The WQCC establishes 401 certification fees by rule according to a tiered schedule, and these fees will take effect in fiscal year 2016-2017.

Fish and Wildlife Mitigation Plans

Colorado State Statute 37-60-122.2 (C.R.S.), known as the Fish and Wildlife Resources Fund and Authorization, declares that fish and wildlife resources are a matter of statewide concern, and that applicants proposing water diversion, delivery, or storage projects should reasonably mitigate impacts on such resources. Applicants must submit a proposed mitigation plan to the CPW Commission for review and approval. If the applicant and the WQCC reach a mutual agreement, the WQCC forwards the proposed plan to the CWCB for adoption as the official State position. If the WQCC rejects an applicant's plan, it still forwards the plan to the CWCB. If the CWCB disagrees with the WQCC, the governor decides whether to approve the plan.

A mitigation plan is generally required when an applicant seeks a permit or license from the federal government for specified types of water projects, with some exceptions as noted in the statute.[67] The CWCB has grant funds available for applicants to help implement the mitigation plans, and has established criteria for such grants.[68] Examples of completed or in progress Section 122.2 plans include Southern Delivery System, Windy Gap Firming Project, Moffat Collection System Project, and Chatfield Reservoir Reallocation Project.

Claimed Water Regulation

The Colorado WQCC Regulation No. 84 (5 CCR 1002-84) and the WQCD's reclaimed water program are designed to promote the use of reclaimed water in Colorado. The regulation includes requirements and minimal standards for reclaimed water, and for treaters and users of reclaimed water, to employ best management practices in its use. These minimal standards are necessary to protect public health and the environment. Regulation applies to the use of reclaimed water for landscape irrigation, agricultural irrigation, fire protection, industrial, and commercial uses as detailed in Table 9.4-1. The treatment and best management practices required before and during use depend on the use of the reclaimed water. Regulation 84 requires treaters and users to obtain and comply with a notice of authorization, which the WQCD issues, and which contains the terms, limits, and conditions deemed necessary to ensure compliance with Regulation 84.

TABLE 9.4-1 RECLAIMED WATER USES AUTHORIZED IN REGULATION 84

	APPROVED USES
Industrial	Evaporative Industrial Processes
	Washwater Applications
	Non-discharging Construction and Road Maintenance
	Non-evaporative Industrial Processes
Landscape Irrigation	Restricted Access
	Unrestricted Access
	Resident-Controlled
Commercial	Zoo Operation
	Commercial Laundries
	Automated Vehicle Washing
	Manual Non-Public Vehicle Washing
Fire Protection	Residential Fire Protection
Agricultural Irrigation	Non-Food Crop Irrigation and Silviculture

Hot air balloons at Chatfield Reservoir. Reallocation of flood storage water received fish and wildlife mitigation plan and 404 permit approvals in 2014.

1041 Local Permits

In 1974, the Colorado General Assembly enacted measures to define the authority of state and local governments in making planning decisions for matters of statewide interest. These powers are commonly referred to as "1041 powers," based on the legislation bill number (House Bill 74-1041). These 1041 powers established under this "Areas and Activities of State Interest Act" allow local governments to identify, designate, and regulate areas and activities of state interest through a local permitting process. The general intention of these powers is to allow local governments to maintain their control over particular development projects, even where the development project has statewide impacts. The statute concerning areas and activities of state interest can be found in 24-65.1-101 (C.R.S.), The Local Government Land Use Control and Enabling Act (as described in Section 2.3) is another source of authority, along with others, which confers upon local governments the authority to regulate the development of water projects within their jurisdictions to ensure the protection of the environment and to provide for the planned and orderly use of land.[69]

Generally, development may only proceed if it is consistent with the local communities' environmental and developmental goals as outlined in their 1041 regulations.

Of particular interest to many local governments are impacts from the construction and operation of large-scale water projects. The Areas and Activities of State Interest Act authorizes local governments to designate as "activities of statewide interest" the site selection and construction of major new domestic water and sewage treatment systems, the major extension of existing domestic water and sewage treatment systems, the site selection and development of new communities, and the efficient utilization of municipal and industrial water projects. Local governments may not pass regulations that are categorically prohibitive of the building of municipal water facilities and expansion of existing projects. However, the Act allows the locality to deny a specific application or require a permit with designated conditions before construction. A permit may be denied for a specific water project that does not meet the standards or criteria of the local regulations.

Past and Existing Colorado Efforts

In the past, there have been several attempts to coordinate the permitting process. The General Assembly created the Colorado Joint Review Process (CJRP) in 1983 to improve the environmental permitting process, primarily as it pertained to energy development. The CJRP was never fully completed for any project.[70] It is not clear whether this is because the energy industry collapsed, or because the process was not considered helpful. Many projects failed to proceed for economic reasons. The CJRP also coordinated the State's combined responses to major projects, such as the review of the proposed Denver International Airport, the Two Forks veto, and Colorado's bid for the Super Conducting Super Collider. In 1996, the General Assembly allowed the CJRP legislation to expire.

Another attempt to coordinate the review process was initiated in 2003 when Colorado's General Assembly established the Colorado Coordination Council through HB03-1323. The executive director of the DNR was designated as the administrator of the council. The coordination process was voluntary; sponsors could choose to use it. The permitting areas allowed within the process included "extraction, use, conservation, transportation, or management of natural resources," which required permits, approvals, or compliance from federal, state, or local governments.[71] This process was never used, and the statutes supporting the council were allowed to expire in 2013. According to DORA, which reviews statutes set to expire, "Very few outside, or even inside, DNR were aware of the Council's existence. Indeed, most stakeholders contacted as part of this sunset review had never heard of the council. Those within DNR acknowledged that DNR conducted no outreach to inform the community of the Council's existence and, to the best of anyone's recollection, no one at DNR had ever suggested that a project sponsor utilize the Council."[72]

Recently, the State and various federal agencies have made progress toward coordinating review processes through the use of MOUs. No formal legislation was passed to initiate the development of MOUs. These documents assist in creating a structure under which the State and the respective agencies can work together, with the intention of developing a more coordinated permitting process.[a] Colorado and federal permitting

[a] Examples include the FERC MOU, concerning collaboration with other federal permitting entities, and the State and Forest Service MOU, concerning coordination with the Colorado Department of Natural Resources and the Forest Service.

TABLE 9.4-2 STAKEHOLDER INPUT

	Met with the CWCB	Provided Written Comments
Colorado Department of Public Health & Environment (CDPHE)	X	
Colorado Parks & Wildlife (CPW)	X	
Colorado Attorney General's Office (AGs Office)	X	
Division of Water Resources (DWR)	X	
Northern Colorado Water Conservancy District (NCWCD)	X	X
Trout Unlimited (TU)	X	
South Metro Water Supply Authority (SMWSA)	X	X
U.S. Army Corps of Engineers (Corps)	X	
Environmental Protection Agency (EPA)	X	
Bureau of Reclamation (BOR)	X	X
Federal Energy Regulatory Commission (FERC)	X	
Denver Water	X	X
Upper Yampa Water Conservancy District	X	
Northwest Colorado Council of Governments	X	X
Western Resource Advocates (WRA)	X	X
Colorado Springs Utilities	X	X
Water Reuse Association	X	X
Aurora Water		X
City of Thornton		X
Front Range Water Council	X	X
Conservation Colorado		X
Colorado Wastewater Utility Council		X
Colorado Oil and Gas Association		X
Pikes Peak Regional Water Authority		X
Fountain Valley Authority		X
Douglas County		X

agencies made progress on developing a Collaborative Approach to Water Supply Permit Evaluation (CAWS) through a series of facilitated conversations among several parties. As a result, the parties reached an informal agreement under which conservation could be treated either as a demand reducer or as an alternative to the project. The DNR initiated the process to mutually understand state and federal permitting processes and requirements, and to identify areas with potential for improved efficiencies.[b]

Despite the lack of an official coordinating statute for state and federal permitting entities, there is coordination. Recently, CPW and the WQCD have become cooperating agencies for several projects undergoing NEPA's EIS process. Project proponents have indicated that this has been a helpful, collaborative effort.[73]

In addition, there is increased coordination within the DNR.

[b] Collaborative Approach to Water Supply Permit Evaluation (CAWS) MOU: Beginning in 2010, the Colorado Department of Natural Resources, U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers met to educate federal permitting partners about state planning and permitting issues. Out of that process, the agencies developed an MOU concerning the use of conserved water. Rather than considering conservation as an alternative, the agencies agreed that conservation would be factored into reducing demands as part of the purpose and need of the project. While this MOU has not yet been finalized, the agencies have begun an important collaborative process to help each agency understand opportunities and constraints that may inform the MOU and streamline processes in the future. Additional efforts will take place to revise and/or finalize the MOU as appropriate.

In 2012, President Obama issued Executive Order 13604, "Improving Performance of Federal Permitting and Review of Infrastructure Projects."[74] Specific federal agencies reportedly applied an expedited review process to 50 pilot projects, each with an accelerated schedule, clear project review milestones, and a designated lead coordinating agency. Agencies tracked the project progress on a "Federal Infrastructure Permitting Dashboard," which contained an IT platform on which agencies could develop a cooperative schedule, share project documents, and quickly communicate with one another.[75]

Basin Roundtable and Interbasin Compact Committee Concepts Concerning Permitting

The IBCC's No-and-Low-Regrets Action Plan and the basin roundtables' BIPs discuss permitting in depth. Of the eight BIPs, six discuss challenges or solutions. Table 9.4-3 at the end of this section quotes these important stakeholder sources. While the individual statements in the table do not reflect the position of the State of Colorado, future discussions should incorporate careful consideration of the challenges and solutions.

Additional Stakeholder Outreach

To further understand the needs, issues, and potential solutions regarding the permitting process, the CWCB staff met with and interviewed a variety of water providers, environmental groups, and state and federal partners. Table 9.4-3 indicates the list of organizations with which the CWCB met or from which it received comments from concerning permitting (not including several individuals who provided comment).

Stakeholders across many industry and government sectors desire improved coordination and increased early involvement, regardless of whether those stakeholders represent environmental or utility interests. In many cases, stakeholders believe that improved coordination and increased early involvement would shorten permitting time while upholding the environmental protections that permitting secures. Multiple stakeholders also express interest in reducing duplication, increasing resources, lowering costs, unifying methods, increasing clarity, examining reuse permitting, improving quality of draft EISs, and encouraging multi-purpose projects.[76]

One common concept these meetings have uncovered is to revive a program akin to the CJRP described above. The establishment of a joint NEPA review process, which would begin before land use authorization applications are submitted for new water projects, may prove to facilitate a more efficient process. The BLM's experience is that applicants who are willing to have pre-application discussion of potential impacts and perform analysis of alternatives before submitting land use authorization applications experience much shorter wait times.

The Northwest Colorado Council of Governments envisioned the process in the greatest detail. This process is summarized below:

Because it is expensive, time consuming, and sometimes "work for the sake of work" for the applicant, regulators, local governments, and other stakeholders to participate in a NEPA process, the State should facilitate a joint review process before and during the NEPA process. This sort of "front loading" minimizes the costs to the applicant and other stakeholders because as early as possible, the applicant and regulators understand what concerns, impacts, and potential for mitigation are relevant in the areas affected by the project; and what will be necessary to satisfy federal, state, and local laws and regulations.

This approach also improves the likelihood that alternatives, reports, and studies that are generated during NEPA will be more focused and responsive to actual, real world concerns, rather than reports and studies that are off the mark. Agreement can be reached on the scope of alternatives, reports, and studies before the applicant/regulators spend money on consultants to prepare pounds of paper that ultimately are not necessary to satisfy NEPA, the regulators, or affected stakeholders.

Another important result of the process is that for each project, the joint review process would define the regulatory framework and where the overlaps between state, local, and federal processes are, so that they could be coordinated rather than duplicative or contradictory. This saves money for the applicant, the regulators, and the public concerned about the project as well as ensuring that permits can be issued more quickly.

Finally, it provides a forum to formulate agreements, like the Windy Gap Firming Project IGA, that result in projects that benefit the project proponent, the environment, and affected interests.

In order to be part of the joint review process, participants would have to agree to certain principals regarding rules of engagement. Those rules would require that the parties work in good faith, explain interests rather than take positions, among others.

The local governments from the areas that would be affected by the project should be responsible for identifying the appropriate local stakeholders and coordinating local input.

Critical input points during the process are during:

1. *Scoping*
2. *Developing alternatives*
3. *Determination of methodologies and data gaps*
4. *Mitigation and enhancement plans*

The Front Range Water Council suggests that Colorado use, or modify, the expedited federal permitting procedures and dashboard developed as a result of Presidential Executive Order 13604 described above.

Permitting Issues and Potential Process Improvements

Several common potential process improvements, as well as comments from water providers, the conservation community, and various state and federal agencies, emerged after the CWCB reviewed the work of the IBCC and the basin roundtables. Based on these discussions, the CWCB identified the following process improvements to explore further:

1. **Improve Coordination**
   - Coordinate review efforts by different state agencies.
   - Coordinate EIS document review across state agencies with the goal of increasing efficiency.
2. **Increase Early Involvement**
   - Examine opportunities for state agencies, local governments, stakeholders, and federal agencies to get involved earlier in the NEPA process.
     - Involve NEPA and CWA Section 404 lead agencies (if applicable) at the very initiation of project planning to ensure a concurrent (vs. sequential) planning process. This will facilitate early identification of required planning steps and information needs.
3. **Coordinate Technical Methods**
   - Reduce duplication of technical methods across state agencies, while respecting the various authorities and obligations within existing law.
4. **Increase State and Other Resources**
   - Shorten the length of time needed to complete the required environmental reviews, while maintaining a robust decision-making process.
   - Evaluate potential future State staff demands and associated resources needed to complete the reviews in a timely manner at the beginning of the permitting process.
5. **Increase Clarity**
   - Increase the understanding of the information required for environmental reviews.
   - Identify required technical elements, assessment methodology, and reporting results of environmental parameters, including hydrology, conservation, scenario planning, water quality status and designated uses, modeling applicability, and risk tolerance.
   - Understand the role of conservation in purpose and need development.
   - Develop a State certification and mitigation handbook for project proponents and stakeholders.
6. **Improve the Quality of Draft EIS Documents**
   - Enhance efficient completion of State certification, federal permitting, and mitigation plan processes.
   - Emphasize issue identification earlier in the EIS process by involving all parties with a decision-making role, and by collecting baseline environmental data.
7. **Encourage Multi-Purpose Projects**
   - Facilitate projects with multiple objectives, such as municipal, industrial, hydropower, environmental, recreational, and agricultural objectives, by increasing sources and availability of funding for these types of projects.

- Explore with project proponents and other beneficiaries opportunities to streamline permitting processes, equitably allocate mitigation responsibilities, and provide State support for these types of multi-purpose projects.

Many of these process improvements will be addressed by conducting a series of lean events with state and federal partners and consulting with stakeholders. Lean events (also called Kaizen events) are short term improvement projects with a specific goal or set of processes to improve.[77] These events are attended by the owners and operators of a process with the intent of making efficiency improvements to that process. The events will accomplish the following:

- Gather operators, managers, and owners of a process in one location;
- Map the existing process;
- Improve on the existing process; and
- Solicit buy-in to the process improvements from all involved parties.

Framework for State of Colorado Support for a Water Project

The State of Colorado could develop a more effective and efficient pathway for a water project to receive State support (Figure 9.4-1, page 9-45) while continuing to uphold state and regulatory review responsibilities. The State will identify milestones and decision points at the beginning of the process to make the regulatory process more efficient and effective.

Figure 9.4-1 (page 9-45) explores a framework for how the State could be involved in the Federal 404 permitting process.

1. Pre-permit work has been shown to resolve many of the issues prior to a project proponent's permit application submittal.
2. The CDPHE and DNR cooperating agency involvement will focus on impacts, analysis, mitigation, and enhancements for water quality and fish and wildlife.
3. In order for the CDPHE and DNR to evaluate the project in a contingent manner, the Draft EIS must a) identify the preferred alternative, and b) detail mitigation and enhancements for water quality and fish and wildlife.
4. The process clarifies the time at which the State's fish and wildlife mitigation plan would happen.
5. Based on the information in the Draft EIS, the Wildlife Mitigation Plan, and public comments, the CDPHE and DNR would provide their recommendations to the Governor's Office. The definition of state support is below.
6. If 401 certification occurs before the ROD, it will automatically be a conditional certification. The first condition would be that if the underlying assumptions of the FEIS change or if the preferred alternative changes as part of the ROD, the 401 certification must be completed again after the ROD.

Pre-Permitting Work (Initial Studies and Stakeholder Involvement)

If a project proponent is seeking State technical or financial support for initial planning, baseline environmental studies, alternatives analysis, feasibility studies, or initial stakeholder involvement, priority will be given to projects that:

- Meet the goals and measurable outcomes identified in the BIPs;
- Identify a project proponent;
- Meet an identified need; and
- Can be built within the next 15 years, assuming a more efficient and effective permitting process as suggested below.

State Support for Projects Aligned with Colorado's Water Values

Importantly, Colorado's Water Plan does not require proponents of water projects to take any action. A project proponent can, however, voluntarily qualify for State support in the form of state engagement, facilitation, or funding by ensuring the project aligns with Colorado's water values (Chapter 1). The State will use the following criteria to determine alignment with these values.

- Does the project proponent demonstrate a **commitment to collaboration?** Does the project proponent:
  - address more than one type of need;

- involve multiple participants where appropriate;
- consult with a broad set of local stakeholders and local governments before or early in the regulatory process (examples of stakeholders include relevant basin roundtables, water users, conservation groups, and community groups); or
- provide meaningful opportunities for input?

- Does the project proponent **address an identified water gap?** Is the project:
  - included in a BIP;
  - identified as meeting a defined need in a basin needs assessment;
  - identified as meeting a defined need identified in the SWSI; or
  - identified as part of the no-and low-regrets scenario planning process?

- Does the project proponent **demonstrate sustainability?** Does the project proponent:
  - adopt an integrated plan or plans geared toward implementing the conservation best practices at the high customer participation levels, as defined in the SWSI;
  - avoid adverse effects to environmental and recreational interests or adopt environmental, watershed health, and recreational mitigation in the planning phase of the project, prior to consideration in the permitting phase of alternatives that minimize or avoid adverse effects (project proponents should consider use of existing tools if available, such as stream management plans that follow state guidance, instream flow water rights, water leasing, restoration, infrastructure upgrades, and consumptive use efficiencies);
  - avoid impacts to, mitigate, or enhance water quality, such as exceeding water quality standards or impairment of classified uses;
  - mitigate or avoid economic and social impacts on agricultural and rural communities;
  - maximize the use of water resources (through reuse, firming the yield of existing supplies, water sharing arrangements, improving or modernizing aging infrastructure, or aquifer storage and recharge projects);
  - partner with the local government(s) being served by the water project to incorporate best water use practices into land use planning efforts (these practices are included in water and land use trainings offered by CWCB and DOLA as described in Section 6.3.3); or
  - demonstrate that the project will not unreasonably increase the risk of non-compliance with any interstate compact or the curtailment of existing water rights (projects depending on water from the Colorado River system can demonstrate this commitment by agreeing to participate in the collaborative contingency planning efforts discussed in Chapter 8 and Section 9.1)?

- Does the project proponent establish the **fiscal and technical feasibility** of the project? Does the project proponent demonstrate:
  - over-all cost-effectiveness;
  - local investment or contribution;
  - financial capability to repay debt (bonds, loans, or other debt instruments);
  - an intent to leverage any state grant or loan with private, local, or federal funding;
  - technical and legal availability of water supplies for the project; or
  - readiness to proceed upon receipt of necessary funding and permits (i.e. completed preliminary planning and design work, obtained necessary water rights, secured necessary financial commitments)?

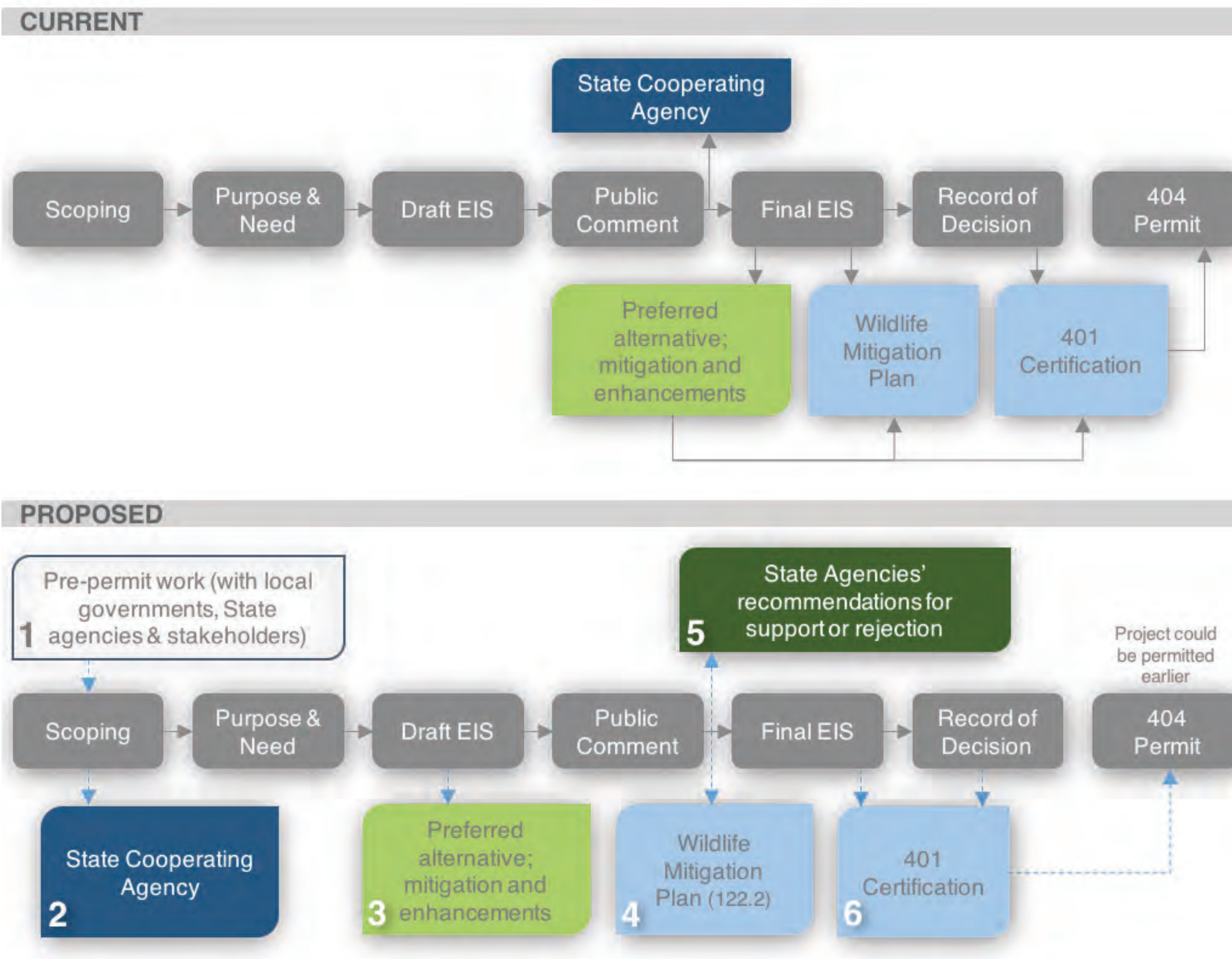
State Resource Prioritization

With the above criteria satisfied, the State will commit to front-loading State efforts at the beginning of the permitting process as available resources allow. This approach enables the State to coordinate with local governments and stakeholders and engage as a cooperating agency through the federal permitting process. Cooperation would need to occur at critical decision points, including scoping, methodological review, alternatives analysis, and development of mitigation and enhancement opportunities. In addition, this process could use a coordinated dashboard approach to define goals, timelines, and necessary permits. Existing regulations suggest that a coordinated approach is allowable under existing state law. For instance, regulation number 82.5(C)(2) states, "Where possible, the 401 certification process should be coordinated or consolidated with the scoping and review processes of other agencies which have a role in a proposed project in an effort to minimize costs and delays for such projects."[78] Federal recognition of the need to increase permitting efficiency also signals the potential for improvement of a process that is widely viewed as broken by stakeholders form multiple sectors.[79]

Preliminary Technical Review for State Processes

Figure 9.4-1 summarizes the current state processes for involvement in the federal 404 permitting process. The DNR's wildlife mitigation process is guided by C.R.S. 37-60-122.2. In 1987, the Colorado General Assembly passed HB 1158, which created a process by which agencies within the DNR come to consensus

FIGURE 9.4-1 STATE INVOLVEMENT IN FEDERAL EIS PERMITTING PROCESS



1. Pre-permit work has been shown to resolve many of the issues prior to a project proponent's permit application submittal.
2. The CDPHE and DNR cooperating agency involvement will focus on impacts, analysis, mitigation, and enhancements for water quality and fish and wildlife.
3. In order for the CDPHE and DNR to evaluate the project early, the Draft EIS must a) identify the preferred alternative, and b) detail mitigation and enhancements for water quality and fish and wildlife.
4. The process clarifies the time at which the State's fish and wildlife mitigation plan would happen.
5. Based on the information in the Draft EIS, the Wildlife Mitigation Plan, and public comments, the CDPHE and DNR would provide their recommendations to the Governor's Office. The definition of state support is below.
6. If 401 certification occurs before the ROD, it will automatically be a conditional certification. The first condition would be that if the underlying assumptions of the FEIS change or if the preferred alternative changes as part of the ROD, the 401 certification must be completed again after the ROD.

A bald eagle and mallard duck on Harriman Reservoir in Littleton with wetlands in the background.

regarding the impacts of water resource development projects on fish and wildlife, and the mitigation of such impacts. Among other things, the statute establishes a process that involves a project's proponent, the Parks and Wildlife Commission, and the CWCB. The process results in the State's official position on the mitigation of impacts on fish and wildlife associated with the development of water resources for Colorado's citizens.

Historically, the project proponent's presentation of a draft mitigation plan to the WQCC initiates this process, after which CPW staff members have 60 days to review the proposed plan and provide further input to the WQCC. At the end of a 60-day period, the WQCC and the project proponent must agree upon a plan; alternatively, the WQCC forwards different versions of the plan to the CWCB for separate deliberation and decision. If the WQCC and proponent agree, the CWCB simply endorses that agreement, and that becomes the official State position. If the CWCB disagrees with a plan and modifies it in any way, that plan goes to the governor for affirmation or modification, resulting in the official State position. Irrespective of the route that a plan has taken, the official State position is then transmitted to each local, state, and federal governmental entity. The statutory process is constructed to encourage agreement between the project proponent and CPW—greatly reducing the amount of time for the process to occur and resulting in an expedited state regulatory process.

The CDPHE's involvement as a cooperating agency in the federal 404 permitting process has typically occurred toward the end of the permitting process, after a draft EIS is issued. Additionally, the CDPHE has typically waited until the project's ROD has been completed before embarking on its official 401 certification review process.

As discussed above, with resources prioritized for earlier state agency involvement in the federal permitting process, state agencies could implement improvements. The State has an obligation to not be pre-decisional in 401 certification and wildlife mitigation plan processes. Earlier state agency involvement in the EIS process would allow for early identification and resolution of State concerns which should result in a higher quality draft EIS. Figure 9.4.-1 (page 9-45) highlights the steps that could help accomplish this early state agency involvement, including early involvement of the CDPHE. Additionally, much of the State's review work could be done prior to, during, and immediately after the draft EIS process.

More specifically, the CDPHE could begin its involvement shortly after the project proponent has established the project objective, or as the project proponent develops evaluation criteria for the EIS alternatives analysis. The CDPHE's input on the evaluation criteria is critical, as the State's methodologies for assessing water quality should be used in the EIS process. In addition, with early involvement, the draft EIS could include the CDPHE's input on mitigation and enhancements.

Once the federal permitting authority has completed the draft EIS, the CDPHE and CPW's review of comments from stakeholders and local government would give the State a good indication of support for or opposition to the project, as well as any outstanding issues related to it.

As a result of early involvement in the project's development or scoping, the CDPHE would be able to evaluate whether the preferred alternative adequately addresses water quality impacts, and whether it includes sufficient mitigation and enhancements for water quality. Likewise, through early communication and collaborative efforts with the project's proponents, CPW staff can have already initiated work on the framework of a mitigation plan for the project. At the appropriate time (following the publication of the draft EIS and after the 122.2 process has been completed), each agency would provide its project recommendations to the Governor's Office. The CDPHE's recommendation would most likely be in letter form, and would specify whether the CDPHE could certify the preferred alternative identified in the draft EIS. The CDPHE would provide this recommendation after the draft EIS public comment period.

Because the specific project that ultimately receives a 404 permit must be certified with a 401 certification, and because the 404 permit cannot be issued before completion of the EIS, 401 certification needs to occur after the final EIS. In all cases, the CDPHE will retain full authority to issue a 401 certification and conduct an independent antidegradation analysis. However, if state processes are coordinated during the draft EIS, the 401 certification could be completed after the EIS is issued, provided that all required processes for public notice and review per WQCC Regulations #21 and #82 are followed (unless the preferred alternative changes or underlying assumptions of the draft EIS change). If the 401 certification is completed before the ROD, it is automatically a conditional certification. The conditions are that, if the underlying assumptions of the EIS change, or if the preferred alternative changes as part of the ROD, the 401 certification process will have to be conducted again after the ROD.

Potential Fish and Wildlife Mitigation Process Changes

The legislation that created the 122.2 process for the mitigation of fish and wildlife impacts associated with water project development is somewhat constraining in that the project proponent and CPW staff do not initiate official communications with one another until after the release of a draft EIS. Furthermore, 122.2 has some rigid timelines that make it difficult for project proponents and CPW staff to jointly develop a quality, comprehensive mitigation plan. It is also difficult to engage stakeholders early in the process, and currently, there is little written guidance (beyond the words in the statute) for either the project proponents or the stakeholders. Therefore, the DNR and the Parks and Wildlife Commission should develop a written policy, administrative directive, or formal rules regarding the implementation of the provisions of 122.2. This written policy should encourage and provide an avenue for early communication and collaboration between project sponsors and CPW staff regarding impacts and mitigation strategies. The policy should provide an avenue for early stakeholder engagement regarding the mitigation of impacts.

State Support

The State could provide project support prior to the Final EIS if:

1. The State implements improvements to its involvement in the permitting process as described above;
2. The draft EIS includes a clear alternative with mitigation and enhancement;
3. The State Fish and Wildlife Mitigation Plan is complete; and
4. Analyses associated with water quality indicate that with the suggested alternative, a conditional 401 certification would likely be issued.

Any level of support will be based on a specific alternative, and if the alternative changes, support would need to be reevaluated. Each state agency would provide its recommendations to the Governor's Office, which could communicate to the appropriate federal agency that the State supports or does not support a particular water project. Such support will not require additional justification beyond already accepted state processes – the State Fish and Wildlife Mitigation Plan, 401 certification, and an integrated water resource plan. However, to the extent the project addresses the criteria described above, they will be included in communications to the Governor's Office. The State support described herein encourages early stakeholder engagement so that comments and concerns are addressed at the front-end of the process.

Quicker Regulatory Process

State support also encourages federal agencies to allocate the appropriate resources needed to complete the final EIS and ROD in a timely manner. The federal prioritization of resources is not intended to circumvent the protections or transparent processes associated with federal permitting processes.

ACTIONS

One of the main goals of Colorado's Water Plan is to find ways to support the implementation of the BIPs. The above permitting process enhancements support the statutory and regulatory requirements of each permitting agency without predetermining outcomes. While a particular agency permitting decision could be "yes" or "no," a more efficient means to reach that decision benefits all project participants, stakeholders, and the State's planning process.

The actions below help determine efficiencies, where possible, and increase coordination. These actions will also provide an incentive that encourages multi-purpose projects with many partners, especially for projects that meet Colorado's water values, such as enhanced conservation and efficiencies. In addition to Colorado's Water Plan, the state and federal permitting partners will develop a handbook detailing the status quo and an updated joint review process. The following actions are needed to support these efforts:

1. The CWCB will host a series of lean events with relevant permitting agencies and stakeholders to examine current processes and determine how to make them more efficient and effective. Specifically, the lean events will examine how to eliminate redundant review efforts, reduce duplication of technical methods, and increase clarity on the required technical elements, as well as coordinate assessment methodology.

2. In partnership with local, state, and federal agencies, the DNR will coordinate the development of a permitting, certification, and mitigation handbook to reflect the updated permitting process.

3. State agencies with permitting authority will

actively participate as cooperating agencies from the outset of the regulatory process, and will encourage parallel processes.

4. Where more than one agency has jurisdiction over a particular issue, the agencies will work together to identify a lead state agency, and a memorandum of understanding will be agreed to by both agencies to assist in the coordination.
5. The State of Colorado will explore options for adding CDPHE and DNR staff and other resources to support a more efficient and effective permitting process.
6. State and federal partners will work together to encourage cooperation through the CAWS MOU process, which factors in conservation as a demand-reducer.
7. State agencies with permitting authority will work with local governments and stakeholders to determine how Colorado will express support for or rejection of a project at the appropriate time during the review process in order to encourage the completion of the federal permit process in a timely manner.
8. In order to encourage stakeholder work prior to a project proponent applying for a federal permit, CWCB will serve as or fund an impartial facilitator between stakeholders as part of pre-application work when requested by a project proponent.
9. The State will coordinate with federal partners to determine if there are opportunities to improve the federal permitting process that stem out of the BIPs or efficiencies identified by the lean process.

TABLE 9.4-3 SUMMARY OF THE IBCC NO-AND-LOW-REGRETS ACTION PLAN AND THE BIP COMMENTS ON PERMITTING[80]

IBCC & Basin Roundtables	Challenges	Solutions
IBCC No-and- Low-Regrets Action Plan	"Needs assessment work conducted as part of the SWSI determined that every basin in Colorado will have a gap in water supply by 2050… Expedited permitting processes for IPPs that are in line with the values of the CWP will ensure that important projects move forward in a timely manner."	As part of the No-and-Low-Regrets Action Plan, the IBCC considered several potential actions in relation to permitting: "Streamline state permitting processes for IPPs that meet values of the CWP: The Executive Order directs the CWP to help expedite permitting at the state level. The State should develop an approach to permitting IPPs that efficiently moves projects through the process and toward an outcome, whether positive or not, while ensuring sufficient protection of nonconsumptive and other values. Public engagement and community outreach regarding water supply needs may need to increase in affected communities to facilitate an efficient permitting process." "Continue state coordination with the federal permitting entities: The State should continue to meet with federal agencies and look for opportunities, including entering into MOUs, to make NEPA and permitting processes more efficient, especially for projects that meet the values of the CWP and are needed across multiple scenarios. Efficiency would not dictate whether the outcome of the positive is positive or not." "Support local permitting authorities to identify, as requested, multi-purpose components up front in a project planning to incorporate county and local concerns." "Upon request of a project proponent, encourage legislative resolutions in support of IPPs that meet the values of the CWP: the CWCB and the IBCC should work with the Legislature to develop and pass resolutions in support of specific IPPs that meet the goals and values of the CWP and have demonstrated broad stakeholder support. However, legislative resolutions supporting specific IPPs should not occur until the project 1) aligns with the goals of the CWP, 2) has broad stakeholder support, and 3) has substantively completed the state permitting process. These resolutions can be simple statements of support or more complex efforts to help specific projects through the permitting process, but they should not seek to override or supplant local decision-making or the protection of nonconsumptive or other values." "Publicly advocate for IPPs that meet the values of the CWP and have stakeholder support: the CWCB, members of the IBCC and the basin roundtables, and the Governor should actively and publicly advocate for IPPs that meet the values of the CWP and have demonstrated broad stakeholder support. However, public advocacy for specific IPPs should not occur until the project 1) aligns with the goals of the CWP, 2) has broad stakeholder support, and 3) has substantively completed the state permitting process. This advocacy should seek to convince decision-makers at all levels and the general public that permitting and implementing these IPPs is critical to meeting Colorado's water supply needs while maintaining our agricultural heritage, healthy environment, and recreational economies." "Water providers that meet a certain threshold of conservation savings or best practices implementation could be offered state support and/or the facilitation of certain permitting approvals."
Arkansas BIP	"Significant challenges exist to achieving the storage goals of the Arkansas Basin, including government permitting, regulation, competing stakeholder interests, and reluctance of storage site owners to take on further responsibility."	No permitting solutions mentioned.

Colorado BIP	"Regulatory restrictions, high costs and variable geologic conditions have prevented proceeding with these conditional storage rights." "Water providers must recognize the change in permitting that has occurred and that has resulted in the lengthy and costly regulatory requirements for reservoirs. Rather than undertake this risk with no assurances of approval, water providers should consider other alternatives."	"This BIP recommends that State, Federal and Local regulatory jurisdictions work collaboratively to improve the permitting process." "Improvements to the permitting process to support new water supply projects are imperative in securing safe drinking water in the future." "Secure 401 certification for specific places prior to a ROD by the Corps, through a coordinated permitting process that includes all permitting agencies, including local government." Measurable Outcome: "Reduced average permitting time for reservoir project to under 10 years." "Improve inefficiencies in reservoir permitting process between federal agencies and promote revisions and BMPs to improve process timeline and cost." "Further research needs to be conducted that will evaluate the reservoir permitting process and provide recommendations on improvements."
Gunnison BIP	Several of the project sheets list permitting as a constraint and challenge. In these cases, the text typically reads: "Issues limiting project implementation may include: Regulations – permitting requirements may limit construction activities and potentially increase cost and timing."	"Due to the numerous benefits to future water resource projects, the Gunnison Basin Roundtable recommends the reinstatement of a process similar to the CJRP or Colorado Coordination Council." In Strategies to address regulations, the following bullet points are included to streamline permitting or develop collaborative solutions: • Collaborate with the CWCB to identify technical support mechanisms for Federal permitting activities • Identify methods to proactively address potential regulatory pitfalls that generate excessive time delays and added costs • Identify methods to streamline regulatory processes between multiple agencies with proactive, time-dependent deadlines • Collaborate with the CWCB to identify financial support mechanisms for Federal permitting activities "Better management tools will optimize projects to meet multiple needs, minimize cost, and protect public health and safety. An example of this is the Extreme Precipitation Analysis Tool (EPAT). Reservoir storage restrictions currently cost the state some 74,000 acre-feet in lost storage opportunities. An updated EPAT would provide cost savings by minimizing necessary dam spillway sizes and would streamline the permitting process."
North Platte BIP	Regulations can be a constraint to securing acceptance of a project. Since a large amount of the land in the North Platte Basin is under federal ownership, permitting issues can impact project feasibility, cost, and schedule.... Regulatory bureaucracy and environmental impact requirements may significantly delay project timelines, increase costs and ultimately limit the ability of a project sponsor to implement a proposed project, regardless of the relative size of project scope. Regulatory streamlining and cooperative strategies may help address regulatory constraints."	In Strategies to address regulations, the following bullet points are included to streamline permitting or develop collaborative solutions: • Collaborate with the CWCB to identify technical support mechanisms for Federal permitting activities. • Identify methods to proactively address potential regulatory pitfalls that generate excessive time delays and added costs. • Identify methods to streamline regulatory processes between multiple agencies with proactive, time-dependent deadlines. • Collaborate with the CWCB to identify financial support mechanisms for Federal permitting activities.
Rio Grande BIP	No permitting challenges mentioned.	No permitting solutions mentioned.

South Platte and Metro BIP	"In order to be developed, water supply, infrastructure, and treatment projects must go through a myriad of federal, state and local permitting processes which are both time and resource intensive. Improving the efficiency of current federal and state permitting requirements has the potential to save the public money while providing the same assurance of quality and due diligence. The Executive Order cites this issue and calls for the identification of potential areas of improvement in CWP. The intent is not to reduce existing environmental protections but to obtain permitting decisions in a more timely and cost effective manner with a more predictable process for federal and state engagement."	"The State of Colorado could support a more efficient EIS process for water supply projects.... Greater efficiency, cooperation, predictability, and consistency in the permitting process could be achieved by establishing guidelines for what the lead federal agency and all state and federal agencies involved in the process require for approval. Efficiency and predictability of the permitting process could be further enhanced by the State compiling agreed upon ranges, tools, and methodologies for assessing contentious topics such as hydrology modeling, system risk, conservation as a demand reducer, and others." "To increase the efficiency, consistency, and predictability of the EIS process, the State could work cooperatively with Federal agencies to develop a Programmatic EIS. Colorado's Water Plan could be used as the platform for a Programmatic EIS. Under a Programmatic EIS, no specific projects are approved, but it would create an analysis from which future specific approvals can rely." "Starting in 2010, the Corps, the DNR including the CWCB, and the US EPA embarked upon a process called CAWS. The major outcome of CAWS was an informal agreement among the three parties that conservation should be used as a demand reducer in analyzing the purpose and need for a project rather than during the alternatives analysis portion of the NEPA process. Though this informal agreement was not publicly documented, an important policy tool going forward could be the use of conservation as a demand reducer in the purpose and need segment of the EIS process. By doing this, water providers will have greater incentive to implement proactive conservation strategies to demonstrate decreased demand and strain on existing resources." "Scoping for 404 or NEPA permitting must follow federally required processes. Delays often result when new areas of analysis are identified late in the permitting process after scoping has occurred. By ensuring that regulating agency concerns are addressed in their entirety during the scoping process, applicants can more accurately plan for the costs associated with the analysis and avoid delays." "The State of Colorado could encourage the Corps and EPA Region 8 to revise their 1990 MOA on sequencing. Their current MOA says that the Corps must determine the Least Environmentally Damaging Practicable Alternative (LEDPA) first and then look at compensatory mitigation to authorize the LEDPA. A revision would enable public works projects to use compensatory mitigation in the identification of the LEDPA. This revision could be limited to public works projects." "The State of Colorado's requirement for 401 certification and an approved Wildlife Mitigation Process could be improved to provide project proponents greater certainty in project planning. Earlier starts for these approval processes could effectively utilize information from the Federal Process to save project proponents and the citizens of Colorado time and money while allowing for greater certainty of project implementation."
Southwest BIP	Permitting is mentioned as a constraint associated with Southwest Basin measurable outcomes.	No permitting solutions mentioned.
Yampa/ White/Green BIP	No permitting challenges mentioned.	"Develop methods to assist with streamlining permitting in a cost-effective manner." "Success in permitting and constructing in-basin storage projects."

9.5 OUTREACH, EDUCATION AND PUBLIC ENGAGEMENT

GOAL

Colorado's Water Plan provides technical and financial assistance for high-quality, balanced, and grassroots water education and outreach efforts that inform Coloradans about the issues so that they may engage in determining Colorado's water future.

To achieve a sustainable water future, Coloradans must be sophisticated water users. Colorado's Water Plan expands outreach and education efforts that engage the public and promote well-informed community discourse regarding balanced water solutions. The plan addresses a number of topics that benefit water consumers, including increased conservation, reuse, preservation and enhancement of the natural environment, multi-purpose water projects, and other efforts to meet our state's future water supply gap. Section 9.5 focuses on the extensive work that occurred to help educate and engage over 30,000 local stakeholders and the public in the formation of BIPs and Colorado's Water Plan. Moreover, this section charts a path to expand this work in the future.

Coloradans are paying more attention to water issues today, and are becoming increasingly aware of the limitations of Colorado's water supply. In a recent survey, more than two-thirds of those polled believe that Colorado does not have enough water for the next 40 years.[81] Despite concerns, most Coloradans are unaware of the main uses of water in the state, and are uncertain about how to best meet our state's future water needs.[82]

Outreach creates public awareness of policies and processes, whereas **education** promotes a deeper understanding of these topics. Both are prerequisites to **public engagement.**

Natural disasters—including more than a decade of systemic drought, catastrophic wildfires in 2012 and 2013, and flooding on the Front Range in 2013—have increased the public's sense of urgency and its desire to get involved in water issues. Outreach, education, and public engagement help ensure that Coloradans have access to accurate information and are empowered to participate in stakeholder decision-making processes.

The development of Colorado's Water Plan is a unique opportunity to build on past efforts. In conjunction with the CWCB's recent statewide outreach and education, over the past 10 years, the nine basin roundtables held more than 1,000 meetings to engage the public, and each roundtable held additional public meetings as it developed its BIP. Additionally, many water providers, watershed groups, schools, districts, and authorities offer many ongoing water education activities. Currently, several nonprofits are solely dedicated to water education, and water providers are working with school districts to engage younger generations in smart water use. This section of Colorado's Water Plan offers recommendations and strategies designed to continue to advance these outreach, education, and public engagement efforts and enhance the overall water supply planning process.

Overview of Outreach, Education, and Public Engagement

Colorado has a long history of water education. As early as the 1800s, explorers on the Pike Expedition and the Long Expedition shared their experiences in the Colorado region and warned westward settlers of the limited water supply.[83] Following John Wesley Powell's historic 1869 journey down the Colorado River, Powell brought his concerns about water supply "west of the hundredth meridian" to Congress.[84] Now, more than 150 years later, water education is evolving to meet the needs of a population whose direct interactions with water resources and supply are very different than in the past.

Previous and Ongoing Efforts and Research

In 2002, the General Assembly created the Colorado Foundation for Water Education (CFWE) to promote a better understanding of Colorado's water resources and issues. The CFWE is a nonpartisan, nonprofit organization that provides, "basic water information and educational programming, but also enhances leadership among water professionals, creates networking opportunities, helps advance the water planning dialogue in the state, and reaches out to those who aren't already involved in the world of Colorado water."[85]

The Public Education, Participation, and Outreach (PEPO) Workgroup was established in 2005 through the *Colorado Water for the 21st Century Act* to support the IBCC process. The PEPO Workgroup, comprising IBCC representatives, education liaisons from each basin roundtable, and other key stakeholders in the water education community, operates by basin. It informs, involves, and educates the public about the activities and negotiations of the IBCC and basin roundtables.[86] In addition, the workgroup is tasked with creating a mechanism for providing public input to IBCC and roundtable members. With the CWCB's direction and funding, the CFWE facilitated the PEPO Workgroup from 2008 to 2015. In July 2015, the CWCB started managing the PEPO Workgroup directly.

Led and funded by the CWCB, several PEPO Workgroup members and the Colorado Watershed Network joined forces with the Colorado Alliance for Environmental Education and other water outreach specialists in 2008 to form a group called the Water Education Task Force. The task force sought to better understand the status of water education in Colorado, and published a report containing recommendations for improvements in water education in Colorado. These recommendations include:

1. Support a statewide public education initiative.
2. Develop information and communication tools that can be used statewide.
3. Establish long-term funding for intrastate and interstate collaboration opportunities.
4. Coordinate efforts across state agencies.
5. Increase coordination with the Colorado Department of Education on K-12 water resource content.[87]

MARSHA DAUGHENBAUGH

YAMPA/WHITE/GREEN RIVER BASIN

Marsha is the Executive Director of the Community Agricultural Alliance and plays a critical role in coordinating the education and outreach efforts of the Yampa-White-Green Basin Roundtable. Marsha is pictured with horses on her ranch.

I hope there will be enough water supply for the future! Conservation and efficient use of water are mandatory. Understanding the future is everyone's responsibility. We can no longer allow ourselves the luxury of wasting either our water or our time. The process leading to the development of Colorado's Water Plan has been phenomenal and I have great respect for everyone involved. The discussions have not always been easy but they are necessary that agriculture will be respected and revered for...

CONTINUED AT END OF CHAPTER

PROFILE

A Community Soil Health Tour in the Rio Grande Basin, Brendon Rockey presenting. Courtesy of Rio de la Vista.

The CFWE assumed management of the Water Education Task Force following publication of the report in 2008. It established a partnership workshop that implemented several recommendations through the Colorado Water 2012 campaign, which celebrated water—past, present, and future. The Colorado Water 2012 campaign leveraged hundreds of passionate volunteers, nonprofits, and other organizations to raise awareness about water, increase support for the management and protection of Colorado's water, showcase exemplary models of cooperation and collaboration, connect Coloradans to their water, and motivate them to participate in planning the future of their water resources.[88] The group commented on the Colorado Department of Education's revision of state content standards, developed a teacher training program, and set the stage for the Value of Water project, which the CWCB commissioned. That project consisted of a statewide survey and report of public opinions, attitudes, and awareness regarding water in Colorado.[89]

Numerous efforts are addressing public engagement in Colorado's water supply issues; below are just a few examples. As the CWCB finalized Colorado's Water Plan and as the plan is implemented, the groups listed below (in addition to other groups not included here), have served or will serve as critical resources in implementing the outreach, education, and public engagement actions the plan identifies.

State Agencies: Many Colorado state agencies conduct water education. These agencies also offer funding for outreach and education efforts, and have developed their own programs.

- The WQCD, an agency of the CDPHE, funds outreach efforts to improve water quality through Section 319 of the Clean Water Act of 1972.
- CPW has many education programs that focus on engaging youth in water issues. The agency funds the Colorado River Watch program in partnership with the Colorado Watershed Assembly, which supports student volunteers who collect data on water quality and watershed health throughout the state.[90] CPW also supports Project WILD, which engages students in environmental education and conservation.[91]
- The CWCB funds and coordinates stakeholder outreach through the basin roundtable process. The CWCB provides education funding through the WEGP for water conservation projects and the WSRA grant program, and also helps to fund the CFWE. In 2013, the CWCB hired an outreach, education, and public engagement specialist to manage these efforts.

Statewide NGOs: Several nonprofit organizations with a statewide reach have water education programs. These groups have specific target audiences and distinct objectives related to water supply planning. These objectives are that:

- The CFWE is a source of balanced water education for all Coloradans.
- The Colorado Water Congress provides leadership on key water resource issues and is the principal voice of Colorado's water community.
- The Colorado Watershed Assembly collaborates with diverse stakeholders to protect and improve the conservation values of land, water, and other natural resources of Colorado's watersheds.
- The Colorado WaterWise Council provides resources to stakeholders in the water efficiency and conservation community.
- The Colorado Foundation for Agriculture provides Colorado educators with current information about state agriculture and natural resources.
- Many membership-based environmental and recreational NGOs, such as Conservation Colorado, Trout Unlimited, Audubon Society, The Nature Conservancy, and Western Resource Advocates provide outreach and education to their members on many environmental issues. (This list is not fully inclusive.)

Universities: Several institutions of higher education are actively involved in water supply planning, research, dialogue, and education.

- The Colorado Water Institute and the Colorado Climate Center at Colorado State University, Western State Colorado University, the One World One Water Center at Metropolitan State University of Denver, and the Water Center at Colorado Mesa University are all engaging students, faculty, and the greater community in water issues.
- The Water Center at Colorado Mesa University assisted the Colorado and Gunnison Basin Roundtables in outreach and educational efforts.

Regional and Local: Many of Colorado's conservancy and conservation districts, water providers, and water utilities operate public outreach and education programs to inform and educate a variety of audiences—including customers, news media, and elected officials—about water supplies, conservation, drought, regulations, rebates, watershed protection, capital improvement projects, water quality testing, and many other important local issues.

- Denver Water has developed a successful water conservation and public education program that encourages reduction in daily water use through behavior change and permanent-fixture and landscape retrofits. Denver Water uses community-based social marketing and media in addition to more traditional campaign methods such as advertising.
- Colorado Springs Utilities currently reaches over 5,000 adults through xeriscape classes, water system tours, business partnerships, and landscape efficiency training programs.
- The City of Grand Junction, Ute Water Conservancy District, and Clifton Water District collaboratively run a conservation-based outreach program known as the Drought Response Information Project. This project helps water providers conduct public outreach and education activities about drought and the Drought Response Plan.
- The Rio Grande Watershed Conservation and Education Initiative provides conservation education to the San Luis Valley community to promote stewardship of natural resources.
- The Roaring Fork Conservancy brings people together to protect rivers through watershed action and education in their respective areas of the Colorado River Basin.
- The Water Information Program is sponsored by water districts and agencies in the Dolores/San Juan River Basin and provides general information to the public on water topics. The Water Information Program assisted the Southwest Basin Roundtable in educating the region about local and statewide water issues, and is the longest-standing program of its kind.

- The Rio Grande Watershed Conservation and Education Initiative assisted the Rio Grande Basin roundtable in its engagement efforts, in addition to many other education programs.
- Aurora Water's Water Conservation Program offers its customers web-based instructional material and in-person classes in xeriscape landscaping, irrigation systems, landscape maintenance, alternatives to turf grass, and vegetable gardening.
- The Community Agriculture Alliance, a nonprofit organization in Steamboat Springs that promotes agriculture, assisted the Yampa/White/Green Basin Roundtable with public education and outreach on the BIP throughout the basin.

K-12 Education: Water providers across the state administer several K-12 programs. All of these programs use education and outreach to help address specific water supply issues, many of them aimed at educating the public on how to reduce municipal and agricultural water use. Other numerous water conservancy district efforts reach thousands of students each year at children's water festivals and special initiatives within area school districts. Below are a few examples:

- The South Metro Water Supply Authority's Water Ambassador Program trains high school students to teach fifth-graders about watershed health.
- Aurora Water reaches more than 6,000 students per year with K-12 education programs that provide classroom presentations, assemblies, and field trips.
- Boulder and Aurora school districts partner with the USFS to train teachers on water education through the "Forests to Faucets" workshops.
- Project WET (Water Education for Teachers) is a national program that trains Colorado teachers how to educate their students about water. Several local organizations sponsor Project WET trainings throughout Colorado, and the national program has developed curriculum that is specifically applicable to different regions in Colorado.
- Ute Water coordinates the state's largest children's water festival, reaching over 2500 fifth-graders in the Grand Junction area each year.

Funding Outreach, Education, and Public Engagement Activities

FIGURE 9.5-1 CWCB EDUCATION FUNDS USED PER FISCAL YEAR

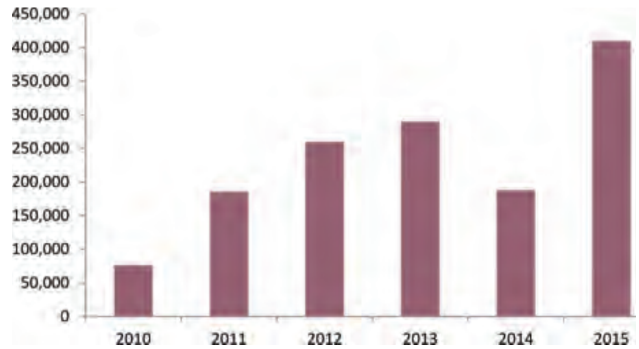


Figure 9.5-1 includes the total amount of CWCB funds allocated for education, including PEPO funds, education action plan funds, WSRA funds for educational projects (not including BIP contract funds), WEGP Public Education and Outreach Grants, and annual funds given to the CFWE. The chart does not include outreach and education funds consultants use for BIPs.

Despite the immense efforts of various organizations, projects, and partnerships, existing programs need to improve coordination to maximize their effectiveness. Collaboration creates new opportunities for water education, outreach, and public engagement activities to reach new and diverse audience groups statewide. Moreover, there is a need to reassess existing statewide programs that focus on water supply requirements and solutions. To address these needs, the Water Plan builds upon efforts such as the Colorado WaterWise Education Toolkit, the Colorado Watershed Assembly Network, and the CFWE's ongoing Water Educator Network. Additionally, a collaborative working group, led by CWCB, should update the 2008 Water Education Task Force Report recommendations in the near future; this will allow the community to determine which unmet needs exist and identify the most effective strategies to address them.

The Funding Gap

During the development of Colorado's Water Plan and the BIPs, it became clear that the $2,000 in funding available to each roundtable could not fully support and sustain educational programs. To meet each basin's unique outreach and education goals, the roundtables leveraged a creative mix of resources, including WSRA grants and work performed by their consultants. The basins also relied on partnerships with the CWCB, the PEPO education liaisons, the roundtable education committees, and the BIP consultant teams to plan and execute public engagement. Figure 9.5-1 illustrates CWCB funds allocated to education and outreach through the PEPO Workgroup, the basin education action plans, the WEGP Public Education and Outreach grants, the annual allocation from CWCB to CFWE, and related WSRA grants.

State funding for the roundtables is not sufficient for the level of outreach roundtables need in order to succeed. On average, costs for outreach activities have amounted to between $15,000 and $50,000 per roundtable over the past year—and most roundtables have indicated that given their level of current BIP outreach, this amount is insufficient. The Rio Grande Basin Roundtable spent an additional $40,000 on outreach beyond what was originally planned in 2014, and estimated that with increased funding, it could spend at least an additional $10,000 for activities outlined in its 2015 education action plan alone.[92] Without securing this additional funding from state and local sources, implementation of the long-range education action plan activities may not occur, and education and outreach cannot sustainably rely on a dedicated volunteer base alone—although using a volunteer base has been the approach of many basin roundtables over the past five years. For example, volunteers organized and ran all 17 of the Arkansas Basin Roundtable's outreach meetings.[93] Impressively, despite insufficient funds, each roundtable increased its outreach activities.

In the future, the roundtables may struggle to maintain these levels of outreach due to a few factors. First, they will not likely be able to rely on assistance from the BIP consultants. Additionally, WSRA funds were not intended to fund many types of educational projects, and several restrictions are placed on the types of educational programs that are eligible. Therefore, despite the prevalence of planned programming related to outreach, education, and public engagement, many potential projects do not have sufficient funding support to move forward.

Furthermore, the Water Education Task Force report stated that the annual amount of revenue for water education across the state was $7.3 million, and survey respondents indicated that $1.6 million of that amount came from state sources.[94] Respondents cited monetary and time limitations as the largest barriers to implementing education programs; more than half of the water education providers surveyed indicated that they conduct water education for less than $5,000 annually. The report also stated that the reality of limited resources should provide an additional incentive and focus for federal and state funding agencies.[95] Should funding become available, the State should allocate some of it to basin roundtable work, as well as other important efforts.

With completion of the BIPs and Colorado's Water Plan in 2015, it will be imperative that the Colorado water community sustain momentum for outreach and education activities, and that funding for such activities increase as the community implements water supply solutions.

The CWCB's Role in Water Outreach, Education, and Public Engagement

Outreach, education, and public engagement efforts during the development of Colorado's Water Plan were unprecedented and built on a decade of stakeholder involvement. Between September 2013 and September 2015, the CWCB received over 30,000 comments before it released the final plan in December 2015. Because Colorado's Water Plan relies upon stakeholder engagement, it is critical to highlight the education and outreach efforts to date. Appendix F includes a summary of activities completed and input received during development of the plan. As the initiative was a grassroots effort, the appendix also outlines the high level of local and volunteer efforts to involve the public in the process.

Outreach, education, and public engagement related to the State's water supply planning efforts, including Colorado's Water Plan, the BIPs, and SWSI, are ongoing, iterative efforts. The CWCB needs to continue the leadership it demonstrated regarding outreach, education, and public engagement activities during the development of Colorado's Water Plan by continuing to aid in research, coordinate efforts, and provide funding and guidance for water education projects statewide.

The CWCB, the PEPO Workgroup, and the basin roundtables will continue education and outreach activities for Colorado's Water Plan and the BIPs throughout 2015 as implementation begins. In the long term, the partnerships and communication channels these entities have developed over the past several years will be crucial for public outreach and education activities and for soliciting input for balanced solutions. Each BIP articulated long-term goals and strategies for cultivating a supportive and engaged citizenry. These are a few selections from basins across the state:

1. Identify milestones and changes in Colorado's Water Plan and the BIP process that need additional media coverage and public participation.
2. Identify the necessary institutional changes, and the related cultural and economic adaptations in Colorado lifestyle, to address increasing water demands.
3. Ensure a diverse and active basin roundtable membership, and provide communication tools to inform roundtable constituents and enable constituents to deliver meaningful feedback to the roundtables in return.
4. Maintain a steady presence throughout the basin via traditional, online, and social media.
5. Engage respected community leaders to champion the solutions the roundtables set forth in the BIPs.
6. Work closely with organizations that specialize in the facilitation of public education and outreach programs in order to leverage existing resources within each basin and increase overall impact.
7. Enhance coordination and financial support that enable watershed groups and other grassroots organizations to effectively engage the public and increase participation.
8. Develop leadership programs that enable college students to explore water careers through scholarships or training opportunities in water supply planning projects and processes.
9. Establish metrics to evaluate the success and effectiveness of statewide and basin-level communication and education programs, and modify strategies as needed.

The lack of financial support and professional resources is a large barrier to implementing these goals. To maintain the momentum of Colorado's Water Plan beyond 2015, outreach and education projects need a dedicated grant fund for information and communication tools that address Colorado's water challenges. While the basin roundtables serve as key forums to address water supply issues through conversation and planning, the creation of a new fund will open up the opportunity for stakeholders interested in water outreach, education, and public engagement to help move important projects forward.

Through this new fund, and as recommended in the actions set forth at the end of this chapter, the CWCB should work with state, local, and federal partners to develop a water education and outreach strategy. Such a strategy should include, but is not limited to, the topics listed below as they relate to Colorado's Water Plan. The Colorado Water Plan explicitly mentions these topics; however, the CWCB will likely add other topics to the education and outreach strategy as it is developed:

- Colorado's Water Plan.
- Colorado's eight BIPs.
- Colorado's water challenges, solutions, and the need to be adaptable to changing conditions.
- Connection between climate change and water.
- Water conservation and reuse.
- Integration of land use and water supply.
- Water quality ("use a watershed approach for outreach and community engagement").
- Agricultural viability options, ATMs, education for farmers on available incentives for on-farm implementation of agricultural conservation measures, water sharing opportunities, and other tools available to growers.
- Education and outreach to support environmental and watershed strategies, such as those designed to protect imperiled warm-water fish species and forest health.
- Outreach to energy companies to encourage and promote the most water-efficient technologies for energy extraction.

Wetland Landowner Workshop on the Rio Grande. Courtesy of Rio de la Vista.

ACTIONS

Based on the analysis this section presents, the CWCB makes the following recommendations, which will enhance Colorado's water outreach, education, and public engagement and advance the water supply planning process.

1. **Create a new outreach, education, and public engagement grant fund:** As part of the funding package Section 9.2 discusses, the DNR will evaluate a new outreach, education, and public engagement grant fund, which the CWCB would administer through the basin roundtables. Specific attributes of the grant fund could include the following:
    - Similar to WSRA funds, these funds could be available for eligible outreach, education, and public engagement projects that meet specific CWCB-developed criteria and guidelines that align with Colorado's Water Plan goals.
    - The funds could be considered for the proposed outreach, education, and public engagement projects already outlined in the BIPs and each basin roundtable's PEPO Education Action Plan.
    - Guidelines could prioritize grants dedicated to projects that assist the basin roundtables with communication, outreach, and public education efforts related to issues that Colorado's Water Plan or the BIPs addressed.
    - Guidelines could stress the importance of measuring success and targeting specific audiences and approaches, and could include other education and outreach best practices that lead to successful public engagement.
2. **Create a data-based water education plan:** Over the next two years, the CWCB will create a data-based water education plan by:
    - Conducting a survey to update the Water Education Task Force Report, which assessed water education programs across the state.
    - Determining critical gaps in water education, both geographically and topically.
3. **Improve the use of existing state resources:** The CWCB:
    - Will work with stakeholders to identify five water challenges that Colorado's innovation community could help solve, develop an award program, and engage Coloradans in the challenge:
        - Will work with Colorado's innovation community, education and outreach experts, research institutions, and the governor's Colorado Innovation Network (COIN) to address Colorado's water challenges with innovation and "outside the box" creativity.
    - Will incorporate education and outreach components in the WSRA grant criteria and guidelines.
    - Will initiate efforts to improve coordination between state agencies on outreach and education activities. This will include the development of performance metrics and a database to track efforts.
    - Intends to foster continued engagement of the Water Education Task Force and use the network of existing water educators in a coordinated fashion to educate the various and diverse audiences in Colorado.

A LOOK AT HISTORY

Members of the Colorado River Compact Commission are pictured here in 1922 at one of their sessions.
The Commission chairman, Herbert Hoover, is in the center, top row.
Colorado's Delph Carpenter is in the center of the second row, directly below Hoover.

SOURCE: Colorado State University Libraries, Archives and Special Collections,
Water Resources Archive, Carpenter Papers #97.

caption: Thomas V. Cech, J William McDonald, Defened and Develop:
A Brief History of the Colorado Water Conservation Board's First 75 Years,
[Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

HEATHER DUTTON, CONTINUED FROM PAGE 9-11

I grew up in the San Luis Valley, where my family has lived for 5 generations. After college, I was fortunate to get my job working for the Rio Grande Headwaters Restoration Project (RGHRP), improving the Rio Grande in Colorado. I am married to a great guy, Tanner, who works for the US Forest Service and shares my passion for managing natural resources and exploring the Rocky Mountains.

Growing up on a potato and barley farm I, like most people in the San Luis Valley, am rooted in water. In the Valley, our ability to harness and manipulate the natural hydrology and ecosystems is the only reason we can live here. Some of my fondest memories are driving around checking fields with my dad, trying to start siphon tubes with my brothers, skiing with my family, and camping along high mountain creeks during horse and llama pack trips. My parents showed us early on how important water is to both our way of life and weekend recreation. Now, I see the connectivity between the watershed, wildlife, and water users that I didn't understand as a child, but those early experiences were the foundation for my connection for water.

In the same way that we use our surrounding ecosystems to live in this harsh alpine valley in Southern Colorado, we have to respect the local ecology. It has been a privilege to work with members of the community to improve the Rio Grande for the farmers, wildlife, families, and fun lovers that cherish this beautiful area. Every time I help bring together a diverse group of partners to complete a project, big or small, I feel the same satisfaction and pride from being able to make a difference. I hope we can find ways to benefit as many water users as possible in every project. I also hope we can grow the State in a way that protects the very reason it is such a great place to live: water. I am committed to being completely engaged in the projects I am fortunate to be a part of, being respectful of other ideas, and being willing to explore new strategies so we can be very deliberate and thoughtful in the way we use water in the future.

I was photographed at the McDonald Ditch Project. This is a partnership between the McDonald Ditch Company, Natural Resources Conservation Service, and RGHRP. The project includes removing the old, poorly functioning and dangerous diversion dam and building a new, more efficient dam with fish and boat passage, and automated headgates. We also restored a nearby wetland and will restore about 2,000 feet of streambanks. The result will be improved riparian and aquatic habitat, water quality, diversion efficiency, and recreation opportunity. We would not have been able to complete the project without all our wonderful local and state partners, and assistance from NRCS, Rio Grande County, and CWCB - the project was partly funded with a CWCB Water Supply Reserve Account grant and loan. The project will be completed in 2015! This project was one of the top 12 projects identified in the 2001 Study, our restoration master plan for the Rio Grande from South Fork to Alamosa, and it is very exciting to see it come to fruition.

LURLINE UNDERBRINK CURRAN, CONTINUED FROM PAGE 9-36

provides opportunities for all to be heard, and Grand County's efforts provide a success story for how our water resources can be directed for benefit for all.

I was raised in Grand County and have worked for Grand County for 33 years. I have two children, and eight grandchildren, all living in Grand County. I served as the Director for the Planning Department for 17 years and have been County Manager for 15 years. I have a BA from Regis University in Religious Studies and an MA in Psychology. My personal connection to water is being raised where the Colorado, Blue and Muddy rivers come together, recreating on all of them and forming a love for their contributions to my way of life. Professionally, I began my foray into the water world by reviewing the Wolford Mountain Project for Grand County and continuing to work on water matters as they arose over the years. Water is the life blood of Colorado, but especially to Grand County since we are the county in the state most impacted from transmountain diversions. Trying to retain and maintain a way of life that is precious to us has been a struggle and a passion.

My key accomplishments are tied to water. I had the honor of being selected the lead negotiator on the Colorado River Cooperative Agreement and Windy Gap Firming Project by the Board of County Commissioners. They gave me their trust and support. The components of both agreements are complex and extensive. The challenge is implementation. I am currently involved on the Learning by Doing Committee (an adaptive management program established by the Colorado River Cooperative Agreement and the Windy Gap Intergovernmental Agreement), the Windy Gap Bypass effort, Grand Lake Clarity, and the Big Lake Ditch Study. As a founding member of the 1177 Colorado River Basin Roundtable, I have been a part of many efforts, but most importantly Colorado's Water Plan.

I hope that the water future of Grand County will not only be secured, but improved due to our agreements as well as the partnerships and cooperation we have and are continuing to build. These partnerships will grow and strengthen as younger people assume their places and a new way of managing our finite resource will be created that will pay benefits.

One of my fondest wishes is that my grandchildren and great grandchildren will be able to enjoy the experiences and beauty that the mighty Colorado River and its tributaries have provided to me and my children. My grandchildren are river rats and love being on the river. I hope that someday when I am older and more gray, and in the assisted living center here in Kremmling, they will be able to say, "Grandma wasn't as crazy as we thought she was, she was part of a very important process that Grand County championed and defended."

MARSHA DAUGHENBAUGH, CONTINUED FROM PAGE 9-54

our wise handling of water, that water rights will continue to hold a sacred place in Colorado's water plans and that collaborative efforts will strengthen between all water users.

I am part of a five-generation family owned cattle and hay ranch on the Elk River, the largest tributary of the Yampa. I worked with the United States Department of Agriculture Farm Service Agency for 25 years and currently serve on the Colorado Farm Service Agency State Committee. I am the Executive Director of the Community Agricultural Alliance, an organization whose goals are to promote local agriculture, educate about the critical importance of agriculture and develop partnerships throughout the Valley between agriculture and consumer interests. The organization collaborates with the community's resort, recreation, business, and agricultural entities to assure agriculture's longevity throughout the Yampa Valley for future generations.

Our family has water rights from the Elk River dating back to the late 1890's and I understand the critical importance of water availability for crops and livestock for our agricultural long-term sustainability. My professional connection with water started to develop in 2003 when Community Agriculture Alliance began to present water education forums and tours for the Steamboat Springs area. In 2010 CAA became the educational arm for the Yampa-White-Green Round Table. We work with regional partners in Routt, Moffat and Rio Blanco Counties to develop and implement forums and workshops on water related issues important to the specific locale, the basin and the State. Water is important to me because it runs through my veins. My parents taught me early the significance of stewarding our natural resources to assure their longevity. Now I feel I have a responsibility to share my personal experiences, knowledge and beliefs to help others understand why we should protect and conserve our water and land. Agriculture, urban and recreation interests have to work together to maintain the quality and quantity of our resources. My involvement with water education started by chance. My commitment to presenting unbiased, fair information evolved through the years and now my passion is to assure everyone has access to factual information. We can make the right decisions when we know the facts.

My family is an integral part of my life. My husband and I are pleased that both of our adult children returned to our Valley and our ranch after receiving their educations. All of us are active in our community serving on a variety of committees in the Steamboat area because we recognize agriculture must be involved with economic development, recreational opportunities, civic decisions and cultural protection. My activities and accomplishments related to water include that our ranch has been recognized by the Colorado Riparian Association, the Colorado Wildlife Commission, the Colorado Division of Wildlife, the Yampa River Legacy Committee and Environment 2000 for our efforts in soil, water and wildlife management. Professionally I feel good when someone comes to me after we finish a water education event saying they learned something and are glad they attended. Our grandchildren are being raised to appreciate and respect our natural resources through hard work and hard play. Yep, when you live in the Yampa Valley you also get to ski, hike, fish and recreate on a regular basis.

Section 9.1: Protecting Colorado's Compact and Upholding Colorado Water Law

[1] C.R.S. § 37-60-106 (2014)

[2] See Water Court Committee of the Colorado Supreme Court, "Report to the Chief Justice," August 1, 2009; Melinda Kassen, "Symposium: A Critical Analysis of Colorado's Water Right Determination and Administration Act of 1969," University of Denver Water Law Review, 58 Issue 3 (1999).

[3] *Kansas v. Colorado,* 543 U.S. 86 (2004); *Kansas v. Colorado,* 533 U.S. 1 (2001); *Kansas v. Colorado,* 522 U.S. 1073 (1998); *Kansas v. Colorado,* 514 U.S. 673 (1995); *Kansas v. Nebraska and Colorado,* 538 U.S. 720 (2003); *Kansas v. Nebraska and Colorado,* 527 U.S. 1020 (1999); see also, Kansas v. Nebraska and Colorado, No. 126 Orig., Report of the Special Master (November 15, 2013).

4 *Wyoming v. Colorado,* 259 U.S. 419 (1922), vacated on joint motion by parties, 353 U.S. 953 (1937); *Kansas v. Colorado,* 206 U.S. 46 (1907); *Kansas v. Colorado,* 185 U.S. 125 (1902).

[5] CRS § 37-60-121 (2014).

[6] CRS § 37-60-121.

Section 9.2: Economics and Funding

[7] Office of the Governor, *Governor Hickenlooper's Budget Request for FY 2015-16* (Denver, 2015), 30, https://docs.google.com/a/state.co.us/file/d/0B0TNL0CtD9wXZ1JoTU8wZ0wxWlU/edit

[8] Colorado Water Conservation Board, Statewide Water Supply Initiative 2010 (Denver, 2011), 7-29, http://cwcb.state.co.us/water-management/water-supply-planning/Documents/SWSI2010/SWSI2010.pdf

[9] Chris Sturm, Personal Communication, Colorado Water Conservation Board, 2014.

[10] Chris Sturm, Personal Communication, Colorado Water Conservation Board, 2014.

[11] Taryn Finnessey, Personal Communication, Colorado Water Conservation Board, 2014.

[12] W. Michael Hanemann, "The economic conception of water." July, 2005. (*In Water Crisis: Myth or Reality?* ed. by Peter P. Rogers, M. Ramon Llamas, and Luis Martinez-Cortina. London: New York: Taylor & Francis, 2006, p.61-91), section 3.4.

[13] Lewis Solomon, *American Water and Waste Water Crisis, The Role of Private Enterprise,* (Piscataway, NJ: Transaction Publishers, 2011).

[14] "Colorado Quick Facts from the US Census Bureau" accessed November 2014, http://quickfacts.census.gov/qfd/states/08000.html

[15] "2014 Water Infrastructure Needs," Water Information Network of Colorado, December 15, 2015, http://wincolorado.org/webmap/

[16] Colorado House Bill 14-1333 (2014).

[17] C.R.S. § 37-60-121.

[18] Colorado Water Conservation Board, *Annual Financial Compilation Report (2014).*

[19] C.R.S. § 39-29-109.

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Critical Action Plan

10

This chapter further describes each of Colorado's water values, and sets forth the measurable objectives, goals, and critical actions needed to ensure that Colorado can maintain these values into the future. We define each of these terms on page 10-3. The high-impact actions included in Chapter 10 were culled from a broader set of actions found throughout the plan, and are also summarized in Appendix H.

Birds take flight over the Yampa River near Steamboat Springs, on the Daughenbaugh Ranch. Photo: M. Nager.

10.1

COLORADO'S WATER VALUES

Colorado's water values drive Colorado's Water Plan toward:

- A productive economy that supports vibrant and sustainable cities; viable and productive agriculture; and a robust skiing, recreation, and tourism industry;
- Efficient and effective water infrastructure; and
- A strong environment that includes healthy watersheds, rivers, streams, and wildlife.[1]

These values shape the measurable objectives, goals, and actions of each section in the plan.

1. **Colorado's Water Plan values a productive economy that supports vibrant and sustainable cities; viable and productive agriculture; and a robust skiing, recreation, and tourism industry:** Colorado will continue to face natural stressors such as deep droughts, destructive wildfires, and catastrophic floods. The best science available indicates that these conditions will only get worse with climate change. Past events in Colorado, as well as recent droughts in California and Texas, serve as important warnings that these challenges harm Colorado's economy and way of life. As Colorado's economy continues to grow with the influx of new residents and industry, water planning for the future must reflect careful deliberation and a balance of the many municipal, industrial, recreational, environmental, and agricultural uses throughout the state. Critical actions must recognize the value of water to Colorado's economy, and identify options for maintaining a viable agricultural industry. Coloradans at all levels—individually, locally, regionally, and statewide—must prepare to respond to these inevitable natural pressures so that Colorado can continue to flourish.
2. **Colorado's Water Plan values efficient and effective water infrastructure:** As Colorado prepares for the uncertainties of hydrology, Coloradans must also contend with the growing and changing needs of our communities, farms, and ranches. Colorado is one of the fastest growing states in the country, and the growth of cities could result in the significant loss of agriculture if we continue on our current path. Innovative solutions and additional conservation and efficiency measures are needed to stretch Colorado's water supplies and maintain aging reservoirs, canals, and distribution systems. Updated water systems will need to address multiple needs, partners, and benefits. Colorado's Water Plan uses a grassroots approach to formulate projects and methods to close water gaps with more agile, informed, and responsible water management.

TABLE 10.1-1 TERMS AND DEFINITIONS

Terms	Definitions
Value	An overarching tenet that guides how Colorado's Water Plan will work to shape Colorado's water future.
Measurable objective	A result or benchmark expected to be achieved from the implementation of Colorado's Water Plan.
Goal	A purpose toward which Colorado's Water Plan is directed.
Action	A necessary step to achieve the measurable objectives and goals, and ultimately to maintain Colorado's water values.

By doing so, Colorado will achieve its long-term goal of meeting municipal, industrial, agricultural, environmental, and recreational needs in a balanced manner.

3. **Colorado's Water Plan values a strong environment that includes healthy watersheds, rivers, streams, and wildlife:** Colorado's identity includes our grand snowy mountains, sweeping rivers, majestic valleys—and access to all of this raw beauty. Underlying Colorado's natural splendor are populations and communities of fish, birds, amphibians, and wetland plants. Colorado is home to endangered and imperiled species along with exemplary pristine ecosystems. Our brand requires that we protect and restore Colorado's natural environment with the most effective tools available. A resilient natural environment is the long-term goal of the critical actions that address this value and our overall brand.

10.2

MEASURABLE OBJECTIVES AND ADAPTIVE MANAGEMENT

Colorado's Water Plan is a living document. The plan and the supporting work of the BIPs and the SWSI will be updated periodically to respond to our State's changing conditions and improved information. Part of this work will require measuring success for each action and adapting over time. Future iterations of Colorado's Water Plan will evaluate progress made, and identify or refine future actions.

Colorado's Water Plan and its measurable objectives will be updated as values, conditions, or data warrant. The CWCB proposes a cyclical planning schedule that recognizes the dynamic nature of Colorado's Water Plan, as described in Chapter 11.

The plan defends Colorado's compact entitlements, improves regulatory processes, and explores financial incentives—all while honoring Colorado's water values and ensuring that water, the State's most valuable natural resource, is protected and available for generations to come. To that end, the plan's success will be measured by whether the following measurable objectives are achieved through implementation of the following actions:

A. **Supply-Demand Gap:** Colorado's Water Plan sets a measurable objective of reducing the projected 2050 municipal and industrial gap from as much as 560,000 acre-feet to zero acre-feet by 2030.

The success of Colorado's Water Plan will ultimately be measured by whether or not the municipal water supply-and-demand gap is closed, and the choices we make to close it. With increased efforts on conservation, storage, land use, alternative transfer methods, and reuse, Colorado can close its gap, balance its water values, and address the effects of climate change on water resources.

B. **Conservation:** Colorado's Water Plan sets a measurable objective to achieve 400,000 acre-feet of municipal and industrial water conservation by 2050.

Colorado must address projected gaps between future water needs and available water provisions from both the supply side and the demand side. Every acre-foot of conserved water used to meet new demands is an acre-foot of water that does not need to come from existing uses.

C. **Land Use:** Colorado's Water Plan sets a measurable objective that by 2025, 75 percent of Coloradans will live in communities that have incorporated water-saving actions into land-use planning.

In order to reduce the amount of water needed for future generations of Coloradans and keep urban-adjacent agricultural lands in production, Colorado must support the growth of the next 5 million residents more strategically than the last 5 million. Colorado's Water Plan calls for a partnership among local water providers and Colorado's communities. This partnership aims to incorporate water-saving actions into local land-use planning. The CWCB will work with the Department of Local Affairs, local governments, water providers, Colorado Counties Inc., Colorado Municipal League, the Special District Association, councils of governments, and homebuilders (Colorado Association of Homebuilders) to examine and strengthen the tools they collectively possess to help Colorado reach this objective.

D. Agriculture: Colorado's Water Plan sets an objective that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production. To achieve this objective, the State will work closely with the agricultural community, in the same collaborative manner that has produced agricultural transfer pilot projects, to share at least 50,000 acre-feet of agricultural water using voluntary alternative transfer methods by 2030.

Without a water plan, Colorado could lose up to 700,000 more acres of irrigated agricultural lands—that equals 20 percent of irrigated agricultural lands statewide and nearly 35 percent in Colorado's most productive basin, the South Platte. While the right to buy or sell water rights must not be infringed upon, Colorado's Water Plan describes market-competitive options to typical "buy-and-dry" transactions. Such alternative transfer methods can keep agriculturally dependent communities whole and continue agricultural production in most years, and if such arrangements can be made more permanent in nature, they will provide certainty to both municipal water providers and agricultural producers. Options include lease-fallowing agreements, deficit irrigation, water banking, interruptible supply agreements, rotational fallowing, water conservation programs, and water cooperatives. The State will encourage innovation and creativity by agricultural producers and research institutions to maximize the productivity of every drop of water.

E. Storage: Colorado's Water Plan sets a measurable objective of attaining 400,000 acre-feet of water storage in order to manage and share conserved water and the yield of IPPs by 2050. This objective equates to an 80 percent success rate for these planned projects.

As the State conserves, Colorado must also develop additional storage to meet growing needs and face the changing climate. Tomorrow's storage projects will increase the capacity of existing reservoirs, address a diverse set of needs, and involve more partners. New storage projects will be increasingly innovative, and will rely on technologies such

VICKI PHELPS

SOUTHWEST RIVER BASIN

Vicki is the co-director of the Telluride Institute's Watershed Education Program, and her life and work are driven by her passion for the kids and future generations. Vicki and students are pictured in front of a pond off the San Miguel River near Placerville.

I want to see communities take charge of their water use and make a committed effort to conserve this precious resource. Colorado's Water Plan addresses critical issues as to the future of healthy watersheds, intact ecosystems and adequate water for human needs.

I feel fortunate to have grown up with the outdoors as my playground. With experiences such as camping, hiking, backpacking, kayaking, climbing, gardening, studying nature, creating nature-inspired art and photography, I have become passionate about understanding and preserving natural environments...

CONTINUED AT END OF CHAPTER

PROFILE

as aquifer storage and recharge. In addition, water managers will need to be more agile in responding to changing conditions, so that storage can be more rapidly added to Colorado's water portfolio. To do this, Colorado will address the broken permitting system.

F. Watershed Health, Environment, and Recreation: Colorado's Water Plan sets a measurable objective to cover 80 percent of the locally prioritized lists of rivers with stream management plans, and 80 percent of critical watersheds with watershed protection plans, all by 2030.

The environment and recreation are too critical to Colorado's brand not to have robust objectives; a strong Colorado environment is critical to the economy and way of life. In addition, the WQCC identified a strategic water quality objective to have fully supported classified uses—which may include drinking water, agriculture, recreation, aquatic life, and wetlands—of all of Colorado's waters by 2050.

G. Funding: Colorado's Water Plan sets an objective to sustainably fund its implementation. In order to support this objective, the State will investigate options to raise additional revenue in the amount of $100 million annually ($3 billion by 2050) starting in 2020. Such funds could establish a repayment guarantee fund and green bond program focused on funding environmental and recreational projects. In addition, such funds could further support conservation, agricultural viability, alternative transfer methods, education and outreach, and other plan implementation priorities.

Colorado faces challenging fiscal conditions, not only for water infrastructure, but most other parts of the State budget. In order to address the water infrastructure fiscal need, the CWCB will explore creation of a repayment guarantee fund and green bond program with an initial investment of $50 million from the Severance Tax Perpetual Fund. A repayment guarantee fund could assist water providers in securing financing for regional multi-partner and multi-purpose projects by backing bonds so that all the partners can achieve financing. Issuance of green bonds could support large-scale environmental and recreational projects. These funds could be operated in a conjunctive manner. As water provider bonds were paid down, the guarantee fund could be reduced and could be used to pay green bonds. By doing so, an initial $50 million investment could leverage half a billion dollars of regional projects. Under a well-planned, phased approach, an additional $100 million per year might address all of the State-related funding needs described in Colorado's Water Plan, as further detailed in Section 9.2.

H. Education, Outreach, and Innovation: Colorado's Water Plan sets a measurable objective to significantly improve the level of public awareness and engagement regarding water issues statewide by 2020, as determined by water awareness surveys. Colorado's Water Plan also sets a measurable objective to engage Coloradans statewide on at least five key water challenges (identified by CWCB) that should be addressed by 2030.

Colorado's Water Plan will expand outreach and education efforts that engage the public to promote well-informed community discourse and decision making regarding balanced water solutions. This work will be collaborative and include state, local, and federal partners. As one component of this overall strategy, the CWCB will work with Colorado's innovation community, education and outreach experts, research institutions, and the Governor's Colorado Innovation Network (COIN) to address Colorado's water challenges with innovation and "outside-the-box" creativity.

10.3 CRITICAL GOALS AND ACTIONS

The State of Colorado will immediately undertake the following critical actions to make progress in achieving the measurable objectives and addressing additional important water challenges Colorado's Water Plan identifies. The referenced section further explains additional information and context for each of the critical actions. In addition, Chapters 6 through 9 include many more actions, and a summary of the complete list of actions is available in Appendix H. Each action is labeled as one of the following types:

- **Legislation:** Although most actions are intended to work within existing state and federal laws, some actions require state legislation. Legislative actions require the Colorado General Assembly to pass a bill changing language in or adding language to the Colorado Revised Statutes. Prior to developing legislative proposals necessary to implement Colorado's Water Plan, the DNR will conduct a thorough review of input provided by the WRRC, the CWCB, roundtables, and interested stakeholders. Any legislative recommendations in the action plan will be evaluated in light of administration priorities and the State budget. To the extent that legislation is necessary to execute Colorado's Water Plan, legislative recommendations will be offered in concert with the phased implementation of the plan over subsequent years.
- **Programmatic:** Programmatic actions can be accomplished within existing authority and existing state programs. Some of these actions may require additional staffing or funding, which will need to be addressed prior to implementation. To that end, legislation may be needed to appropriate adequate resources.
- **Board Policy:** Board policy actions can be accomplished through a rule-making or other formal approval CWCB process to give CWCB staff the authority to accomplish these actions. Other state agencies may also need to adopt policies, as noted below. Resources to develop and implement the policy changes will need to be identified.
- **Process:** Process actions indicate actions that will involve several parties or sub-committees that develop a plan or make recommendations to the CWCB or other appropriate authority. Process actions can be accomplished within existing statutory authority. Resources to address the process actions will need to be acquired prior to implementation.

A. Supply-Demand Gap

❖ **Meet Colorado's Water Gaps:** Use a grassroots approach to formulate projects and methods that avoid some of the undesirable outcomes of the supply-demand gaps. The plan addresses the gap from multiple perspectives (e.g., water storage, reuse, recycling, integrated water management, restoration, and conservation).

❖ **Protect and Develop Compact Entitlements and Manage Risks:** Protect Colorado's ability to fully develop compact entitlements, and continue to support agreements that strengthen Colorado's position in interstate negotiations while ensuring the long-term viability of Colorado's interstate compacts and relationships. Focus planning efforts on maintaining healthy systems and avoiding a Colorado River Compact deficit rather than on responding to compact curtailment.

	CRITICAL ACTIONS TO MEET WATER GAPS	SECTION	PARTNERS	TYPE
1	Support and assist the basin roundtables in moving forward priority municipal, industrial, environmental, and agricultural projects and methods identified in their BIPs through technical, financial and facilitation support when requested by a project proponent and the pertinent BRT.	6.5, 6.6	CWCB, BRTs	Programmatic
2	Develop a collaborative water management program for the Colorado River Basin, as described in the Conceptual Framework, to maximize the use of compact water while actively avoiding a Colorado River Compact deficit.	8, 9.1	CWCB, other Upper Division states, stakeholders	Programmatic, policy, and funding

B. Conservation

❖ **Increase Municipal Conservation and Efficiency:** Implement long-term water efficiency strategies to meet local and statewide water needs that are cost-effective and promote a water efficiency ethic throughout Colorado.

	CRITICAL CONSERVATION ACTIONS	SECTION	PARTNERS	TYPE
1	Consider comprehensive, integrated water resource planning, conducted by water providers, as one of the components to achieve state support of projects and financial assistance. These plans should use the water conservation best practices at the high customer participation levels where possible, as defined in SWSI.	6.3.1, 9.4	CWCB, other permitting agencies, stakeholders	Policy
2	Support legislation that would require retailers to sell only irrigation technologies that meet WaterSense specifications by providing technical details about the potential savings and hosting a stakeholder process.	6.3.1	CWCB, DNR, General Assembly, stakeholders	Process, possible legislation

C. Land Use

❖ **Integrate Land Use and Water Planning:** Initiate the use of local land use tools, where appropriate, to reduce water demands for municipalities, and the need to urbanize agricultural lands.

	CRITICAL LAND USE ACTION	SECTION	PARTNERS	TYPE
1	Through voluntary trainings for local governments, encourage the incorporation of best management practices in land use for water demand management, water efficiency, and water conservation.	6.3.3	CWCB, DOLA, stakeholders	Programmatic

D. Agriculture

❖ **Maintain Agricultural Viability:** Maintain Colorado's agricultural productivity, support of rural economies, and food security (through meaningful incentives and grassroots efforts).

❖ **Facilitate Alternative Transfer Methods:** Respect property rights and contributions of the agricultural industry by establishing alternative options that compete with, if not out-perform, traditional "buy-and-dry" transactions in the water market.

❖ **Support Agricultural Conservation and Efficiency:** Support Colorado's agricultural industry to make it more efficient, resilient, and able to reduce water consumption without impacting agricultural productivity.

	CRITICAL AGRICULTURE ACTIONS	SECTION	PARTNERS	TYPE
1	Establish an education and assistance program for farmers and ranchers to help realize more market-competitive transactions that promote implementation of ATMs, and enable Coloradans to enter the agriculture industry.	6.5, 6.4, 6.3.4	CWCB, CDA	Programmatic
2	Encourage ditch-wide and regional planning to explore system-wide conservation and efficiency opportunities and tradeoffs, the potential for water sharing, and long-term infrastructure maintenance needs.	6.5, 6.3.4	CWCB, agricultural partners, BRTs	Programmatic
3	Provide grants, loans, and technical support to update and improve Colorado's aging agricultural infrastructure, especially where improvements provide multiple benefits.	6.5, 6.3.4	CWCB, BRTs, agricultural partners, other stakeholders	Programmatic
4	Develop model voluntary flow agreement language, facilitation, and technical support to encourage the use of these agreements when paired with irrigation efficiency practices.	6.3.4	CWCB, DWR, agricultural partners, environmental groups, BRTs	Programmatic, state agency policies
5	Explore the development of administrative means to track and administer agricultural conserved water for the purposes of marketing these waters.	6.3.4, 6.4	DWR, CWCB	Process
6	Explore expanded grant funding that supports implementation of ATM projects, related infrastructure, or entities that would help facilitate alternative transfer methods.	6.4	CWCB, BRTs, DWR, stakeholders	Process

E. Storage

- **Promote Additional Storage and Infrastructure:** Assess and promote opportunities for multipurpose and multi-partner storage projects that address strategic needs.

- **Improve Permitting Processes:** Advocate for more effective and efficient permitting in which state agencies work together to complete their work early in the permitting process. This will provide the opportunity for State support without being pre-decisional.

	CRITICAL STORAGE AND PERMITTING ACTIONS	SECTION	PARTNERS	TYPE
1	Provide financial support to technical and practical storage innovations.	6.5	CWCB	Programmatic
2	Prioritize grants and loans to support the implementation of BIP-identified multipurpose projects and methods, taking into consideration locally identified geographic and seasonal gaps.	6.5, 6.6	CWCB, BRTs	Funding
3	Conduct a series of lean events with permitting agencies and stakeholders to determine ways to make permitting more efficient.	9.4	CWCB (host), local, state, federal, & partners	Process
4	Relevant state agencies will actively participate as cooperating agencies in federal NEPA permitting processes at the outset of the regulatory process to engage in scoping, developing alternatives, determining methodologies and data gaps, and developing mitigation and enhancement plans.	9.4	State agencies with permitting authority on a project, including DNR and CDPHE	Programmatic
5	Where more than one state agency has jurisdiction over a particular issue (e.g., fish health), a lead state agency will be identified, and a memorandum of understanding will be agreed to by all agencies to assist in the coordination.	9.4	State agencies with permitting authority, including DNR and CDPHE	Programmatic

F. Watershed Health, Environment, and Recreation

- **Recover Imperiled Species:** Promote restoration, recovery, and resiliency of endangered, threatened, and imperiled aquatic and riparian dependent species and plant communities.
- **Enhance Environmental and Recreational Economic Values:** Protect and enhance river-based environments and recreational opportunities that support local and statewide economies and are important for the enjoyment of current and future generations of Coloradans.
- **Protect Healthy Environments:** Understand, protect, maintain, and improve conditions of streams, lakes, wetlands, and riparian areas to promote self-sustaining fisheries and functional riparian and wetland habitat to promote long-term resiliency.
- **Promote Protection and Restoration of Water Quality:** The protection and restoration of water quality should be a key objective when planning for Colorado's current and future consumptive, recreational, and environmental water needs.
- **Protect and Restore Critical Watersheds:** Protect and restore watersheds critical to water infrastructure, environmental or recreational areas.

	CRITICAL WATERSHED HEALTH, ENVIRONMENT, AND RECREATION ACTIONS	SECTION	PARTNERS	TYPE
1	Continue to support and participate in collaborative approaches to prevent listings under the Endangered Species Act. Promote the sustainability of endangered, threatened, and imperiled aquatic- and riparian-dependent species and communities (e.g., recovery programs, cooperative agreements, and other efforts) by developing a plan that compiles and develops near-term projects and methods. At the same time, the CWCB will support the strategic implementation of currently identified projects with technical and financial assistance.	6.6	CWCB, CPW, federal partners, other agencies, BRTs, and stakeholders	Programmatic
2	Develop a plan that compiles and develops near-term projects and methods to support economically important water-based recreation.	6.6	CWCB, BRTs, interested stakeholders	Programmatic
3	Develop stream management plans for priority streams (identified in a BIP or otherwise) as having environmental or recreational value. As part of this work, the CWCB will provide guidelines and templates for developing stream management plans, and will conduct ongoing analyses through SWSI.	6.6, 7.1, 9.2	CWCB, BRTs, federal partners, other stakeholder groups	Programmatic
4	Develop common metrics for assessing the health and resiliency of watersheds, rivers, and streams.	6.6	CWCB, CPW, federal partners, other state agencies, BRTs, stakeholders	Programmatic
5	Advance policy initiatives that allow for creative, solution-oriented actions while maximizing water quality protection, ensuring consideration of the net environmental benefit of projects, and evaluating the water quality impacts of water quantity management approaches.	7.3, 7.2	CDPHE, CWCB, other state agencies	Programmatic
6	Provide technical and financial support to local stakeholder groups to develop watershed master plans for watersheds that are critical to consumptive or nonconsumptive water supply and quality.	6.6, 7.1, 7.3	CPW, CDPHE, CWCB	Programmatic
7	Prioritize and implement projects identified in master planning efforts.	6.6, 7.1	CPW, CDPHE, CWCB, local coalitions	Programmatic

G. Funding

❖ **Explore New Funding Opportunities:** Develop near-term funding opportunities whereby the smallest amount of funding possible has the greatest benefit to implementing Colorado's Water Plan.

	CRITICAL FUNDING ACTIONS	SECTION	PARTNERS	TYPE
1	Seek an amendment to expand the CWCB loan program's authority to fund treated water supply, reuse, conservation, environmental, and recreation projects and methods.	9.2, 6.3.2, 6.3.1	CWCB, DNR, CPW, CWPDA, CDPHE, General Assembly	Legislation
2	Explore a public-private partnership (P3) center of excellence that models how to develop P3 agreements and explores financial incentives for regionalization.	9.2	CWCB, Funding Committee, P3 experts in other sectors	Programmatic
3	Continue to encourage regional and multipurpose projects and methods that address water supply gaps by providing financial incentives, such as an interest rate reduction or extended loan repayment periods.	9.2	CWCB, Water & Power Authority	Board policy
4	Continue to provide $1 million or more, if needed, on an annual basis to support stream management and watershed plans.	9.2	CWCB and General Assembly (Projects Bill)	Legislation
5	Develop a sustainable funding plan that integrates a guarantee repayment fund, green bonds, and additional support grants and loans for the WSRA, education, conservation, reuse, ATMs, and agricultural viability. This will include the dedication of $50 million dollars of severance tax funds to kick-start the initiatives in the plan, and the identification of an approach to develop a new viable public source of funding.	9.2	CWCB, Funding Committee	Process

H. Education, Outreach, and Innovation

❖ **Advance Education, Outreach, and Innovation:** Inform Coloradans about water issues to encourage engagement and innovation in determining Colorado's water future.

	CRITICAL EDUCATION AND OUTREACH ACTIONS	SECTION	PARTNERS	TYPE
1	Create a new outreach, education, and public engagement grant program to fund basin roundtable education action plans and initiatives indicated in Colorado's Water Plan.	9.5, 9.2	CWCB, General Assembly	Possible legislation
2	Conduct a water education assessment to help develop a plan that addresses critical gaps in water education, advances efforts in Colorado's Water Plan, and supports basin roundtable work.	9.5	CWCB, BRTs, education partners	Programmatic
3	Identify five water challenges that Colorado's innovation community could help solve, develop an award program, and engage Coloradans in the challenge.	9.5	CWCB, COIN, research institutions, stakeholders	

I. Additional Critical Goals and Actions

- **Plan for the Future:** Coordinate and sequence updates to SWSI, the BIPs, and future iterations of Colorado's Water Plan to represent the most up-to-date technical, stakeholder, and policy information available.
- **Prepare for and Respond to Natural Disasters:** Colorado's Water Plan promotes water resource resilience from natural disasters through strategic preparedness and response.
- **Prepare for Climate Change:** Respond to, monitor, and prepare for climate change.
- **Encourage Reuse:** Encourage the development of reuse solutions to maximize fully consumable water supplies.

	ADDITIONAL CRITICAL ACTIONS	SECTION	PARTNERS	TYPE
1	Implement the actions identified in the Colorado Resiliency Framework to build communities that are more resilient to natural disasters.	7.2	Local communities, CWCB, Colorado Resiliency & Recovery Office	Programmatic
2	Evaluate and incorporate appropriate adaptation for the potential effects of climate change on municipal, industrial, environmental, and agricultural projects and methods that address the water supply gaps.	6.5, 6.6	CWCB, IBCC, water providers, researchers	Programmatic
3	Work on creating resilient watersheds to protect, restore, and enhance water quality in the face of climate change.	7.3	CDPHE	CDPHE policy
4	Support technical reviews of local and regional reuse options and provide grants to support on-site, local, and regional reuse plans and projects.	6.3.2, 7.3	CWCB, water providers, reuse experts	Programmatic
5	Evaluate regulations to foster reuse of water supplies while protecting public health and the environment.	6.3.2, 7.3, 9.4	CDPHE, CWCB, DWR, stakeholders	CDPHE policy, potential legislation

VICKI PHELPS, CONTINUED FROM PAGE 10-6

My love of science and the outdoors led me to major in biology, environmental science, and art in college. I worked with the National Park Service, both as a fire lookout and nature interpreter. I was a botanist, landscaping supervisor, and outdoor educator for the Arizona Sonora Desert Museum. My family ranched and farmed in southwest Colorado. All of these experiences have emphasized the essential role of water for life and the health of the planet.

I became a teacher and spent 27 years teaching secondary science and math and elementary grades. I have facilitated many outdoor environmental education studies in my schools. I was also a River Watch teacher, where I supervised students in collecting and analyzing water samples from the San Miguel River for the Colorado Department of Wildlife. My goals have been to expose students (and adults) to the natural ecosystems around them, and to help them reflect on regional cultural history, develop a sense of their place in the picture, and inspire them to become better stewards of the land. It brings me great joy to see kids get their feet wet and their hands dirty, while making joyful discoveries of the wonders of the natural world. Watching my daughter Jamie become an avid nature-lover and go on to major in science in college was one of my greatest joys.

Currently, I am the co-director of the Telluride Institute's Watershed Education Program. With nature as my classroom, along with other experts in the field, I help lead outdoor experiential field trips with students from four different school districts along the San Miguel River Watershed. With hands-on activities, students develop a keen sense of where their water comes from and how essential it is for natural ecosystems and humans.

With the reality of climate change, I am committed to joining scientists and engineers, who are seeking solutions to reducing human impact on the Earth.

[1] Governor John Hickenlooper, "Executive Order D 2013-05, Directing the Colorado Water Conservation Board to Commence Work on the Colorado Water Plan," May 14, 2013.

A LOOK AT HISTORY

Mayor Benjamin Stapleton, surrounded by onlookers, digs a shovelful of dirt at the ground breaking ceremony for the Denver City and County Building, Denver, 1929. Groundbreaking events don't always require a shovel.

source: Denver Public Library.

Updating Colorado's Water Plan

11

Colorado's Water Plan is dynamic by design. The plan addresses today's water challenges with the understanding that our water landscape may change quickly. Colorado's Water Plan will be agile in the face of future uncertainty regarding both water supply and demand, and will include advancements in water resource management to meet these changing conditions.

The children of several of the authors of Colorado's Water Plan, standing together at Clear Creek in Golden. They represent the importance of planning for a sustainable water future. Pictured are: Gizachew Mitchell, Taye Mitchell holding Emma Bornstein, Saba Mitchell holding Wrenna McIntire, Forest Eklund, Aidan Reidy, Maeve Reidy, Sierra Mitchell holding Clay McIntire, and Rowan Eklund. Photo: M. Nager.

GOAL

Colorado's Water Plan is a dynamic document that incorporates Colorado's changing economy, water supplies, water needs, and stakeholder efforts.

The CWCB will initiate the next iteration of Colorado's Water Plan by 2020, following updates to the BIPs and SWSI. Periodically updating Colorado's Water Plan in the future will ensure that water remains a focus of Colorado's ongoing policy development and that state policies continue to be responsive to ongoing technical and stakeholder work. The following chart demonstrates the cyclical planning process proposed by the CWCB. The year indicated represents the calendar year in which work will begin on each product, with delivery of the first iteration of Colorado's Water Plan at the end of 2015.

It is important that Colorado's Water Plan facilitates ongoing implementation of the projects and methods the BIPs identified, and of the actions the plan identified at the statewide, basin, and local level. As part of these ongoing efforts, the CWCB will encourage the basin roundtables to be caretakers of the BIPs and to be catalysts for implementation at the local and basin levels. The CWCB will also continue to rely on the IBCC to deliberate and find consensus around difficult issues that warrant interbasin communication and debate.

CWCB will coordinate ongoing updates regarding the BIPs, the SWSI, the work of the IBCC, and other studies and stakeholder work, and will incorporate those updates into future drafts of Colorado's Water Plan. As Chapter 10 discusses, the CWCB will monitor statewide progress on the goals and measurable objectives.

TABLE 11-1 CYCLICAL PLANNING PROCESS PROPOSED BY THE CWCB

Product	Year Initiated
Basin Implementation Plans	2013
Colorado's Water Plan	2013
Statewide Water Supply Initiative	2016
Basin Implementation Plans	2018
Colorado's Water Plan	2020
Statewide Water Supply Initiative	2022

ACTIONS

1. The CWCB will work with other state agencies, the basin roundtables, and the people of Colorado to update Colorado's Water Plan, beginning no later than 2020.
2. The CWCB will develop guidelines for Basin Roundtable WSRA grants to help facilitate the implementation of the BIPs.

The General Assembly's Water Resources Review Committee conducting hearings on Colorado's Water Plan, which they did twice in each basin across the state during development of the plan. Courtesy of the Water Resources Review Committee.

Appendix A: Executive Order D 2013-005

STATE OF COLORADO

OFFICE OF THE GOVERNOR

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Denver, Colorado 80203
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D 2013-005

John W. Hickenlooper
Governor

EXECUTIVE ORDER

DIRECTING THE COLORADO WATER CONSERVATION BOARD TO COMMENCE WORK ON THE COLORADO WATER PLAN

Pursuant to the authority vested in the Governor of the State of Colorado, and in particular, pursuant to powers vested in the Governor pursuant to article IV, section 2 of the Colorado Constitution, I, John W. Hickenlooper, Governor of the State of Colorado, hereby direct the Colorado Water Conservation Board to commence work on the Colorado Water Plan.

I. Background

Colorado has long been on the leading edge of water innovation and solutions. We are the home of the "Colorado Doctrine" of prior appropriation and the birthplace of the interstate water compact, of which we have nine. We are a headwater state – vital rivers and streams begin here, provide water to Colorado uses, and exit to water 18 downstream states as well as the United Mexican States. Colorado has benefited much from its water and has taken seriously its responsibilities as a headwater state. The creation of a Colorado Water Plan is in keeping with Colorado's water heritage and continued responsibility.

The Colorado Water Conservation Board (CWCB) was created in 1937 "[f]or the purpose of aiding in the protection and development of the waters of the state, for the benefit of the present and future inhabitants of the state." C.R.S. § 37-60-102. More than 75 years later, we reaffirm this purpose and seek to tap Colorado collaboration and innovation in addressing our water challenges. The Board's recently-adopted strategic framework is consistent with this mission.

We also recognize the important role the Office of the State Engineer has played throughout Colorado's water history. This office administers water rights, issues water well permits, represents Colorado in certain interstate water compact proceedings, monitors streamflow and water use, approves construction and repair of dams and performs dam safety inspections, assures the safe and proper construction of water wells, and maintains numerous databases of state water information.

The Interbasin Compact Committee and Basin Roundtable processes, established by House Bill 05-1177, have produced more than eight years worth of important discussion and information about the basins from Coloradans in each basin.

In addition, many state agencies, lead by DNR, play important roles in Colorado water including:

- The Colorado Department of Public Health and Environment that includes the Colorado Water Quality Control Division and the Commission, the administrative agency responsible for developing specific state water quality policies, in a manner that implements the broader policies set forth by the Legislature in the Colorado Water Quality Control Act. The Commission adopts water quality classifications and standards for surface and ground waters of the state, as well as various regulations aimed at achieving compliance with those classifications and standards.
- The Colorado Water Resources and Power Development Authority that provides low-cost financing to governmental agencies in Colorado primarily for water and wastewater infrastructure development.
- The Colorado Department of Agriculture that works to strengthen and advance Colorado's largest consumptive use of water, its agriculture industry.
- The Colorado Energy Office that maintains information helpful in understanding Colorado's water-energy nexus as well as state agency water use.

Throughout our state's history, other water plans have been created by federal agencies or for the purpose of obtaining federal dollars. We embark on Colorado's first water plan written by Coloradans, for Coloradans. Nevertheless, our past and current data and studies will aid in developing a plan for the future.

II. Purpose and Need

The Colorado Water Plan is necessary to address the following:

A. The gap between our water supply and water demand is real and looming. The Statewide Water Supply Initiative forecasts that this gap could exceed 500,000 acre feet by 2050. Moreover, our largest regional gap is set to occur in the South Platte Basin, our most populous as well as our largest agriculture-producing basin.

B. Colorado's drought conditions threaten to hasten the impact of the water supply gap. Indeed, the past two decades have been Colorado's warmest on record, dating back to the 1890s.

C. Coloradans find that the current rate of purchase and transfer of water rights from irrigated agriculture (also known as "buy-and-dry") is unacceptable. We have witnessed the economic and environmental impacts on rural communities when water is sold and removed from an agricultural area. For example, projected reduction in irrigated acreage in the South Platte Basin alone is currently estimated at 20% of agricultural land under production.

D. The Interbasin Compact Committee and Basin Roundtables have worked for the past eight years to engage in a visioning process and to discuss long-standing intrabasin and interbasin challenges by defining scenarios, portfolios, and strategies. These efforts have produced informed discussions, provided a forum for building consensus, and generated momentum that the Colorado Water Plan should utilize.

E. Colorado's water quantity and quality questions can no longer be thought of separately. Each impacts the other and our state water policy should address them conjunctively.

F. Our interstate water concerns are as pressing as ever and require Colorado to be vigilant in protecting its interstate water rights pursuant to its nine interstate compacts and two equitable apportionment decrees.

G. CWCB is well-positioned to conduct this work given its duties and history, statewide representation, and expertise.

III. <u>Declaration and Directives</u>

A. Colorado's water policy must reflect its water values. The Basin Roundtables have discussed and developed statewide and basin-specific water values and the Colorado Water Plan must incorporate the following:

- a productive economy that supports vibrant and sustainable cities, viable and productive agriculture, and a robust skiing, recreation, and tourism industry;
- efficient and effective water infrastructure promoting smart land use; and
- a strong environment that includes healthy watersheds, rivers and streams, and wildlife.

B. The CWCB is directed to commence the work necessary to submit a draft Colorado Water Plan for review by the Governor's Office no later than December 10, 2014. The CWCB will work with the Governor's Office to complete the final plan no later than December 10, 2015.

C. The CWCB is directed to align state water projects, studies, funding, and other efforts as part of the Colorado Water Plan to the greatest extent possible. As part of this alignment, the CWCB is directed to develop an inventory of water rights held by state agencies and evaluate the opportunities for those rights. The CWCB is also directed to ensure that financial assistance for water funding activities is in accordance with the Colorado Water Plan.

D. The CWCB is directed to align the state's role in water project permitting and review processes with the water values included in the Colorado Water Plan and to streamline the state role in the approval and regulatory processes regarding water projects. The

Colorado Water Plan should place an emphasis on expediting permitting processes for projects that stress conservation, innovation, collaboration, and other criteria as determined by the CWCB. Efficient infrastructure promoting smart land use, healthy watersheds that support Colorado's rivers and streams, and smart water conservation practices that utilize demand-management are examples of criteria to be considered.

E. In drafting the Colorado Water Plan, the CWCB is directed to utilize the Interbasin Compact Committee and the Basin Roundtables. The CWCB is also directed to review and build upon discussions and points of consensus that have emerged as part of the Interbasin Compact Committee and Basin Roundtable processes so as to capitalize on the momentum generated by these grassroots efforts.

F. When drafting the Colorado Water Plan, the CWCB is directed to work with its sister agencies within the Colorado Department of Natural Resources as well as the Colorado Department of Public Health and Environment, the Colorado Water Resources and Power Development Authority, the Colorado Department of Agriculture, the Colorado Energy Office, and other relevant state agencies as needed. Each of these agencies is directed to cooperate with the CWCB as needed on the Colorado Water Plan.

G. The CWCB is directed to assemble ad-hoc panels of Coloradans and inter-agency water working groups to develop recommendations regarding specific topics as it deems necessary.

H. The Colorado Water Plan will reaffirm the Colorado Constitution's recognition of priority of appropriation while offering recommendations to the Governor for legislation that will improve coordination, streamline processes, and align state efforts.

IV. Duration

This Executive Order shall remain in full force and effect until modified or rescinded by future Executive Order of the Governor.

GIVEN under my hand and the Executive Seal of the State of Colorado this fourteenth day of May, 2013.

John W. Hickenlooper
Governor

Appendix B: How Other States Have Worked to Meet Their Gaps

B

Arizona:

Arizona Water Banking: The Arizona Water Banking Authority (AWBA; Water Bank) was established in 1996 to increase use of the state's Colorado River entitlement and develop long-term storage credits for the state. The five person board is made up of the Director of the Arizona Department of Water Resources (ADWR), who is chair, the President of the Board of the CAP and three persons appointed by the Governor. AWBA "banks" unused Colorado River water to use in times of shortage to firm Arizona's water supplies. These water supplies help to benefit municipal and industrial users and communities along the Colorado River, fulfill the water management objectives of the state, store water for use as part of water rights settlement agreements among Indian communities, and assist Nevada and California through interstate water banking. Through these mechanisms, the AWBA aids in ensuring long-term water supplies for Arizona.

Each year, the AWBA pays the delivery and storage costs to bring Colorado River water into central and southern Arizona through the Central Arizona Project canal (this is a federal/municipal project and is 336 miles long). The water is stored underground in existing aquifers (direct recharge) or is used by irrigation districts in lieu of pumping groundwater (indirect or in-lieu recharge). For each acre-foot stored, the AWBA accrues credit that can be redeemed in the future when Arizona's communities or neighboring states need this backup water supply.

Central Arizona Project: The first State Water Plan published in the mid-1970s noted that the growth of Arizona cities and industries could only be assured if groundwater pumping was offset by the use of CAP water. In the late 1970s, there was an impasse between the farmers and the municipal and mining interests regarding groundwater management. Governor Bruce Babbitt convinced the U.S. Secretary of the Interior at that time, Cecil Andrus, to issue an ultimatum: unless Arizona enacted tough groundwater laws, he would refuse to approve construction of the Central Arizona Project. Soon the cities, mines and agriculture asked Babbitt to mediate the discussions regarding groundwater. One of the first items of agreement was creation of the Arizona Department of Water Resources. CAP was completed in 1993, costing $3.7 billion to construct. The Arizona Department of Water Resources continues to financially support the project, but it is primarily run by a regional commission and was approved by Congress as a federal project.

California:

State Water Project: California has a State Water project, which provides drinking water for over 25 million people and generates an average 6.5 million mega-watt hours of hydroelectricity annually. It also provides water to 750,000 acres of irrigated land. Construction began in the late 1950s, with major funding approved through a 1960s bond measure. Bond measures paid for most of the project, and annual operation and maintenance costs (including debt service) are primarily paid for by beneficiaries, although the state pays for the fish and wildlife benefits. The state water project is ongoing, with additional facilities being planned. The project started as a state-supported federal project.

QUICK FACTS

- The Project includes 34 storage facilities, reservoirs and lakes; 20 pumping plants; 4 pumping-generating plants; 5 hydroelectric power plants; and about 701 miles of open canals and pipelines.
- By the end of 2001, about $5.2 billion had been spent to construct SWP facilities.

CALFED Bay-Delta Program: In 1994 California and federal entities signed an agreement to manage the competing demands in the Sacramento-San Joaquin Delta. There are numerous competing environmental and water supply needs related to the Delta. This is a large and ongoing component of the State Water

Project.

In July of 2012, Governor Jerry Brown joined Secretary of the Interior Ken Salazar to announce plans to move a project forward that would put two tunnels under the bay to stabilize water deliveries, which have been reduced by court order over concerns for the endangered Delta Smelt. This is the latest version of the peripheral canal. There is significant opposition to the project from environmentalists, salmon sports fishermen, and local farmers, although Governor Brown said the tunnels would be the "preferred alternative" for a plan that would ensure the "co-equal" goals of reliable water supplies and delta habitat restoration. There will still be permit requirements, and an analysis is due next year.

QUICK FACTS:

- The project could deliver up to 7 million acre-feet.
- The proposed system would cost about $19 billion to build, operate, and manage, along with $3 to 4 billion for habitat restoration.
- The habitat costs would be funded through bonds that would be paid from the state's general fund and would require voter approval. Water users will pay for the cost of the construction and operation of the tunnels.

Read more:

http://www.sfgate.com/science/article/New-state-water-plan-tunnels-under-delta-3735999.php

State Water Plan: California also has a State Water Plan. Their five year update was published in 2013, and includes a financial plan, which is "a necessary step in implementing the strategic plan and many other California Water Plan recommendations. This new financial focus will identify critical priorities for State investment in integrated water management activities. It will also recommend innovative, stable, equitable, and fiscally responsible financial strategies and revenue sources should any funding gaps be identified as part of the water plan's development." The plan will also focus on regional solutions.

Colorado:

In addition to the technical and financial support provided by almost every state, Colorado has supported several projects in various ways. These include being a participant in a project (e.g., Chatfield Reallocation), purchasing a block of water to be able to market to various interests in the future (e.g., Animas-La Plata), providing loans and/or grants to assist a project in moving forward (e.g. Prairie Waters, Arkansas Valley Conduit), and the passing of a CWCB resolution in support of a project (e.g., Chatfield Reallocation, WISE Partnership). Several Governors have also weighed in on water projects, including pressure to move permitting forward and explicit support for specific water projects. The latest example can be found here: http://www.denverpost.com/news/ci_21314294. Other support includes working with water providers who are working collaboratively with other stakeholders to find creative ways to administer these projects.

CWCB also undergoes significant planning activities, which support understanding Colorado's water supply gaps and avenues to meet them. The Statewide Water Supply Initiative (SWSI) gathers statewide information on municipal, industrial, agricultural, environmental, and recreational needs as well as projects and methods to meet those needs. In so doing, it provides a strategic planning framework. CWCB also staffs the Basin Roundtable and Interbasin Compact Committee processes. The stakeholder groups found across the state are charged with assessing their needs and determining projects and methods to meet those needs. SWSI 2010 used data from the basin roundtables and IBCC. SWSI 2010 also has a list of recommendations which are important components to meeting

Colorado's water gaps.

New Mexico:

Regional Water Planning: The New Mexico Legislature created the state's regional water planning program in 1987 and gave the Interstate Stream Commission the responsibility of funding, overseeing, and approving the plans of the 16 regions. Through the program, regions are charged with the inventory of existing water supplies, projecting future demand, identifying supply inadequacies, and developing strategic alternatives to meet supply shortages. The New Mexico State Water calls for the State to "support and adequately fund the completion, update, and implementation of regional water plans."

San Juan-Chama Project and Navajo Nation Water Rights Settlement: The Governor, State Engineer, and the Interstate Stream Commission Director testified in support of the Settlement and associated Project. The State contributed nearly $50 million dollars to the project.

Taos Pueblo Water Rights Settlement: The Governor, State Engineer, and Interstate Stream Commission Director testified in support of the Settlement. The State, has contributed $1.5 million dollars while agreeing to future appropriations of $18.5 million dollars over time.

Aamodt Water Rights Settlement: The Aamodt Settlement (Pueblos of Pojoaque, Tesuque, Nambe & San Ildefonso) was supported by the Governor, State Engineer, and the Interstate Stream Commission Director. No appropriations have been made to date, yet the State is potentially on the hook for up to $50 million dollars.

Eastern New Mexico Water Supply Project: The Governor, State Engineer, and the Interstate Stream Commission Director supported the Settlement. The State has contributed $20 million dollars while agreeing to fund around $75 million dollars over time.

San Juan-Chama Shortage Sharing Agreement: The parties involved in the Navajo Dam and San Juan River operations, together with the New Mexico State Engineer's Office and the Bureau of Reclamation, came to an agreement to share water losses (as opposed to traditional state water rights administration). If the shortage agreement is not adhered to, the State will administer the system in a conventional manner.

Texas:

Texas has an active regional planning effort that identifies projects and then works to fund projects that are consistent with the plan or, for some funding sources, explicitly recommended as water management strategies in the regional or state plans. They also have their own Commission on Environmental Quality which grants water right permits only if (some exceptions do apply) they are consistent with the regional water plans and the state water plan. The plans are updated every five years, and the Texas Water Development Board provides technical and administrative support. The legislature also designates "sites of unique value for the construction of reservoirs" as well as stream reaches with "unique ecological value." There are several recommendations in the 2012 state plan that have not yet been implemented. These include the recommended purchase of reservoir sites and implementation of specific water projects and methods that go through an evaluation process.

QUICK FACTS

- Municipal conservation strategies are expected to result in about 650,000 acre-feet of supply by 2060, with irrigation and other conservation strategies totaling another 1.5 million acre-feet per year.
- The planning groups recommended 26 new major reservoirs projected to generate approximately 1.5 million acre-feet per year by 2060. Other surface water strategies would result in about 3 million acre-feet per year.
- Recommended strategies relying on groundwater are projected to result in about 800,000

additional acre-feet per year by 2060.

Utah:

Lake Powell Pipeline: Utah is planning, buying up the right of way, and has financing in place for construction of the Lake Powell Pipeline, to deliver water from the Colorado River (from Utah's unused allocation) to the St. George area in Southwest Utah. Utah's Board of Water Resources, under the Lake Powell Pipeline Development Act passed by the Utah State Legislature in 2006, is authorized to build the Lake Powell Pipeline. The legislation authorizes a pipeline to take water from Lake Powell, and transport it to Washington, Kane and Iron counties. The water diverted into the pipeline will be a portion of Utah's Upper Colorado River Compact allocation, and will consist of water rights to be held or acquired by the three water districts and the Board of Water Resources. The state will build the project and the districts will repay the costs through water sales.

QUICK FACTS

- The pipeline will total 177 miles from Lake Powell to Iron County
- The project will deliver 100,000 acre-feet
- Deliveries are planned to begin in 2020
- The project will cost over $1billion in capital costs

West Desert Pumping Project: The Utah legislature authorized a major pumping project to protect the risk of flooding out of the Great Salt Lake.

Bear River Development: Bear River is often referred to as Utah's last untapped river. In the Bear River Development Act, passed by the Legislature in 1991, the Division of Water Resources is directed to develop the surface waters of the Bear River and its tributaries. The act also allocates water among various counties and provides for the protection of existing water rights. The act allocates a total of 220,000 acre-feet of water annually. The total cost of the project is estimated to be between $130 million and $260 million, depending upon which dam site is chosen. Most of the required conveyance and treatment systems will be the responsibility of the contracting entities. An article in the Utah Environmental Law Review states "According to several administrative documents, the state intends to make Bear water available within the next two decades, and it appears that the state will finally push forward to realize their 60 year old desire to tap the Bear." This article can be accessed here: http://epubs.utah.edu/index.php/jlrel/article/viewArticle/103. It is unclear in this initial review what the state intends to do with this project in the near future.

Central Utah Project: The Central Utah Project (CUP) is a state supported federal project. CUP is being constructed by the U.S. Bureau of Reclamation and the Central Utah Water Conservancy District (CUWCD) took over construction of some of the final water distribution components. The project is explicitly listed in the Utah's State Water Plan as being necessary. It is located in the central and east central part of Utah. CUP is the largest water resources development program ever undertaken in the State. The project provides Utah with the opportunity to beneficially use a sizable portion of its allotted share of the Colorado River water. Project irrigation water will be provided to Utah's rural areas in the Uintah and Bonneville Basins. Water will also be provided to meet the M&I requirements of the most highly developed part of the State along the Wasatch Front where population growth and industrial development are continuing at a rapid rate. Water developed by the Central Utah Project will be used for municipal, industrial, irrigation, hydroelectric power, fish, wildlife, conservation, and recreation. The project will improve flood control capability and assist in water quality control.

One key component of the project is the Bonneville Unit. This complex unit is currently being constructed and includes 10 new reservoirs, more than 200 miles of aqueducts, tunnels, and canals; a power plant, pumping plants, and 300 miles of drains. Starvation Reservoir, constructed on the Strawberry River about three miles above Duchesne, has a capacity of 167,000 acre-feet and Soldier Creek Dam has nearly quadrupled the capacity of Strawberry Reservoir from 283,000 to 1,106,500 acre-feet.

Other States:

Wyoming

The Wyoming Water Development Commission has financed many projects, including the State's share of the cost of raising Reclamation's Buffalo Bill Dam.

Kansas

Kansas purchased storage in Corps reservoirs for water supply uses.

Appendix C: Instream Flow and Natural Lake Level Examples

Following are specific examples of instream flow and natural lake level water rights that were appropriated or acquired to preserve, and in some cases to improve, the natural environment to a reasonable degree.

Black Hollow Creek

In 2010, based upon a recommendation from Colorado Parks and Wildlife, the CWCB appropriated an instream flow water right on approximately 5.5 miles of Black Hollow Creek in Larimer County from the stream's headwaters down to the confluence with the Cache La Poudre River. This appropriation protects flows in three different seasons: 2.2 cubic feet per second from May 1 to September 30; 1.4 cubic feet per second from October 1 to November 15; and 0.75 cubic feet per second from November 16 to April 30. The natural environment in this segment of stream consists of a healthy population of greenback cutthroat trout.

Deadhorse Creek and Hanging Lake

In 1996, the CWCB appropriated water rights on both Hanging Lake and Dead Horse Creek and determined that all of the unappropriated water in this stream and lake system was required to preserve the natural environment to a reasonable degree. The CWCB took this approach based upon the fact that the natural environments on the lake and creek are unique, consisting of distinct assemblages of riparian vegetation, endemic hanging garden communities and globally imperiled species.

Big Dominguez and Little Dominguez Creeks

In 2011, the CWCB appropriated all of the unappropriated water on both Big Dominguez and Little Dominguez Creeks to preserve aquatic and riparian aspects of the natural environment. These instream flow appropriations not only preserve distinct fish populations, but also protect amphibians, aquatic insects and increasingly rare and distinctive communities of cottonwood trees and other associated riparian vegetation. Another important objective for these appropriations was to maintain the creeks in their natural pristine condition because of their location in a designated Wilderness Area.

Colorado River Instream Flow Reaches from the Blue River to the Confluence with the Eagle River

In 2011, the CWCB appropriated water rights on three segments of the mainstem of the Colorado River: 1) Blue River to the Piney River; 2) Piney River to the confluence with Cabin Creek; and 3) Cabin Creek to a point immediately upstream from the Eagle River. These reaches, which appropriated between 500 and 900 cubic feet per second at various times throughout the year, were recommended by the Upper Colorado River Wild and Scenic Stakeholder Group as part of a comprehensive plan to manage these reaches of the River that includes a suite of protective measures as an alternative to a finding of suitability for Wild and Scenic designation.

Acquisition to Implement a Portion of the Colorado River Cooperative Agreement on the Fraser River and its Tributaries, Williams Fork River and its Tributaries, and the Colorado River

Under a Water Delivery Agreement and water court decree, Denver Water will provide annually 1,000 acre-feet of water to Grand County for instream flow use by the CWCB. The instream flow use will consist of: 1) preserving the natural environment to a reasonable degree by maintaining flows in stream reaches where the CWCB has decreed instream flow water rights when those rights are not satisfied; 2) improving the natural environment to a reasonable degree by increasing flows in existing instream flow reaches above the CWCB's decreed amounts up to recommended flow rates; and 3) improving the natural environment to a reasonable degree on streams with no existing instream flow water rights.

Acquisition of Breem Ditch Water Right for Instream Flow Use on Washington Gulch and Slate River

Under a Water Conservation Use Right and water court decree, CWCB may use the senior Breem Ditch water right that once swept the stream dry to re-water the stream. This water will be used to preserve and improve the natural environment to a reasonable degree on Washington Gulch and to preserve the natural environment to a reasonable degree on the Slate River. The historical consumptive portion of the water right may be diverted downstream of the instream flow reaches for municipal use by Skyland Metropolitan District, thus making multiple uses of the changed irrigation right for consumptive (municipal) and nonconsumptive (environmental) uses.

Appendix D: Existent Watershed Plans in Colorado

D

Plan Title:	Year	Basin	River/Stream	Organization	Link
Fountain Creek Watershed Plan	2003	Arkansas	Fountain Creek	Pikes Peak Area Council of Governments	http://cwcbweblink.state.co.us/weblink/0/doc/136931/Electronic.aspx?searchid=eeac973e-818b-4075-b648-6d9a08192b4a
Arkansas River Watershed Invasive Plants Plan	2008	Arkansas	Arkansas River; Purgatoire River; Huerfano River' Apishapa River; Fountain Creek	Southeastern Colorado Water Conservancy District	http://www.tamariskcoalition.org/sites/default/files/images/ARKWIPP%20Plan.pdf
Tackling Tamarisk on the Purgatoire: A Consolidated Woody Invasive Species Management Plan for Colorado's Purgatoire Watershed	2008	Arkansas	Purgatoire River	Tamarisk Coalition and Partners	http://www.tamariskcoalition.org/sites/default/files/images/TTP%20Plan%20final%208-08.pdf
Lower Arkansas Watershed Plan-Phase I	2008	Arkansas	Lower Arkansas River	Southeast Colorado Resource Conservation & Development	For more information please contact: Southeast Colorado Resource Conservation & Development at 719-336-3437
Strategic Plan for the Fountain Creek Watershed	2009	Arkansas	Fountain Creek	Fountain Creek Vision Task Force	ftp://ft.dphe.state.co.us/wqc/wqcc/31_85NutrientsRMH_2012/ResponsivePrehearing/LFMSDDex2a.pdf
Fountain Creek Watershed Study, Watershed Management Plan	2009	Arkansas	Fountain Creek	Army Corp of Engineers	http://cwcbweblink.state.co.us/weblink/0/doc/136930/Electronic.aspx?searchid=b6879eae-7485-483b-8267-bf919164e02b
The Lake Fork of the Arkansas River Watershed Plan	2010	Arkansas	Upper Arkansas River	The Lake Fork Watershed Working Group	http://coloradomtn.edu/wp-content/uploads/filebase/lfwwg/watershed-information/Final_Lake_Fork_Watershed_Plan_07292011.pdf
Fountain Creek Corridor Master Plan	2011	Arkansas	Fountain Creek	Fountain Creek Flood Control and Greenway District; Upper Fountain and Cheyenne Creek Coalition	http://www.fountain-crk.org/files/REPORTS/corr_rest_masterplan101811_final.pdf
Stakeholders' Cooperative Management Analysis for the Upper Arkansas River Basin	2011	Arkansas	Arkansas River Basin	Arkansas River Roundtable	http://cwcbweblink.state.co.us/weblink/0/doc/157760/Electronic.aspx?searchid=f26ab306-ce4c-4ed2-9595-ae9c21e1e23e
Purgatoire River Watershed Plan	2014	Arkansas	Purgatoire River	Purgatoire Watershed Partnership	http://purgatoirepartnership.org/wp-content/uploads/2015/PWP%20Watershed%20Plan%202014%20FINAL_new.pdf
Upper Fountain Creek and Cheyenne Creek Flood Restoration Master Plan	2015	Arkansas	Fountain Creek and Cheyenne Creek	Upper Fountain Creek and Cheyenne Creek Flood Restoration Coalition	http://cwcbweblink.state.co.us/WebLink/0/doc/196305/Electronic.aspx?searchid=d00be47f-263c-46f5-8f56-b51c7cc767db
Protecting Critical Watershed in Colorado from Wildfire: A Technical Approach to Watershed Assessment and Prioritization	2009	Arkansas, Colorado, South Platte	Arkansas Headwaters, Big Thompson, Cache la Poudre, Clear Creek, Colorado Headwaters, Fountain, South Platte Headwaters, St. Vrain, Upper Arkansas, Upper South Platte	Front Range Watershed Protection Data Refinement Work Group	http://www.jw-associates.org/Resources/Work%20Group%20Final%20Report%20V6.pdf

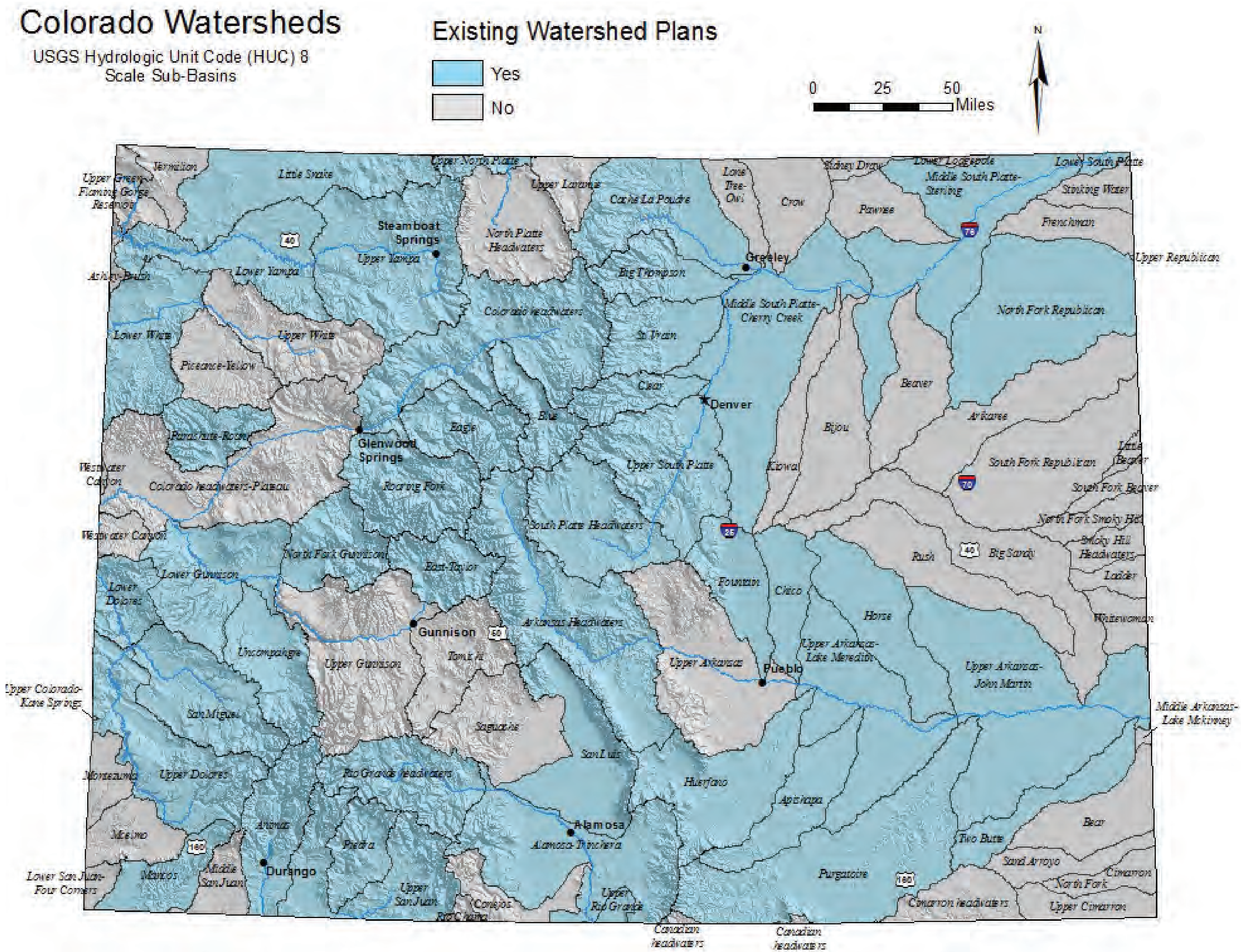
Plan Title:	Year	Basin	River/Stream	Organization	Link
Sediment Control Action Plan Straight Creek I-70 Corridor	2002	Colorado	Straight Creek	Colorado Department of Trasnportation	https://www.codot.gov/projects/contextsensitivesolutions/docs/plans/sc-scap-final.pdf
Snake River Watershed Plan	2009	Colorado	Snake River	Blue River Watershed Group	http://blueriverwatershed.org/wp-content/uploads/2009/05/srwp-final-grant-report.pdf
Grand County Stream Management Plan Draft Report	2010	Colorado	Fraser River, Colorado River, Williams Fork, Muddy Creek, Blue River, Reeder Creek, Troublesome Creek, Willow Creek	Board of County Commissioners	http://co.grand.co.us/DocumentCenter/View/866
Roaring Fork Watershed Plan	2012	Colorado	Roaring Fork	Roaring Fork Watershed Collaborative/ Roaring Fork Conservancy/The Watershed Collaborative	For more information please visit: http://www.roaringfork.org/
Tenmile Creek Restoration Project Preliminary Design Plan	2013	Colorado	Tenmile Creek	Blue River Watershed Group & USFS	http://blueriverwatershed.org/wp-content/uploads/2013/02/Tenmile-Creek-Restoration-Project-Design-Report.pdf
Eagle River Watershed Plan Update	2013	Colorado	Eagle River	Eagle County & Eagle River Watershed Council	http://www.townofeagle.org/DocumentCenter/View/5960
Snake River Watershed Plan	2013	Colorado	Snake River	Blue River Watershed Group & Snake River Watershed Task Force	http://www.snakerivertaskforce.org/Snake_River_Watershed_Task_Force/Data___Reports.html
Middle Colorado Watershed Council: Surface Water Quality Data Analysis	2015	Colorado	Middle Colorado River	The Middle Colorado Watershed Council	http://www.midcowatershed.org/technical_documents/FINAL%20MCWC%20Surface%20Water%20Quality%20Data%20Analysis%203-25-15.pdf
Middle Colorado Watershed Plan	Ongoing	Colorado	Rifle Creek Sub-Watershed	Middle Colorado Watershed Council	https://www.colorado.gov/pacific/sites/default/files/WQ_nonpoint_source-2015-NPS-Projects-Combined.pdf
Eagle River Watershed Plan	1996	Colorado	Eagle River	Eagle River Watershed Council	http://cwcbweblink.state.co.us/weblink/0/doc/136938/Electronic.aspx?searchid=eeac973e-818b-4075-b648-6d9a08192b4a
State of the Roaring Fork Watershed Report	2008	Colorado	Roaring Fork River	Roaring Fork Conservancy and Ruedi Water & Power Authority	http://www.roaringfork.org/
Colorado River Inventory and Assessment	2014	Colorado	Eagle River	Eagle River Watershed Council	http://www.erwc.org/wp-content/uploads/2014/01/CRIA_Final.pdf
Crystal River Stream Management Plan	Ongoing	Colorado	Crystal River	Roaring Fork Conservancy District	http://www.roaringfork.org/your-watershed/crystal-river/stream-management-plan/
Coal Creek Watershed Protection Plan	2005	Gunnison	Coal Creek	Coal Creek Watershed Coalition	http://www.coalcreek.org/uploads/3/8/1/2/38125461/coal_creek_watershed_plan.pdf

Plan Title:	Year	Basin	River/Stream	Organization	Link
North Fork of the Gunnison Watershed Plan Update	2010	Gunnison	North Fork of the Gunnison River	North Fork River Improvement Association (NFRIA)	http://www.lfvc.org/
Gunnison River Basin Selenium Task Force Action Plan	2012	Gunnison	Lower Gunnison	Gunnison Basin and Grand Valley Selenium Task Forces	https://www.colorado.gov/pacific/sites/default/files/WQ_nonpoint_source-3rd-Lower-Gunnison-Selenium-Watershed-Plan-Final-2012.pdf
Lake Fork Valley Conservancy Long Term Monitoring Plan: 2012 to 2022	2012	Gunnison	Lake Fork of the Gunnison River	Lake Fork Valley Conservancy	http://www.lfvc.org/uploads/1/1/1/6/11162750/lfvc_long_term_monitoring_plan-final.pdf
Uncompahgre Watershed Plan	2013	Gunnison	Uncompahgre River	Uncompahgre Watershed Partnership	http://www.uncompahgrewatershed.org/wp-content/uploads/2012/03/UncompahgrePlan-Jan2013.pdf
Upper Slate River Watershed Plan	2014	Gunnison	Slate River	Coal Creek Watershed Coalition	https://www.colorado.gov/pacific/sites/default/files/WQ_nonpoint_source-2nd-Upper-Slate-River-Watershed-Plan%20Final-2014.pdf
Lake Fork of the Gunnison Watershed Plan	Ongoing	Gunnison	Lake Fork of the Gunnison River	Lake Fork Valley Conservancy	For more information please visit: http://www.lfvc.org/
Updated Sampling and Analysis Plan for Site Reclamation and Surface Water, Groundwater, Biological, and Waste Rock Sampling	2003	Rio Grande	Willow Creek	Willow Creek Reclamation Committee	For more information please visit: http://www.willowcreede.org/completed-projects.html
Alamosa River Watershed Restoration Master Plan and Environmental Assessment	2005	Rio Grande	Alamosa River	Alamosa River Foundation	http://cwcbweblink.state.co.us/weblink/0/doc/123626/Page1.aspx?searchid=da985f7b-9053-48f5-af6f-22dbcdeb250d
Rio Grande Watershed Restoration Strategic Plan	2007	Rio Grande	Rio Grande Basin	Rio Grande Basin Headwaters Restoration Project Task Force	For more information please visit: http://www.riograndeheadwaters.org/programs.html
Kerber Creek Watershed Management Plan Draft	2010	Rio Grande	Kerber Creek	Kerber Creek Restoration Project	http://www.kerbercreek.org/watershedplan.pdf
San Luis Valley Regional Habitat Conservation Plan	2012	Rio Grande	San Luis Valley	Rio Grande Water Conservation District	http://www.slvhcp.com/Web_Docs/Final%20SLV%20HCP%20-%20Nov%202012.pdf
San Miguel Watershed Plan	1998	San Juan/ Dolores	San Miguel River	San Miguel Watershed Coalition	http://sanmiguelwatershed.org/uploads/docs/resource_management/smwcWatershedPlan.pdf
Stollsteimer Creek Watershed Plan	2006	San Juan/ Dolores	Stollsteimer Creek	NRCS, San Juan Conservation District, and Pagosa Lakes Property Owners Association	http://www.pawsd.org/2006-Stollsteimer-Watershed-Plan.html
Watershed Plan for the East Fork of the Dolores River in Dolores County	2006	San Juan/ Dolores	East Fork Dolores River	Town of Rico	http://cwcbweblink.state.co.us/weblink/0/doc/137080/Electronic.aspx?searchid=eeac973e-818b-4075-b648-6d9a08192b4a

Plan Title:	Year	Basin	River/Stream	Organization	Link
San Juan Watershed Woody-Invasives Initiative Implementation Plan - Version 1	2008	San Juan/ Dolores	San Juan Watershed (includes Arizona, Colorado, New Mexico and Utah)	San Juan Watershed Woody-Invasives Initiative	http://www.sjwwii.org/Implementation%20Plan%20SJWWII%201-30-08.pdf
Upper Pine River State of the Watershed Report	2008	San Juan/ Dolores	Pine River	Pine River Watershed Group	http://cwcbweblink.state.co.us/WebLink/ElectronicFile.aspx?docid=136973&dbid=0
Dolores River Riparian Action Plan	2010	San Juan/ Dolores	Dolores River	Dolores River Restoration Partnership	http://ocs.fortlewis.edu/drrp/pdf/2010_Dolores_River_Riparian_Action_Plan.pdf
Animas River Watershed Based Plan	2011	San Juan/ Dolores	Lower Animas River	Animas Watershed Partnership	http://animasriverstakeholdersgroup.org/blog/
Mancos Watershed Plan	2011	San Juan/ Dolores	Mancos River	Mancos Valley Watershed Group	http://www.dolorescd.org/docs/WTRSHDPLAN.pdf
The Animas Watershed Plan	2013	San Juan/ Dolores	Upper Animas River	Animas River Stakeholder Group	For more information please visit: http://www.animasriverstakeholdersgroup.org/
Dolores River – Nonpoint Source Pollution Watershed Plan	2013	San Juan/ Dolores	Lower Dolores River	Dolores River Dialogue	http://ocs.fortlewis.edu/drd/pdf/Dolores-Watershed-Plan-17-june-2013.pdf
Big Dry Creek Watershed Management Plan	2002	South Platte	Big Dry Creek	Big Dry Creek Watershed Association	http://www.bigdrycreek.org/documents/FinalWatershedManagementJuly02.pdf
Watershed Management Plan for the Upper Lefthand Creek	2005	South Platte	Lefthand Creek	Lefthand Watershed Oversight Group	http://lwog.org/document/watershed-plan/
Big Thompson Watershed Management Plan	2007	South Platte	Big Thompson River	Big Thompson Watershed Forum	http://www.btwatershed.org/2008/Reports/Final%20CWCB%20CWPF%20grant%20report_12-4-07.pdf
Clear Creek Watershed Report Exploring Watershed Sustainability	2007	South Platte	Clear Creek	Clear Creek Watershed Foundation	http://www.clearcreekwater.org/pdfs/CCWF-2007-report-optimized.pdf
Boulder Creek Community Stewardship Plan	2007	South Platte	Boulder Creek	Boulder Creek Watershed Initiative	http://cwcbweblink.state.co.us/WebLink/DocView.aspx?id=123865&page=1&dbid=0
Barr-Lake and Milton Reservoir Watershed Management Plan	2008	South Platte	Barr- Lake and Milton Reservoir	Barr Lake and Milton Reservoir Watershed Association	http://www.barr-milton.org/wp-content/uploads/2011/08/BMW_WP_Draft_Text_102008.pdf
North Fork of the Republican River Watershed Plan	2008	South Platte	North Fork of the Republican	Yuma County Conservation District	For more information please visit: http://www.ycconservation.com/index.html
Big Thompson State of the Watershed 2010 Report	2010	South Platte	Big Thompson River	Big Thompson Watershed Forum	For more information please visit: http://www.btwatershed.org/

Plan Title:	Year	Basin	River/Stream	Organization	Link
The Trail Creek Watershed Master Plan for Stream Restoration & Sediment Reduction	2011	South Platte	Trail Creek	Coalition for the Upper South Platte	http://cusp.ws/wp-content/uploads/2014/10/TrailCreek_MasterPlanComp.pdf
South Platte River Sportsman's Paradise & Happy Meadows Reaches 20, 21 & 22 River Assessment & Restoration Plan	2011	South Platte	South Platte River (confluence with Beaver Creek and the Crystal Creek)	Coalition for the Upper South Platte	http://www.cusp.ws/wp-content/uploads/2014/10/Sportsmen-Happy_MeadowsHydroReportComp.pdf_
Cherry Creek Watershed Plan	2012	South Platte	Cherry Creek	Cherry Creek Basin Water Quality Authority	http://www.cherrycreekbasin.org/wp-content/uploads/2014/03/Watershed-Plan-2012.pdf
Lower South Platte Watershed Plan - Phase I	2012	South Platte	Lower South Platte River	Colorade State Conservation Board	For more information please visit: https://www.colorado.gov/pacific/agconservation/conservationboard
North Platte River Water Quality Mangement Plan	2012	South Platte	North Platte	Northwest Colorado Council of Governments	http://nwccog.org/wp-content/uploads/2015/04/Noth-Platte-Watershed-2012-208-Plan.pdf
The Waldo Canyon Fire Master Plan for Watershed Restoration & Sediment Reduction	2013	South Platte	Camp Creek; Douglas Creek; Fountain Creek; Monument Creek	Coalition for the Upper South Platte	http://cusp.ws/wp-content/uploads/2014/10/FinalWaldoCanyonFireMasterRestorationPlanComp.pdf
Updated 2014 Bear Creek Watershed Management Plan	2014	South Platte	Bear Creek	Bear Creek Watershed Association	http://www.bearcreekwatershed.org/Watershed%20Plan.htm
Upper Clear Creek Watershed Plan Update	2014	South Platte	Clear Creek	Upper Clear Creek Watershed Association	For more information please visit: http://www.clearcreekwater.org/organization.html
Upper Coal Creek Restoration Watershed Master Plan	2014	South Platte	Upper Coal Creek	Coal Creek Canyon Watershed Partnership	http://www.cccwp.org/watershed/upper-coal-creek-watershed-restoration-master-plan/
Upper South Platte Watershed Plan	2014	South Platte	Upper South Platte	Coalition for the Upper South Platte	For more information please visit: http://cusp.ws/
Little Thompson Watershed Restoration Master Plan	2014	South Platte	Little Thompson	Little Thompson Watershed Restoration Coalition	http://www.ltwrc.org/Proposal%20-%20Tetra%20Tech_edited.pdf
Left Hand Creek Watershed Master Plan	2014	South Platte	Left Hand Creek	Left Hand Creek Coalition	http://lwog.org/wp-content/uploads/final-left-hand-creek-watershed-master-plan2.pdf
Fourmile Creek Watershed Master Plan	2014	South Platte	Fourmile Creek	Boulder County	http://cwcbweblink.state.co.us/WebLink/0/doc/196316/Electronic.aspx?searchid=d00be47f-263c-46f5-8f56-b51c7cc767db
Town of Jamestown Stream Corridor Recovery Design	2014	South Platte	James Creek and Little James Creek	Town of Jamestown	http://cwcbweblink.state.co.us/WebLink/0/doc/196304/Electronic.aspx?searchid=d00be47f-263c-46f5-8f56-b51c7cc767db
St. Vrain Creek Watershed Master Plan	2014	South Platte	St. Vrain Creek		http://cwcbweblink.state.co.us/WebLink/0/doc/196311/Electronic.aspx?searchid=d00be47f-263c-46f5-8f56-b51c7cc767db
Big Thompson River Restoration Master Plan	2015	South Platte	Big Thompson River		http://cwcbweblink.state.co.us/WebLink/0/doc/196307/Electronic.aspx?searchid=d00be47f-263c-46f5-8f56-b51c7cc767db

Plan Title:	Year	Basin	River/Stream	Organization	Link
Fall River Corridor Plan for Resiliency Draft	2015	South Platte	Fall River	Fall River Coalition (transitioning to Estes Valley Chapter)	http://cwcbweblink.state.co.us/WebLink/0/doc/196317/Electronic.aspx?searchid=d00be47f-263c-46f5-8f56-b51c7cc767db
Fish Creek Corridor Plan for Resiliency Draft	2015	South Platte	Fish Creek	Fish Creek Coalition (transitioning to Estes Valley Chapter)	http://cwcbweblink.state.co.us/WebLink/0/doc/196319/Electronic.aspx?searchid=d00be47f-263c-46f5-8f56-b51c7cc767db
Nonpoint Source Watershed Protection Plan for Jackson County Draft	Ongoing	South Platte	North Platte	Owl Mountain Partnership	For more information please visit: http://www.owlmountainpartnership.org
Chatfield Watershed Plan Draft	Ongoing	South Platte	Chatfield Reservoir; Plum Creek; South Platte River; Deer Creek; and Massey Draw	Chatfield Watershed Authority	http://chatfieldwatershedauthority.org/wp-content/uploads/2013/07/Item-2-Chatfield-Watershed-Plan_09-10-14_redlined-Final-Draft.pdf
Watershed Management Plan for Boulder Creek Watershed and Monitoring Plan for St. Vrain Watershed	Ongoing	South Platte	Boulder Creek and St. Vrain	Keep it Clean Partnership	http://www.keepitcleanpartnership.org/watershed/
Upper Cache la Poudre Watershed Plan	Ongoing	South Platte	Cache la Poudre	Coalition for the Poudre River Watershed	https://www.colorado.gov/pacific/sites/default/files/WQ_nonpoint_source-2015-NPS-Projects-Combined.pdf
Lower Beak Creek Watershed Plan	Ongoing	South Platte	Bear Creek	Groundwork Denver	https://www.colorado.gov/pacific/sites/default/files/WQ_nonpoint_source-2015-NPS-Projects-Combined.pdf
South Platte River Restoration Plan Draft	Ongoing	South Platte	Middle South Platte	City of Evans	http://www.middlesouthplatte.org/uploads/5/1/7/6/51766553/south_platte_river_restoration_master_plan_-_draft.pdf
Yampa River Basin Partnership Work Plan	2006	Yampa/ White/ Green	Yampa River	Yampa River Basin Partnership	For more information please visit: http://yampavalleypartners.com/yampa-river-basin-partnership/
Upper Yampa River Basin Implementation Plan	2006	Yampa/ White/ Green	Upper Yampa River	Routt County Conservation District	http://routtcountycd.com/wp-content/uploads/2012/04/implementation-plan.pdf
Northwest Colorado Watershed Partnership Action Plan (NCWPAP)	2011	Yampa/ White/ Green	Yampa, Little Snake, White, and Green Rivers	Northwest Colorado Riparian Restoration Partnership	http://www.tamariskcoalition.org/sites/default/files/files/Northwest%20Colorado%20Watershed%20Partnership%20Action%20Plan.pdf
Upper Yampa State of the Watershed Report	2014	Yampa/ White/ Green	Upper Yampa River	Upper Yampa River Watershed Group	http://www.co.routt.co.us/AgendaCenter/ViewFile/Item/1656?fileID=1840
Upper Yampa Watershed Plan	Ongoing	Yampa/ White/ Green	Upper Yampa Watershed	Routt County Conservation District	http://www.flipgorilla.com/p/23023990364732953/show#/23023990364732953/2


Colorado Watersheds
USGS Hydrologic Unit Code (HUC) 8
Scale Sub-Basins
Existing Watershed Plans
Yes
No
0
25
50
Miles
N
Vermilion
Upper Green-Flaming Gorge Reservoir
Little Snake
Upper North Platte
Upper Laramie
Cache La Poudre
Lone Tree-Owl
Crow
Sidney Draw
Pawnee
Lower Lodgepole
Middle South Platte-Sterling
Lower South Platte
Stinking Water
Frenchman
Upper Republican
Steamboat Springs
Upper Yampa
North Platte Headwaters
Greeley
Big Thompson
Lower Yampa
Lower White
Upper White
Colorado headwaters
St. Vrain
Middle South Platte-Cherry Creek
North Fork Republican
Piceance-Yellow
Clear
Denver
Beaver
Bijou
Arikaree
Blue
Eagle
Glenwood Springs
Parachute-Roan
Upper South Platte
Kiowa
South Fork Republican
Little Beaver
South Fork Beaver
Colorado headwaters-Plateau
Roaring Fork
Westwater Canyon
South Platte Headwaters
North Fork Smoky Hill
Smoky Hill Headwaters
Rush
Big Sandy
Ladder
North Fork Gunnison
East-Taylor
Lower Gunnison
Lower Dolores
Fountain
Chico
Horse
Whitewoman
Gunnison
Arkansas Headwaters
Uncompahgre
Upper Gunnison
Tomichi
Upper Arkansas
Pueblo
Upper Arkansas-Lake Meredith
Upper Arkansas-John Martin
Upper Colorado-Kane Springs
San Miguel
Saguache
Middle Arkansas-Lake Mckinney
San Luis
Montezuma
Upper Dolores
Rio Grande headwaters
Huerfano
Apishapa
Animas
Alamosa
Alamosa-Trinchera
Bear
Mcelmo
Piedra
Two Butte
Sand Arroyo
Lower San Juan-Four Corners
Mancos
Middle San Juan
Durango
Purgatoire
Cimarron
North Fork
Upper San Juan
Conejos
Upper Rio Grande
Cimarron headwaters
Upper Cimarron
Canadian headwaters
Canadian headwaters
40
160
50
25
70
76

Appendix E: Source Water Protection Plans in Colorado

E

Surface Water System Plans

Organization	Reporting Year	Population Served
Salida, City of	2005	6,000
Gunnison County WSD	2005	700
Mad Dog WC	2005	75
Ponderosa Lodge	2005	125
Bayfield, Town of	2005	1,600
Penrose WD	2006	3,298
Rockyford, City of	2006	4,286
Southern Ute Tribe	2006	2,300
Palmer Lake,Town of	2006	2,450
Cuchara WSD	2007	1,400
Grand Junction, City of	2007	28,000
Palisades, Town of	2007	3,000
Park Center WD	2007	3,020
La Veta, Town of	2007	950
Walsenburg, City of	2007	4,534
Beulah Water Works District	2008	600
Mesa Water and Sanitation District	2008	300
Pine Drive Water District	2008	416
Grand Mesa MD 2 (Powderhorn Metro 1 District)	2008	1,823
Collbran, Town of	2008	660
Mancos, Town of	2009	1,390
Mancos Rural Water Company	2009	1,500
Mesa Verde National Park	2009	60
Thornton, City of	2010	120,000
Northglenn, City of	2010	35,357
Westminster, City of	2010	214,652
Coalby Domestic Water Company	2010	212
Dillon Valley District	2010	2,700
St. Charles Mesa WD	2010	11,020
Cedaredge, Town of	2010	2,054
Dillon, Town of	2010	4,821
Kremmling, Town of	2010	1,881
Orchard City, Town of	2010	2,990
Rangely, Town of	2010	2,000
Upper Surface Creek Domestic Water	2010	2,700
Jamestown, Town of	2011	250
Left Hand WD	2011	28,040
Little Thompson WD	2012	20,001
Mount Crested Butte WSD	2012	1,800
Meridian Lake Park	2012	300
Little Elk Creek HOA	2012	200

Surface Water System Plans

Organization	Reporting Year	Population Served
Wigwam Mutual Water Company	2013	1,000
Stucker Mesa Water Company	2013	400
New Castle, Town of	2013	3,800
Ridgeway, Town of	2013	1,000
Silt, Town of	2013	2,400
Rifle, City of	2013	7,001
Crawford Mesa WA	2013	220
Durango, City of (Florida River)	2013	20,000
Forest View Acres	2014	300
Parkville WD	2014	2,838
Florence, City of	2014	3,714
Canon City, City of	2014	16,477
Town of Hotchkiss	2014	1,120
Victor, City of	2014	434
Rye, Town of	2014	244
Bone Mesa Domestic Water District	2014	400
Central City, City of	2014	3,565
Alma, Town of	2014	275
Colorado City MD	2014	1,811
Glenwood Springs, City of	2015	9,400
Evergreen MD	2015	13,500
Carbondale, Town of	2015	6,000
Oak Creek, Town of	2015	884
Central City, City of	2015	672
Manitou Springs, City of	2015	4,890
Nederland, Town of	2015	2,000
Georgetown, Town of	2015	1,088
Denver Water Board	2015	1,300,000
Buena Vista, Town of	2016	2,317
Aspen, City of	2016	7,600
Snowmass Village WSD	2016	3,200
Glacier Club	2016	525
Gypsum, Town of	2016	6,400
Trinidad, City of	2016	11,400
Silverton, Town of	2016	680
Blackhawk, City of	2016	15,150
Rocky Ford, City of	2016	4,093
Lafayette, City of	2016	25,000
Homestead, WC	2016	780
Fort Collins, City of	2016	129,100
Cragmont, WC	2016	50
Total	**82**	**2,131,193**

Ground Water System Plans

Organization	Reporting Year	Population Served
Forest Lakes MD	2005	1,258
Angel of Shavano CG 1	2005	131
Angel of Shavano Group Area	2005	131
Boone, Town of	2005	350
Gunnison, City of	2005	7,620
Costilla WSD	2005	561
Crawford, Town of	2005	248
Garfield Monarch Mtn Lodge	2005	525
Heart of the Rockies	2005	20
Las Animas, City of	2005	2,758
Limon, Town of	2005	2,300
Monarch Park 1	2005	118
Monarch Park 2	2005	118
Monarch Ski Area	2005	3,000
O'Haver Lake 1	2005	96
O'Haver Lake 2	2005	96
Round Mountain WSD	2005	925
Simla, Town of	2005	913
Kiowa, Town of	2005	950
Walsh, Town of	2005	822
Youtsey WC	2005	1,000
Holly, Town of	2006	900
Springfield, Town of	2006	1,750
Ramah, Town of	2007	134
Northern Colorado WD	2007	4,550
Avondale, Town of	2008	1,500
Brush, City of	2009	5,117
Meeker, Town of	2009	2,483
Crested Butte South MD	2010	900
Morgan County Quality Water	2010	6,595
Prairie View Subdivision	2010	200
Snake River Water District	2010	17,900
Huajatolla Valley Estates	2011	115
Colorado Centre MD	2011	2,570
Basalt, Town of	2011	2,125
Paonia, Town of	2011	295
Hugo, Town of	2011	885
Woodmoor WSD	2011	7,124
Win Mar Cottages	2012	40
ChristLife Community Church	2012	305
Black Bear Lodge	2012	62

Red = Substantial Implementation   Blue = 2015-16 Proposed Plans

Ground Water System Plans

Organization	Reporting Year	Population Served
La Jara, Town of	2012	825
Romeo, Town of	2012	450
Sanford, Town of	2012	850
San Luis Water and San District	2012	790
Castlewood Canyon State Park	2012	806
Garcia Domestic Water User's Association	2012	100
KV HOA	2012	120
Academy WSD	2012	750
Ward, Town of	2012	160
Mesa Cortina WSD	2012	300
Little Elk Creek HOA	2012	200
Mid Colorado Investment	2012	500
Deer Valley Ranch	2012	197
One Mile Campground	2012	86
Sunshine Campground	2012	70
Republic Paperboard	2012	50
Wilderness Young Life Ranch	2012	95
Saguache, Town of	2012	570
Ellicott Plaza	2012	33
Valley View Hot Springs	2012	87
Aspen Mesa HOA	2012	225
Gateway Metropolitan District	2012	160
Red Table Acres HOA	2012	90
Sopris Village HOA	2012	425
Blanca, Town of	2012	391
Garcia Domestic Water User's Association	2012	100
Canyon Creek Estates HOA	2012	140
Westbank Mesa HOA	2013	110
Westbank Ranch HOA	2013	310
WJ Metro District	2013	252
Woody Creek HOA	2013	450
East Cherry Creek Valley WSD	2013	50,500
Colorado Mountain College	2013	1,015
Elbert Water and Sanitation District	2013	120
Kings Row HOA	2013	52
Mitchell Cooper Ditch and Pipe	2013	1,200
Parachute, Town of	2013	1,320
Pitkin Mesa Pipeline Company	2013	295
Stratmoor Hills	2013	6,500
Julesburg , Town of	2013	1,472
Ovid, Town of	2013	330

Red = Substantial Implementation Blue = 2015-16 Proposed Plans

Ground Water System Plans

Organization	Reporting Year	Population Served
Sedgwick, Town of	2013	190
Crowley County WA	2013	530
Crowley County WS	2013	2,260
Talbott Enterprises Inc.	2013	1,100
Ordway, Town of	2013	1,300
Olney Springs, Town of	2013	225
Crawford, Town of	2013	415
Springfield, Town of	2013	105
Campo, Town of	2013	160
Durango-La Plata County Airport	2013	100
El Ranch Florida	2013	400
Forrest Groves Estates	2013	89
Fort Garland	2013	432
Edgemont Ranch	2013	700
Colorado Trails Ranch	2013	100
Ridgeway, Town of	2013	100
Canyon Creek Estates HOA	2014	140
Oak Meadow Service Company	2014	101
Cattle Creek Water Association	2014	47
Falls Creek Ranch Water 1 and 2	2014	200
Erie, Town of	2014	18,135
Eads, Town of	2014	747
Colvig Silver Camp	2014	250
Town of Aquilar	2014	825
Pine Brook Water District	2015	1,100
Cheyenne Wells, Town of	2015	846
Deerwood Service Company	2015	62
Elizabeth, Town of	2015	1,435
Forest View Acres WD	2015	350
Kit Carson, Town of	2015	326
Arapahoe, WC	2015	98
Oak Meadows Water Association	2015	101
Triview MD	2015	3,107
Strasburg WSD	2015	2,050
Hamilton Creek MD	2014	162
Roaring Fork Water and Sanitation District	2016	1,000
Cripple Creek, City of	2016	11,680
East Dillon Water District	2016	1,500
Poncha Springs, Town of	2016	799
Goodman POA	2016	101
Animas Water Company	2016	1,100

Red = Substantial Implementation   Blue = 2015-16 Proposed Plans

Ground Water System Plans

Organization	Reporting Year	Population Served
Blue Sky Ranch	2016	100
Purgatory Metro District	2016	1,200
Buffalo Mountain Metro District	2016	2,500
Hermosa MHV	2016	100
Wiggins, Town of	2016	1,000
Lake Creek, MD	2016	350
Peetz, Town of	2016	296
Spring Park Meadows, HOA	2016	38
Silver Heights, WSD	2016	301
Monte Vista, City of	2016	4,600
Fowler, Town of	2016	1,200
Flagler, Town of	2016	612
Deer Trail, Town of	2016	600
Monument, Town of	2016	1,900
Yampa, Town of	2016	429
Crook, Town of	2016	115
Creede, City of	2016	290
Tabernash Meadows, WSD	2016	450
Shannon WSD	2016	450
Sage, WUA	2016	280
Marble, WC	2016	93
Total	**144**	**223,358**

Surface and Groundwater Protection Plan Total	**226**	
Surface and Groundwater Protection Population Total	**2,354,551**	

Number of Proposed Plans (2015-2016)	41	
Number of Substantially Implemented Plans	153	
Population of Substantially Implemented Plans	2,067,586	

Please contact the Source Water Protection Work Group Leader at 303.692.3534 or [visit www.colorado.gov/cdphe/wqcd](www.colorado.gov/cdphe/wqcd) *for more information*

Appendix F: Summary of Outreach, Education, and Public Engagement Activities Completed during Development of Colorado's Water Plan

Outreach, education, and public engagement efforts during development of Colorado's Water Plan were unprecedented and built on a decade of stakeholder involvement. Between September 2013 and September 2015, the CWCB received and responded to over 30,000 comments before it released the final plan in December 2015. Because Colorado's Water Plan rests upon stakeholder engagement, it is critical to highlight education and outreach efforts. This was a grassroots effort, and this appendix outlines the high level of local and volunteer efforts used to involve the public in the process.

Statewide Outreach, Education, and Public Engagement Activities

Public engagement, coupled with consistent and clear communication, was crucial throughout the development of Colorado's Water Plan—and these activities built upon the strong foundation of outreach efforts the CWCB and basin roundtables (through the Public Education, Participation, and Outreach (PEPO) Workgroup) conducted over the past 10 years. Both statewide and within each basin, the CWCB, basin roundtables, and stakeholder groups distributed information to the water community, interested stakeholder constituencies, and the general public. In September 2013, the CWCB developed an outreach and communication plan around four clearly defined goals to provide a cohesive strategy and structure for all communication and outreach activities associated with the development of Colorado's Water Plan. Table F-1 provides a review of the methods the CWCB used to achieve those goals. Following the table is an analysis of the over 30,000 comments these activities generated.

The outreach and communications plan goals were:

1. To engage the public and create general public awareness and dialogue about Colorado's Water Plan and its role in ensuring a secure water future for Colorado.
2. To build support within the water community for Colorado's Water Plan and increase the level of understanding of the plan and its components.
3. To proactively identify and address issues that may create barriers to success for Colorado's Water Plan, and mitigate and manage negativity.
4. To share the responsibility of implementing and executing communication about Colorado's Water Plan across CWCB leadership and key stakeholders to foster a collective voice.

TABLE F-1 OUTREACH METHODS

Basin Roundtable Engagement	The CWCB and basin roundtables (through PEPO and BIP consultants) developed communication materials and messaging about Colorado's Water Plan and BIPs.
Grassroots Stakeholder Group Outreach	The CWCB established and used a database of key community, civic, and water organizations (e.g. Chambers of Commerce, Colorado Municipal League, Water Congress, and regional advocacy groups, among others) with established communication networks (e.g. websites, newsletters, and email updates) to distribute Colorado's Water Plan materials. The CWCB engaged these groups in the development of the plan and distributed information to their constituents. These groups also provided important speaking opportunities at various meetings and gatherings.
Public Input and Response	The CWCB solicited public input for all communication materials related to Colorado's Water Plan. The agency built a public comment form into the Colorado's Water Plan website, and established a new email account (cowaterplan@state.co.us) to receive public input. It also created guides for submitting public input. All public comments and staff responses are available for review online. At each CWCB board meeting from September 2013 to September 2015, the CWCB provided an opportunity for public input to encourage comment regarding Colorado's Water Plan. The CWCB also encouraged members of the public to engage directly with their basin roundtables.
Media Relations	The CWCB worked with the press to clearly articulate Colorado's Water Plan development process and to establish a foundation of knowledge and awareness among members of the media.
DNR/CWCB/IBCC Leadership Presentation Circuit	Meetings with DNR, CWCB, and IBCC leadership helped enhance understanding of and build support for Colorado's Water Plan in the water community. The CWCB met and worked with over 100 key organizations and individuals listed in Appendix G. In coordination with the IBCC and the basin roundtables, the CWCB identified representatives from geographically diverse areas who spoke about Colorado's Water Plan in various forums across the state. This included engaging key partners, such as agricultural and municipal water providers. The CWCB arranged speaking engagements, and developed materials and training sessions for spokespeople. As appropriate, staff conducted targeted pre-event outreach and follow-up activities to increase stakeholder attendance at important events, and created opportunities for additional interaction and dialogue.
Materials and Branding	The CWCB developed an overarching brand—including a logo, templates, and consistent look-and-feel—that reflected Colorado's Water Plan purpose and values. The CWCB also developed a suite of printed materials, which are available for download on the Colorado's Water Plan website, and which the CWCB distributed to communities at speaking engagements and conferences.

TABLE F-1	OUTREACH METHODS (CONTINUED)
Digital Engagement – Web and Social Media	The CWCB developed a robust online presence for Colorado's Water Plan that served as a hub where stakeholders and the public could obtain information, subscribe to updates, provide input, and get involved with the process. The strategy included the development of Colorado's Water Plan website, social media channels, and targeted email campaigns tied to key milestones, such as the release of the BIPs. The website included a master calendar of events to promote existing opportunities to reach key stakeholders. The CWCB also created Facebook and Twitter accounts and integrated them into the Colorado's Water Plan website. The CWCB launched and promoted the accounts through a variety of channels, including the website and email campaigns. These social media tools continue to provide an informal and interactive venue for dialogue and the exchange of ideas. The CWCB staff monitor and administer these accounts and regularly post relevant information, answer questions, and participate in the conversation.

Input Generated on Colorado's Water Plan Between September 2013 and September 2015

Between September 2013 when the CWCB began work on the first draft of Colorado's Water Plan, and September 2015, it received, reviewed and responded to over 30,000 comments for consideration in the final plan. Those comments included over 7,000 unique submissions and over 22,000 form letters. Comments came in from every basin in Colorado and were submitted by individuals, organizations, students, state, and federal agencies across all interest groups. The CWCB reviewed nearly 500 documents, in addition to all of the emails and webforms. CWCB staff members engaged with over 150 organizations, agencies, and other partners statewide regarding their involvement in the development of Colorado's Water Plan. Appendix G includes a list of those organizations.

Pursuant to SB14-115, the Water Resources Review Committee (WRRC) held public hearings in every basin to gather comments on Colorado's Water Plan during summer 2014 and summer 2015.[1] Input submitted to the CWCB on November 1, 2014 included over 200 public comments. Input submitted to the CWCB on September 15, 2015 included nearly 70 comments.

How Public Comments Were Incorporated During Development of Colorado's Water Plan

Comments received from the public and interested stakeholders shaped every single chapter and section of Colorado's Water Plan throughout the development process. Members of CWCB's staff read input the public submitted by email to cowaterplan@state.co.us or through the web form on Colorado's Water Plan website. CWCB staff members then identified which section of Colorado's Water Plan each comment addressed, incorporated where appropriate, and drafted a tailored response. CWCB catalogued all input and presented it at the subsequent CWCB board meeting, as well as posted it to www.coloradowaterplan.com under the "Get Involved" tab on the "Record of Input Received to Date" page. CWCB staff members considered public input as they prepared each draft of Colorado's Water Plan and the final plan. The final public comment period ended September 17, 2015.

Colorado's Water Plan Website

The CWCB launched Colorado's Water Plan website on November 1, 2013 to provide outreach and educational resources about Colorado's Water Plan. The CWCB promoted the website through social media, CWCB staff presentations, and publications related to Colorado's Water Plan. The number of people visiting the website each month rose steadily, and through October 2015, the site had received over 16,000 unique visitors.

TABLE F-2	CODES FOR COLORADO'S WATER PLAN INPUT TOPICS
Pro Nonconsumptive Needs	
Municipal Conservation and Efficiency	
Increase in Conservation Target	
Anti-Transmountain Diversion	
Agricultural Conservation and Efficiency	
Agricultural Transfer Methods	
Climate change concern	
Watershed health	
Reuse	
Anti-dam	
Land use management	
Funding	
Legislation	
Streamflow Management (plans)	
Preserving water for future generations	
Preserving Agriculture	
Pro-storage / Regarding storage	
Need better water quality	
Pro- Instream Flow program	
General	
Education and Outreach	
Lawns	
Compact compliance issues	
Permitting efficiency	
Water / Energy Nexus	
Anti- Land Development/ Municipal growth/sprawl	
Groundwater	
Anti- Fracking	
Anti Population Growth	
Pro- Tiered Rate	
Local Control	
Anti-extractive industries	
South Platte / Metro BIP	
Pro- Rainwater harvesting	
Pro- Transmountain Diversion	
Tribal interest	
Pro- Fracking	

The website will continue to be the primary access point for accessing the final draft of Colorado's Water Plan. Other documents and information will continue to be available on the site, including the BIPs, all input the CWCB directly received about Colorado's Water Plan through 2015, and the formal responses the CWCB provides to commenters.

Input Received – Data and Analysis

The CWCB analyzed and coded the over 30,000 comments received between September 2013 and September 2015. Comments received were coded according to over 40 different topics, which are all listed in Table F-2. The comments were also coded based on the water values driving Colorado's Water Plan including vibrant and sustainable cities, viable and productive agriculture, a robust skiing, recreation and tourism industry, and a thriving environment that includes healthy watersheds, rivers, streams, and wildlife.

Comment coding data for the more than 30,000 comments revealed each of the values driving the plan had strong representation in the comments. The data also shows that a great majority of commenters believe the environment is an important part of Colorado's Water Plan and that a lot of Coloradans care about that aspect of the plan. However, the coding data alone does not necessarily tell the whole story. For example, just because the CWCB did not receive the same number of comments from the agricultural community as it did from the environmental community does not necessarily mean that agricultural interests are not an equally important value that should be reflected in the plan. When drawing conclusions around public perceptions and attitudes about water topics it's important to include analysis from a range of reports, such as scientifically valid surveys.

For example, in 2013, when the CWCB worked with BBC Consultants to complete a statewide survey of water awareness, the survey showed conflicting results in terms of what values are most important to people in Colorado. The data from that survey showed that the amount of water available for Colorado's farms and ranches was the second most important water-related issue to the public. The first was the quality of water in their homes. That survey also revealed that when asked what should be done to address Colorado's most important water concerns, the public answered "develop more new projects and build new dams" nearly as often as they answered "prioritize environmental needs." In general, these types of surveys will be more accurate indicators of public attitudes, while comments indicate the public engagement approach that different interests take, and the level of interest from environmentally oriented Coloradans to participate through comment letters. Colorado's Water Plan includes recommendations and actions that will allow for additional analysis of existing surveys, and possibly updates to add to existing data in the future. These actions will help guide the strategy for water education moving forward.

For comparison purposes, one of the reasons the comments sent to the CWCB on Colorado's Water Plan show a lot of interest in environmental issues is that there were a large number of environmental advocacy groups stimulating individual comments on those topics. The agricultural groups submitting comments used different methods that resulted in their comments representing a smaller percentage of the comments received. For example – the Colorado Agriculture Water Alliance's two comment letters, which were very substantive in nature, represented the voice of their constituencies all over the state, who met with each other several times to craft their letters.

The most important take away from coding the comments received by the CWCB on Colorado's Water Plan is to understand that Colorado's Water Plan incorporated these comments after careful consideration of each one by the CWCB.

Basin Outreach, Education, and Public Engagement Activities

This section provides an explanation and summary of the basin roundtable and PEPO outreach efforts throughout the development phases of the BIPs and Colorado's Water Plan.

Each basin's PEPO education liaison and roundtable leadership supported the collection of information and input. The scope of these efforts far exceeds any other period of voluntary, roundtable-driven outreach activities—resulting in a significant increase in public engagement and, ultimately, an inclusive, comprehensive, deliberative, and community-supported water supply planning process.

During the BIP process, the roundtables captured data that have provided quantification on:

- The number of technical outreach meetings each roundtable, the BIP consultants, and stakeholder groups held to identify specific water needs and projects.
- The number of dedicated public meetings these groups organized to obtain responses to the BIP goals, needs assessments, and proposed projects.
- The number and type of attendees at each stakeholder and public meeting.
- The type of input communities provided to the roundtables.
- The way in which the BIPs factored in the input.
- Other roundtable outreach activities.
- A summary of future planned outreach activities.

Between February 2014 and April 2015, the basin roundtables collectively hosted over 150 dedicated public meetings in addition to regular basin roundtable meetings. All in all, nearly 4000 participants engaged in those meetings (among roundtables that collected data on attendance). Each BIP summarizes those meetings. In addition to hosting public meetings, the roundtables employed innovative approaches to education and outreach. They published hundreds of local newspaper articles, participated in radio shows, developed and maintained websites to share BIP information, produced printed materials to distribute at local events, gave presentations at various community events, surveyed basin residents about BIP issues, solicited public input, incorporated comments into BIPs, and engaged diverse stakeholder groups and individuals basin-wide. The final BIP documents incorporate a total of 954 public comments from the three reporting basins that tracked that data. Most basins did not have the capacity to report on this level of detail.[2]

Sustaining Long-Term Strategies

In addition to receiving assistance from the BIP consultant teams while drafting its respective BIP, each basin roundtable used its PEPO education action plan to guide outreach strategies, and used the $2000 available annually (which increased to $6500 annually beginning fiscal year 2016) through the PEPO Workgroup. Many roundtables used current funds and staff to implement outreach activities, while others sub-contracted this work out to the BIP consultants or relied on external partnerships. Some basins used WSRA grants to fund more comprehensive education and outreach programs. Regardless, all of the roundtables collaborated with their outreach teams more than ever before; it will be imperative to consider ways to sustain this momentum into the future.

The BIPs contain information about the extent and detail of each basin's education and outreach efforts. A comparison of the commonalities among the basins' long-term strategies shows that all basins articulated the need for building an active roundtable membership, coordinating partnerships, defining critical audiences, and building relationships with key constituencies. The following section features unique activities the basins incorporated into the BIPs and outreach strategies they identified as critical in moving forward.

Arkansas River Basin

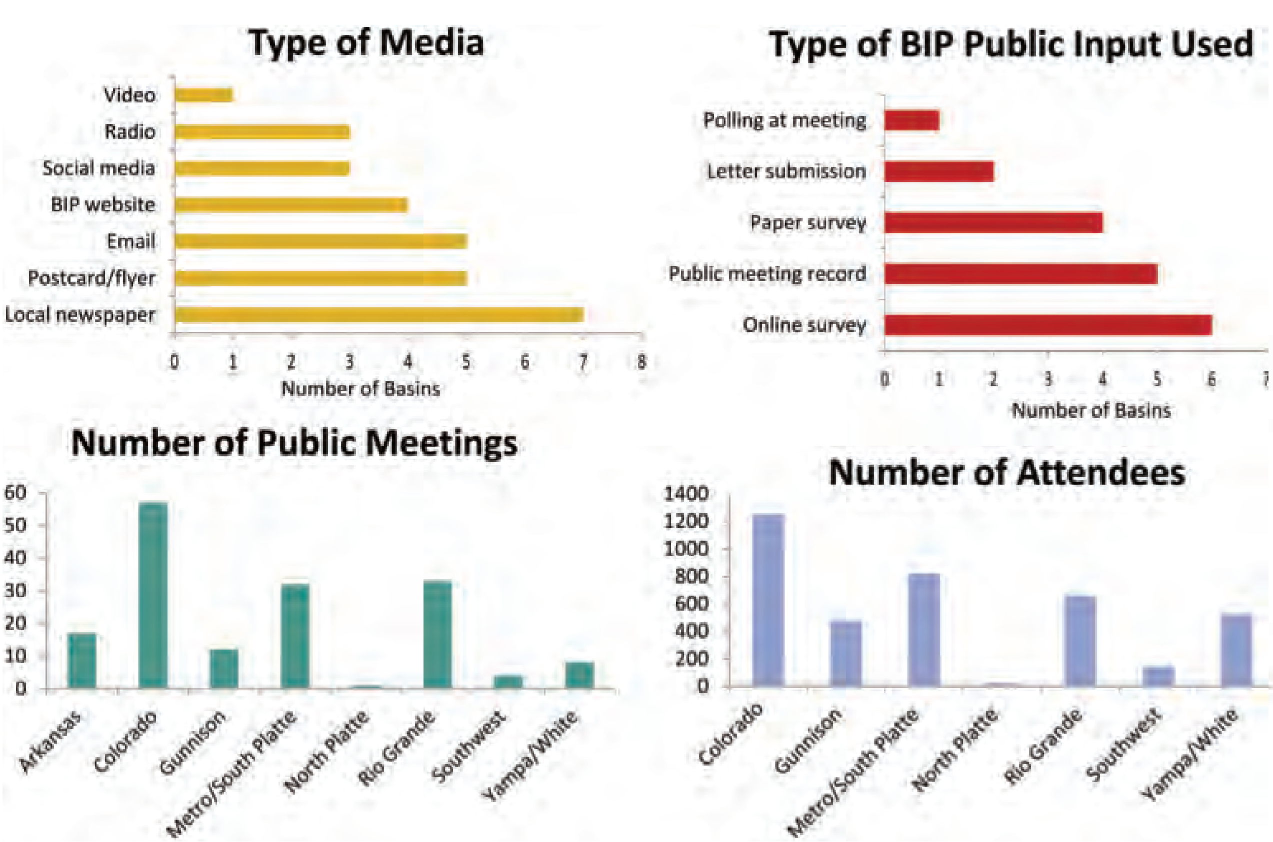
Featured Activity

In partnership with Colorado Springs Utilities and with funding from an WSRA grant, the Watershed Health Working Group conducted outreach efforts to bring together basin roundtable members, representatives from federal and state natural resource agencies, NGO stakeholders, and local government officials. The group developed strategies to improve communication and collaboration between entities that respond to watershed health-related threats and events, and developed value maps and an action plan for the basin. An outcome of this internal capacity-building process was the creation of the Arkansas River Watershed Collaborative.

Featured Strategy

The basin plans to undertake a structured public relations effort to maintain and improve partnerships and relationships among community leaders, media outlets, and active citizen groups while enhancing efforts to educate stakeholder groups about the purpose and progress of the water planning process in the Arkansas Basin. Education efforts may include the development of a whitepaper for public policy makers. These efforts will require significant resources to define critical audiences, craft calls to actions, and measure the effectiveness of communication channels.

FIGURE F-1 BIP PUBLIC MEETING DATA



Colorado River Basin

Featured Activity

With an WSRA grant and in collaboration with Colorado Mesa University's Water Center, the Colorado Basin Roundtable solicited input from the public through online surveys, which it advertised in a series of newspaper articles; open discussions at 57 meetings for 1250 attendees; and comment letters and emails. Working with Roaring Fork Conservancy, Eagle River Watershed, Trout Unlimited, and Club 20, the roundtable conducted surveys that generated over 500 responses from adult audiences and student groups, who shared significant concern about future water supplies and the health of the environment in the Colorado Basin. The roundtable developed its six major "themes of the basin" as a result of this data collection.

Featured Strategy

The basin roundtable plans to use the partnerships and communication channels it developed through the BIP outreach process to continue educating the public about basin roundtable activities and regional and statewide water needs, and to encourage the public to provide input about how these needs should be met. The roundtable will share the results of these activities with the CWCB as its planning efforts continue. Longer-term strategies will engage the public regarding basin-wide and statewide water challenges and opportunities, with goals to maintain a steady presence in both traditional and social media, and to ensure that members and partner organizations have the tools they need to inform their constituencies and collect public input on basin roundtable issues.

Gunnison River Basin

Featured Activity

The development of the BIP prompted an organized outreach effort among representatives from each of the six sub-basins of the Gunnison Basin, including educational entities and watershed groups. Basin members organized information-and-input events, and used *The Gunnison River Basin, A Handbook for Residents*[3] for town hall meetings with the general public in order to obtain responses to the goals, needs assessments, and proposed projects. Overall input demonstrated strong support for the BIP Basin Goals and Statewide Principles.

Featured Strategy

A long-term strategy focuses on engaging non-roundtable stakeholders to contribute input and feedback about key BIP elements in order to help the basin roundtable reach out to potential new project proponents and partnerships. To help address the basin's water needs, the roundtable encourages the implementation of several concepts and activities by 2025, such as educating the next generation and political leaders, and conducting research on climate change adaptation and the BIP's 10 "tier one" projects. Due to limited resources, the successful continuation of education and outreach activities will require careful coordination with existing organizations, programs, and resources.

Metro/South Platte River Basin

Featured Activity

During the development of the draft and final BIP, the roundtable hosted a total of 32 public meetings, which it publicized through local media, in unique locations across the basin. At least 820 participants attended. They represented a wide variety of interests including agriculture, municipal, industrial, business, recreation, and environmental interests. With assistance from their BIP consultant team, the roundtable used surveys to collect public and stakeholder comments during the meetings, and shared the comments with the basin roundtables for analysis and incorporation into the joint BIP.

Featured Strategy

A facilitated Metro/South Platte basin education committee workshop will identify the staffing and coordination the roundtable will need to identify common priorities and develop implementation strategies. An initial strategy will be the development of a joint communication plan targeted at stakeholders, including water users, political leaders, and major business and industry leaders throughout the state. This plan will maximize existing opportunities and avoid duplication of efforts in order to generate a lasting baseline of public awareness and support for the need for innovative water rate structures, energetic conservation measures, and more integrated land use and water supply planning.

North Platte River Basin

Featured Activity

During the BIP process, basin roundtable members participated in a public outreach meeting and targeted technical workshop meetings with both consumptive and environmental and recreational stakeholders. The public outreach meeting was announced in the local newspaper, and 22 members of the public attended to learn about the history of the roundtable and current planning efforts.

Featured Strategy

Public education and outreach programs can effectively address adverse perceptions and increase project acceptance. By working closely with organizations that specialize in the facilitation of public education and outreach programs, the basin will increase public understanding and participation in important water issues, and capitalize on the basin's education liaison's previous educational efforts.

Rio Grande River Basin

Featured Activity

The BIP process strengthened the roundtable's existing comprehensive outreach program by using numerous media platforms, such as weekly newspaper articles, monthly radio programs, a dedicated website, and a "water 101" booklet developed specifically for the basin. This program has resulted in increased public attendance at regular roundtable meetings, as well as increased momentum for creation of a forum to discuss multiple-use project implementation.

Featured Strategy

Through a continued partnership with the Rio Grande Watershed Conservation and Education Initiative, the basin will establish a long-term education and outreach strategy for water use and needs. This strategy builds the basin's public communication around three key ideals—outreach, education, and participation—across all demographics, including water users, public officials, communities, and water leaders. The roundtable can achieve this strategy through the development of relationships with active and diverse basin roundtable members, educational opportunities, and strategic planning forums.

Southwest River Basin

Featured Activity

Unique to this basin is the "social hour" before each roundtable meeting, during which nearly as many members of the public attend to learn and network as roundtable members themselves. An additional set of meetings has provided local decision makers with information about the CWP and BIP, as well as discussion topics to spur participation and input—resulting in a greater understanding of public concerns and interests as they relate to water development and uses within the basin. Similarly, the basin asked attendees to widely share the CWCB's fact sheets and the winter 2015 issue of Headwaters magazine with their constituents.

Featured Strategy

Working with the Water Information Program, the roundtable plans to continue to inform local decision makers and the public about consumptive and nonconsumptive needs and planned projects, ways to promote partnerships, representation on the roundtable, and ways to disseminate information on natural variability of river flows and the hydrologic cycle. One short-term strategy to achieve BIP goals related to conservation, land-use planning, and water reuse is to implement a pilot conservation and land-use planning session.

Yampa/White/Green River Basin

Featured Activity

Through a WSRA grant, the Community Agriculture Alliance implemented and facilitated education and outreach activities for the basin. This included forming a partnership with three local National Resources Conservation Service (NRCS) conservation districts to host and widely advertise a water forum and Q&A session at their annual meetings, thereby expanding the basin roundtable's constituency. The education committee administered input surveys to the 255 attendees as well as to other stakeholders throughout the BIP process, resulting in three new IPPs for consumptive use projects and 17 additional IPPs for environmental and recreational projects.

Featured Strategy

The basin roundtable recognizes the importance of including stakeholders in the process of developing and implementing IPPs, and will therefore serve as a source for information exchange. It will encourage participation in the public process to provide transparent and open dialogue among all involved parties. Additionally, some IPPs can influence streamflows both upstream and downstream of a project location; as such, the basin roundtable can generate public awareness of projects and help build consensus regarding water management challenges and opportunities.

1 C.R.S. § 37-60-106.

2 Kate McIntire, memorandum to the Colorado Water Conservation Board, "Agenda Item 9a, Statewide Outreach Status Update – May 2014," (2014), http://cwcbweblink.state.co.us/weblink/0doc/195420/Electronic.aspx?searchid=27f8d999-7734-4ef1-afa6-f1cb603e6d3d.

3 Gunnison Basin Roundtable, The Gunnison River Basin: A Handbook for Inhabitants (Grand Junction, CO: Water Center at Colorado Mesa University, 2013), http://www.coloradomesa.edu/watercenter/documents/Gunnison_Basin_Special_2013.pdf.

Appendix G: Organizations CWCB Met with while Developing Colorado's Water Plan

1. Accelerate Colorado
2. Action 22
3. American Council of Engineering Companies of Colorado
4. American Ground Water Trust
5. American Water Resources Association
6. American Water Summit
7. American Water Works Association
8. American Whitewater
9. Arkansas River Compact Administration
10. Arkansas Valley Ditch Association
11. Arkansas Valley Farm/Ranch/Water Symposium and Trade Show
12. Association of Home Builders
13. Audubon Rockies
14. Balcomb & Green, PC
15. Berg Hill Greenleaf & Ruscitti, LLP
16. Biennial of the Americas
17. Boulder County Agriculture Forum 2015
18. Brownstein Hyatt Farber Schreck, LLP
19. Carlson, Hammond & Paddock
20. Cavanaugh & Associates, P.A.
21. Center for a Sustainable WE2ST
22. Center for ReSource Conservation
23. CH2M
24. City of Aurora Youth Water Festival
25. City of Boulder Youth Water Festival
26. City of Greeley
27. City of Greeley Youth Water Festival
28. Clinton Global Initiative
29. Club 20
30. CoBank
31. Collins Cockrel & Cole
32. Colorado Agriculture Water Alliance
33. Colorado Association of Realtors
34. Colorado Bar Association
35. Colorado Business Roundtable
36. Colorado Cattlemen's Association
37. Colorado Cleantech Industry Association
38. Colorado Competitive Council
39. Colorado Counties, Inc.
40. Colorado Department of Agriculture
41. Colorado Department of Local Affairs
42. Colorado Department of Natural Resources
43. Colorado Department of Public Health and Environment
44. Colorado Department of Regulatory Agencies
45. Colorado Department of Transportation
46. Colorado Division of Water Resources
47. Colorado Energy Office
48. Colorado Forum
49. Colorado Foundation for Water Education
50. Colorado General Assembly, Joint Agriculture Committee
51. Colorado General Assembly, Water Resource Review Committee
52. Colorado Groundwater Association
53. Colorado Groundwater Commission
54. Colorado Mesa University
55. Colorado Municipal League
56. Colorado Natural Resource Group
57. Colorado Oil & Gas Association
58. Colorado Office of Economic Development and International Trade
59. Colorado Parks and Wildlife Commission
60. Colorado Petroleum Council
61. Colorado Public Radio
62. Colorado River District
63. Colorado River Outfitters Association
64. Colorado River Water Conservation District
65. Colorado Rural Electric Association
66. Colorado School of Mines, Division of Economics & Business
67. Colorado Springs Utilities Leadership Team
68. Colorado Springs Utilities Water System Tour

69. Colorado State Fair
70. Colorado State University – Fort Collins
71. Colorado State University - Colorado Water Institute
72. Colorado State University - Osher Lifelong Learning Institute
73. Colorado Water Congress
74. Colorado Water Institute
75. Colorado Water Quality Forum
76. Colorado Water Resources and Power Development Authority
77. Colorado Water Trust
78. Colorado Water Utility Council
79. Colorado Watershed Assembly
80. Conservation Colorado
81. Consolidated Mutual Water Company
82. Continuing Legal Education
83. Davis Graham & Stubbs, LLC
84. Deloitte
85. Denver Inter-Neighborhood Cooperation
86. Denver Metro Chamber Leadership Foundation
87. Denver Metro Chamber of Commerce
88. Denver Metro Chamber Public Affairs Council
89. Denver Metro Youth Water Festival
90. Denver Museum of Nature and Science
91. Denver Post
92. Denver South Economic Development
93. Denver Water Citizens Advisory Committee
94. Ditch and Reservoir Company Alliance
95. Eagle River Water & Sanitation District
96. Earth Resources Institute
97. Environmental Defense Fund
98. Environmental Entrepreneurs
99. Faegre Baker Daniels
100. Family Farm Alliance
101. Farm Bureau
102. Fort Morgan Reservoir and Irrigation Company Board of Directors
103. Four States Irrigation Council
104. Front Range Water Council
105. Future Farmers of America
106. Garden Club of Denver
107. Garfield County Board of County Commissioners
108. Gates Family Foundation
109. Getches-Wilkinson Center for Natural Resources, Energy, and the Environment
110. Google
111. The Greenway Foundation
112. Hill & Robbins P.C.
113. Hydro Advisors, LLC
114. Lewis Roca Rothgerber LLP
115. Lower Arkansas Conservancy District
116. Metro Denver Economic Development Corporation
117. Metro Mayors Caucus
118. Metropolitan State University of Denver, One World One Water Center
119. Molson Coors
120. National Audubon Society
121. National Public Radio
122. National Renewable Energy Laboratory
123. National Young Farmers Coalition
124. Northern Colorado Economic Alliance
125. Northern Colorado Water Conservancy District
126. Northwest Colorado Council of Governments Water Quality/ Water Quantity Committee
127. Nuestro Rio
128. Open Water Foundation
129. Petrock & Fendel, P.C.
130. Pikes Peak Water Authority
131. Porzak Browning & Bushong, LLP
132. Protect the Flows
133. Pueblo Chamber of Commerce
134. Red Rocks Community College
135. Renew Strategies LLC

136. Rio Blanco Water Conservancy District
137. Rocky Mountain Farmers Union
138. Rocky Mountain Water Environment Association
139. Rotary Club - Westminster
140. Sierra Club Rocky Mountain Chapter
141. South Metro Denver Chamber
142. South Metro Water Supply Authority
143. Southeastern Colorado Water Conservancy District
144. Southern Colorado Business Partnership
145. Southwest Colorado Water Conservation District
146. Southern Ute Indian Tribe
147. Special Districts Association
148. Stanford University
149. Statewide Basin Roundtable Summit
150. Sustaining Colorado's Watersheds Conference
151. The Aspen Institute
152. The Keystone Center
153. The Nature Conservancy
154. The Rocky Mountain Climate Organization
155. Trout Unlimited
156. U.S. Army Corps of Engineers
157. U.S. Department of Agriculture, Forest Service
158. U.S. Department of the Interior, Bureau of Land Management
159. U.S. Department of the Interior, Bureau of Reclamation
160. U.S. Environmental Protection Agency
161. U.S. Geological Survey
162. University of Colorado - Boulder
163. University of Colorado - Boulder, Center of the American West
164. University of Colorado - Denver, Business School
165. University of Colorado - Denver, College of Architecture and Planning
166. University of Colorado - Denver, School of Public Affairs
167. University of Denver, Josef Korbel School of International Studies
168. University of Denver, Sturm College of Law
169. University of Wyoming, College of Law
170. Upper Eagle Regional Water Authority
171. Ute Mountain Ute Tribe
172. Ute Water Conservancy District Kid's Water Festival
173. Water Availability Task Force
174. Western Governor's Association
175. Western Resource Advocates
176. Western Slope Caucus
177. Western State Colorado University – Colorado Water Workshop
178. Western States' Water Council
179. White & Jankowski, LLP
180. Xcel Energy

Appendix H: Summary of Actions in Colorado's Water Plan

H

6.1 Scenario Planning & Developing an Adaptive Water Strategy

ACTIONS

The following actions will continue to support scenario planning and Colorado's adaptive strategies:

1. **Support the implementation of the no-and-low-regrets strategy:** The CWCB, in partnership with other state agencies, will commit state financial, technical, and regulatory resources to the near-term implementation of prioritized water management projects as specified in the no-and-low-regrets actions. As part of this work, and in partnership with the basin roundtables, the CWCB will evaluate progress toward achieving the no-and-low-regrets actions.
2. **Monitor drivers:** To determine which scenario Colorado will most likely face, the CWCB will work with partners, such as the Climate Change Technical Advisory Group, to monitor the critical drivers of water supply, demand, and the level of "green" versus "full-resource use" values through future SWSI updates and other technical work. As part of this work the CWCB will work with stakeholder groups to update the scenarios and adaptive strategies.
3. **Promote use of scenario planning and adaptive strategies:** The CWCB and the basin roundtables will continue to use and promote scenario planning and the use of adaptive strategies to respond to, mitigate, and prepare for climate change. In partnership with project proponents, the CWCB will also encourage and facilitate the adoption of adaptive strategies for municipal, industrial, agricultural, environmental, and recreational needs as Colorado moves into the future.
4. **Support Colorado's Decision Support Systems (CDSS):** The CWCB and the DWR will continue to develop and support the CDSS to encourage data-driven planning and decision making.
5. **Support innovative and collaborative science:** The CWCB will continue to work with local, state, and federal partners to build coalitions to purchase, deploy, maintain, and operate new equipment and new science necessary for 21st-century water management. Concepts and technologies such as watershed-based gap-filling radars for continuous weather coverage, radiometers for improved profiles of the atmosphere and modeling support, and improved high-resolution atmospheric and hydrological modeling specific to Colorado, lead to accurate quantification of the snowpack and runoff, regardless of the scenario.

6.2 Meeting Colorado's Water Gaps

ACTIONS

The projects and methods in the BIPs met many of the identified gaps; however, gaps remain, even with the significant efforts described. Several next steps will help the basin roundtables meet their needs. In its BIP, the Gunnison Roundtable summarized many of these next steps and potential actions; Table H-1 illustrates this work.

A primary purpose of Colorado's Water Plan is to address Colorado's water gaps. To accomplish this, several of the next steps and potential actions include the following, as summarized in Table H-1:

- ❖ Partnerships and cooperative strategies are vital to overcoming conflict and building local consensus so that a project can move forward. Section 9.4 further discusses this approach in the context of more effective and efficient permitting.
- ❖ Public education and outreach can also help inform people about Colorado's water needs and solutions. Section 9.5 explores avenues to better support water education throughout Colorado.
- ❖ Many sections of Colorado's Water Plan mention incentive-based programs. For instance, Section 6.3 explores opportunities to encourage conservation, reuse, and water-wise land-use practices. Section 6.4 explores opportunities to encourage ATMs.
- ❖ Funding is also a common theme throughout many of the BIPs. Section 9.2 further explores funding options.
- ❖ Many of the BIPs express concerns around permitting and other regulatory topics. Section 9.4 explores ways to make these processes more effective and efficient.

Colorado's Water Plan's success will ultimately be measured by whether the municipal water supply and demand gap is closed. With increased efforts on conservation, storage, land use, alternative transfer methods, and reuse, Colorado can close its gap, balance

TABLE H-1 STRATEGIES FOR IMPLEMENTATION OF THE BASIN IMPLEMENTATION PLANS

CATEGORY	CONSTRAINT	NEXT STEPS AND POTENTIAL ACTIONS
Project Evaluation	Constraint	• Partnerships • Cooperative Strategies
	Perception	• Public Education and Outreach • Incentive-Based Programs
	Regulations	• Cooperative Strategies • Effective and Efficient Permitting
Project Feasibility	Cost	• Creative Funding Mechanisms • Partnerships and Cooperative Strategies
	Water Availability	• Water Availability Analyses • Water Administrative Strategies
	Constructability	• Feasibility Analyses • Engineering Design

Colorado's water values, and also address the water resource impacts of a changing climate. Colorado's Water Plan sets a measurable objective to identify proponents for new projects, processes, and initiatives by 2030 that would reduce the projected 2050 municipal and industrial gap from as much as 560,000 acre-feet to 0 acre-feet.

In SWSI 2010, the gap was calculated based on future water needs and the identification of projects and methods that water providers indicated they were planning to implement in order to serve future customers. The basin roundtables partially reduce this gap by identifying additional projects and methods within the BIPs, as Section 6.5 describes. However many of these additional projects and methods either do not have project proponents identified, or are insufficiently developed. Further development of these projects and methods, reductions in water use from conservation and changes in land-use practices, and refinement of additional options such as ATMs and regional reuse will address the remaining gap.

Colorado must identify and address its water gaps. The CWCB will take the following steps to accomplish this starting in 2016:

1. The CWCB will support the evaluation, feasibility, and completion of the BIPs through WSRA grants.
2. The CWCB will support increased consistency and technical support in the BIPs in the following ways:
    - ❖ Provide technical support for several of the BIPs through continued decision-support development and maintenance in order to explore municipal, agricultural, industrial, and environmental shortage analyses similar to those in the Yampa/White/Green BIP.
    - ❖ Provide technical support for several of the BIPs to explore the use of project information sheets and project tiering, similar to those delineated in the Rio Grande, North Platte, and Gunnison BIPs.
    - ❖ Support the further quantification of costs associated with projects and methods, development of new acre-feet, development of new irrigated acres, and protection of new stream-miles.
3. The CWCB will incorporate the BIP information into the next version of SWSI, and will reassess the municipal, industrial, environmental, recreational, and agricultural gaps at that time.
4. The CWCB will establish guidelines for basin-roundtable WSRA grants, enabling the basin roundtables to facilitate implementation of their BIPs in their basins. The purpose of the grants would be to foster the ability to meet municipal, industrial, agricultural, environmental, and recreational needs in a manner that is consistent with the BIPs.

6.3 Water Conservation and Reuse

6.3.1 Municipal Water Conservation

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

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.[1]
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 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.[2] Section 9.5 contains more detail regarding specific education and outreach 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

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.

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 marketplace. 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

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:** 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.230F
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:** 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

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

ACTION

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.

6.4 Alternative Agricultural Transfers

ACTIONS

The CWCB should consider the following options or action steps to help ensure attainment of alternatives to permanent farmland dry-up:

1. Monitor current and future legislation necessary for the implementation of ATMs, including enhanced sharing opportunities and system agility.
2. Encourage funding grants that focus on implementing on-the-ground ATM projects, data collection, agile administration practices, ATM affordability, basin-specific ATM projects, and infrastructure modernization.
3. Support appropriate fallowing-leasing pilot projects, such as the Catlin Canal pilot project, by responding to and processing applications in a timely manner under House Bill 13-1248 (C.R.S 37-60-115). The ATM grant program could further support these projects. To proactively cultivate these projects, the CWCB will work with partners or co-sponsors to organize and conduct regional workshops. These events will enable stakeholders to share lessons learned on actual ATM projects, and to garner additional interest by discussing program benefits.
4. Encourage adaptive strategies that capture a "learning by doing" concept for pilot programs and other on-the-ground ATM applications.

5. Continue to provide ATM leadership as well as technical and financial support to basin roundtables during the development of their BIPs.
6. Assess quantitative information related to agricultural dry-up in SWSI 2016, including evaluating lessons learned and monitoring the effects of ATMs in reducing permanent agricultural dry-up.
7. Explore financial incentives through a stakeholder process as part of the funding Section 9.2 describes. These incentives or grants could include new and ongoing revenue streams and tax incentives at the local and state level.
8. Work with the South Platte, Metro, and Arkansas Basin Roundtables to explore a WSRA or an ATM grant, with municipal and agricultural stakeholders that could lead to the formation of one or more pilot regional water sharing cooperatives. The mission of a cooperative would be to facilitate water-sharing arrangements. The cooperative could include ways to determine initial start-up costs necessary to reach stated goals. For instance, methods may include acquiring funding needed to reduce barriers associated with the high transaction costs of water-rights transfers, and working through water court to make a water right more agile.
9. Continue collaborating with water users to develop tools and models that can be used as an approved common baseline for water court litigants and parties. Administrative change cases could rely upon these for conservative yet streamlined estimates of consumptive use, return flows, and injury.
10. Seek to help stakeholders understand the benefits and social barriers of ATMs and how they can function under existing and future law.
11. Interact with the Colorado water community and decision makers to consider the following options in support of ATM goals:
    - Continue to monitor basin-level work and explore options to develop agility in the use of certain agricultural water rights for multiple purposes.
    - Implement tools Senate Bill 15-198 (C.R.S. 37-60-115) provides that broaden pilot-project end uses House Bill 13-1248 (C.R.S. 37-60-115) sets forth. Such pilot projects could demonstrate agricultural transfers that meet environmental, recreational, industrial, or compact needs in addition to urban needs. The CWCB will encourage pilot projects to test the latest concepts or meet multiple benefits.
    - Reduce barriers, such as high transaction costs associated with water-rights transfers and water-rights accounting uncertainties, through continued exploration of pilot projects and other voluntary transactions that demonstrate a streamlined approach or provide financial support.
    - After a thorough outreach and stakeholder process, consider legislation to protect existing municipal, transferred water-rights owners that choose to undergo the court process to demand that their permanent agricultural transfers operate as ATMs. Such legislation could help ensure that a water-rights owner could revert to its previously adopted stipulations, if the water court process for an ATM option yields an unfavorable outcome.
    - Strengthen recognition for new types of legal beneficial uses, such as leased or agile-use water.
    - Identify and develop a request for a multi-basin WSRA grant through the basin roundtables. The goals of a potential grant would be to compile ATM data, identify actions to encourage irrigators to enter agreements, analyze barriers, and increase program awareness.
    - Research benefits and challenges of “buy and supply,” which could preserve local irrigated agriculture and associated benefits. The concept of “buy and supply” is that M&I water users purchase irrigated lands with associated water rights, establish a conservation easement for future farming, and then supply a full amount of water for a certain number of years within a 10-year period. The M&I user could then receive water supply in the remaining non-farming years.
    - Explore the possibility of third parties providing assistance in funding ATMs to ensure that farmers are appropriately compensated and that water suppliers pay a reasonable incremental cost for firm yield. In this case, the third party would essentially assist in the effort to uphold the value of continued viable agriculture.

- Support research into the benefits and challenges of temporary rotational "idling" of crops, deficit irrigation, and split-season irrigation.
- Incorporate improved water-use data into decision-making processes in a way that reduces uncertainty for water managers, and develop basin-specific models for use in water court cases to help reduce transaction costs.

6.5 Municipal, Industrial, and Agricultural Infrastructure Projects and Methods

ACTIONS

Colorado's Water Plan sets a 2050 measurable objective to attain 400,000 acre-feet of innovative storage in order to manage and share conserved water and the yield of IPPs. This objective equates to an 80 percent success rate for these planned projects, as stated in the IBCC's No-and-Low Regrets Portfolio.

While the right to buy or sell private property water rights must not be infringed upon, the State will encourage innovation and creativity by agricultural producers and research institutions to maximize the productivity of every drop of water. Colorado's Water Plan sets an objective that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production.

To support projects and methods that meet future municipal, industrial, and agricultural needs, several next-steps are necessary.

1. **BIP project support:** The CWCB will continue to support and assist the basin roundtables in moving forward the municipal, industrial, and agricultural projects and methods they identified in their BIPs. It will accomplish this through technical, financial, and facilitation support when a project proponent requests it.
2. **Climate change incorporation:** The CWCB will work with the basin roundtables and, upon request, work with project proponents, to incorporate the potential effects of climate change on municipal, industrial, and agricultural projects and methods.
3. **Expansion of projects to be multipurpose:** The CWCB will prioritize funding to the basin roundtables to support an integrated approach to understanding the ways in which environmental and recreational projects and methods may interact with municipal, agricultural, and industrial projects and methods. As part of this task, basin roundtables will work with local stakeholders and project proponents to explore multipurpose projects and convert existing and planned single-purpose projects and methods into those that are multipurpose.
4. **Project tracking:** In partnership with the basin roundtables, the CWCB will continue to track municipal, industrial, and agricultural projects and methods.
5. **Project support:** The CWCB will continue to support and implement State programs that contribute to implementing municipal, industrial, and agricultural projects and methods. These include loan and grant programs, as well as ongoing studies, such as the SWSI.
6. **Project funding:** As Section 9.2 discusses, the CWCB will work with partners to strengthen funding opportunities for municipal, industrial, and agricultural projects and methods by:
   a. Coordinating current funding
   b. Assessing funding needs
   c. Exploring additional funding opportunities
7. **Storage opportunity assessment:** As part of the next version of SWSI, the CWCB will work with the DWR and local partners to assess storage opportunities to determine where existing storage can and should be expanded, where it is needed to prepare for climate change, where it can help to better improve sharing and use of conserved water, and where it can help meet Colorado's compact obligations. Furthermore, the CWCB will provide financial support to technical and practical innovations in the use of aquifer storage and recharge where it is practicable.
8. **Multipurpose project funding:** The CWCB will prioritize support for multipurpose projects and those that modernize, make more efficient, or lead to the building of new critical infrastructure for agriculture purposes, M&I uses, and hydropower production. Section 9.2 explores these programs.
9. **Permitting:** As Section 9.4 discusses, the CWCB will refine the permitting process to make it more effective and efficient.

10. **Technical and financial support of efforts to understand impacts to agricultural viability:** The CWCB and IBCC will work with stakeholders to provide grassroots-level support for efforts that foster a greater understanding of the effects of reductions in agricultural use on communities.
11. **Facilitation of agricultural opportunities:** The CWCB and the CDA will establish an education and assistance program for farmers and ranchers to help realize more transactions that allow for ATMs, and to enable new Colorado farmers to successfully enter the agricultural industry. This assistance may include financial and other support for land links, land trusts, and conservation easements that protect working farmland and make irrigated land affordable for the next generation of farmers and ranchers. The CWCB will need to create the program's scope of work, goals, geographic range, and responsibilities, in addition to measurements for success. Because many aspects of the program relate to agreements between municipalities and agricultural producers, the CWCB should involve both sectors in the development of the program, and should provide continued input.
12. **Enforcement of minimum standard for water-rights applications:** The court should be diligent in enforcing the minimum water-rights application requirements, which are already in existence, and should standardize these requirements statewide. Better guidance for applicants who do not have legal counsel or engineering consultants should be provided and advertised.
13. **Framework for evaluations of agricultural transfers:** The CWCB will develop a technical and legal framework for an evaluation of agricultural transfers before considering the requirement of such an evaluation. To help produce such a framework, the CWCB will host a stakeholder group, which will include local government, agricultural producers, municipalities, water providers, landowners, and environmental interests.
14. **Update and improve Colorado's aging agricultural infrastructure:** Over the next five years, the CWCB will work with the basin roundtables and agricultural partners to further identify and prioritize aging infrastructure projects, especially where there can be a large effect on or multiple benefits to other sectors. The CWCB will coordinate funding opportunities to address these needs.
15. **Encourage ditch-wide and regional planning:** Over the next two years, the CWCB will work with agricultural partners to explore opportunities to conduct ditch-wide and regional planning, such as the planning that is occurring in the Uncompahgre. These plans will explore system-wide conservation and efficiency opportunities, explore the potential for water sharing, and develop a long-term infrastructure-maintenance and -upgrade plan.

6.6 Environmental and Recreational Projects and Methods

ACTIONS

A strong Colorado environment is critical to the state's economy and way of life. Colorado's Water Plan sets a measurable objective to cover 80 percent of the locally prioritized lists of rivers with stream management plans, and 80 percent of critical watersheds with watershed protection plans, all by 2030.

To support a strong environment that includes healthy watersheds, rivers and streams, and wildlife, as well as a robust recreation and tourism industry, several actions are necessary:

1. **Technical work:** As part of the next version of SWSI, the CWCB, in consultation with the basin roundtables, will conduct additional technical work associated with the environmental and recreational focus areas to better determine the levels of existing protections, and where additional projects and methods should focus.
2. **Near-term projects and methods to address high-priority needs:** The CWCB will work with CPW, the basin roundtables, and other relevant agencies to establish and achieve measurable outcomes for (a) federally and state-listed endangered and threatened species, and imperiled species; and (b) economically important water-based recreational uses. It will accomplish this by developing a plan within the next three years that compiles and develops near-term projects and methods that address these high-priority needs, including projects the BIPs identified. This work will build on the work of the basin roundtables and the SWSI, including the work done in Action 1 above. At the same time, the CWCB will continue to provide technical and financial assistance to support the strategic implementation of currently identified projects.

3. **Common metrics:** In coordination with other state agencies, basin roundtables, and other stakeholders, the CWCB will develop common metrics for assessing the health and resiliency of watersheds, rivers, and streams.

4. **Watershed master plans:** As Section 7.1 indicates, the CWCB will work with watershed and other stakeholder groups toward a long-term goal of developing watershed master plans for every large watershed area to maintain watershed health. The CWCB will encourage and support capacity in areas that currently do not have watershed groups or other broad, local stakeholder groups.

5. **Stream management plans:** To promote healthy watersheds, rivers, streams, and wildlife, the CWCB encourages and will work with basin roundtables and other stakeholder groups to develop stream management plans for priority streams identified in a BIP, or otherwise identified as having environmental or recreational value. As part of this work, the CWCB will provide guidelines and templates for developing stream management plans, and will conduct ongoing analyses through the SWSI. To ensure continued planning and implementation in this context, the CWCB will explore additional funding sources, in addition to funding sources the 2015 CWCB Projects Bill provides.

6. **Incorporation of drought and climate change:** The basin roundtables and the CWCB will incorporate into the BIPs and the next update of the SWSI the potential effects of drought and climate change on environmental and recreational attributes.

7. **Multipurpose projects:** To support the development of multipurpose projects and methods, the CWCB will work with the basin roundtables and other stakeholders on an integrated approach to understanding how environmental and recreational projects and methods can interact with municipal, agricultural, and industrial projects and methods to achieve multiple benefits. The CWCB will strategically support the implementation of BIP-identified multipurpose, projects, and methods that help meet environmental, recreational, agricultural and community water needs. It will accomplish this with state financial and technical resources, taking into consideration locally identified geographic and/or seasonal gaps. This will include establishing priorities in Colorado's grant and loan programs for multipurpose projects and methods. Working with the basin roundtables and BIPs, the CWCB will also coordinate with project sponsors to explore and support opportunities to increase benefits to environmental and recreational values associated with existing and planned storage and infrastructure.

8. **Proactive implementation of existing programs:** The CWCB, other state agencies, basin roundtables, and other interested stakeholders will continue to support and implement state programs that benefit environmental and recreational attributes, such as the Colorado Watershed Restoration Program, Instream Flow and Natural Lake Level Program, Wild and Scenic Rivers Act Alternatives Fund, and CPW's Wetlands for Wildlife Program. The DNR and its agencies will institute policies, criteria, and programmatic approaches to proactively developing projects and methods that strategically address important aquatic, riparian, and wetland habitats.

9. **Continued support of ESA activities:** The CWCB, CPW, and water users will continue to support and participate in collaborative approaches to ESA issues, including recovery programs, cooperative agreements, and other efforts to prevent listings and promote the sustainability of endangered, threatened, and imperiled aquatic- and riparian-dependent species and plant communities.

10. **Broadened support of recreational uses:** The CWCB will support local governments with water recreation opportunities through continued technical consultation and funding, where appropriate. To assist with water project planning, the CWCB will support the development of tools that can be used to better understand the relationship between stream flows and recreational water uses. Additionally, the DNR will explore opportunities to protect instream flows for recreational uses without the requirement of a control structure.

11. **Funding:** As Section 9.2 discusses, the CWCB will work with appropriate entities to strengthen funding opportunities for environmental and recreational projects, including funding for long-term monitoring and maintenance of such projects, by:

    a. Coordinating current funding

    b. Assessing funding needs

    c. Exploring additional funding opportunities

Chapter 7: Water Resource Management and Protection

7.1 Watershed Health and Management

ACTIONS

To better understand and promote watershed health, it is important to support the development of watershed coalitions and watershed master plans that address needs from a diverse set of local stakeholders. The parties responsible for implementing action plans should be watershed coalitions and forest partnerships. Water-supply stakeholders should participate in the development of effective watershed coalitions. The Watershed Wildfire Protection Group, other watershed groups with a state- or region-wide geographic scope, and state agencies focusing on watershed health should manage coordination across watershed divides. State agencies include CPW, the CDPHE, and the CWCB.

Actions include:

1. Identify existing watershed coalitions and existing watershed plans and assessments, including source-water protection plans.
2. Encourage and support capacity in many areas that currently do not have watershed groups or other groups that work with a broad set of local stakeholders.
3. Assist stakeholders in existing watershed groups to identify tools and resources that address gaps and build capacity in existing plans.
4. Identify public and private funding sources that together can support watershed- and forest-health projects.
5. Identify watersheds that are critical to water supply.
6. Work toward a long-term goal of developing watershed master plans for watersheds critical to consumptive and nonconsumptive water supply.
7. Prioritize and implement projects identified in master planning.
8. Monitor projects to ensure that objectives are met and maintained
9. Conduct adaptive management as necessary
10. Coordinate statewide watershed-coalition and partnership plans, projects, monitoring, and adaptive management strategies.
11. Watershed management plans may include potential impacts to the environment, public water supplies, and agricultural production from abandoned mines, and a strategy for addressing these impacts. CDPHE and DRMS are potential partners in developing a prioritized list of mines which could impact streams.

7.2 Natural Disaster Management

ACTIONS

1. Where appropriate, the State of Colorado will continue to support and expand drought, flood, and wildfire preparedness and response programs.
2. The State of Colorado will actively encourage local communities to develop drought preparedness plans by providing tools and resources for development and implementation.
3. The CWCB and the Colorado Recovery and Resiliency Office will implement the actions identified in the Colorado Resiliency Framework to build communities that are more resilient to natural disasters.
4. The CWCB and CDPHE will work with utilities, federal agencies, and others to proactively identify and address regulatory barriers to climate preparedness and adaptation.

7.3 Water Quality

ACTIONS

The WQCD worked with the Colorado Water Quality Forum and the WQCC to develop recommendations. As the CWCB updates the Colorado's Water Plan in the future, these recommendations will serve as a starting point for implementation efforts focused on:

A. Integrated water quality-and-quantity management.

B. Policy considerations.

C. Financial considerations.

D. Stakeholder and public outreach.

In addition, the State will assign these recommendations to a responsible party and prioritize them for implementation over time.

A. Integrated Water Quality and-Quantity Management Actions

Recommendations to promote increased integration of water quality and -quantity management include:

1. Evaluate the water quality effects associated with the proposed solutions and scenarios the BIPs and Colorado's Water Plan (Sections 6.3 through 6.6) have presented. Identification of those effects will help define the scope of strategies that entities need to explore to protect and restore water quality. The State will share information about these effects among all involved parties.
2. In cooperation with basin roundtables, the CWCB, and others, define opportunities for projects or processes that restore and enhance existing water quality conditions, with an aim of addressing potential water quality effects resulting from water-quantity solution implementation. An initial step will be to assist the basin roundtables in developing water quality goals, objectives, and measurable outcomes based on current water quality information; each basin will be able to use this information when updating its BIP. This collaboration supports the basin roundtables in identifying projects and methods that integrate water quality and -quantity management to protect and restore water quality.
3. Define green-infrastructure approaches for the arid West, and explore ways in which entities can use green infrastructure to address Colorado's consumptive and nonconsumptive gaps. For example, green infrastructure in the arid West can go beyond stormwater management activities and low-impact development methods by including landscape-scale land-use planning that identifies where activities should occur in order to meet dynamic goals, including protecting and restoring water quality. Green-building and stormwater management groups have developed information that provides a starting point for developing and maintaining a library of green-infrastructure options.
4. Evaluate new water-supply projects and the potential for multiple benefits, including water quality protection and enhancement. Strive to ensure that project plans incorporate all water quality benefits.
5. Examine ways to design and operate new or existing supply projects to advance water quality objectives. Actively pursue incorporation of these design and operation considerations into proposed projects.
6. Identify the role of reuse by developing a library of reuse examples, such as direct potable reuse, indirect potable reuse, non-potable reuse, graywater use, onsite water recycling, and the associated water quality issues for each type of reuse. Ensure that any initiative that desires to use these resources addresses the issues. Section 6.3 further discusses reuse and identified actions.
7. Promote the use of aquifer storage and recovery, since water quality effects associated with this storage strategy are minimal.
8. Explore the role of stormwater management from both a quality and a quantity perspective in order to determine whether stormwater is a viable additional source of supply to address consumptive needs.
9. Address nonpoint sources through ongoing management activities, which play an important role in protecting and restoring water quality for the benefit of future water uses. These activities should include cataloguing and evaluating local-government land-use planning tools that minimize nonpoint-source pollution associated with development. Entities should also explore a comprehensive approach to nonpoint-source management, including water- quality trading.
10. Identify the risks of climate change as they relate to integrated water quality and water-quantity management. Develop specific recommendations for addressing these risks.
11. Explore how entities can most efficiently and cost-effectively integrate the CWA requirements and Safe Drinking Water Act requirements. Develop specific implementation recommendations.

B. Policy Considerations

Chapter 10 of Colorado's Water Plan summarizes legislative recommendations. In addition to the legislative recommendations, policy considerations related to quality and quantity integration include:

1. Continue to engage in creative, solution-oriented actions, such as implementing site-specific standards, temporary modifications, discharger-specific variances, pollutant trading, and conditional 401 water quality certifications. Use all available means to improve water quality and protect the high-quality waters that are considered better-than-necessary for supporting classified uses. Maintain ongoing, non-regulatory programs, including nonpoint-source management and source-water protection planning. These solution-oriented actions will also be necessary for addressing the effects of climate change.
2. As entities continue to maximize wastewater reuse in Colorado, establish a more complete understanding of the concept of "net environmental benefit." This concept demonstrates that the ecological value of using effluent to support riparian and aquatic habitats exceeds the ecological benefits of removing the discharge from the waterbody.
3. Review and appropriately modify existing regulations, guidance, and policy documents for new types of wastewater reuse so that revisions will protect public health and the environment, while also providing sufficient flexibility for water suppliers to develop new water-reuse projects across the state.
4. Consider and document the water-rights implications of water quality strategies and the water quality implications of water development strategies as they both pertain to integrated water quality and -quantity management. For example, integrated stormwater management may have effects on downstream flows, and entities would have to understand and address possible water-rights effects before implementing such a strategy.
5. Continue to work with neighboring states to address interstate water quality and quantity-issues to protect Colorado's compact entitlements.
6. Continue statewide monitoring that supports assessment of the quality- and quantity-integration goals and measures.

C. Financial Considerations

Future efforts to integrate water quality and quantity will require funding. Chapters 9 and 10 of Colorado's Water Plan further detail the recommendations outlined below.

1. Continue to fund nonpoint-source pollution management efforts. Identify new funding opportunities and nonpoint-source pollution-control strategies.
2. Identify costs and funding sources for implementation of green infrastructure and reuse.
3. Pursue state funding of regional watershed-based water quality planning to better integrate current and future water-quantity efforts.
4. Develop and implement State funding mechanisms for future water projects that implement consumptive and nonconsumptive strategies in ways that are consistent with Colorado's Water Plan. Plans should emphasize funding portions of projects that result in a public benefit.
5. Develop and implement State funding mechanisms for the implementation of mitigation activities required either under a state water-court water-rights decision, or under a federal or state water quality protection regulatory action.
6. Develop and implement funding mechanisms for the protection, restoration, or enhancement of water quality values in river or stream reaches.
7. Explore ways to facilitate innovative treatment and engineering solutions through technology transfer and liability management techniques.

D. Stakeholder and Public Outreach

Stakeholder and public outreach is critical to meeting the water quality and -quantity integration goal. Chapter 9.5 of Colorado's Water Plan further details the recommendations outlined below.

1. Use a watershed approach for outreach and community engagement around water quality, ways to protect water quality, and solutions to water quality issues. Colorado's many watershed groups already use this approach to effectively plan for and implement actions that protect and restore water quality. The approach can be used when developing and implementing strategies that integrate water quality and -quantity management.

2. Refine future water quality goals and measurable outcomes by monitoring public attitudes and opinions about water quality as it relates to domestic water supply as well as environmental and recreational uses of water.
3. Develop additional water quality goals and performance measures based on the completed BIPs from the basin roundtables.
4. Conduct joint CWCB and WQCC meetings at least annually to discuss water quality and water-quantity integration issues.
5. Consider holding workshops as part of WQCC's annual basin rulemaking process. To gather input and share information related to progress on water quality and -quantity integration efforts, workshops should include participation from basin roundtable representatives for the basin that is the subject of the annual rulemaking hearing.
6. As the CWCB updates or implements the water plan in the future, it will participate in the Colorado Water Quality Forum's process and working groups which provide stakeholder input on water quality issues.

Chapter 8 Interbasin Projects and Agreements

ACTIONS

The following next steps will support the policies, conceptual agreements, and points of consensus in the conceptual framework:

1. At the roundtable and IBCC levels, the CWCB will monitor ongoing discussions that involve the topics associated with the seven principles of the Conceptual Framework.
2. The CWCB, the DWR, and the Attorney General's Office will protect the ability to fully develop Colorado's compact entitlements and continue to support intrastate agreements that strengthen Colorado's position in interstate negotiations. The State of Colorado will support strategies to maximize the use of compact water while actively avoiding a Colorado River Compact deficit. Colorado will focus planning efforts on maintaining healthy systems and avoiding a Colorado River Compact deficit rather than on its response to compact curtailment.
3. The CWCB will help Colorado prepare for a future with more scarce water supplies; in other words, it will hope for the best and plan for the worst. Colorado will work with other states to evaluate options for sustainable water solutions that balance the development of Colorado's compact entitlements with the risk of a compact deficit in the Colorado River System. Colorado's conceptual framework, under Principle 4, and Section 9.1 in Colorado's Water Plan further describe this concept. The CWCB will also support continued outreach to stakeholders regarding interstate cooperative solutions.

Chapter 9 Alignment of State Resources and Policies

9.1 Protecting Colorado's Compacts and Upholding Colorado Water Law

ACTIONS

The following actions will promote continued collaboration among the State of Colorado and federal, state, tribal, and local entities regarding interstate and intrastate water management issues. These actions seek to protect Colorado's compact entitlements while encouraging collaborative solutions to protect existing and future uses within the state.

A. **The State of Colorado will continue to uphold the prior appropriation doctrine.**
   1. The CWCB encourages ongoing efforts to make the water court system more efficient—including the work of the Water Court Committee of the Colorado Supreme Court. CWCB envisions that these efforts will make the prior appropriate doctrine process more efficient and easily navigated, while maintaining the protection of these important private property rights.
   2. The IBCC's work on potential legislative solutions suggests that broad stakeholder input is needed to garner support for achieving process improvements through the legislative process. The CWCB will explore potential avenues for broad input on improvements to the water court process, whether through the roundtable and the IBCC process, or other mechanisms.

3. Using broad stakeholder input to garner support, the CWCB will explore potential avenues for achieving process improvements that will make Colorado's existing water law system more agile, effective, and efficient.

B. **The State of Colorado will continue to uphold Colorado's water entitlements under Colorado's compacts, equitable apportionment decrees, and other interstate agreements.**

   1. The CWCB will continue to maintain a sufficient balance in the litigation fund to ensure that the State has adequate resources to protect its water resources.
   2. The CWCB, with support from the Attorney General's Office and the Division of Water Resources, will continue to make every effort to comply with compact and decree obligations.
   3. The CWCB, in concert with the Attorney General's Office, will continue to work with federal agencies to ensure that their responsibilities are implemented in a way that respects Colorado's compact and decree entitlements, and respects the State's authorities to administer waters within the state.

C. **The State of Colorado will continue to ensure a proper balance between state and federal roles in Colorado's water law and water management system.**

   1. The CWCB and the Attorney General's Office will remain involved in maintaining the balance of state and federal roles within Colorado. As federal procedures and policies are developed and implemented, the State will defend Colorado's water allocation and management system to the extent that proposed federal actions may interfere with and potentially undermine water rights as decreed and administered within the state.

D. **The State of Colorado will continue to work within Colorado's local structure.**

   1. In proposing innovative strategies to meet Colorado's existing and future water needs, the CWCB will continue to work collaboratively with local governments, while recognizing the authority of counties and municipalities in making water development and management decisions.

E. **The State of Colorado will support strategies to maximize use of compact water while actively avoiding a Colorado River Compact deficit.**

   1. The CWCB will continue to support water banking efforts and prioritize the development of the programmatic approach as described over the next several years. This development will require extensive statewide stakeholder participation and educational efforts.
   2. The CWCB's future study and collection of collaborative stakeholder input will help the CWCB gauge the potential for a programmatic approach to meet existing and future needs, while maintaining equitable distribution of the reduced consumptive use. Multiple types of water users in locations on eastern and western slopes should share the burdens of demand management.
   3. As the CWCB begins technical investigation of a potential collaborative program, a key issue to resolve will be the potential scope of demand management. The greater the number of existing uses such a collaborative program will cover, the greater the number of necessary voluntary reductions and amount of compensation.

9.2 Economics and Funding

ACTIONS

According to studies conducted by the U.S. EPA, the Congressional Budget Office, and the Water Infrastructure Network, the cost of addressing our nation's clean water infrastructure needs over the next 20 years could exceed $400 billion, which amounts to roughly twice the current level of investment by all levels of government.[3] Colorado alone has nearly $20 billion in identified water project needs, including water supply and environmental and recreational projects.[4] While there is no easy or inexpensive way to provide Coloradans with a sustainable long-term water supply, the overarching goal is to provide clean, reliable water at an affordable price for many generations.

Action Summary

Realistic, long-term funding sources are essential to Colorado's ability to meet its future water funding needs. It cannot be assumed that existing programs and revenue streams are sufficient to address the state's long-term water supply and environmental needs, or to maintain existing water supply infrastructure. The actions and initiatives below could greatly assist in meeting Colorado's water funding needs over the next decade and in generating the momentum required to address long-term funding needs. The CWCB will work with the Statewide Water Investment Funding Committee to explore options for implementing these initiatives.

1. **Public funding sources:** Identify and determine a path to develop a new viable public source of funding (such as through a container fee ballot initiative) to support a repayment guarantee fund or green bonds, and to provide additional support grants and loans for the WSRA, education, alternative transfer methods, conservation, and agricultural viability.
2. **State repayment guarantee fund:** Establish a state repayment guarantee fund.
3. **Green bonds:** Develop issuance and repayment strategies needed to establish a green bond program to provide a funding source for large environmental and recreational projects.
4. **Water education and outreach:** Fund a water education and outreach grant program based on basin roundtable education action plans and the initiatives indicated in Colorado's Water Plan.
5. **WSRA:** Provide additional state account funds to the WSRA program.
6. **Public/Private Partnerships:** Modify Colorado's statutes to clearly allow for public/private partnerships for water projects (§C.R.S. 43).
7. **Conservation:** Explore a tax credit for homeowners who install efficient outdoor landscapes and irrigation as part of the integrated funding plan.

Colorado's Water Plan identifies the following actions:

1. The CWCB will work with the Statewide Water Investment Funding Committee to develop a sustainable funding plan that integrates a repayment guarantee fund, green bonds, and additional support grants and loans for the WSRA, education, alternative transfer methods, conservation, and agricultural viability.
2. The CWCB will assess funding needs across multiple sectors using the BIPs and other resources as guides. Needs may include municipal, environmental, industrial, recreational, agricultural, conservation, and education and outreach, among others.
3. The CWCB will determine the economic benefits and effects of meeting or not meeting Colorado's future water needs.
4. The CWCB will work with the General Assembly and state agencies to align state funding policies and promote coordination among state agencies in order to strategically support the values Colorado's Water Plan identifies. These values include the need for multipurpose and multipartner projects and methods. The State will take the following actions:
   - ❖ Develop a common grant-inquiry process to be coordinated across funding agencies for each sector, including environmental, recreational, municipal, and agricultural project proponents. This will include revisiting and reorganizing how agencies conduct the current state funding coordinators meeting.
   - ❖ Review the CWCB's financial policies, taking into consideration providing financial incentives to move projects and methods forward and assisting small water providers in addressing upfront planning costs. Such policies may include reduced interest-rate categories and extended terms (40 years).
   - ❖ Pursue additional funds to support the WEGP, which provides financial incentives for implementing conservation programs and planning for drought; investigate expanding the program's authority to provide grant funds to municipalities for documented water conservation and savings to help offset the economic impact of lost revenue due to reduced water usage; and develop funding recommendations.
   - ❖ Assess whether there are additional loan opportunities for municipal conservation practices.
   - ❖ Pursue funding to establish a water education and outreach grant program, and develop funding recommendations.
   - ❖ Assess opportunities for additional WSRA grant funds, and work to amend the WSRA guidelines on how additional funding is allocated, approved, and disbursed in order to prioritize projects that provide the greatest benefit to Colorado.

- ❖ Seek an amendment to statutory language to expand the CWCB's loan program's authority to fund treated water supply, reuse, conservation, and environmental and recreational projects and methods.
- ❖ Continue to provide $1 million or more if needed on an annual basis to support stream management and watershed plans, and develop an established funding source.
- ❖ In partnership with the Water Investment Funding Committee and in coordination with the basin roundtable representatives, review and prioritize BIP-identified water projects to develop a funding plan for those that could move forward. Based on the identified funding level, develop funding strategies that use existing and new funding sources to move high-priority projects forward in one to three years.
- ❖ Develop policies for how and when the CWCB becomes a project beneficiary through an arranged partnership for projects that are central to fulfilling the goals of Colorado's Water Plan.
- ❖ Identify and develop, in two years, a single multi-benefit, multi-partner, shared infrastructure pilot project that is funded through a joint revenue stream of public and private funding. From this pilot project, develop a framework for how future water public/private partnership projects will move forward, taking into consideration best procurement practices, maintenance and operation, water administration and management, and other factors.
- ❖ Continue to use the Water Investment Funding Committee—comprising representatives from each basin, the CWCB, the Water and Power Authority, the Executive Director's Office, large water providers, and the private sector—to evaluate funding recommendations contained within Colorado's Water Plan and other plans. The goal of such evaluation will be to develop a well-planned, phased approach to provide funding for water projects, environmental projects, recreational projects, and stream and watershed management throughout the state. This committee met over the course of 2015 and will continue to meet to provide funding and implementation recommendations to the CWCB.
- ❖ Over the next year, continue to develop and fund a modern method for determining probable maximum precipitation for spillway sizing for dams in Colorado, with the intent to provide additional storage while minimizing capital investment.
- ❖ Consider allocating all or a portion of any surplus in the DNR's severance tax operational account revenues to efforts prioritized in Colorado's Water Plan.

5. The State will explore near-term opportunities to increase funding resources by implementing the following actions:
    - ❖ Develop preliminary support data for various public funding options, such as state referendums, individual county mill levy increases, insurance tax premiums, user fees, and other potential funding mechanisms.
    - ❖ Explore implementation of a Center of Excellence to create a working model of public/private partnerships for water projects and methods.
    - ❖ Explore how a water investment (public tax) fund could be created, managed, and disbursed.
    - ❖ Work with other applicable state agencies to develop a reserve fund that would act as a security or repayment guarantee by the State to water providers seeking bond funds through the Authority.
    - ❖ Explore the concept of a container fee ballot initiative.
    - ❖ Develop issuance and repayment strategies in issuing green bonds as early as 2016 for environmental and recreational projects. CWCB recommends that green bonds be issued incrementally, based on identified need, to minimize repayment costs.
    - ❖ Reassess the Instream Flow Tax Credit program to determine how to make it more usable.
    - ❖ Work with various stakeholders, the Department of Real Estate, the Department of Revenue, and appropriate legislative committees to develop strategies that maximize the conservation tax credit program.
    - ❖ Explore potential uses of conservation tax credit revenues for stream and watershed restoration.

- ❖ Explore with water providers the possibility of issuing a state tap fee for future taps installed statewide. Funds developed could be used to support the CWCB Water Efficiency Grant Program and/or water education. The amount assessed per tap would be determined based on the estimated number of new taps issued statewide, and target revenue.
- ❖ Assess funding and loan opportunities from the Water Infrastructure Finance and Innovation Authority (WIFIA) and the Rural Infrastructure Fund to rebuild aging water infrastructure. Encourage the U.S. Department of Transportation and other agencies to share lessons learned regarding innovative financing programs with the Army Corps of Engineers (Corps) and the EPA as they implement WIFIA.
- ❖ Work collaboratively with foundations and nonprofits to support the environment, recreation, and education priorities through philanthropy.

9.3 State Water Rights and Alignment

ACTIONS

Based on the information compiled in the state agency water rights inventory process, the state agencies this section discusses are currently using their water rights in ways that accomplish their respective missions, benefit the state, and further the water values underlying Colorado's Water Plan. To further align state water rights with these values, and to maximize the use of these water rights to realize all possible benefits to the state, the following actions are necessary:

1. The CWCB will continue to work with state agencies to compile and update inventories of their water rights.
2. The CWCB and other state agencies will use the information resulting from the inventory as a basis for coordinating agencies' water right uses and potentially sharing water to provide additional benefits to the state. To accomplish this, the CWCB and other state agencies will:
   a. Convene work groups comprising multiple agencies' staff members. These work groups will identify opportunities to align the agencies' water rights to achieve additional benefits and, where feasible, use those water rights to meet identified needs. For example, the CWCB and CPW can identify opportunities for releases from CPW reservoirs to be protected under Colorado's Instream Flow Program.
   b. Encourage sharing and optimal use of water among state agencies where efficiency savings might be realized.
   c. Conduct technical and legal feasibility analyses of identified opportunities for aligning or sharing agency water rights, and advance feasible projects in a timely manner.
3. The CWCB will identify State-owned water rights within the Colorado River Basin and evaluate opportunities for these rights to assist with Colorado River Compact compliance. For example, the Animas-La Plata Project contract between the BOR and the CWCB recognizes that the State's stored water rights in the project could be used for compact compliance purposes. There may be other state resources that could assist in complying with the State's obligations under the Colorado River Compact.
4. The CWCB will continue to schedule joint meetings with local governmental water management agencies around the state to facilitate information sharing and coordination on common water rights issues.
5. The CWCB will work with local stakeholder groups to determine where instream flow water rights could provide the greatest benefits, and assist such groups with the instream flow recommendation process.
6. The CWCB will partner in the early stages of future multipurpose projects as a water rights holder when such partnership is needed to ensure the success of the project, minimize environmental impacts of a project, or otherwise further the water values Chapter 1 outlines.

7. In coordination with the CWCB and interested stakeholders, CPW will take the lead on identifying opportunities to use CPW's water rights to help fill environmental and recreational gaps while maintaining consistency with its mission, statutory mandate, and rules/policies governing the use of CPW property.[a]

9.4 Framework for a More Efficient Permitting Process

ACTIONS

One of the main goals of Colorado's Water Plan is to find ways to support the implementation of the BIPs. The above permitting process enhancments support the statutory and regulatory requirements of each permitting agency without predetermining outcomes. While a particular agency permitting decision could be a "yes" or "no," a more efficient means to reach that decision benefits all project participants, stakeholders, and the State's planning process.

The actions below help determine efficiencies, where possible, and increase coordination. These actions will also provide an incentive that encourages multi-purpose projects with many partners, especially for projects that meet Colorado's water values, such as enhanced conservation and efficiencies. In addition to the Water Plan, the state and federal permitting partners will develop a handbook detailing the status quo and an updated joint review process. The following actions are needed to support these efforts:

1. The CWCB will host a series of lean events with relevant permitting agencies and stakeholders to examine current processes and determine how to make them more efficient and effective. Specifically, the lean events will examine how to eliminate redundant review efforts, reduce duplication of technical methods, and increase clarity on the required technical elements, as well as coordinate assessment methodology.
2. In partnership with local, state, and federal agencies, the DNR will coordinate the development of a permitting, certification, and mitigation handbook to reflect the updated permitting process.
3. State agencies with permitting authority will actively participate as cooperating agencies from the outset of the regulatory process, and will encourage parallel processes.
4. Where more than one agency has jurisdiction over a particular issue, the agencies will work together to identify a lead state agency, and a memorandum of understanding will be agreed to by both agencies to assist in the coordination.
5. The State of Colorado will explore options for adding CDPHE and DNR staff and other resources to support a more efficient and effective permitting process.
6. State and federal partners will work together to encourage cooperation through the CAWS MOU process, which factors in conservation as a demand-reducer.
7. State agencies with permitting authority will work with local governments and stakeholders to determine how Colorado will express support for or rejection of a project at the appropriate time during the review process in order to encourage the completion of the federal permit process in a timely manner.
8. In order to encourage stakeholder work prior to a project proponent applying for a federal permit, CWCB will serve as or fund an impartial facilitator between stakeholders as part of pre-application work when requested by a project proponent.
9. The State will coordinate with federal partners to determine if there are opportunities to improve the federal permitting process that stem out of the BIPs or efficiencies identified by the lean process.

9.5 Outreach, Education, and Public Engagement

ACTIONS

Colorado's Water Plan sets a measurable objective of significantly improving the level of public awareness and engagement on water issues statewide by 2020. Colorado's Water Plan also sets a measurable objective of engaging Coloradans statewide in an educational

[a] CPW is funded primarily through the sale of hunting and fishing licenses, parks passes and permits, and the receipt of associated federal parks and wildlife funds. All real property interests, including water rights, purchased with wildlife cash, parks cash, or associated federal funds, are required to be used only for parks and wildlife purposes. See sections 33-1-112(1), 117, 118, and 119, 33-9-107 and 109, 33-10-108(1), 111, 112, and 113, C.R.S.; see also 16 U.S.C. 669 to 669i, 16 U.S.C. 777 to 777l, and 16 U.S.C. 460l-4 to 460l-11. As such, there is limited ability to use such water rights for any purpose other than the originally intended parks and wildlife purposes. Any secondary or shared uses must be consistent with, and not otherwise impair, the water rights' originally intended parks and wildlife purposes.

challenge to create innovative solutions to address at least 5 water challenges identified by CWCB that should to be addressed by 2030. Based on the analysis this section presents, the CWCB makes the following recommendations, which will enhance Colorado's water outreach, education, and public engagement and advance the water supply planning process.

1. **Create a new outreach, education, and public engagement grant fund:** As part of the funding package Section 9.2 discusses, the DNR will evaluate a new outreach, education, and public engagement grant fund, which the CWCB would administer through the basin roundtables. Specific attributes of the grant fund could include the following:
   - Similar to WSRA funds, these funds could be available for eligible outreach, education, and public engagement projects that meet specific CWCB-developed criteria and guidelines that align with Colorado's Water Plan goals.
   - The funds could be considered for the proposed outreach, education, and public engagement projects already outlined in the BIPs and each basin roundtable's PEPO Education Action Plan.
   - Guidelines could prioritize grants dedicated to projects that assist the basin roundtables with communication, outreach, and public education efforts related to issues that Colorado's Water Plan or the BIPs addressed.
   - Guidelines could stress the importance of measuring success and targeting specific audiences and approaches, and could include other education and outreach best practices that lead to successful public engagement.
2. **Create a data-based water education plan:** Over the next two years, the CWCB will create a data-based water education plan by:
   - Conducting a survey to update the Water Education Task Force Report, which assessed water education programs across the state.
   - Determining critical gaps in water education, both geographically and topically.
3. **Improve the use of existing state resources:** The CWCB:
   - Will work with stakeholders to identify five water challenges that Colorado's innovation community could help solve, develop an award program, and engage Coloradans in the challenge.
     - Will work with Colorado's innovation community, education and outreach experts, research institutions, and the Governor's Colorado Innovation Network (COIN) to address Colorado's water challenges with innovation and "outside the box" creativity.
   - Will incorporate education and outreach components in the WSRA grant criteria and guidelines.
   - Will initiate efforts to improve coordination between state agencies on outreach and education activities. This will include the development of performance metrics and a database to track efforts.
   - Intends to foster continued engagement of the Water Education Task Force and use the network of existing water educators in a coordinated fashion to educate the various and diverse audiences in Colorado.

Chapter 11 Updating Colorado's Water Plan

ACTIONS

1. The CWCB will work with other state agencies, the basin roundtables, and the people of Colorado to update Colorado's Water Plan, beginning no later than 2020.
2. The CWCB will develop guidelines for Basin Roundtable WSRA grants to help facilitate the implementation of the BIPs.

[1] P. Brandhuber, S. Craig, T. Thomure, Considering the Implementation of Direct Potable Reuse in Colorado (2015).

[2] P. Brandhuber, S. Craig, T. Thomure, Considering the Implementation of Direct Potable Reuse in Colorado (2015).

[3] Committee on Transportation and Infrastructure of the House of Representatives – Panel on Public-Private Partnerships, Public Private Partnerships: Balancing the needs of the public and private sectors to finance the nation's infrastructure (2014), http://transportation.house.gov/uploadedfiles/p3_panel_report.pdf.

[4] Colorado Water Conservation Board, Statewide Water Supply Initiative 2010, 37. http://cwcb.state.co.us/water-management/water-supply-planning/Documents/SWSI2010/SWSI2010.pdf.

CPW 2019

APPENDIX A - *VOLUME II TABLE OF CONTENTS*

CURRENT AND PROJECTED WATER DEMANDS

PROJECTED WATER SUPPLIES AND GAPS

TOOLS FOR BASIN ROUNDTABLES AND WATER STAKEHOLDERS

INSIGHTS FOR BASIN ROUNDTABLES AND WATER STAKEHOLDERS

APPENDIX B - *NARRATIVE TO NUMBERS*

Table 4: Business as Usual Scenario Hydrologic Modeling Inputs

	Relevant Scenario Narrative Language	Key Driver	Water Demand Model Parameter	Input Adjustment (**~no adjustment,** --- large decrease, – moderate **decrease,** - small **decrease,** + small **increase,** ++ moderate **increase,** **+++ large increase)**
M&SSI Demands	By 2050, Colorado's population is close to 9 million people. Single family homes dominate, but there is a slow increase of denser developments in large urban areas. Municipal water conservation efforts slowly increase.	Land Use & Associated Population Growth	Population	~ Per SDO Office Forecast
M&SSI Demands	The economy goes through regular economic cycles but grows over time.	Economic Growth	Indoor and Outdoor gpcd	~ Economic conditions have similar to historical impact on water use
M&SSI Demands	The climate is similar to the observed conditions of the 20th century. Municipal water conservation efforts slowly increase.	Climate Conditions	Outdoor gpcd	~ Water use not significantly impacted by climate change
M&SSI Demands	Social values and regulations remain the same. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers.	Regulations & Technology Change	Indoor and Outdoor gpcd	~ Regulations / technology does not change historic water use
M&SSI Demands	Social values and regulations remain the same. Willingness to pay for social and environmental mitigation of new water development slowly increases.	Social Values Changes	Indoor and Outdoor gpcd	~ Social values **do not change** historic water use behaviors
Agricultural Demands	Transfer of water from agriculture to urban uses continues. Efforts to mitigate the effects of the transfers slowly increase. Large portions of agricultural land around cities are developed by 2050.	Land Use Changes	Acres of Crops	- - Irrigated agricultural land within and adjacent to city boundaries is converted to housing except in counties with no projected growth
Agricultural Demands	The climate is similar to the observed conditions of the 20th century.	Climate Conditions	Crop Consumptive Use	~ Similar to recent past
Agricultural Demands	Agricultural economics continue to be viable, but agricultural water use continues to decline.	Technology Changes	Irrigation Efficiency	~ Similar to recent past
Agricultural Demands	Social values and regulations remain the same.	Social Values Changes	Crop Types	~ Similar to recent past
Hydrologic	The climate is similar to the observed conditions of the 20th century.	-	Stream Flows	20th century observed
Hydrologic	-	-	Demands	Business as Usual Scenario Demands

APPENDIX B *CONTINUED*

Table 5: Weak Economy Scenario Hydrologic Modeling Inputs

	Relevant Scenario Narrative Language	Key Driver	Water Demand Model Parameter	Input Adjustment (~no adjustment, --- large decrease, -- moderate decrease, - small decrease, + small increase, ++ moderate increase, +++ large increase)
M&SSI Demands	Population growth is lower than currently projected, slowing the conversion of agricultural land to housing.	Land Use & Associated Population Growth	Population	- Rural areas have less population decline than SDO forecast & urban areas have less growth than SDO forecast
	The world's economy struggles, and the state's economy is slow to improve. Many sectors of the state's economy, including most water users and water dependent businesses, begin to struggle financially.	Economic Growth	Indoor and Outdoor gpcd	- Poor economy limits water purchases
	Greenhouse gas emissions do not grow as much as currently projected and the climate is similar to the observed conditions of the 20th century.	Climate Conditions	Outdoor gpcd	~ Water use not significantly impact by climate change
	Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. The maintenance of infrastructure, including water facilities, becomes difficult to fund. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations.	Regulations & Technology Change	Indoor and Outdoor gpcd	~ Poor economy results in reduced maintenance & increased leakage
	There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations.	Social Values Changes	Indoor and Outdoor gpcd	~ Social values **do not** change historic water use behaviors
Agricultural Demands	Population growth is lower than currently projected, slowing the conversion of agricultural land to housing. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations.	Land Use Changes	Acres of Crops	- Irrigated agricultural land within and adjacent to city boundaries is converted to housing except in counties with no projected growth
	Greenhouse gas emissions do not grow as much as currently projected and the climate is similar to the observed conditions of the 20th century.	Climate Conditions	Crop Consumptive Use	~ Similar to recent past
	There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations.	Technology Changes	Irrigation Efficiency	~ Similar to recent past
	There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations.	Social Values Changes	Crop Types	~ Similar to recent past
Hydrologic Modeling Inputs	Greenhouse gas emissions do not grow as much as currently projected and the climate is similar to the observed conditions of the 20th century.	-	Stream Flows	20th century observed
	-	-	Demands	Weak Economy Scenario Demands

APPENDIX B *CONTINUED*

Table 6: Cooperative Growth Scenario Hydrologic Modeling Inputs

	Relevant Scenario Narrative Language	Key Driver	Water Demand Model Parameter	Input Adjustment (~no adjustment, --- large decrease, -- moderate decrease, - small decrease, + small increase, ++ moderate increase, +++ large increase)
M&SSI Demands	Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and in mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development.	Land Use & Associated Population Growth	Population	~ Overall urban and rural growth per SDO forecast, but more population in urban areas than suburban areas.
M&SSI Demands	Broad alliances form to provide for more integrated and efficient planning and development. Eco-tourism thrives.	Economic Growth	Indoor and Outdoor gpcd	~ Economic conditions have similar to historic impact on water use
M&SSI Demands	There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting stream flows and supplies.	Climate Conditions	Outdoor gpcd	+ Moderate warming results in slight increase of outdoor water use
M&SSI Demands	Coloradans embrace water and energy conservation. New water-saving technologies emerge. Water-development controls are more restrictive and require both high water-use efficiency and environmental and recreation benefits. Environmental regulations are more protective, and include efforts to re-operate water supply projects to reduce effects.	Regulations & Technology Change	Indoor and Outdoor gpcd	- - Water saving technology advancements occur and are required
M&SSI Demands	Environmental stewardship becomes the norm. Coloradans embrace water and energy conservation. Demand for more water-efficient foods reduces water use. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.	Social Values Changes	Indoor and Outdoor gpcd	- - Increased conservation behaviors
Agricultural Demands	Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and in mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development.	Land Use Changes	Acres of Crops	- Irrigated agricultural land within and adjacent to city boundaries is converted to housing but less dry-up occurs from agricultural water transfers
Agricultural Demands	There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting stream flows and supplies.	Climate Conditions	Crop Consumptive Use	+ Moderate warming
Agricultural Demands	Coloradans embrace water and energy conservation. New water-saving technologies emerge. Water-development controls are more restrictive and require both high water-use efficiency and environmental and recreation benefits.	Technology Changes	Irrigation Efficiency	~ Agriculture maintains current trends in efficiency improvements
Agricultural Demands			Crop Types	-
	Environmental stewardship becomes the norm. Coloradans embrace water and energy conservation. Demand for more water-efficient foods reduces water use. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.	Social Values Changes		Similar to recent past
Hydrologic Modeling Inputs	There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting stream flows and supplies.	-	Stream Flows	In-between 20th century observed and hot and dry
Hydrologic Modeling Inputs		-	Demands	Cooperative Growth Scenario Demands

APPENDIX B *CONTINUED*

Table 7: Adaptive Innovation Scenario Hydrologic Modeling Inputs

	Relevant Scenario Narrative Language	Key Driver	Water Demand Model Parameter	Input Adjustment (~no adjustment, --- large decrease, -- moderate decrease, - small decrease, + small increase, ++ moderate increase, +++ large increase)
M&SSI Demands	The relatively cooler weather in Colorado (due to its higher elevation) and the high-tech job market cause population to grow faster than currently projected. More food is bought locally, increasing local food prices and reducing the loss of agricultural land to urban development. More compact urban development occurs through innovations in mass transit.	Land Use & Associated Population Growth	Population	+ More population growth than forecasted by SDO with greatest growth in urban areas
	Renewable and clean energy become dominant. Colorado is a research hub and has a strong economy. The warmer climate reduces global food production increasing the market for local agriculture and food imports to Colorado	Economic Growth	Indoor and Outdoor gpcd	~ Economic conditions have similar to historic impact on water use
	A much warmer climate causes major environmental problems globally and locally.	Climate Conditions	Outdoor gpcd	++ Significant warming results in increased outdoor water use
	Technological innovation becomes the dominant solution. Strong investments in research lead to breakthrough efficiencies in the use of natural resources, including water. The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand. The regulations are well defined and permitting outcomes are predictable and expedited.	Regulations & Technology Change	Indoor and Outdoor gpcd	- - Water saving technology advancements occur and are required
	Social attitudes shift to a shared responsibility to address problems	Social Values Changes	Indoor and Outdoor gpcd	- - Increased conservation behaviors
Agricultural Demands	More food is bought locally, increasing local food prices and reducing the loss of agricultural land to urban development.	Land Use Changes	Acres of Crops	- Irrigated agricultural land within and adjacent to city boundaries is converted to housing but less dry-up occurs from agricultural water transfers
	A much warmer climate causes major environmental problems globally and locally.	Climate Conditions	Crop Consumptive Use	++ Much warmer
	The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand.	Technology Changes	Irrigation Efficiency	+ New technologies increase efficiency
	The warmer climate reduces global food production increasing the market for local agriculture and food imports to Colorado. More food is bought locally, increasing local food prices and reducing the loss of agricultural land to urban development.	Social Values Changes	Crop Types	- Demand for locally grown foods allows for investment in new irrigation efficiency technologies and crops. Increased temperatures and drier conditions lead to crop hybrids that consume less water.
Hydrologic Modeling Inputs	A much warmer climate causes major environmental problems globally and locally. Droughts and floods become more extreme.	-	Stream Flows	Hot and dry
		-	Demands	Adaptive Innovation Scenario Demands

APPENDIX B *CONTINUED*

Table 8: Hot Growth Scenario Hydrologic Modeling Inputs

	Relevant Scenario Narrative Language	Key Driver	Water Demand Model Parameter	Input Adjustment (~no adjustment, --- large decrease, -- moderate decrease, - small decrease, + small increase, ++ moderate increase, +++ large increase)
M&SSI Demands	A vibrant economy fuels population growth and development throughout the state. Families prefer low-density housing and many seek rural properties, ranchettes, and mountain living. Agricultural and other open lands are rapidly developed. A much warmer global climate brings more people to Colorado with its relatively cooler climate.	Land Use & Associated Population Growth	Population	+ More population growth than forecasted by SDO with growth in both urban and suburban areas
	A vibrant economy fuels population growth and development throughout the state. Worldwide demand for agricultural products rises, greatly increasing food prices. Fossil fuel is the dominant energy source, and there is large production of oil shale, coal, natural gas, and oil in the state.	Economic Growth	Indoor and Outdoor gpcd	++ Increased oil and gas production increases water use
	Hot and dry conditions lead to a decline in stream flows and water supplies. A much warmer global climate brings more people to Colorado with its relatively cooler climate.	Climate Conditions	Outdoor gpcd	++ Significant warming results in increased outdoor water use
	Regulations are relaxed in favor of flexibility to promote and pursue business development.	Regulations & Technology Change	Indoor and Outdoor gpcd	+ Regulations are relaxed in favor of business
	Regulations are relaxed in favor of flexibility to promote and pursue business development.	Social Values Changes	Indoor and Outdoor gpcd	~ Social values do not change historic water use behaviors
Agricultural Demands	Agricultural and other open lands are rapidly developed.	Land Use Changes	Acres of Crops	- - - More agricultural land near cities and in rural areas is converted to housing and more irrigated land is dried up for agricultural water transfers
	Hot and dry conditions lead to a decline in stream flows and water supplies. A much warmer global climate brings more people to Colorado with its relatively cooler climate. A hotter climate decreases global food production. Worldwide demand for agricultural products rises, greatly increasing food prices.	Climate Conditions	Crop Consumptive Use	++ Much warmer
	Regulations are relaxed in favor of flexibility to promote and pursue business development.	Technology Changes	Irrigation Efficiency	~ Similar to recent past
	Agricultural and other open lands are rapidly developed.	Social Values Changes	Crop Types	~ Similar to recent past
Hydrologic Modeling Inputs	Hot and dry conditions lead to a decline in stream flows and water supplies. Droughts and floods become more extreme.	-	Stream Flows	Hot and dry
		-	Demands	Hot Growth Scenario Demands

APPENDIX C - *CONSULTANT TEAM*

Technical Update to the Colorado Water Plan Consultant Teams		
Prime Consultant	**Subconsultants**	**Subconsultant Responsibilities**
Brown and Caldwell	CDR Associates	Facilitation (if needed)
	HDR Engineering, Inc.	Facilitation and public relations assistance (if needed), technical advisors related to general water resources
	Lynker Technologies, Inc.	Technical advisors related to general water resources and climate change
CDM Smith	The Nature Conservancy	Technical advisors related to environmental and recreational needs, gaps, etc.
Jacobs	BBC Research & Consulting	Research and calculations related to population estimates and water-related values
	ELEMENT Water Consulting	Research and calculations related to municipal and self-supplied industrial water demands and water conservation
	The Open Water Foundation	IPP information development
	Southwest Water Resource Consulting	Technical advisors related to planning scenarios
	Wilson Water Group	Research and calculations related to water supplies, projects and methods, and gap analyses

APPENDIX D - *TECHNICAL ADVISORY GROUP (TAG) & IMPLEMENTATION WORKING GROUP (IWG) PARTICIPANTS*

Technical Advisory Group Participant List (July 2017)			
NAME	**BASIN**	**ORGANIZATION**	**TAG**
Laurna Kaatz	Metro	Denver Water	Planning Scenario
Joe Frank	South Platte	Lower South Platte WCD	Planning Scenario
Frank Kugel	Gunnison	Upper Gunnison WCD	Planning Scenario
Steve Harris	Southwest	Harris Water Engineering	Planning Scenario
Cary Denison	Gunnison	Trout Unlimited, Gunnison Basin	Planning Scenario
Jim Hall	South Platte	Northern Water Conservancy District	Planning Scenario
Heather Dutton	Rio Grande	San Luis Valley WCD	Planning Scenario
Kevin McBride	Yampa/White	Upper Yampa WCD	Planning Scenario
Jim Broderick	Arkansas	Southeastern WCD	Planning Scenario
John Currier	Colorado	Colorado River WCD	Planning Scenario
David Graf	Gunnison, CO & SW	Colorado Parks and Wildlife	Planning Scenario
Ken Neubecker	Colorado (Enviro Rep)	American Rivers	Environmental & Recreational
Cary Denison	Gunnison (Enviro Rep)	Trout Unlimited	Environmental & Recreational
David Nickum	Metro (Enviro Rep)	Trout Unlimited	Environmental & Recreational
Barbara Vasquez	North Platte (Enviro Rep)	At-large	Environmental & Recreational
Rio de la Vista	Rio Grande (Enviro Rep)	Rio Grande Headwaters Land Trust	Environmental & Recreational
Jason Roudebush	South Platte	Ducks Unlimited	Environmental & Recreational
SeEtta Moss	Arkansas (Rec Rep)	Arkansas Basin Roundtable	Environmental & Recreational
Tim Hunter	Southwest (Rec Rep)	At-large	Environmental & Recreational
Geoff Blakeslee	Yampa White (Enviro Rep)	The Nature Conservancy	Environmental & Recreational
Kent Vertrees	Yampa White (Rec Rep)	Steamboat Powdercats	Environmental & Recreational
Pete Conovitz	Statewide	Colorado Parks and Wildlife	Environmental & Recreational
Mickey O'Hara	Statewide	Colorado Water Trust	Environmental & Recreational
Laura Belanger	Statewide	Western Resource Advocates	Environmental & Recreational
Tammy Allen	Statewide	CDPHE	Environmental & Recreational
Matt Rice	Statewide	American Rivers	Environmental & Recreational
Nathan Fey	Statewide	American Whitewater	Environmental & Recreational
Greg Fisher	Metro	Denver Water	Municipal & Industrial
Lyle Whitney	Metro	Aurora Water	Municipal & Industrial
Rick Marsicek	Metro	South Metro Water Supply Authority	Municipal & Industrial
Liesl Hans	South Platte	City of Fort Collins	Municipal & Industrial
Katie Melander	South Platte	Northern Water	Municipal & Industrial
Ben Moline	South Platte	Molson Coors	Municipal & Industrial
Scott Winter	Arkansas	Colorado Springs Utilities	Municipal & Industrial
Alan Ward	Arkansas	Pueblo Water	Municipal & Industrial

APPENDIX D *CONTINUED*

Technical Advisory Group Participant List (July 2017), continued			
NAME	**BASIN**	**ORGANIZATION**	**TAG**
Maureen Egan	Colorado	Eagle River Water San. Dist.	Municipal & Industrial
Rick Brinkman	Gunnison & Colorado	City of Grand Junction	Municipal & Industrial
Jackie Brown	Yampa/White	Tri State	Municipal & Industrial
Ann Bunting	Rio Grande	Town of Crestone	Municipal & Industrial
Ed Tolin	Southwest	La Plata Archuleta Water District	Municipal & Industrial
Richard Belt	Statewide	Xcel Energy	Municipal & Industrial
Jorge Figueroa	Statewide	Western Resource Advocates	Municipal & Industrial
Kelley Thompson	Statewide	Colorado DWR	Agriculture
Perry Cabot	Statewide	CSU Extension	Agriculture
Cindy Lair	Statewide	Colorado Dept of Agriculture	Agriculture
Tom Trout	Statewide	USDA	Agriculture
Terry Fankhauser	Statewide	Colorado Cattlemen's Association	Agriculture
Eric Wilkinson	South Platte	Northern Water	Agriculture
Mark Sponslor	South Platte	Colorado Corn	Agriculture
Jim Yahn	South Platte	South Platte Roundtable	Agriculture
Joe Frank	South Platte	South Platte Roundtable	Agriculture
T. Wright Dickinson	Yampa/White	Yampa Roundtable	Agriculture
Mary Brown	Yampa/White	Yampa Roundtable	Agriculture
Ty Wattenberg	North Platte	North Platte Roundtable	Agriculture
Travis Smith	Rio Grande	Rio Grande Roundtable	Agriculture
Ken Curtis	Southwest	Southwest Roundtable	Agriculture
Terry Scanga	Arkansas	Arkansas Roundtable	Agriculture
Jack Goble	Arkansas	Arkansas Roundtable	Agriculture
Paul Bruchez	Colorado	Colorado Roundtable	Agriculture
Frank Kugel	Gunnison	Gunnison Roundtable	Agriculture

APPENDIX D *CONTINUED*

Implementation Working Group Participant List (January 2019)	
NAME	**BASIN**
Terry Scanga	Arkansas
Amber Shanklin	Arkansas
Abby Ortega	Arkansas
Jim Pokrandt	Colorado
Ken Neubecker	Colorado
Mike Wageck	Colorado
Joanne Fagan	Gunnison
Frank Kugel	Gunnison
Cary Denison	Gunnison
Lisa Darling	Metro
Casey Davenhill	Metro
Rick Marsicek	Metro
Curran Trick	North Platte
Kent Crowder	North Platte
Barbara Vasquez	North Platte
Ty Wattenberg	North Platte
Heather Dutton	Rio Grande
Emma Reesor	Rio Grande
Daniel Boyes	Rio Grande
Judy Lopez	Rio Grande
Sean Cronin	South
Lisa McVicker	South
Mike Shimmin	South
Mely Whiting	Southwest
Philip Johnson	Southwest
Karen Guglielmone	Southwest
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Alden Brink	Yampa
Jackie Brown	Yampa
Kelly Romero-Heaney	Yampa

COLLABORATING ON COLORADO'S WATER FUTURE

ANALYSIS & TECHNICAL UPDATE TO THE

COLORADO WATER PLAN

VOLUME I

Analysis and Technical Update to the Colorado Water Plan

ANALYSIS & TECHNICAL UPDATE TO THE

COLORADO WATER PLAN

This report was assembled by the Colorado Water Conservation Board (CWCB) staff and the contract team who supported the Analysis & Technical Update to the Colorado Water Plan. However, this effort was supported by numerous stakeholder interactions that helped drive the methodologies, review and presentation of this report. CWCB staff extends its appreciation to everyone who provided input throughout this process, including the Department of Natural Resources, the Division of Water Resources, senior leadership at the CWCB, the CWCB board, the Interbasin Compact Committee, members of the Technical Advisory Groups, members of the Implementation Working Group, each of the nine basin roundtables and many other subject matter experts, and engaged community members and colleagues whose efforts were invaluable to making this report as comprehensive and grass-roots driven as possible.

It is staff's sincere hope that this effort will continue to engage stakeholders and partners across the State of Colorado and will be used, refined and enhanced in future iterations of Basin Implementation Plan Updates and, ultimately, the Water Plan itself.

COLORADO

Colorado Water Conservation Board

Department of Natural Resources

[DISCLAIMER]

The Analysis and Technical Update to the Colorado Water Plan (Technical Update) provides technical data and information regarding Colorado's water resources. The technical data and information generated are intended to help inform decision making and planning regarding water resources at a statewide or basinwide planning level. The information made available is not intended to replace projections or analyses prepared by local entities for specific project or planning purposes.

The Colorado Water Conservation Board intends for the Technical Update to help promote and facilitate a better understanding of water supply and demand considerations within the State; however, the datasets provided are from a snapshot in time and cannot reflect actual or exact conditions in any given basin or the State at any given time. While this Technical Update strives to reflect the Colorado Water Conservation Board's best estimates of future water supply and demands under various scenarios, the reliability of these estimates is affected by the availability and reliability of data and the current capabilities of data evaluation. Moreover, the Technical Update cannot incorporate the varied and complex legal and policy considerations that may be relevant and applicable to any particular basin or project; therefore, nothing in the Technical Update or the associated Flow Tool or Costing Tool is intended for use in any administrative, judicial or other proceeding to evince or otherwise reflect the State of Colorado's or the CWCB's legal interpretations of state or federal law.

Furthermore, nothing in the Technical Update, Flow Tool, Costing Tool, or any subsequent reports generated from these datasets is intended to, nor should be construed so as to, interpret, diminish, or modify the rights, authorities, or obligations of the State of Colorado or the CWCB under state law, federal law, administrative rule, regulation, guideline or other administrative provision.

Prior to the 2015 Colorado Water Plan (Water Plan), past statewide water supply analyses included data analysis, project information and policy components. After the release of the Water Plan, these elements were split between the Water Plan (policy), Basin Implementation Plans (local projects) and statewide water supply initiatives (technical data analysis). To better recognize these delineations and make the connection to the Water Plan clear, the statewide water supply initiative (often referenced as SWSI) is now being referred to as the Analysis and Technical Update to the Water Plan (or Technical Update). The new name more accurately reflects the technical nature of the evaluations described in the report and better establishes how that data will be used to inform Water Plan updates. While the Technical Update is a statewide water supply initiative and continues that legacy, the SWSI acronym will be relegated to referencing earlier efforts that proceeded the Water Plan (e.g. SWSI 2010).

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[KEY TERMINOLOGY]

The following are definitions for key terms used throughout the Technical Update report:

1051 Data – 1051 Data is the municipal water usage data reported to the CWCB by water providers pursuant to House Bill 2010-1051.

Active vs Passive Conservation – Active water conservation measures are water-saving strategies implemented or incentivized by water providers. Active water conservation includes watering restrictions, public education campaigns, or efficiency improvements. Passive water conservation are measures associated with the installation of new water-efficient fixtures and appliances without incentives from utilities, e.g., replacing an old toilet with a new low-flush toilet.

Adoption Rate – Portion of existing (2015) population that will have water use consistent with the future gallons per capita per day (gpcd) value for a given planning scenario by the year 2050 (i.e., retrofit population).

Agricultural Diversion Demand – The amount of water that needs to be diverted or pumped to meet the full crop irrigation water requirement. Note that SWSI 2010 (see definition below) defined agricultural demand as the amount of water consumed by crops at the field level and not the amount of water that needs to be diverted or pumped.

Agricultural Gap – The amount of additional water that would need to be diverted or pumped to meet crop irrigation shortages. The results of the calculations are also referred to as the "total agricultural gap". The "incremental agricultural gap" is a portion of the agricultural gap and is defined below. Note that Statewide Water Supply Initiative (SWSI) 2010 defined the agricultural gap as crop or field-based shortages, though it recognized river headgate diversions and pumping would need to be much larger to meet crop shortages.

Applied Water – Water that is diverted from the river, pumped from ground water, or released from reservoirs for irrigation purposes. It is also referred to as irrigation supplies. Applied water does not include or reflect precipitation consumed by crops.

Baseline M&I Demand – Reported and estimated demands representing average conditions for the Technical Update baseline year of 2015. Municipal demands are represented by the gpcd and on a volumetric basis, which is calculated from population and gpcd data.

Basin Implementation Plans (BIP) – Basin Implementation Plans provide critical input to the Colorado Water Plan. BIPs were developed by basin roundtables and demonstrate how each basin roundtable plans to meet its future municipal, industrial, agricultural, recreational, and environmental needs. The BIPs identify projects and methods to meet future water needs and develop goals and measurable outcomes, needs, and constraints and opportunities in each basin. Data and information from the Technical Update will be used by basin roundtables to update their BIPs.

Buy and Dry – The process of buying agricultural water rights and subsequently using the water rights for another purpose (typically for municipal or industrial use). The formerly irrigated agricultural lands are "dried up" and no longer irrigated by virtue of the water transfer.

Climate Change Projections – The climate change projections developed for the Colorado Water Plan and this Technical Update were built upon the foundational work of the multi-phase Colorado River Water Availability Study, Phase II (CRWAS-II). CRWAS-II identified a suite of future climate change projections intended to explore a range of water supply and demand conditions for Colorado in 2050. Three composite projections were used in the Colorado Water Plan and in the Technical Update—the "Current" (recent historical hydrology), "Hot and Dry", and "Between 20th Century Observed and Hot and Dry" (also, "Between" or "In-Between").

Colorado's Decision Support Systems (CDSS) – Colorado's Decisions Support Systems is a water management system developed by the Colorado Water Conservation Board (CWCB) and the Division of Water Resources for each of Colorado's major river basins. The CDSS includes water-focused data sets, models, geographic information system (GIS) layers and other tools, including StateMod, StateCU, Hydrobase and others, to assist with surface water and groundwater management in Colorado.

Crop Shortages – Crop shortages are the difference between the amount of water crops needed to meet full crop consumptive use (a.k.a., irrigation water requirement [IWR]) and the amount of applied water crops consumed when irrigation supplies are insufficient to meet the full demand (a.k.a., water supply limited [WSL] consumptive use.

Distributed Water – The volume of water entering the municipal distribution system, calculated as total water production from all sources minus water exported to another water provider.

Drivers – In many contexts in the Technical Update, "drivers" refer to the nine factors identified by the Interbasin Compact Committee (IBCC) that will shape the future of water supplies and demands by the year 2050.

E&R – In the context of the Technical update, E&R refers to attributes and data products related to "environment and recreation".

Evapotranspiration – The sum of water evaporated from the soil surface and transpired through vegetation.

Flow-ecology Relationships – Flow-ecology quantifies the relationship between specific flow statistics (such as average magnitude of peak flow or the ratio of flow in August and September to mean annual flow) and the risk status (low to very high) for environmental attributes under the flow scenario being analyzed.

Gaps – In the Technical Update, gaps were calculated using water allocation models and other analysis tools (in basins where models are not currently available) and were evaluated for both agricultural and municipal and industrial (M&I) uses. Gaps were calculated as the difference between the amount of water available to meet agricultural or M&I diversion demands and the full diversion demand. In other words, gaps reflect the amount by which agricultural or municipal demands could be shorted because of inadequate supplies.

Implementation Working Group – The Implementation Working Group refers to the basin roundtable, Interbasin Compact Committee and CWCB Board members who helped inform the Technical Update recommendations as well as the next steps for the updates to the BIPs.

Incremental Agricultural Gap – The incremental agricultural gap quantifies the degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.

Irrigation System Efficiency – The percent of diverted or pumped water consumed by crops or stored in soil moisture, which is calculated by dividing the sum of WSL (see definition below) and water stored in soil moisture by the total applied water from all sources. System efficiency reflects the losses to applied water due to canal seepage and on-farm application losses.

Irrigation Water Requirement (IWR) – The amount of water that must be applied to crops to meet the full crop consumptive use, also referred to as the crop demand or the consumptive irrigation requirement (CIR). IWR provides an estimate of the maximum amount of applied water the crops could consume if it was physically and legally available.

Metered Municipal Water Use – Water that reaches the end use, including billed/unbilled and authorized/unauthorized uses.

Model Year – The baseline water allocation models used in the Technical Update use time series of hydrology reflective of historical conditions from 1975 to the most recent year available. For planning analyses, the historical hydrology was adjusted to reflect climate change impacts in the applicable scenarios. Demands in the baseline models reflect current conditions; planning scenario models reflect future conditions. Water allocation modeling results are a time series of stream flows, diversions, and shortages that reflect historical variability but are affected by current or future demands. The term "model year" is used to describe model output that reflects historical variability, but is not intended to reflect actual historical conditions.

Municipal Demand – Portion of distributed water attributable to uses typical of municipal systems, including residential, commercial, light industrial, non-agricultural-related irrigation, firefighting, and non-revenue water. Demands for self-supplied households not connected to a public water supply are also included in the municipal demand category. Municipal demands represent diversion demands used in the water allocation models.

M&I Demands – This refers to municipal and industrial water demands inclusive of the self-supplied industrial (SSI) demands. In the Technical Update, this is sometimes also referred to as M&SSI demands or simply "industrial demands".

M&I Gap – The difference between the amount of water available to meet M&I demands and the full M&I diversion demand. Note that the M&I gap in SWSI 2010 was based on the difference between new M&I demands that will occur in the future and the yield of projects currently being pursued to provide future supplies.

Municipal Water Efficiency Plans (WEP) – The Water Conservation Act of 2004 (HB04-1365) requires all covered entities (i.e., retail water providers that sell 2,000 acre-feet or more on an annual basis) to have a state-approved water efficiency plan that contains certain required minimum plan elements.

Non-Revenue Water – The calculated difference between distributed water and authorized metered water use. Non-revenue water thus represents system water loss.

Nonconsumptive Needs and Datasets – In prior SWSIs, "nonconsumptive" referred to "environment and recreation" datasets and analyses. For the Technical Update, these two terms can be viewed as interchangeable; however, the phrase "environment and recreation" (or E&R) will be used moving forward.

Resiliency – The ability of water systems to adapt and continue providing adequate levels of service in the face of changing circumstances and drivers.

Scenario Planning – Scenario planning is a strategic planning process that acknowledges that the future is uncertain, identifies the drivers that affect water supplies and demands, and envisions alternative water futures that reflect the potential variability of drivers. Adaptive management plans can be developed to meet future needs identified in the scenarios.

Self-Supplied Industrial (SSI) Demands – Self-supplied industrial demands are defined as the water needs of large industrial water users that have their own water supplies or lease raw water from others. Industrial needs met by municipal water providers are incorporated into municipal water demands and are not part of SSI demands. Self-supplied industrial demands are also referenced simply as “industrial” demands in the Technical Update.

Statewide Water Supply Initiative (SWSI) 2010 – Refers to the Statewide Water Supply Initiative completed in 2010 (SWSI 2010). This effort built on the earlier SWSI I and SWSI II efforts. Since the 2015 launch of the Colorado Water Plan, SWSI is now referred to as the Analysis and Technical Update to the Colorado Water Plan (or simply “Technical Update”).

Systemwide Municipal Demand – Systemwide municipal demand is equivalent to distributed water as defined by 1051 data or water supplied as defined in the American Water Works Association (AWWA) Water Loss Control audit methodology. This is equal to the sum of all municipal demand categories, including residential indoor, residential outdoor, non-residential indoor, non-residential outdoor and non-revenue water.

Targeted Water Provider Outreach (Targeted Outreach) – Targeted outreach that was facilitated by CWCB staff to gather municipal water usage data and information in select counties that had no 1051, Water Efficiency Plan, or BIP data.

Technical Advisory Groups (TAG) – The Technical Advisory Groups refer to the basin roundtable members and subject matter experts who helped inform the methodologies used in the Technical Update.

Technical Update – This refers to the analysis and technical update to the Colorado Water Plan. The Technical Update is similar to prior SWSI efforts but with important differences (see Section 3 for a comparison of SWSI to the Technical Update).

Water Conservation – Water conservation is the minimization of water loss or waste. The goal of water conservation is to use only the amount of water necessary to complete a task or meet a need. Water conservation can be achieved through policies, programs, and practices designed to encourage less water use.

Water Efficiency – Water efficiency refers to strategies or technologies that facilitate using less water to accomplish an activity. Low-flow toilets and showerheads are examples of technologies that increase water efficiency. Water efficiency improvements are typically accomplished via engineered products or solutions.

Water Efficiency Plans – See Municipal Water Efficiency Plans above.

Water Future – Colorado’s “water future” refers broadly to future conditions with respect to water supplies and demands, social values, condition of environmental and recreational attributes, and the types of strategies and projects that will be implemented to meet future needs.

Water Plan – Abbreviated reference to the Colorado Water Plan (also referred to as the Colorado Water Plan).

Water Supply Limited (WSL) Consumptive Use – The amount of applied water consumed by crops, also referred to as actual crop consumptive use. WSL is the minimum of the IWR and the amount of applied water that reaches crops.

ANALYSIS & TECHNICAL UPDATE TO THE COLORADO WATER PLAN

Clean and reliable water supplies are essential to our way of life. All of us—agricultural producers, urbanites, environmentalists, and recreationalists—depend on it for quality of life, a vibrant economy, and a healthy environment. These are the reasons we call Colorado home, the qualities that attract new Colorado residents, and the drivers of the Colorado Water Plan.

Colorado's water supplies are highly variable, and our demands are growing. Throughout Colorado's history, and increasingly in recent decades, we have experienced severe drought conditions, extreme flooding events, population booms, and economic recessions. These extremes often reflect larger shifts that highlight the importance of resilience in our water supplies and thoughtful, collaborative planning—the heart of the Colorado Water Plan (Water Plan).

The Water Plan provides a framework for developing resilient responses to our water-related challenges. It articulates a vision for collaborative and balanced water solutions led by the Colorado Water Conservation Board (CWCB) and our grassroots basin roundtable structure. This vision recognizes the evolving nature of water resource planning and implementation.

Following the launch of the Water Plan and Basin Implementation Plans (BIP) in 2015, the CWCB initiated the process of updating the underlying water supply and demand analyses in 2016, culminating in this report. The work began with the input of Technical Advisory Groups (TAG)—a group of representatives from across the state who provided expertise and advice on methods for the next phase of analysis. The resulting "Technical Update" (formerly known as the Statewide Water Supply Initiative or SWSI) establishes a new approach to statewide water analysis and data sharing.

The Technical Update and its related insights and tools build on a nearly 15-year legacy of CWCB water supply planning initiatives that began with the first SWSI in 2004. It also leverages a 27-year investment in statewide water modeling efforts, which began in 1992. To that end, this Technical Update provides a significant improvement in the scope, science, and approach to water supply planning (in SWSI I, SWSI II, and SWSI 2010). This approach positions Colorado for a streamlined and robust evaluation of its future water needs.

1 CHANGES IN THE APPROACH

The Colorado Water Plan set an adaptive management framework for future water planning activities and described five planning scenarios under which demands, supplies, and gaps were to be estimated. The scenarios included new considerations, such as climate change, that were not a part of prior SWSIs. In addition, the CWCB has continued to work with the Division of Water Resources to develop and refine consumptive use and surface water allocation models that were not ready for use in earlier analyses. As a result of these factors, the Technical Update takes a different and more robust approach to estimating future gaps.

The new methodology provides basin roundtables with datasets and tools that can be used to develop enhanced implementation strategies to meet Colorado's water needs.

New Analysis Needs

The Technical Update estimates future available water supplies and gaps under the five planning scenarios described in the Water Plan. Previous SWSIs were conducted prior to the Water Plan and, therefore, did not consider the scenarios. The scenarios incorporate water supply and demand drivers associated with the potential effects of climate change, population growth, and other factors.

New Planning Process

In their BIPs, the basin roundtables cataloged various projects and methods to mitigate future water supply gaps. The Technical Update focuses on developing tools and more detailed datasets to help basin roundtables update their portfolios of projects and methods for meeting future water needs in a targeted manner, with forthcoming updates to their BIPs.

New Models and Data Sets

New analysis tools and datasets have been developed since SWSI 2010. Consumptive use and surface water allocation models developed through Colorado's Decision Support Systems (CDSS) are now available in most river basins. The CDSS tools allow the evaluation of water availability gaps under a variety of hydrologic conditions. Municipal water demand and conservation data are available via HB10-1051 reporting. The availability of these new tools and datasets allows for a more robust approach to assessing future water availability and potential gaps.

REFINED OBJECTIVES

Given the new planning concepts described above, the overall objectives of the Technical Update are to:

1. **Update** and **recharacterize** future gaps

2. **Evaluate** environmental and recreational issues with new tools

3. **Create** user-friendly standardized tools, basin datasets, and information

2 NEW METHODS

The CWCB undertook a collaborative approach to developing methodologies for the Technical Update through the use of TAGs. Four TAGs were formed that provided input on scenario quantification, agricultural demands, municipal and industrial (M&I) demands, and environment and recreational tools (E&R). TAG participants included water stakeholders, subject matter experts, and basin roundtable members from each basin across the state.

New Features and Improved Data

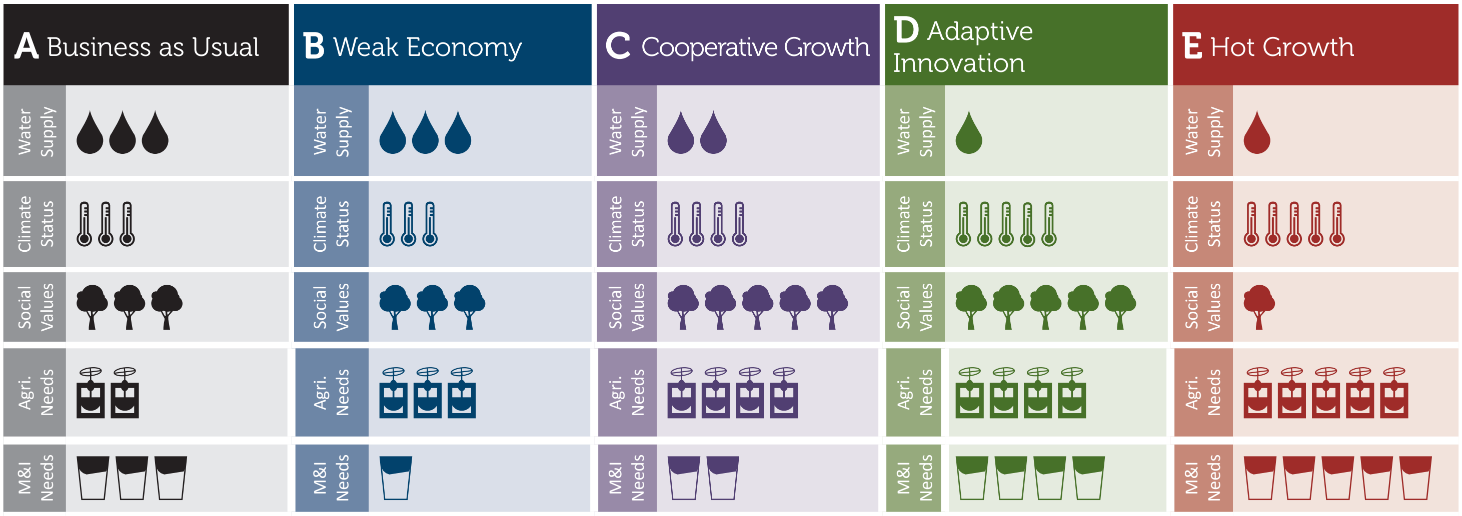
Section 2 of the Technical Update (Volume 1) summarizes the methodologies used to estimate current and future municipal and industrial (M&) and agricultural demands, water supplies and potential gaps, and tools for evaluating environment and recreation needs. Technical memoranda (see Volume 2) provide additional details.

The methodologies used for the Technical Update built on previous datasets and new and improved data sources and, to the extent possible, leveraged Colorado's investment in models developed through CDSS. Highlights of the new methodologies are described below.

Incorporation of scenario planning: Scenario planning is a new feature of the Technical Update and forms the context under which specific methodologies were developed. The five scenarios used come directly from the Colorado Water Plan (also shown on the following page).

- **"1051" water usage data:** New data describing recent municipal water usage was employed to estimate municipal water demands. The data are collected and reported by water providers pursuant to House Bill 2010-1051 ("1051"), which requires that the CWCB implement a process for reporting water use and conservation data by covered entities. This type of data was not available in prior SWSI efforts.
- **CDSS Tools:** The technical analyses made extensive use of modeling tools available through CDSS. CDSS is a water management system developed by the CWCB and the Division of Water Resources for each of Colorado's major water basins. Tools in CDSS include Hydrobase (a vast database of statewide water-related data), GIS data, surface water allocation models, and models that quantify consumptive use from crops and other vegetation. CDSS tools are available in most basins in the state. In basins where particular CDSS tools are not available, alternative methodologies were used to estimate demands and potential future gaps.
- **Consideration of climate change:** Three of the five planning scenarios include assumptions related to a hotter and drier future climate. Projections of future climate conditions were not a part of SWSI 2010 and can have a significant influence on hydrology, water use, and estimated gaps.
- **Quantification of an agricultural gap:** Water demands and shortages for irrigated crops at the field level were estimated in SWSI 2010, but were not quantified using surface water modeling. Using the full suite of modeling tools available from CDSS made it possible to estimate agricultural gaps in the Technical Update under current and planning scenario conditions. Agricultural gaps are described in two ways:
  - » *1. Total Gap:* The overall shortage of agricultural water supplies to meet diversion demands required to provide full crop consumptive uses.
  - » *2. Incremental Gap:* The degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.
- **Improved environment and recreation tools:** The Technical Update built on prior SWSI efforts and improved the data associated with environment and recreation attributes statewide. In addition, an Environment and Recreation (E&R) Flow Tool (Flow Tool) was developed to help assess potential flow conditions and associated ecological health in river segments in each basin. The Flow Tool was built on the framework of the Watershed Flow Evaluation Tool, a Colorado-specific application of a framework for assessing environmental flow needs at a regional scale previously developed with CWCB support. The tool uses flow data from the surface water allocation modeling developed for the Technical Update.

Figure ES.1 CWP Planning Scenarios Key Drivers Graphical Summary



A. Business as Usual

Recent trends continue into the future. Few unanticipated events occur. The economy goes through regular economic cycles but grows over time. By 2050, Colorado's population is expected to be close to 9 million. Single-family homes dominate, but there is a slow increase of denser developments in large urban areas. Social values and regulations remain the same, but streamflows and water supplies show increased stress. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation of new water development slowly increases. Municipal water conservation efforts slowly increase. Oil-shale development continues to be researched as an option. Large portions of agricultural land around cities are developed by 2050. Transfer of water from agriculture to urban uses continues. Efforts to mitigate the effects of the transfers slowly increase. Agricultural economics continue to be viable, but agricultural water use continues to decline. The climate is similar to the observed conditions of the 20th century.

B. Weak Economy

The world's economy struggles, and the state's economy is slow to improve. Population growth is lower than currently projected, which is slowing the conversion of agricultural land to housing. The maintenance of infrastructure, including water facilities, becomes difficult to fund. Many sectors of the state's economy, including most water users and water-dependent businesses, begin to struggle financially. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation decreases due to economic concerns. Greenhouse gas emissions do not grow as much as currently projected, and the climate is similar to the 20th century observed conditions.

C. Cooperative Growth

Environmental stewardship becomes the norm. Broad alliances form to provide for more integrated and efficient planning and development. Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and in mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development. Coloradans embrace water and energy conservation. New water-saving technologies emerge. Eco-tourism thrives. Water development controls are more restrictive and require both high water-use efficiency and environmental and recreational benefits. Environmental regulations are more protective, and include efforts to re-operate water supply projects to reduce effects. Demand for more water-efficient foods reduces water use. There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting streamflows and supplies. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.

D. Adaptive Innovation

A much warmer climate causes major environmental problems globally and locally. Social attitudes shift to a shared responsibility to address problems. Technological innovation becomes the dominant solution. Strong investments in research lead to breakthrough efficiencies in the use of natural resources, including water. Renewable and clean energy become dominant. Colorado is a research hub and has a strong economy. The relatively cooler weather in Colorado (due to its higher elevation) and the high-tech job market cause population to grow faster than currently projected. The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand. The warmer climate reduces global food production, which increases the market for local agriculture and food imports to Colorado. More food is bought locally, which increases local food prices and reduces the loss of agricultural land to urban development. Higher water efficiency helps maintain streamflows, even as water supplies decline. Regulations are well defined, and permitting outcomes are predictable and expedited. The environment declines and shifts to becoming habitat for warmer-weather species. Droughts and floods become more extreme. More compact urban development occurs through innovations in mass transit.

E. Hot Growth

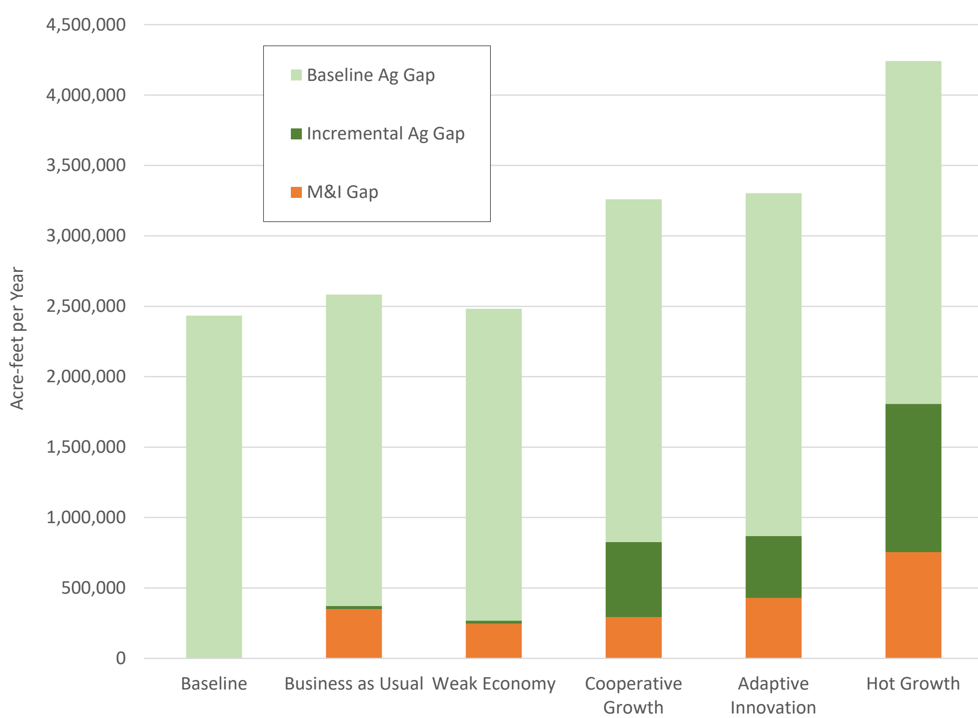
A vibrant economy fuels population growth and development throughout the state. Regulations are relaxed in favor of flexibility to promote and pursue business development. A much warmer global climate brings more people to Colorado with its relatively cooler climate. Families prefer low-density housing, and many seek rural properties, ranchettes, and mountain living. Agricultural and other open lands are rapidly developed. A hotter climate decreases global food production. Worldwide demand for agricultural products rises, which greatly increases food prices. Hot and dry conditions lead to a decline in streamflows and water supplies. The environment degrades and shifts to becoming habitat for species adapted to warmer waters and climate. Droughts and floods become more extreme. Communities struggle unilaterally to provide services needed to accommodate rapid business and population growth. Fossil fuel is the dominant energy source, and there is large production of oil shale, coal, natural gas, and oil in the state.

3 REVISITING THE GAPS

Statewide gaps may vary substantially, depending on future climate conditions and population increases, which underscores the need to take an adaptive approach to developing water management strategies and projects and methods to fill potential future gaps (see figure ES.2).

- **Agriculture** currently experiences a gap, and it is projected to increase statewide. Increases may be modest under the *Business as Usual* and *Weak Economy* scenarios but may be more substantial under scenarios that assume a hotter and drier future climate (the *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth* scenarios) due to decreasing supply and increasing crop irrigation requirements.
- **M&I** users do not currently experience a gap, but a growing population and potential impacts from climate change are projected to create gaps. Projected M&I gaps vary based on assumptions regarding future population and climate conditions but may be reduced by conservation measures.
- **E&R** gaps were not directly quantified but tools were developed to help evaluate potential risks that impact aquatic habitat, species and boating due to flow conditions. These potential future risks are documented in various sections of the Technical Update but are not a part of the gap estimates below.

Figure ES.2 Summary of Statewide Gap Estimates by Planning Scenario



COMPARING THE 2015 WATER PLAN GAP NUMBERS TO GAPS IN

THE TECHNICAL UPDATE

SIMILAR GAPS. ABSENT PROJECTS. LOWER POPULATION. LOWER DEMANDS.

1 Gaps Absent Projects

Gap projections in the Technical Update do not include estimates of basin-identified project yields. This is primarily due to a lack of specific project data that would allow projects to be modeled. Forthcoming basin plan updates will reevaluate projects and consider strategies to address gaps.

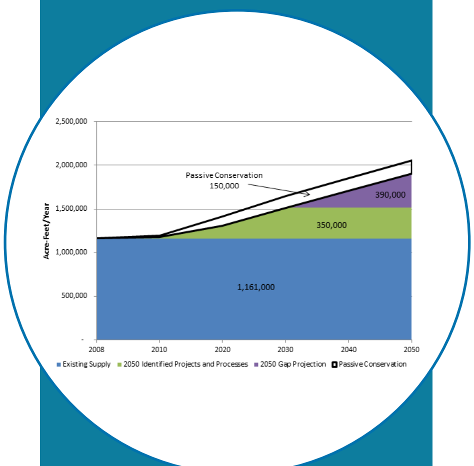
2 Gaps Across Scenarios

Unlike past projections that estimated high, medium and low gaps at 2050, the Technical Update identifies 2050 gaps for each of the Water Plan's five scenarios.

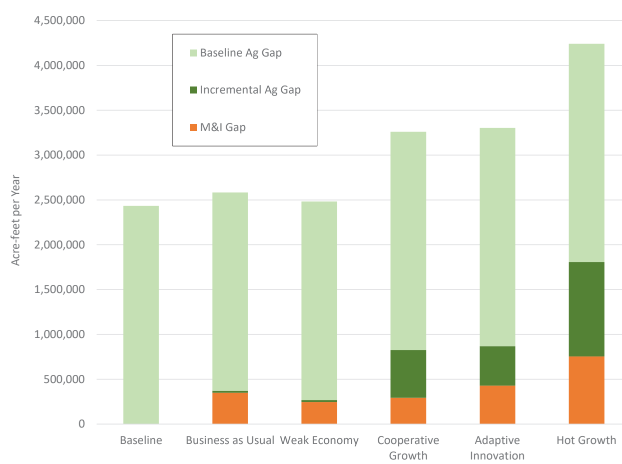
3 Gap Influences

Some of the main drivers (population, climate) and assumptions (storage operations) heavily influence the gaps in the Technical Update. Population projections, while lower than in previous analyses, remain a major driver of demands. Climate change is included in three of the five scenarios, which drives irrigation, streamflow and storage timing. Modeled storage operations maximize the use of stored water to meet demands and lower gaps.

GAPS SHOWN IN THE 2015 WATER PLAN



GAPS SHOWN IN THE 2019 TECHNICAL UPDATE



4 Gap Mitigation

When basins reevaluate plans it will be important to evaluate core projects that represent low-regret actions to meet future needs under any scenario. The Adaptive Innovation scenario, for example, illustrates how adaptive actions (e.g. efficiency) can help offset impacts from climate change and population growth.

2015 Water Plan	2019 Technical Update
190,000 - 630,000 AFY 2050 M&I GAP	250,000 - 750,000 AFY 2050 M&I GAP
1,722,000 AFY 2050 AG SHORTAGE	23,000 - 1,053,000 AFY 2050 INCREMENTAL AG GAP

5 Gaps: Max, Average & Incremental

Gaps are shown in a manner that reflects the difference in how M&I and agriculture plan in any given year. Feedback on earlier studies suggested that agriculture gaps may have been overstated because many agricultural producers live with annual shortages (especially in over-appropriated basins).

To address this, agricultural gaps are expressed in terms of average and incremental gaps—the degree to which gaps may increase in the future. Maximum agricultural gaps can also be found in the Technical Update results. At the same time, M&I gaps are primarily expressed in terms of maximums, which is consistent with firm yield planning.

AGRICULTURAL IMPACTS

The Colorado Water Plan identifies that up to 700,000 acres of agriculture could come out of production if agricultural transfers ("buy and dry") are exclusively used to meet future M&I demands. Because the Technical Update did not quantify basin projects, roundtables will evaluate how gaps should be met in the forthcoming basin plan updates. The Technical Update indicates that where municipal boundaries expand, agriculture is likely to be lost. This urbanization could result in the loss of more than 152,400 irrigated acres. Additionally, stakeholders identified that planned agricultural to M&I water transfers could result in a loss of up to 76,000 acres of agriculture in the South Platte and Arkansas basins alone.

SIGN OF CONCERN

Scenarios with moderate and significant climate impacts show shifts to earlier runoff seasons which will likely impact storage, irrigation, and streamflows.

SIGN OF SUCCESS

The statewide baseline per capita systemwide municipal demand has decreased from 172 gpcd ito nearly 164 gpcd. That represents about a 5 percent reduction in demands between 2008 and 2015.

4 KEY RESULTS

The Technical Update generated a rich dataset throughout Colorado that describes agricultural and M&I water demands, potential gaps, and available water supply under current conditions and under each of the five planning scenarios. The data and results are provided for basin roundtables and others to use for water planning purposes.

Key results and findings of the Technical Update pertaining to statewide agricultural and M&I demands and gaps, as well as findings related to environment and recreation attributes in potential future conditions, are summarized below.

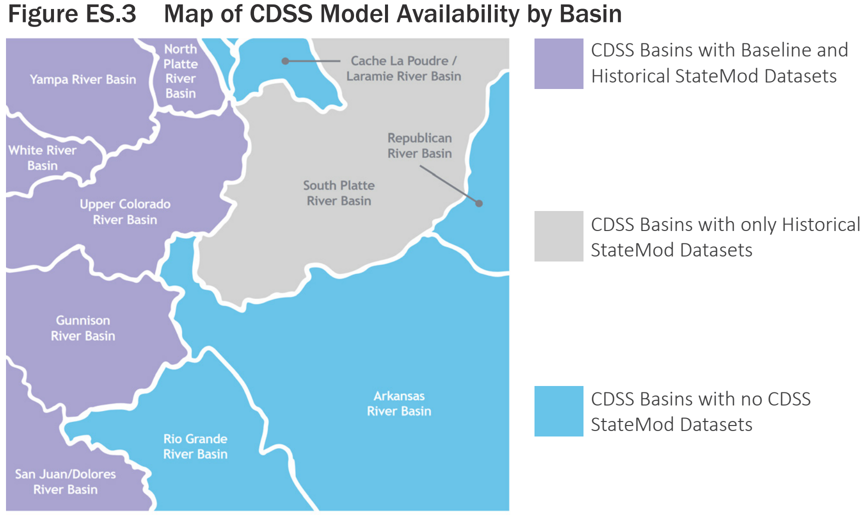
Summary of Key Statewide Results

Agricultural	Environmental and Recreational	Municipal and Industrial
• Agriculture currently experiences gaps, and gaps may increase in the future if climate conditions are hotter (which increases irrigation water demand) and supplies diminish (due to drier hydrology). • Irrigated acreage is projected to decrease in most basins due to urbanization, planned agricultural-to-municipal water transfers, and groundwater sustainability issues. • Gaps under the Adaptive Innovation scenario are significantly less than *Hot Growth* despite similar assumptions related to future climate conditions, which demonstrates the potential benefits of higher system efficiencies and emerging technologies that could reduce consumptive use; however, in return flow driven systems, conservation in one area could impact water supplies downstream, so thoughtful approaches are necessary.	• Climate change and its impact on streamflow will be a primary driver of risk to E&R assets. • Projected future stream flow hydrographs in most locations across the state show earlier peaks and potentially drier conditions in the late summer months under scenarios with climate change. • Drier conditions in late summer months could increase risk to coldwater and warmwater fish due to higher water temperatures and reduced habitat. The degree of increased risk is related to the level of stream flow decline. • Instream flow rights and recreational in-channel diversion water rights may be met less often in climate-impacted scenarios.	• Municipal and industrial users do not currently experience a gap, but increasing population and potentially hotter and drier future climate conditions will create a need for additional supply despite efforts to conserve water. • Conservation efforts, however, can create significant future benefits in lowering the gap, as demonstrated by comparing the *Adaptive Innovation* and *Hot Growth* scenarios (which have similar assumptions on population and climate).

BASIN MODELING

CDSS surface water allocation models (StateMod) were used in basins where they are available to evaluate streamflows and gaps. Baseline data sets were used to assess available water supplies under current conditions; these data sets were modified to estimate future water supplies in the planning scenarious. In basins where the CDSS program has not been fully implemented, the methodology was modified using available tools and water supply information, such as historical streamflow data.

Figure ES.3 Map of CDSS Model Availability by Basin



[An overview of each of these areas is provided on the following pages.]

Agricultural Diversion Demands

Agricultur diversion demand represents the amount of water that would need to be diverted or pumped to meet the full crop irrigation water requirement (IWR) or full crop consumptive use. The diversion demand does not reflect historical irrigation supplies because irrigators often operate under water short conditions and do not have enough supply to fully irrigate their crops.

Current statewide total agricultural diversion demand is approximately 13 million acre-feet (AF), with more than 80 percent of that demand attributable to surface water supplies (though groundwater is the primary source of supply in some basins). The South Platte, Arkansas, Gunnison, and Rio Grande basins have the highest demands for irrigation diversions.

Future agricultural diversion demands will be affected by urbanization, planned agricultural projects that add irrigated acreage, aquifer sustainability, and climate change. Emerging technologies that increase system efficiency and/or reduce crop consumptive use of water may reduce water supply shortages and potentially reduce the amount of water diverted or pumped.

Future statewide agricultural diversion demand estimates range from 10 million AF in the *Adaptive Innovation* scenario to 13.5 million AF in the *Hot Growth* scenario. Urbanization, transfers of agricultural water to municipalities, and declining aquifer levels are projected to cause reductions in irrigated lands across the state (in some basins more than others), leading to reduced overall diversion demand compared to current demand. In scenarios that assume a hotter and drier climate, the impact of acreage loss on diversion demand could be offset by higher crop water requirements, which could lead to an overall increase in demands (see the *Cooperative Growth* and *Hot Growth* scenarios). The *Adaptive Innovation* scenario has the lowest statewide agricultural diversion demand due to assumptions of higher system efficiencies and emerging technologies that reduce crop water demands.

Figure ES.4 Current Average Annual Agricultural Diversion Demand by Basin

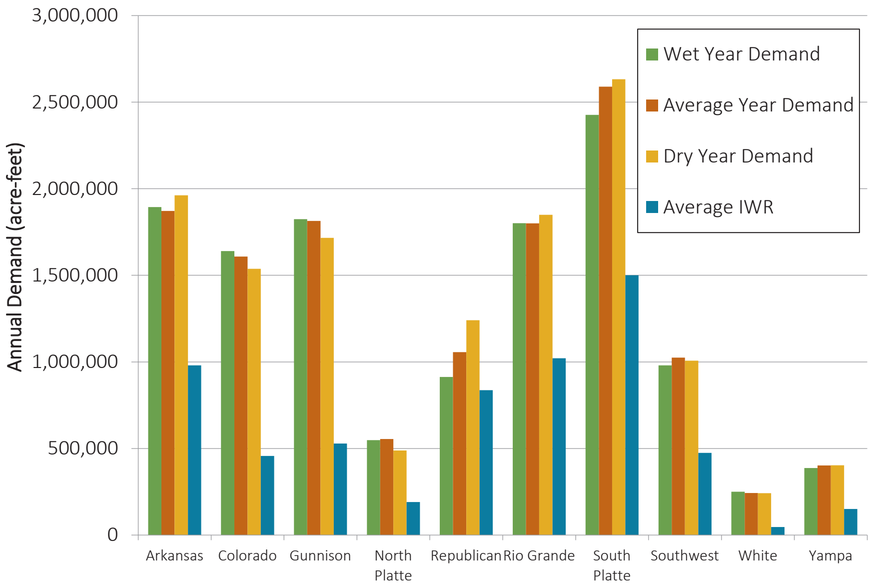
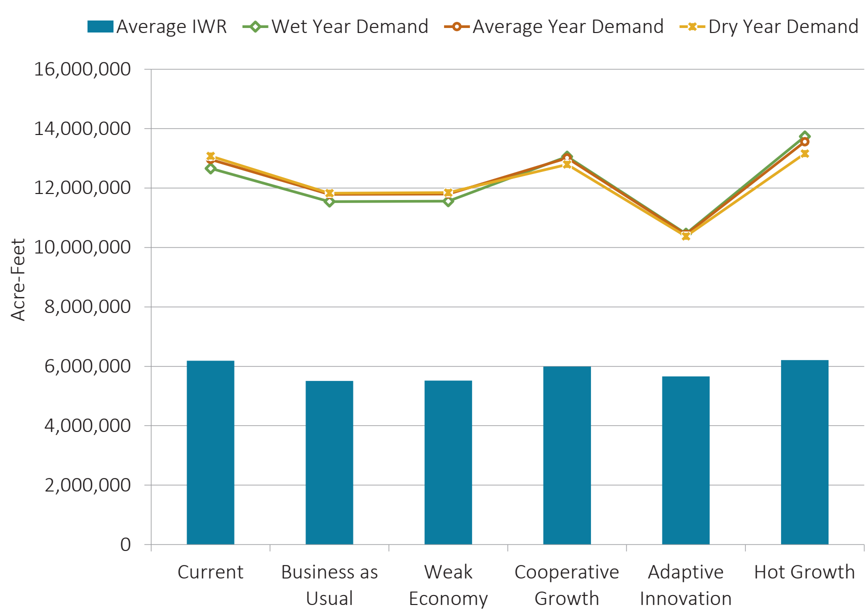
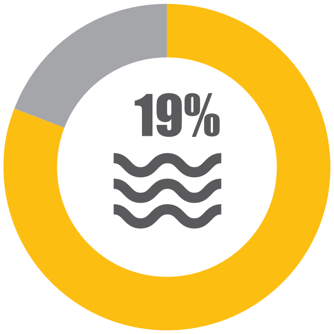


Figure ES.5 Future Statewide Average Annual Agricultural Diversion Demand Estimates for Planning Scenarios



TECHNICAL UPDATE / AGRICULTURAL FINDINGS



Demand for groundwater is approximately 19 percent of the overall demand. Groundwater demands occur primarily in the Arkansas, Republican, Rio Grande, and South Platte basins where irrigation from wells is prominent.

3 X

Based on known agricultural water transfers currently in water court or deemed to be highly likely by agricultural stakeholders, the estimates of planned buy and dry gransfers in the Technical Update (33,000 - 76,000 acres) are almost three times higher on the upper end than the data that informed the Water Plan (26,200 acres).

In all basins where significant agriculture comes out of production, diversion demands will go down due to the decrease in irrigation even as the plant demand for irrigation (were those lands to be irrigated) increases.

20% UNMET DEMAND

On average, approximately 80 percent of the overall agricultural diversion demand is currently met (and 20 percent is unmet) on a statewide basis, though this varies in each basin.

Agricultural diversion demands statewide are projected to decrease in three of the five scenarios by up to 9 percent compared to current conditions. In *Adaptive Innovation*, decreased demand from loss of irrigated lands will be offset, in part, by climate-driven irrigation demand increases; however, increased efficiency and decreased consumptive use show a 20 percent reduction in diversion demands. In *Hot Growth*, irrigated lands are projected to be lost, but climate change could more than offset that loss, resulting in an overall 5 percent increase in diversion demands.

700K ACRE LOSS STILL POSSIBLE

The Colorado Water Plan identifies that up to 700,000 acres of agriculture could come out of production if agricultural transfers (buy and dry) are used to meet future M&I demands. Because the Technical Update did not re-quantify basin projects, roundtables will need to evaluate how gaps could and should be met when updating projects (and project data). The Technical Update does indicate that where municipal boundaries expand, agriculture is likely to be lost. This urbanization could result in the loss of 152,400 irrigated acres.

M&I Diversion Demands

Current and future diversion demands for municipal water users are driven by population and water usage rates. Population estimates were based on State Demography Office (SDO) projections and adjusted upward or downward (depending on the scenario) based on historical growth statistics. The current population statewide is 5.7 million people and is projected to grow to 8.5 million by the year 2050 according to the SDO. High and low statewide projections developed for the Technical Update range from 7.7 million to 9.3 million people.

The statewide baseline per capita systemwide demand has decreased from 172 gallons per capita per day (gallons per capita per day) in SWSI 2010 to approximately 164 gpcd, which is nearly a 5 percent reduction in demand between 2008 and 2015. The reduction is associated with improved data availability, conservation efforts, and ongoing behavioral changes. Projected future per capita demands vary from 143 to 169 gpcd (see Figure ES.6), depending on the scenario. Scenario assumptions can create offsetting factors. For example, projected decreases in outdoor demand resulting from implementation of conservation measures in some scenarios was offset by increases in outdoor demand due to climate change.

Total statewide municipal diversion demands are shown in Figure ES.7, along with population projections. In general, overall municipal demands are projected to increase and generally in proportion to population increases; however, in *Adaptive Innovation*, projected municipal demands are similar to the *Business as Usual* demands despite the increased population projections and hotter and drier climate assumed for *Adaptive Innovation*, which demonstrates the potential benefits of increased water conservation measures.

Statewide baseline SSI water demands are comprised of four major industrial uses. Baseline and projected SSI demands for all planning scenarios were calculated. With the exception of *Hot Growth*, the updated projections for all planning scenarios were below SWSI 2010 estimates, primarily due to changes in assumptions for thermoelectric demands related to regulations that require an increase in power generation from renewable sources.

Figure ES.6 Statewide per Capita Demand for Five Planning Scenarios

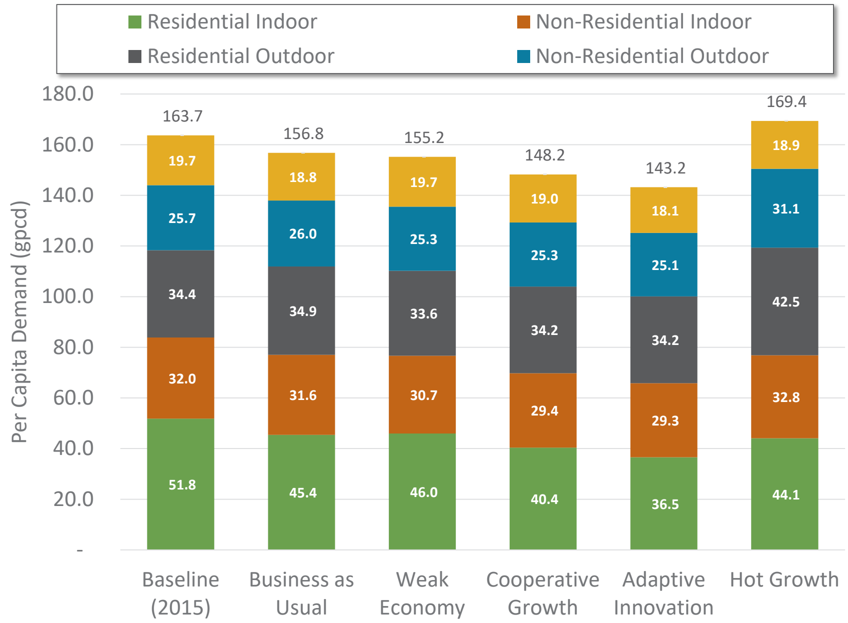
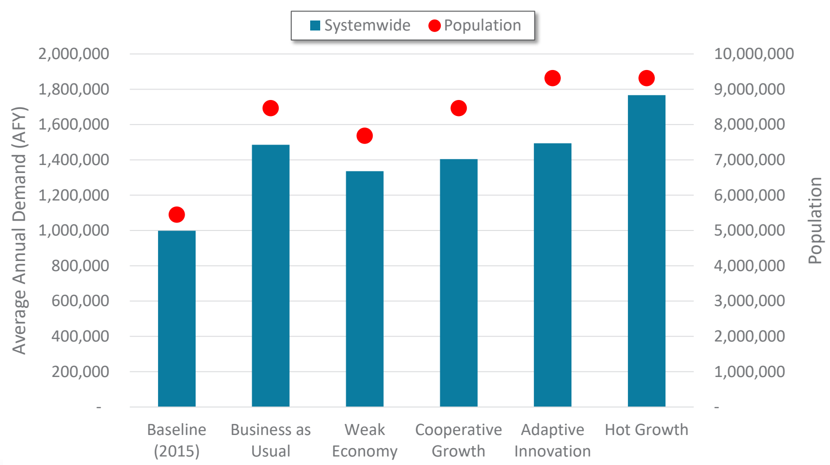
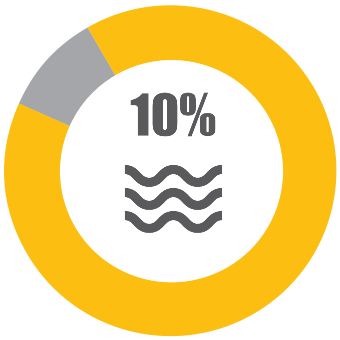


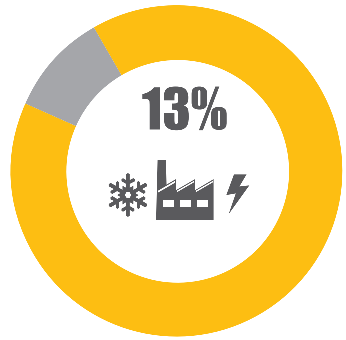
Figure ES.7 Statewide Baseline and Projected Population and Municipal Demands



TECHNICAL UPDATE / M&I FINDINGS



M&I demands comprise approximately 10 percent of the combined agricultural and M&I statewide demands that are currently met with existing water supplies and projects.



On average, SSI demands account for 13 percent of the total M&I demands. This includes snowmaking; and thermoelectric, energy development, and large industrial users.

Per capita baseline system demand has decreased from 172 to 164 gpcd—a 5 percent reduction in demands between 2008 - 2015.

Adaptive Innovation shows a 13 percent decrease in gpcd (from 164 to 143 gpcd) compared to current conditions. Total municipal demand in *Adaptive Innovation* tracks closely with *Business As Usual*. This highlights how social values that prioritize water conservation and water saving technologies could help mitigate impacts from climate and population.

35% +

While per capita usage is expected to decrease in all but *Hot Growth*, overall statewide M&I water demand is projected to increase from 35 percent in *Weak Economy* to 77 percent in *Hot Growth* over current demands. Even at that highest level, it is still lower than Water Plan due to the revised population projections, which are lower than previously estimated.

5%

Current population (5.4 million) is 5 percent less than the Water Plan's projected 2015 levels. The State Demography Office estimates that Colorado will grow to 8.5 million by 2050.

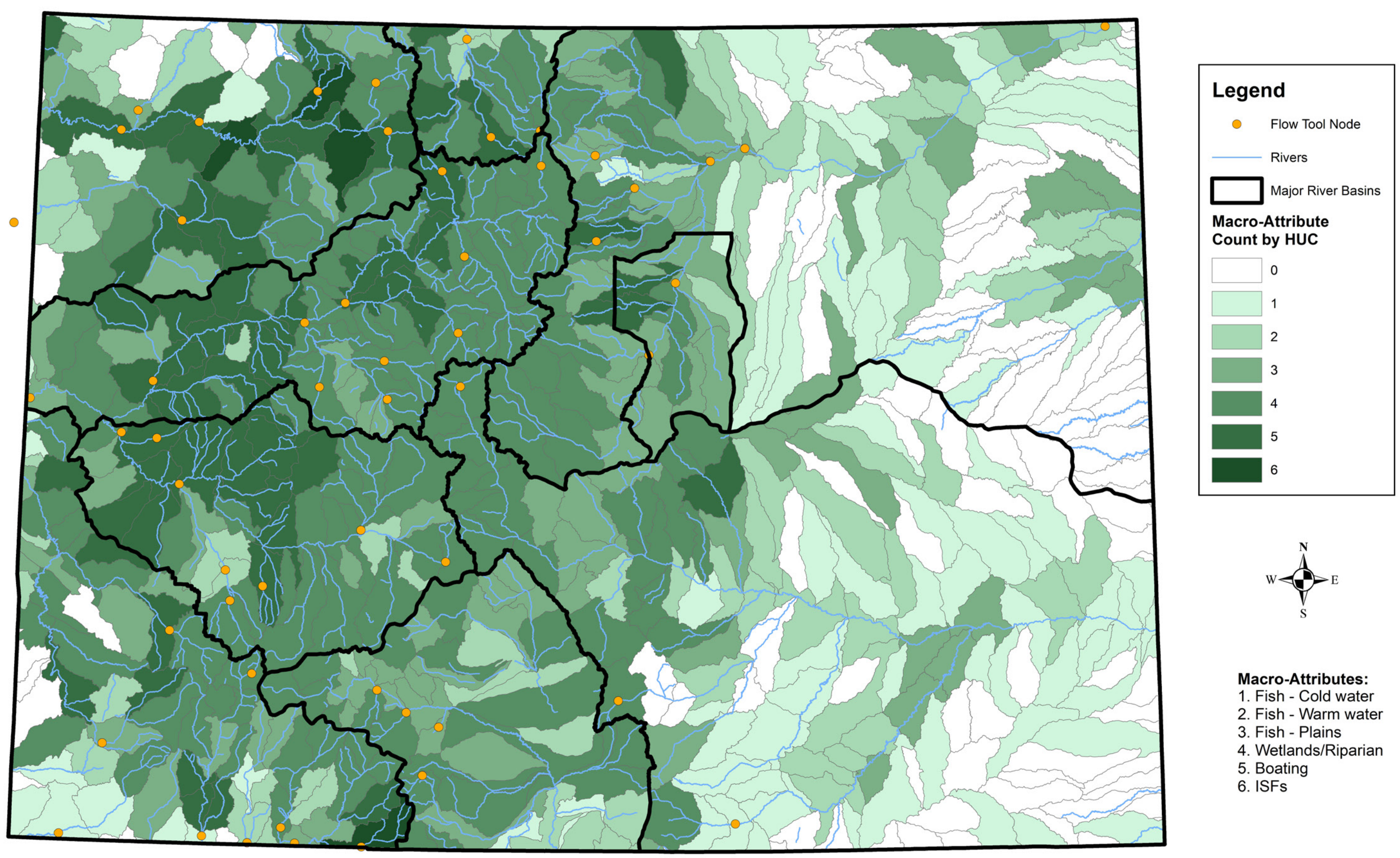
Environment and Recreation

The Colorado Environment and Recreation Flow Tool (Flow Tool) helps basin roundtables refine, categorize, and prioritize their portfolio of E&R projects and methods through an improved understanding of flow needs and potential flow impairments, both existing and projected. The Flow Tool uses hydrologic data from CDSS, additional modeled hydrologic data for various planning scenarios, and established flow-ecology relationships to assess risks to flows and E&R attribute categories at preselected gages across the state. The Flow Tool is a high-level tool that is intended to provide guidance during Stream Management Plan development and BIP development.

The Flow Tool estimates the response of E&R attributes in rivers under various hydrologic scenarios. The flow-ecology relationships in the Flow Tool were first developed as part of the Watershed Flow Evaluation Tool and were patterned after similar relationships that have been developed across the globe to inform water management. Flow-ecology science quantifies the relationship between specific flow statistics (e.g., average magnitude of peak flow, the ratio of flow in August and September to mean annual flow) and the risk status (low to very high) for environmental attributes under the flow scenario being analyzed. Data-derived relationships have been developed for riparian/wetland plants (cottonwoods), coldwater fish (trout), warmwater fish (bluehead sucker, flannelmouth sucker, and roundtail chub), and Plains fish. Other metrics were developed with basic, well-established relationships between hydrology and stream ecology. Relationships for recreational boating were also developed with stakeholders during Watershed Flow Evaluation Tool development.

The Flow Tool incorporates data from 54 nodes in the water supply and gap analysis; the tool visualizes changes in flow regime and risks to E&R attributes under existing and future conditions associated with the five planning scenarios.

Figure ES.8 Gages Included in the Flow Tool



TECHNICAL UPDATE / E&R FINDINGS

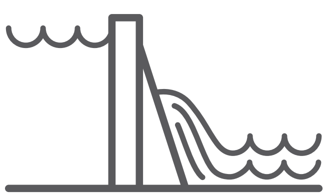
Projected future streamflow hydrographs in most locations across the state show potentially drier conditions in the late summer months under scenarios with climate change that suggest air temperatures could increase by 3.78°F to 4.15°F by 2050.

Instream Flow (ISF) and recreational in-channel diversions (RICD) water rights may be met less often in climate-impacted scenarios that see more consistent temperature increases and more variable precipitation and runoff conditions.

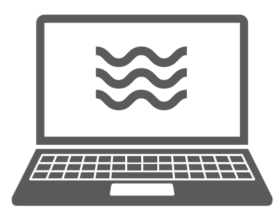
↑ 1 MONTH

Peak runoff may shift as much as one month earlier, which could lead to drier conditions in summer months and produce multiple implications for storage, irrigation and streamflow.

Under climate change scenarios, runoff and peak flows may occur earlier, and result in possible mismatches between peak flow timing and species' needs. Drier conditions in late summer months could increase risk to coldwater and warmwater fish due to higher water temperatures and reduced habitat.



In mountainous regions with infrastructure, risks to E&R assets may vary. Streams that are already depleted may see increased risks in scenarios with climate change; however, some streams may be sustained by reservoir releases, which will help moderate risks in scenarios with climate change.



The Flow Tool created as part of the Technical Update was designed to compare modeling outputs from the five planning scenarios against baseline (existing) and naturalized (unimpaired) flow conditions. Key outputs include a comparison of monthly flow regimes relative to ecological-flow indicators, building off past stakeholder-driven efforts in Colorado.

5 INSIGHTS, TOOLS & RECOMMENDATIONS

The Technical Update developed a variety of high-level analyses on the topics of public perceptions, alternative transfer methods (ATM), water reuse, storage opportunities, and economic impacts. The intent of these analyses was to provide insight into various issues that will be valuable for basin roundtables as they update their BIPs and consider solutions to address potential future gaps. Findings from these analyses are included in Section 5 of the Technical Update (Volume 1).

The Technical Update also developed several tools for basin roundtables to use when updating their BIPs. During the Technical Update, several types of data from existing BIPs were reviewed that indicated the need to improve the completeness and uniformity of basin project information. In addition, the Technical Update included the development of tools like a Project Cost Estimating Tool and E&R Flow Tool.

A list of recommendations aims to allow basins flexibility in the BIP update process to tailor approaches to best suit basin goals while at the same time providing a framework for standardization across the BIP updates. This iterative process is meant to support statewide water supply planning, cross-basin dialogue, project funding, enhanced future supply analyses, revised basin goals, and updated project lists.

Integrating Technical Update findings with the BIPs, project lists and, ultimately, the Colorado Water Plan update ensures state water planning will continue to be informed by the best available data.

ANALYSIS & TECHNICAL UPDATE TO THE

COLORADO WATER PLAN

VOLUME I

Analysis and Technical Update to the Colorado Water Plan

ANALYSIS & TECHNICAL UPDATE TO THE

COLORADO WATER PLAN

This report was assembled by the Colorado Water Conservation Board (CWCB) staff and the contract team who supported the Analysis & Technical Update to the Colorado Water Plan. However, this effort was supported by numerous stakeholder interactions that helped drive the methodologies, review and presentation of this report. CWCB staff extends its appreciation to everyone who provided input throughout this process, including the Department of Natural Resources, the Division of Water Resources, senior leadership at the CWCB, the CWCB board, the Interbasin Compact Committee, members of the Technical Advisory Groups, members of the Implementation Working Group, each of the nine basin roundtables and many other subject matter experts, and engaged community members and colleagues whose efforts were invaluable to making this report as comprehensive and grass-roots driven as possible.

It is staff's sincere hope that this effort will continue to engage stakeholders and partners across the State of Colorado and will be used, refined and enhanced in future iterations of Basin Implementation Plan Updates and, ultimately, the Water Plan itself.

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Colorado Water Conservation Board

Department of Natural Resources

Brown AND Caldwell

JACOBS

CDM Smith

wilsonwater group

we've got your basins covered

ELEMENT Water Consulting

BBC RESEARCH & CONSULTING

openwater FOUNDATION

RS21 THERE'S A SMARTER WAY

The Nature Conservancy

HDR

CDR ASSOCIATES

COLLABORATIVE DECISION RESOURCES

Lynker

[DISCLAIMER]

The Analysis and Technical Update to the Colorado Water Plan (Technical Update) provides technical data and information regarding Colorado's water resources. The technical data and information generated are intended to help inform decision making and planning regarding water resources at a statewide or basinwide planning level. The information made available is not intended to replace projections or analyses prepared by local entities for specific project or planning purposes.

The Colorado Water Conservation Board intends for the Technical Update to help promote and facilitate a better understanding of water supply and demand considerations within the State; however, the datasets provided are from a snapshot in time and cannot reflect actual or exact conditions in any given basin or the State at any given time. While this Technical Update strives to reflect the Colorado Water Conservation Board's best estimates of future water supply and demands under various scenarios, the reliability of these estimates is affected by the availability and reliability of data and the current capabilities of data evaluation. Moreover, the Technical Update cannot incorporate the varied and complex legal and policy considerations that may be relevant and applicable to any particular basin or project; therefore, nothing in the Technical Update or the associated Flow Tool or Costing Tool is intended for use in any administrative, judicial or other proceeding to evince or otherwise reflect the State of Colorado's or the CWCB's legal interpretations of state or federal law.

Furthermore, nothing in the Technical Update, Flow Tool, Costing Tool, or any subsequent reports generated from these datasets is intended to, nor should be construed so as to, interpret, diminish, or modify the rights, authorities, or obligations of the State of Colorado or the CWCB under state law, federal law, administrative rule, regulation, guideline or other administrative provision.

Prior to the 2015 Colorado Water Plan (Water Plan), past statewide water supply analyses included data analysis, project information and policy components. After the release of the Water Plan, these elements were split between the Water Plan (policy), Basin Implementation Plans (local projects) and statewide water supply initiatives (technical data analysis). To better recognize these delineations and make the connection to the Water Plan clear, the statewide water supply initiative (often referenced as SWSI) is now being referred to as the Analysis and Technical Update to the Water Plan (or Technical Update). The new name more accurately reflects the technical nature of the evaluations described in the report and better establishes how that data will be used to inform Water Plan updates. While the Technical Update is a statewide water supply initiative and continues that legacy, the SWSI acronym will be relegated to referencing earlier efforts that proceeded the Water Plan (e.g. SWSI 2010).

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[KEY TERMINOLOGY]

The following are definitions for key terms used throughout the Technical Update report:

1051 Data – 1051 Data is the municipal water usage data reported to the CWCB by water providers pursuant to House Bill 2010-1051.

Active vs Passive Conservation – Active water conservation measures are water-saving strategies implemented or incentivized by water providers. Active water conservation includes watering restrictions, public education campaigns, or efficiency improvements. Passive water conservation are measures associated with the installation of new water-efficient fixtures and appliances without incentives from utilities, e.g., replacing an old toilet with a new low-flush toilet.

Adoption Rate – Portion of existing (2015) population that will have water use consistent with the future gallons per capita per day (gpcd) value for a given planning scenario by the year 2050 (i.e., retrofit population).

Agricultural Diversion Demand – The amount of water that needs to be diverted or pumped to meet the full crop irrigation water requirement. Note that SWSI 2010 (see definition below) defined agricultural demand as the amount of water consumed by crops at the field level and not the amount of water that needs to be diverted or pumped.

Agricultural Gap – The amount of additional water that would need to be diverted or pumped to meet crop irrigation shortages. The results of the calculations are also referred to as the “total agricultural gap”. The “incremental agricultural gap” is a portion of the agricultural gap and is defined below. Note that Statewide Water Supply Initiative (SWSI) 2010 defined the agricultural gap as crop or field-based shortages, though it recognized river headgate diversions and pumping would need to be much larger to meet crop shortages.

Applied Water – Water that is diverted from the river, pumped from ground water, or released from reservoirs for irrigation purposes. It is also referred to as irrigation supplies. Applied water does not include or reflect precipitation consumed by crops.

Baseline M&I Demand – Reported and estimated demands representing average conditions for the Technical Update baseline year of 2015. Municipal demands are represented by the gpcd and on a volumetric basis, which is calculated from population and gpcd data.

Basin Implementation Plans (BIP) – Basin Implementation Plans provide critical input to the Colorado Water Plan. BIPs were developed by basin roundtables and demonstrate how each basin roundtable plans to meet its future municipal, industrial, agricultural, recreational, and environmental needs. The BIPs identify projects and methods to meet future water needs and develop goals and measurable outcomes, needs, and constraints and opportunities in each basin. Data and information from the Technical Update will be used by basin roundtables to update their BIPs.

Buy and Dry – The process of buying agricultural water rights and subsequently using the water rights for another purpose (typically for municipal or industrial use). The formerly irrigated agricultural lands are “dried up” and no longer irrigated by virtue of the water transfer.

Climate Change Projections – The climate change projections developed for the Colorado Water Plan and this Technical Update were built upon the foundational work of the multi-phase Colorado River Water Availability Study, Phase II (CRWAS-II). CRWAS-II identified a suite of future climate change projections intended to explore a range of water supply and demand conditions for Colorado in 2050. Three composite projections were used in the Colorado Water Plan and in the Technical Update—the “Current” (recent historical hydrology), “Hot and Dry”, and “Between 20th Century Observed and Hot and Dry” (also, “Between” or “In-Between”).

Colorado’s Decision Support Systems (CDSS) – Colorado’s Decisions Support Systems is a water management system developed by the Colorado Water Conservation Board (CWCB) and the Division of Water Resources for each of Colorado’s major river basins. The CDSS includes water-focused data sets, models, geographic information system (GIS) layers and other tools, including StateMod, StateCU, Hydrobase and others, to assist with surface water and groundwater management in Colorado.

Crop Shortages – Crop shortages are the difference between the amount of water crops needed to meet full crop consumptive use (a.k.a., irrigation water requirement [IWR]) and the amount of applied water crops consumed when irrigation supplies are insufficient to meet the full demand (a.k.a., water supply limited [WSL] consumptive use.

Distributed Water – The volume of water entering the municipal distribution system, calculated as total water production from all sources minus water exported to another water provider.

Drivers – In many contexts in the Technical Update, "drivers" refer to the nine factors identified by the Interbasin Compact Committee (IBCC) that will shape the future of water supplies and demands by the year 2050.

E&R – In the context of the Technical update, E&R refers to attributes and data products related to "environment and recreation".

Evapotranspiration – The sum of water evaporated from the soil surface and transpired through vegetation.

Flow-ecology Relationships – Flow-ecology quantifies the relationship between specific flow statistics (such as average magnitude of peak flow or the ratio of flow in August and September to mean annual flow) and the risk status (low to very high) for environmental attributes under the flow scenario being analyzed.

Gaps – In the Technical Update, gaps were calculated using water allocation models and other analysis tools (in basins where models are not currently available) and were evaluated for both agricultural and municipal and industrial (M&I) uses. Gaps were calculated as the difference between the amount of water available to meet agricultural or M&I diversion demands and the full diversion demand. In other words, gaps reflect the amount by which agricultural or municipal demands could be shorted because of inadequate supplies.

Implementation Working Group – The Implementation Working Group refers to the basin roundtable, Interbasin Compact Committee and CWCB Board members who helped inform the Technical Update recommendations as well as the next steps for the updates to the BIPs.

Incremental Agricultural Gap – The incremental agricultural gap quantifies the degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.

Irrigation System Efficiency – The percent of diverted or pumped water consumed by crops or stored in soil moisture, which is calculated by dividing the sum of WSL (see definition below) and water stored in soil moisture by the total applied water from all sources. System efficiency reflects the losses to applied water due to canal seepage and on-farm application losses.

Irrigation Water Requirement (IWR) – The amount of water that must be applied to crops to meet the full crop consumptive use, also referred to as the crop demand or the consumptive irrigation requirement (CIR). IWR provides an estimate of the maximum amount of applied water the crops could consume if it was physically and legally available.

Metered Municipal Water Use – Water that reaches the end use, including billed/unbilled and authorized/unauthorized uses.

Model Year – The baseline water allocation models used in the Technical Update use time series of hydrology reflective of historical conditions from 1975 to the most recent year available. For planning analyses, the historical hydrology was adjusted to reflect climate change impacts in the applicable scenarios. Demands in the baseline models reflect current conditions; planning scenario models reflect future conditions. Water allocation modeling results are a time series of stream flows, diversions, and shortages that reflect historical variability but are affected by current or future demands. The term "model year" is used to describe model output that reflects historical variability, but is not intended to reflect actual historical conditions.

Municipal Demand – Portion of distributed water attributable to uses typical of municipal systems, including residential, commercial, light industrial, non-agricultural-related irrigation, firefighting, and non-revenue water. Demands for self-supplied households not connected to a public water supply are also included in the municipal demand category. Municipal demands represent diversion demands used in the water allocation models.

M&I Demands – This refers to municipal and industrial water demands inclusive of the self-supplied industrial (SSI) demands. In the Technical Update, this is sometimes also referred to as M&SSI demands or simply "industrial demands".

M&I Gap – The difference between the amount of water available to meet M&I demands and the full M&I diversion demand. Note that the M&I gap in SWSI 2010 was based on the difference between new M&I demands that will occur in the future and the yield of projects currently being pursued to provide future supplies.

Municipal Water Efficiency Plans (WEP) – The Water Conservation Act of 2004 (HB04-1365) requires all covered entities (i.e., retail water providers that sell 2,000 acre-feet or more on an annual basis) to have a state-approved water efficiency plan that contains certain required minimum plan elements.

Non-Revenue Water – The calculated difference between distributed water and authorized metered water use. Non-revenue water thus represents system water loss.

Nonconsumptive Needs and Datasets – In prior SWSIs, "nonconsumptive" referred to "environment and recreation" datasets and analyses. For the Technical Update, these two terms can be viewed as interchangeable; however, the phrase "environment and recreation" (or E&R) will be used moving forward.

Resiliency – The ability of water systems to adapt and continue providing adequate levels of service in the face of changing circumstances and drivers.

Scenario Planning – Scenario planning is a strategic planning process that acknowledges that the future is uncertain, identifies the drivers that affect water supplies and demands, and envisions alternative water futures that reflect the potential variability of drivers. Adaptive management plans can be developed to meet future needs identified in the scenarios.

Self-Supplied Industrial (SSI) Demands – Self-supplied industrial demands are defined as the water needs of large industrial water users that have their own water supplies or lease raw water from others. Industrial needs met by municipal water providers are incorporated into municipal water demands and are not part of SSI demands. Self-supplied industrial demands are also referenced simply as “industrial” demands in the Technical Update.

Statewide Water Supply Initiative (SWSI) 2010 – Refers to the Statewide Water Supply Initiative completed in 2010 (SWSI 2010). This effort built on the earlier SWSI I and SWSI II efforts. Since the 2015 launch of the Colorado Water Plan, SWSI is now referred to as the Analysis and Technical Update to the Colorado Water Plan (or simply “Technical Update”).

Systemwide Municipal Demand – Systemwide municipal demand is equivalent to distributed water as defined by 1051 data or water supplied as defined in the American Water Works Association (AWWA) Water Loss Control audit methodology. This is equal to the sum of all municipal demand categories, including residential indoor, residential outdoor, non-residential indoor, non-residential outdoor and non-revenue water.

Targeted Water Provider Outreach (Targeted Outreach) – Targeted outreach that was facilitated by CWCB staff to gather municipal water usage data and information in select counties that had no 1051, Water Efficiency Plan, or BIP data.

Technical Advisory Groups (TAG) – The Technical Advisory Groups refer to the basin roundtable members and subject matter experts who helped inform the methodologies used in the Technical Update.

Technical Update – This refers to the analysis and technical update to the Colorado Water Plan. The Technical Update is similar to prior SWSI efforts but with important differences (see Section 3 for a comparison of SWSI to the Technical Update).

Water Conservation – Water conservation is the minimization of water loss or waste. The goal of water conservation is to use only the amount of water necessary to complete a task or meet a need. Water conservation can be achieved through policies, programs, and practices designed to encourage less water use.

Water Efficiency – Water efficiency refers to strategies or technologies that facilitate using less water to accomplish an activity. Low-flow toilets and showerheads are examples of technologies that increase water efficiency. Water efficiency improvements are typically accomplished via engineered products or solutions.

Water Efficiency Plans – See Municipal Water Efficiency Plans above.

Water Future – Colorado’s “water future” refers broadly to future conditions with respect to water supplies and demands, social values, condition of environmental and recreational attributes, and the types of strategies and projects that will be implemented to meet future needs.

Water Plan – Abbreviated reference to the Colorado Water Plan (also referred to as the Colorado Water Plan).

Water Supply Limited (WSL) Consumptive Use – The amount of applied water consumed by crops, also referred to as actual crop consumptive use. WSL is the minimum of the IWR and the amount of applied water that reaches crops.

[EXECUTIVE SUMMARY]

ANALYSIS & TECHNICAL UPDATE TO THE

COLORADO WATER PLAN

Clean and reliable water supplies are essential to our way of life. All of us—agricultural producers, urbanites, environmentalists, and recreationalists—depend on it for quality of life, a vibrant economy, and a healthy environment. These are the reasons we call Colorado home, the qualities that attract new Colorado residents, and the drivers of the Colorado Water Plan.

Colorado's water supplies are highly variable, and our demands are growing. Throughout Colorado's history, and increasingly in recent decades, we have experienced severe drought conditions, extreme flooding events, population booms, and economic recessions. These extremes often reflect larger shifts that highlight the importance of resilience in our water supplies and thoughtful, collaborative planning—the heart of the Colorado Water Plan (Water Plan).

The Water Plan provides a framework for developing resilient responses to our water-related challenges. It articulates a vision for collaborative and balanced water solutions led by the Colorado Water Conservation Board (CWCB) and our grassroots basin roundtable structure. This vision recognizes the evolving nature of water resource planning and implementation.

Following the launch of the Water Plan and Basin Implementation Plans (BIP) in 2015, the CWCB initiated the process of updating the underlying water supply and demand analyses in 2016, culminating in this report. The work began with the input of Technical Advisory Groups (TAG)—a group of representatives from across the state who provided expertise and advice on methods for the next phase of analysis. The resulting "Technical Update" (formerly known as the Statewide Water Supply Initiative or SWSI) establishes a new approach to statewide water analysis and data sharing.

The Technical Update and its related insights and tools build on a nearly 15-year legacy of CWCB water supply planning initiatives that began with the first SWSI in 2004. It also leverages a 27-year investment in statewide water modeling efforts, which began in 1992. To that end, this Technical Update provides a significant improvement in the scope, science, and approach to water supply planning (in SWSI I, SWSI II, and SWSI 2010). This approach positions Colorado for a streamlined and robust evaluation of its future water needs.

1 CHANGES IN THE APPROACH

The Colorado Water Plan set an adaptive management framework for future water planning activities and described five planning scenarios under which demands, supplies, and gaps were to be estimated. The scenarios included new considerations, such as climate change, that were not a part of prior SWSIs. In addition, the CWCB has continued to work with the Division of Water Resources to develop and refine consumptive use and surface water allocation models that were not ready for use in earlier analyses. As a result of these factors, the Technical Update takes a different and more robust approach to estimating future gaps.

The new methodology provides basin roundtables with datasets and tools that can be used to develop enhanced implementation strategies to meet Colorado's water needs.

New Analysis Needs

The Technical Update estimates future available water supplies and gaps under the five planning scenarios described in the Water Plan. Previous SWSIs were conducted prior to the Water Plan and, therefore, did not consider the scenarios. The scenarios incorporate water supply and demand drivers associated with the potential effects of climate change, population growth, and other factors.

New Planning Process

In their BIPs, the basin roundtables cataloged various projects and methods to mitigate future water supply gaps. The Technical Update focuses on developing tools and more detailed datasets to help basin roundtables update their portfolios of projects and methods for meeting future water needs in a targeted manner, with forthcoming updates to their BIPs.

New Models and Data Sets

New analysis tools and datasets have been developed since SWSI 2010. Consumptive use and surface water allocation models developed through Colorado's Decision Support Systems (CDSS) are now available in most river basins. The CDSS tools allow the evaluation of water availability gaps under a variety of hydrologic conditions. Municipal water demand and conservation data are available via HB10-1051 reporting. The availability of these new tools and datasets allows for a more robust approach to assessing future water availability and potential gaps.

REFINED OBJECTIVES

Given the new planning concepts described above, the overall objectives of the Technical Update are to:

1. **Update** and **recharacterize** future gaps

2. **Evaluate** environmental and recreational issues with new tools

3. **Create** user-friendly standardized tools, basin datasets, and information

2 NEW METHODS

The CWCB undertook a collaborative approach to developing methodologies for the Technical Update through the use of TAGs. Four TAGs were formed that provided input on scenario quantification, agricultural demands, municipal and industrial (M&I) demands, and environment and recreational tools (E&R). TAG participants included water stakeholders, subject matter experts, and basin roundtable members from each basin across the state.

New Features and Improved Data

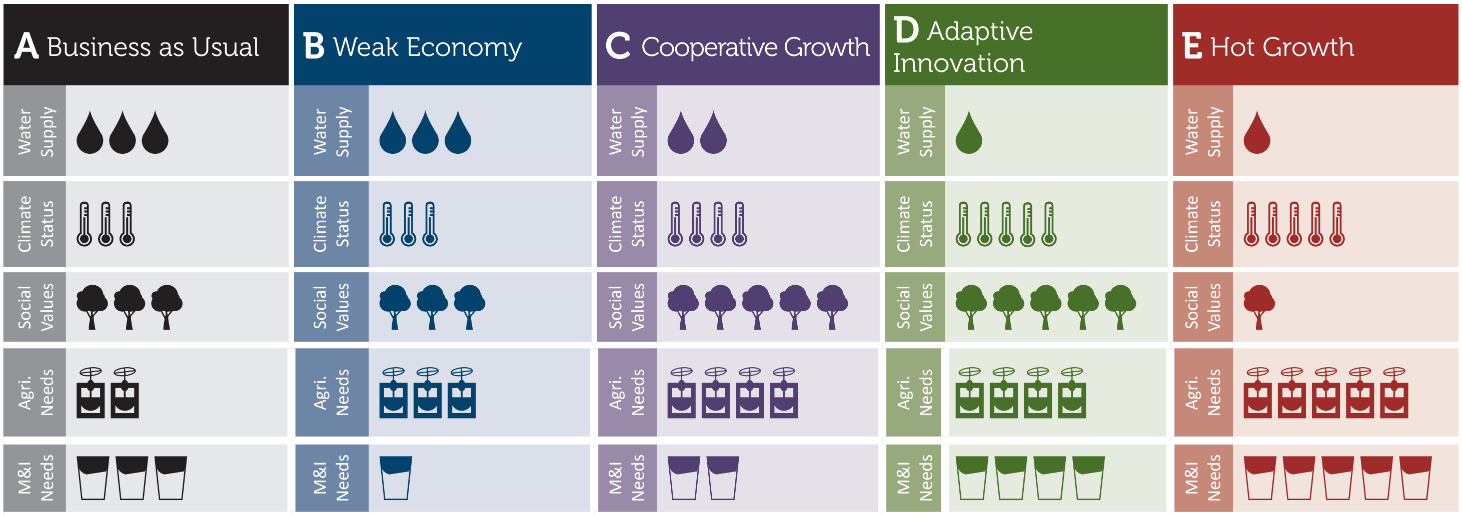
Section 2 of the Technical Update (Volume 1) summarizes the methodologies used to estimate current and future municipal and industrial (M&) and agricultural demands, water supplies and potential gaps, and tools for evaluating environment and recreation needs. Technical memoranda (see Volume 2) provide additional details.

The methodologies used for the Technical Update built on previous datasets and new and improved data sources and, to the extent possible, leveraged Colorado's investment in models developed through CDSS. Highlights of the new methodologies are described below.

Incorporation of scenario planning: Scenario planning is a new feature of the Technical Update and forms the context under which specific methodologies were developed. The five scenarios used come directly from the Colorado Water Plan (also shown on the following page).

- **"1051" water usage data:** New data describing recent municipal water usage was employed to estimate municipal water demands. The data are collected and reported by water providers pursuant to House Bill 2010-1051 ("1051"), which requires that the CWCB implement a process for reporting water use and conservation data by covered entities. This type of data was not available in prior SWSI efforts.
- **CDSS Tools:** The technical analyses made extensive use of modeling tools available through CDSS. CDSS is a water management system developed by the CWCB and the Division of Water Resources for each of Colorado's major water basins. Tools in CDSS include Hydrobase (a vast database of statewide water-related data), GIS data, surface water allocation models, and models that quantify consumptive use from crops and other vegetation. CDSS tools are available in most basins in the state. In basins where particular CDSS tools are not available, alternative methodologies were used to estimate demands and potential future gaps.
- **Consideration of climate change:** Three of the five planning scenarios include assumptions related to a hotter and drier future climate. Projections of future climate conditions were not a part of SWSI 2010 and can have a significant influence on hydrology, water use, and estimated gaps.
- **Quantification of an agricultural gap:** Water demands and shortages for irrigated crops at the field level were estimated in SWSI 2010, but were not quantified using surface water modeling. Using the full suite of modeling tools available from CDSS made it possible to estimate agricultural gaps in the Technical Update under current and planning scenario conditions. Agricultural gaps are described in two ways:
  - » *1. Total Gap:* The overall shortage of agricultural water supplies to meet diversion demands required to provide full crop consumptive uses.
  - » *2. Incremental Gap:* The degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.
- **Improved environment and recreation tools:** The Technical Update built on prior SWSI efforts and improved the data associated with environment and recreation attributes statewide. In addition, an Environment and Recreation (E&R) Flow Tool (Flow Tool) was developed to help assess potential flow conditions and associated ecological health in river segments in each basin. The Flow Tool was built on the framework of the Watershed Flow Evaluation Tool, a Colorado-specific application of a framework for assessing environmental flow needs at a regional scale previously developed with CWCB support. The tool uses flow data from the surface water allocation modeling developed for the Technical Update.

Figure ES.1 CWP Planning Scenarios Key Drivers Graphical Summary



A. Business as Usual

Recent trends continue into the future. Few unanticipated events occur. The economy goes through regular economic cycles but grows over time. By 2050, Colorado's population is expected to be close to 9 million. Single-family homes dominate, but there is a slow increase of denser developments in large urban areas. Social values and regulations remain the same, but streamflows and water supplies show increased stress. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation of new water development slowly increases. Municipal water conservation efforts slowly increase. Oil-shale development continues to be researched as an option. Large portions of agricultural land around cities are developed by 2050. Transfer of water from agriculture to urban uses continues. Efforts to mitigate the effects of the transfers slowly increase. Agricultural economics continue to be viable, but agricultural water use continues to decline. The climate is similar to the observed conditions of the 20th century.

B. Weak Economy

The world's economy struggles, and the state's economy is slow to improve. Population growth is lower than currently projected, which is slowing the conversion of agricultural land to housing. The maintenance of infrastructure, including water facilities, becomes difficult to fund. Many sectors of the state's economy, including most water users and water-dependent businesses, begin to struggle financially. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation decreases due to economic concerns. Greenhouse gas emissions do not grow as much as currently projected, and the climate is similar to the 20th century observed conditions.

C. Cooperative Growth

Environmental stewardship becomes the norm. Broad alliances form to provide for more integrated and efficient planning and development. Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and in mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development. Coloradans embrace water and energy conservation. New water-saving technologies emerge. Eco-tourism thrives. Water development controls are more restrictive and require both high water-use efficiency and environmental and recreational benefits. Environmental regulations are more protective, and include efforts to re-operate water supply projects to reduce effects. Demand for more water-efficient foods reduces water use. There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting streamflows and supplies. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.

D. Adaptive Innovation

A much warmer climate causes major environmental problems globally and locally. Social attitudes shift to a shared responsibility to address problems. Technological innovation becomes the dominant solution. Strong investments in research lead to breakthrough efficiencies in the use of natural resources, including water. Renewable and clean energy become dominant. Colorado is a research hub and has a strong economy. The relatively cooler weather in Colorado (due to its higher elevation) and the high-tech job market cause population to grow faster than currently projected. The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand. The warmer climate reduces global food production, which increases the market for local agriculture and food imports to Colorado. More food is bought locally, which increases local food prices and reduces the loss of agricultural land to urban development. Higher water efficiency helps maintain streamflows, even as water supplies decline. Regulations are well defined, and permitting outcomes are predictable and expedited. The environment declines and shifts to becoming habitat for warmer-weather species. Droughts and floods become more extreme. More compact urban development occurs through innovations in mass transit.

E. Hot Growth

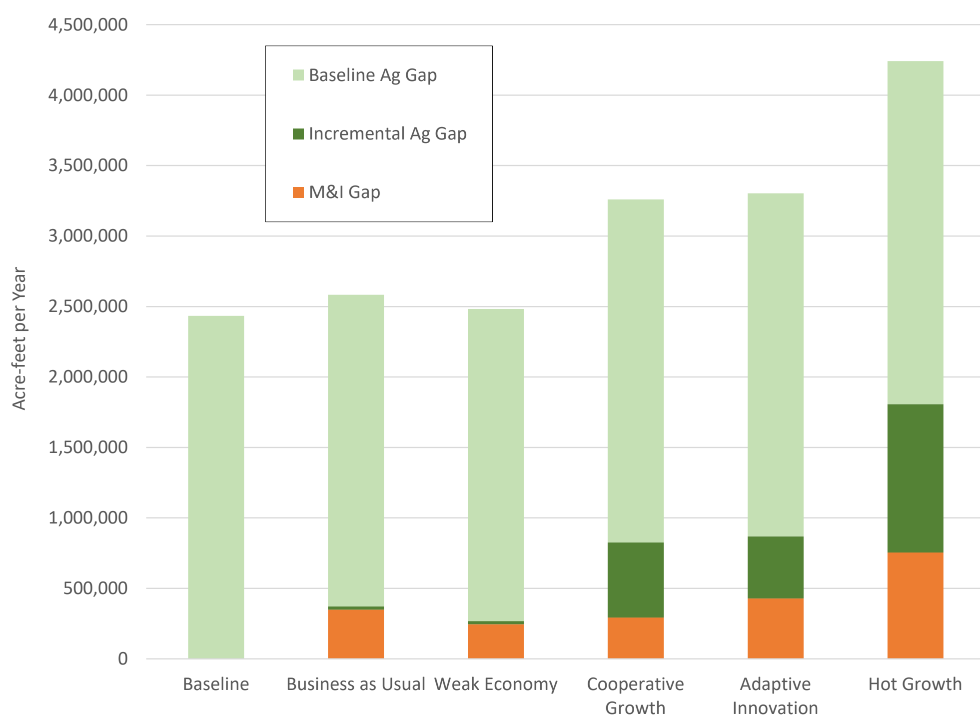
A vibrant economy fuels population growth and development throughout the state. Regulations are relaxed in favor of flexibility to promote and pursue business development. A much warmer global climate brings more people to Colorado with its relatively cooler climate. Families prefer low-density housing, and many seek rural properties, ranchettes, and mountain living. Agricultural and other open lands are rapidly developed. A hotter climate decreases global food production. Worldwide demand for agricultural products rises, which greatly increases food prices. Hot and dry conditions lead to a decline in streamflows and water supplies. The environment degrades and shifts to becoming habitat for species adapted to warmer waters and climate. Droughts and floods become more extreme. Communities struggle unilaterally to provide services needed to accommodate rapid business and population growth. Fossil fuel is the dominant energy source, and there is large production of oil shale, coal, natural gas, and oil in the state.

3 REVISITING THE GAPS

Statewide gaps may vary substantially, depending on future climate conditions and population increases, which underscores the need to take an adaptive approach to developing water management strategies and projects and methods to fill potential future gaps (see figure ES.2).

- **Agriculture** currently experiences a gap, and it is projected to increase statewide. Increases may be modest under the *Business as Usual* and *Weak Economy* scenarios but may be more substantial under scenarios that assume a hotter and drier future climate (the *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth* scenarios) due to decreasing supply and increasing crop irrigation requirements.
- **M&I** users do not currently experience a gap, but a growing population and potential impacts from climate change are projected to create gaps. Projected M&I gaps vary based on assumptions regarding future population and climate conditions but may be reduced by conservation measures.
- **E&R** gaps were not directly quantified but tools were developed to help evaluate potential risks that impact aquatic habitat, species and boating due to flow conditions. These potential future risks are documented in various sections of the Technical Update but are not a part of the gap estimates below.

Figure ES.2 Summary of Statewide Gap Estimates by Planning Scenario



COMPARING THE 2015 WATER PLAN GAP NUMBERS TO GAPS IN

THE TECHNICAL UPDATE

SIMILAR GAPS. ABSENT PROJECTS. LOWER POPULATION. LOWER DEMANDS.

1 Gaps Absent Projects

Gap projections in the Technical Update do not include estimates of basin-identified project yields. This is primarily due to a lack of specific project data that would allow projects to be modeled. Forthcoming basin plan updates will reevaluate projects and consider strategies to address gaps.

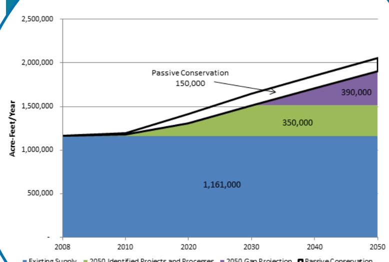
2 Gaps Across Scenarios

Unlike past projections that estimated high, medium and low gaps at 2050, the Technical Update identifies 2050 gaps for each of the Water Plan's five scenarios.

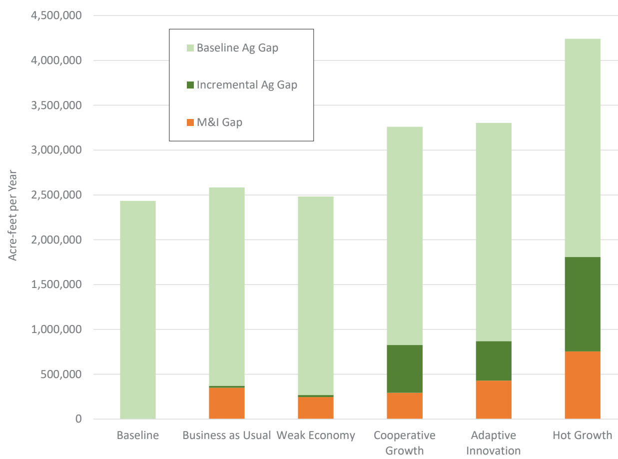
3 Gap Influences

Some of the main drivers (population, climate) and assumptions (storage operations) heavily influence the gaps in the Technical Update. Population projections, while lower than in previous analyses, remain a major driver of demands. Climate change is included in three of the five scenarios, which drives irrigation, streamflow and storage timing. Modeled storage operations maximize the use of stored water to meet demands and lower gaps.

GAPS SHOWN IN THE 2015 WATER PLAN



GAPS SHOWN IN THE 2019 TECHNICAL UPDATE



2015 Water Plan	2019 Technical Update
190,000 - 630,000 AFY 2050 M&I GAP	250,000 - 750,000 AFY 2050 M&I GAP
1,722,000 AFY 2050 AG SHORTAGE	23,000 - 1,053,000 AFY 2050 INCREMENTAL AG GAP

4 Gap Mitigation

When basins reevaluate plans it will be important to evaluate core projects that represent low-regret actions to meet future needs under any scenario. The Adaptive Innovation scenario, for example, illustrates how adaptive actions (e.g. efficiency) can help offset impacts from climate change and population growth.

5 Gaps: Max, Average & Incremental

Gaps are shown in a manner that reflects the difference in how M&I and agriculture plan in any given year. Feedback on earlier studies suggested that agriculture gaps may have been overstated because many agricultural producers live with annual shortages (especially in over-appropriated basins).

To address this, agricultural gaps are expressed in terms of average and incremental gaps—the degree to which gaps may increase in the future. Maximum agricultural gaps can also be found in the Technical Update results. At the same time, M&I gaps are primarily expressed in terms of maximums, which is consistent with firm yield planning.

AGRICULTURAL IMPACTS

The Colorado Water Plan identifies that up to 700,000 acres of agriculture could come out of production if agricultural transfers ("buy and dry") are exclusively used to meet future M&I demands. Because the Technical Update did not quantify basin projects, roundtables will evaluate how gaps should be met in the forthcoming basin plan updates. The Technical Update indicates that where municipal boundaries expand, agriculture is likely to be lost. This urbanization could result in the loss of more than 152,400 irrigated acres. Additionally, stakeholders identified that planned agricultural to M&I water transfers could result in a loss of up to 76,000 acres of agriculture in the South Platte and Arkansas basins alone.

SIGN OF CONCERN

Scenarios with moderate and significant climate impacts show shifts to earlier runoff seasons which will likely impact storage, irrigation, and streamflows.

SIGN OF SUCCESS

The statewide baseline per capita systemwide municipal demand has decreased from 172 gpcd ito nearly 164 gpcd. That represents about a 5 percent reduction in demands between 2008 and 2015.

4 KEY RESULTS

The Technical Update generated a rich dataset throughout Colorado that describes agricultural and M&I water demands, potential gaps, and available water supply under current conditions and under each of the five planning scenarios. The data and results are provided for basin roundtables and others to use for water planning purposes.

Key results and findings of the Technical Update pertaining to statewide agricultural and M&I demands and gaps, as well as findings related to environment and recreation attributes in potential future conditions, are summarized below.

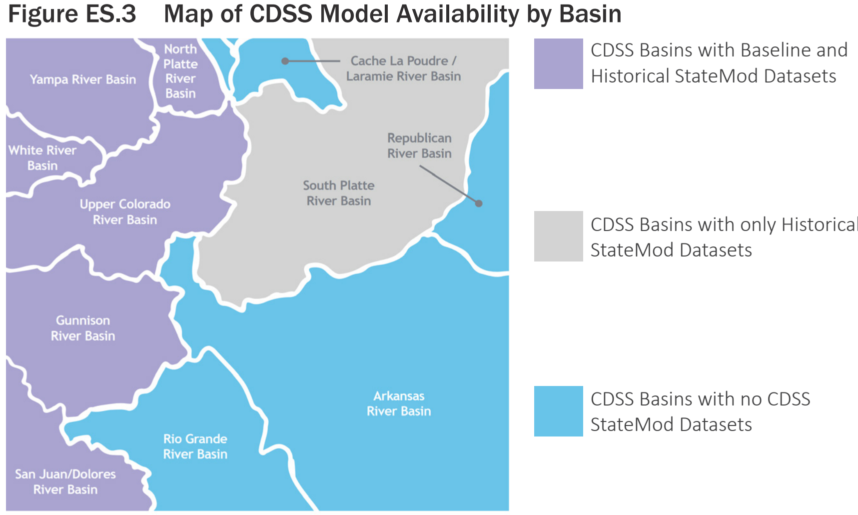
Summary of Key Statewide Results

Agricultural	Environmental and Recreational	Municipal and Industrial
• Agriculture currently experiences gaps, and gaps may increase in the future if climate conditions are hotter (which increases irrigation water demand) and supplies diminish (due to drier hydrology). • Irrigated acreage is projected to decrease in most basins due to urbanization, planned agricultural-to-municipal water transfers, and groundwater sustainability issues. • Gaps under the Adaptive Innovation scenario are significantly less than *Hot Growth* despite similar assumptions related to future climate conditions, which demonstrates the potential benefits of higher system efficiencies and emerging technologies that could reduce consumptive use; however, in return flow driven systems, conservation in one area could impact water supplies downstream, so thoughtful approaches are necessary.	• Climate change and its impact on streamflow will be a primary driver of risk to E&R assets. • Projected future stream flow hydrographs in most locations across the state show earlier peaks and potentially drier conditions in the late summer months under scenarios with climate change. • Drier conditions in late summer months could increase risk to coldwater and warmwater fish due to higher water temperatures and reduced habitat. The degree of increased risk is related to the level of stream flow decline. • Instream flow rights and recreational in-channel diversion water rights may be met less often in climate-impacted scenarios.	• Municipal and industrial users do not currently experience a gap, but increasing population and potentially hotter and drier future climate conditions will create a need for additional supply despite efforts to conserve water. • Conservation efforts, however, can create significant future benefits in lowering the gap, as demonstrated by comparing the *Adaptive Innovation* and *Hot Growth* scenarios (which have similar assumptions on population and climate).

BASIN MODELING

CDSS surface water allocation models (StateMod) were used in basins where they are available to evaluate streamflows and gaps. Baseline data sets were used to assess available water supplies under current conditions; these data sets were modified to estimate future water supplies in the planning scenarious. In basins where the CDSS program has not been fully implemented, the methodology was modified using available tools and water supply information, such as historical streamflow data.

Figure ES.3 Map of CDSS Model Availability by Basin



[An overview of each of these areas is provided on the following pages.]

Agricultural Diversion Demands

Agricultur diversion demand represents the amount of water that would need to be diverted or pumped to meet the full crop irrigation water requirement (IWR) or full crop consumptive use. The diversion demand does not reflect historical irrigation supplies because irrigators often operate under water short conditions and do not have enough supply to fully irrigate their crops.

Current statewide total agricultural diversion demand is approximately 13 million acre-feet (AF), with more than 80 percent of that demand attributable to surface water supplies (though groundwater is the primary source of supply in some basins). The South Platte, Arkansas, Gunnison, and Rio Grande basins have the highest demands for irrigation diversions.

Future agricultural diversion demands will be affected by urbanization, planned agricultural projects that add irrigated acreage, aquifer sustainability, and climate change. Emerging technologies that increase system efficiency and/or reduce crop consumptive use of water may reduce water supply shortages and potentially reduce the amount of water diverted or pumped.

Future statewide agricultural diversion demand estimates range from 10 million AF in the *Adaptive Innovation* scenario to 13.5 million AF in the *Hot Growth* scenario. Urbanization, transfers of agricultural water to municipalities, and declining aquifer levels are projected to cause reductions in irrigated lands across the state (in some basins more than others), leading to reduced overall diversion demand compared to current demand. In scenarios that assume a hotter and drier climate, the impact of acreage loss on diversion demand could be offset by higher crop water requirements, which could lead to an overall increase in demands (see the *Cooperative Growth* and *Hot Growth* scenarios). The *Adaptive Innovation* scenario has the lowest statewide agricultural diversion demand due to assumptions of higher system efficiencies and emerging technologies that reduce crop water demands.

Figure ES.4 Current Average Annual Agricultural Diversion Demand by Basin

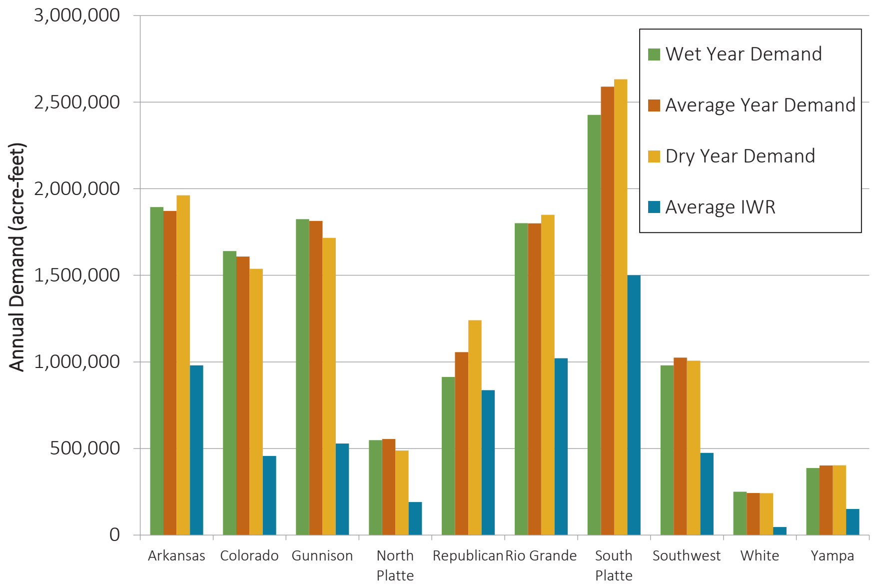
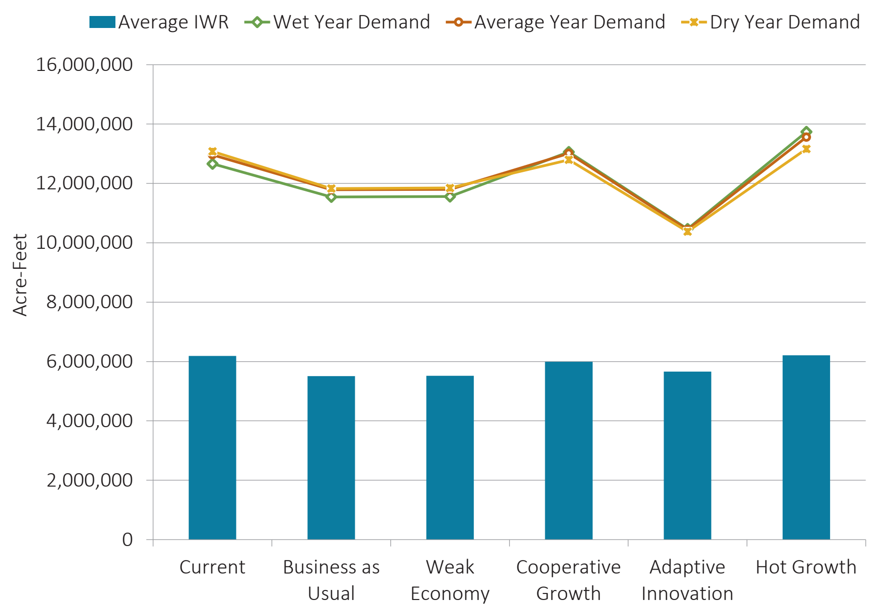
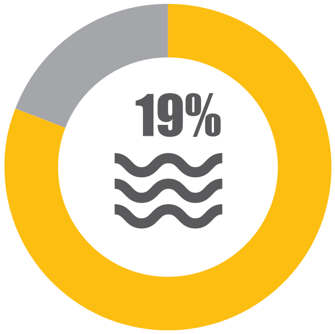


Figure ES.5 Future Statewide Average Annual Agricultural Diversion Demand Estimates for Planning Scenarios



TECHNICAL UPDATE / AGRICULTURAL FINDINGS



Demand for groundwater is approximately 19 percent of the overall demand. Groundwater demands occur primarily in the Arkansas, Republican, Rio Grande, and South Platte basins where irrigation from wells is prominent.

3 X

Based on known agricultural water transfers currently in water court or deemed to be highly likely by agricultural stakeholders, the estimates of planned buy and dry gransfers in the Technical Update (33,000 - 76,000 acres) are almost three times higher on the upper end than the data that informed the Water Plan (26,200 acres).

In all basins where significant agriculture comes out of production, diversion demands will go down due to the decrease in irrigation even as the plant demand for irrigation (were those lands to be irrigated) increases.

20% UNMET DEMAND

On average, approximately 80 percent of the overall agricultural diversion demand is currently met (and 20 percent is unmet) on a statewide basis, though this varies in each basin.

Agricultural diversion demands statewide are projected to decrease in three of the five scenarios by up to 9 percent compared to current conditions. In *Adaptive Innovation*, decreased demand from loss of irrigated lands will be offset, in part, by climate-driven irrigation demand increases; however, increased efficiency and decreased consumptive use show a 20 percent reduction in diversion demands. In *Hot Growth*, irrigated lands are projected to be lost, but climate change could more than offset that loss, resulting in an overall 5 percent increase in diversion demands.

700K ACRE LOSS STILL POSSIBLE

The Colorado Water Plan identifies that up to 700,000 acres of agriculture could come out of production if agricultural transfers (buy and dry) are used to meet future M&I demands. Because the Technical Update did not re-quantify basin projects, roundtables will need to evaluate how gaps could and should be met when updating projects (and project data). The Technical Update does indicate that where municipal boundaries expand, agriculture is likely to be lost. This urbanization could result in the loss of 152,400 irrigated acres.

M&I Diversion Demands

Current and future diversion demands for municipal water users are driven by population and water usage rates. Population estimates were based on State Demography Office (SDO) projections and adjusted upward or downward (depending on the scenario) based on historical growth statistics. The current population statewide is 5.7 million people and is projected to grow to 8.5 million by the year 2050 according to the SDO. High and low statewide projections developed for the Technical Update range from 7.7 million to 9.3 million people.

The statewide baseline per capita systemwide demand has decreased from 172 gallons per capita per day (gallons per capita per day) in SWSI 2010 to approximately 164 gpcd, which is nearly a 5 percent reduction in demand between 2008 and 2015. The reduction is associated with improved data availability, conservation efforts, and ongoing behavioral changes. Projected future per capita demands vary from 143 to 169 gpcd (see Figure ES.6), depending on the scenario. Scenario assumptions can create offsetting factors. For example, projected decreases in outdoor demand resulting from implementation of conservation measures in some scenarios was offset by increases in outdoor demand due to climate change.

Total statewide municipal diversion demands are shown in Figure ES.7, along with population projections. In general, overall municipal demands are projected to increase and generally in proportion to population increases; however, in *Adaptive Innovation*, projected municipal demands are similar to the *Business as Usual* demands despite the increased population projections and hotter and drier climate assumed for *Adaptive Innovation*, which demonstrates the potential benefits of increased water conservation measures.

Statewide baseline SSI water demands are comprised of four major industrial uses. Baseline and projected SSI demands for all planning scenarios were calculated. With the exception of *Hot Growth*, the updated projections for all planning scenarios were below SWSI 2010 estimates, primarily due to changes in assumptions for thermoelectric demands related to regulations that require an increase in power generation from renewable sources.

Figure ES.6 Statewide per Capita Demand for Five Planning Scenarios

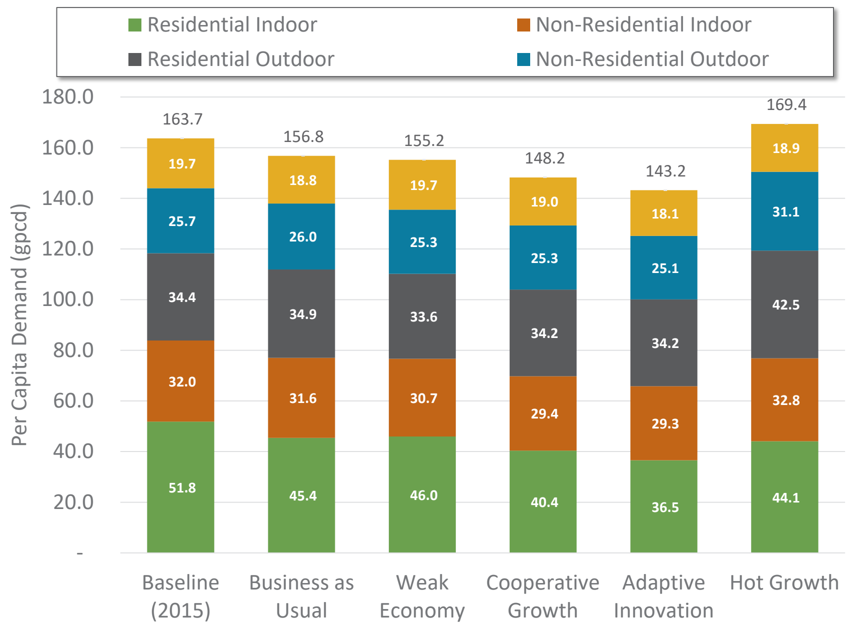
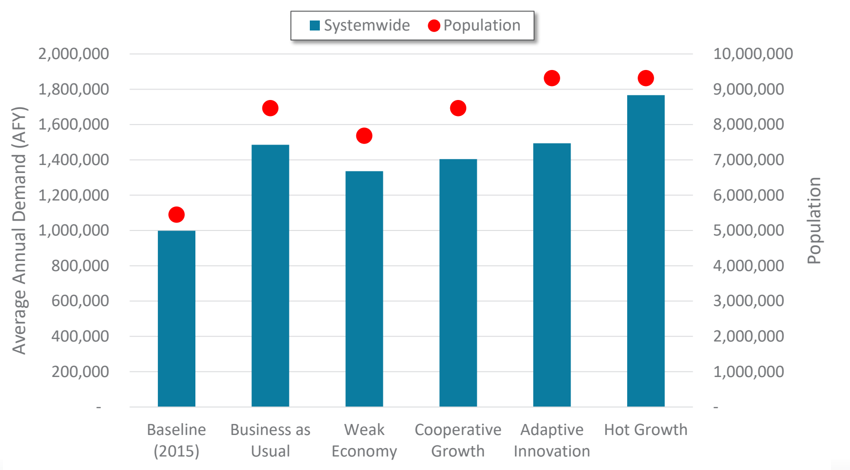
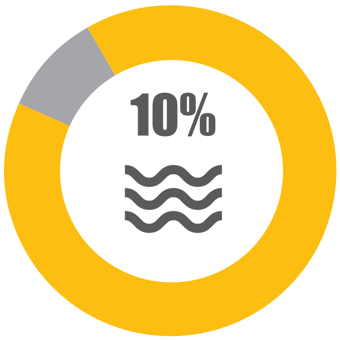


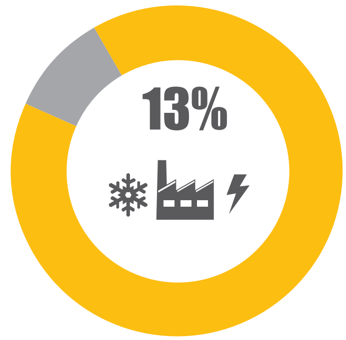
Figure ES.7 Statewide Baseline and Projected Population and Municipal Demands



TECHNICAL UPDATE / M&I FINDINGS



M&I demands comprise approximately 10 percent of the combined agricultural and M&I statewide demands that are currently met with existing water supplies and projects.



On average, SSI demands account for 13 percent of the total M&I demands. This includes snowmaking; and thermoelectric, energy development, and large industrial users.

Per capita baseline system demand has decreased from 172 to 164 gpcd—a 5 percent reduction in demands between 2008 - 2015.

Adaptive Innovation shows a 13 percent decrease in gpcd (from 164 to 143 gpcd) compared to current conditions. Total municipal demand in *Adaptive Innovation* tracks closely with *Business As Usual*. This highlights how social values that prioritize water conservation and water saving technologies could help mitigate impacts from climate and population.

35% +

While per capita usage is expected to decrease in all but *Hot Growth*, overall statewide M&I water demand is projected to increase from 35 percent in *Weak Economy* to 77 percent in *Hot Growth* over current demands. Even at that highest level, it is still lower than Water Plan due to the revised population projections, which are lower than previously estimated.

5%

Current population (5.4 million) is 5 percent less than the Water Plan's projected 2015 levels. The State Demography Office estimates that Colorado will grow to 8.5 million by 2050.

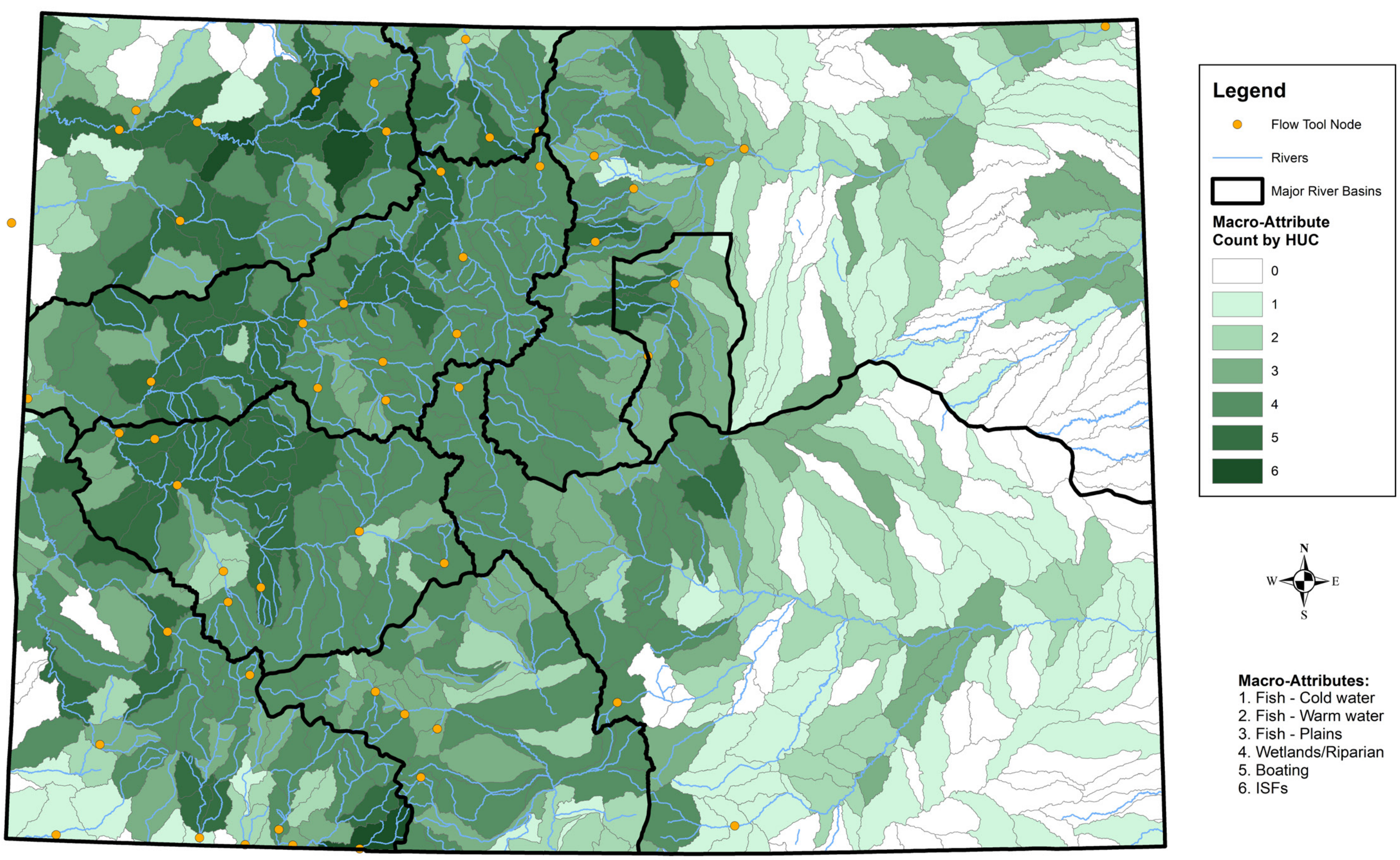
Environment and Recreation

The Colorado Environment and Recreation Flow Tool (Flow Tool) helps basin roundtables refine, categorize, and prioritize their portfolio of E&R projects and methods through an improved understanding of flow needs and potential flow impairments, both existing and projected. The Flow Tool uses hydrologic data from CDSS, additional modeled hydrologic data for various planning scenarios, and established flow-ecology relationships to assess risks to flows and E&R attribute categories at preselected gages across the state. The Flow Tool is a high-level tool that is intended to provide guidance during Stream Management Plan development and BIP development.

The Flow Tool estimates the response of E&R attributes in rivers under various hydrologic scenarios. The flow-ecology relationships in the Flow Tool were first developed as part of the Watershed Flow Evaluation Tool and were patterned after similar relationships that have been developed across the globe to inform water management. Flow-ecology science quantifies the relationship between specific flow statistics (e.g., average magnitude of peak flow, the ratio of flow in August and September to mean annual flow) and the risk status (low to very high) for environmental attributes under the flow scenario being analyzed. Data-derived relationships have been developed for riparian/wetland plants (cottonwoods), coldwater fish (trout), warmwater fish (bluehead sucker, flannelmouth sucker, and roundtail chub), and Plains fish. Other metrics were developed with basic, well-established relationships between hydrology and stream ecology. Relationships for recreational boating were also developed with stakeholders during Watershed Flow Evaluation Tool development.

The Flow Tool incorporates data from 54 nodes in the water supply and gap analysis; the tool visualizes changes in flow regime and risks to E&R attributes under existing and future conditions associated with the five planning scenarios.

Figure ES.8 Gages Included in the Flow Tool



TECHNICAL UPDATE / E&R FINDINGS

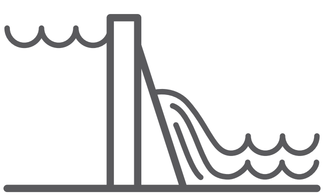
Projected future streamflow hydrographs in most locations across the state show potentially drier conditions in the late summer months under scenarios with climate change that suggest air temperatures could increase by 3.78°F to 4.15°F by 2050.

Instream Flow (ISF) and recreational in-channel diversions (RICD) water rights may be met less often in climate-impacted scenarios that see more consistent temperature increases and more variable precipitation and runoff conditions.

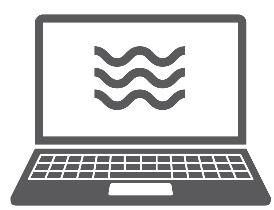
↑ 1 MONTH

Peak runoff may shift as much as one month earlier, which could lead to drier conditions in summer months and produce multiple implications for storage, irrigation and streamflow.

Under climate change scenarios, runoff and peak flows may occur earlier, and result in possible mismatches between peak flow timing and species' needs. Drier conditions in late summer months could increase risk to coldwater and warmwater fish due to higher water temperatures and reduced habitat.



In mountainous regions with infrastructure, risks to E&R assets may vary. Streams that are already depleted may see increased risks in scenarios with climate change; however, some streams may be sustained by reservoir releases, which will help moderate risks in scenarios with climate change.



The Flow Tool created as part of the Technical Update was designed to compare modeling outputs from the five planning scenarios against baseline (existing) and naturalized (unimpaired) flow conditions. Key outputs include a comparison of monthly flow regimes relative to ecological-flow indicators, building off past stakeholder-driven efforts in Colorado.

5 INSIGHTS, TOOLS & RECOMMENDATIONS

The Technical Update developed a variety of high-level analyses on the topics of public perceptions, alternative transfer methods (ATM), water reuse, storage opportunities, and economic impacts. The intent of these analyses was to provide insight into various issues that will be valuable for basin roundtables as they update their BIPs and consider solutions to address potential future gaps. Findings from these analyses are included in Section 5 of the Technical Update (Volume 1).

The Technical Update also developed several tools for basin roundtables to use when updating their BIPs. During the Technical Update, several types of data from existing BIPs were reviewed that indicated the need to improve the completeness and uniformity of basin project information. In addition, the Technical Update included the development of tools like a Project Cost Estimating Tool and E&R Flow Tool.

A list of recommendations aims to allow basins flexibility in the BIP update process to tailor approaches to best suit basin goals while at the same time providing a framework for standardization across the BIP updates. This iterative process is meant to support statewide water supply planning, cross-basin dialogue, project funding, enhanced future supply analyses, revised basin goals, and updated project lists.

Integrating Technical Update findings with the BIPs, project lists and, ultimately, the Colorado Water Plan update ensures state water planning will continue to be informed by the best available data.

SECTION 1
INTRODUCTION

Clean and reliable water supplies are essential to our way of life. All of us—agricultural producers, urbanites, environmentalists, and recreationalists—depend on it for healthy lifestyles, a vibrant economy, and a beautiful environment. These are the reasons we call Colorado home, the qualities that attract new Colorado residents, and the drivers of the Colorado Water Plan (Water Plan).

Colorado's water supplies are limited, yet our demands on those supplies continue to increase. Throughout Colorado's history, and especially in recent decades, we have experienced severe drought conditions, extreme flooding events, population booms, and economic recessions. These extremes often reflect larger shifts that highlight the importance of resiliency in our water supplies, and the need for thoughtful, collaborative planning.

The Colorado Water Plan provides a framework for developing resilient responses to our water-related challenges. It articulates a vision for collaborative and balanced water solutions led by the Colorado Water Conservation Board (CWCB) and our grassroots basin roundtable structure. The Water Plan's success will be fostered by the development of technical information and robust analysis tools that support informed decision making on how to tackle our State's challenges.

Following the 2015 launch of the Water Plan and BIPs, the CWCB began a process of updating the underlying water supply and demand analyses. The work included collaboration with TAGs, which included diverse basin roundtable representatives from each basin and subject matter experts. The TAGs helped outline the methods to be used in the Analysis and Technical Update to the Colorado Water Plan, hereafter Technical Update (formerly known as the Statewide Water Supply Initiative or SWSI), which establishes a new approach to statewide water analysis and data sharing.

While this effort stems from past water supply and demand projections (SWSI I, SWSI II, and SWSI 2010), it is markedly different in its scope and approach. Key features include more robust modeling, integration of scenario planning, incorporation of climate change, and the development of functional support tools to promote data refinement. With these enhancements, the Technical Update sets the stage for enhanced basin-level planning.

The Technical Update methods and results are described in this report, along with a description of how the study fits into the next phases of Colorado water planning. Designed for accessibility, this document summarizes the findings of the analysis and is supported by additional technical memoranda and data that can be accessed at www.colorado.gov/cowaterplan.

1.1 COLORADO'S STATEWIDE WATER PLANNING CYCLE

1.1.1 Colorado's Statewide Water Planning Cycle & Recent Water Planning Efforts

In the early 2000s, severe statewide drought, combined with increasing water demands, spurred Colorado's General Assembly to undertake long-term water planning initiatives. One key initiative established the nine basin roundtables as well as the creation of the Interbasin Compact Committee (IBCC). A second key action was the initiation of the Statewide Water Supply Initiative (SWSI). The latter, created a statewide technical analysis to quantify future demands and potential gaps in the ability to supply Colorado's water needs. The roundtables formalized a grassroots process to bolster communication and collaboration within and between major river basins.

Since the early 2000s, Colorado's statewide planning process has evolved to include additional planning phases that foster communication, transparency, and action. Updates to the SWSI data sets and analyses provided new and enhanced information for basin roundtables to use in developing strategies and tangible solutions to meet future consumptive and nonconsumptive needs.

In 2015, BIPs were completed to provide basin-focused portfolios of solutions to projected supply gaps. The BIPs provided basin-level details to the Colorado Water Plan, which sets statewide policy and implementation strategies to meet current and future water-related challenges. The timeline on the following page summarizes major water planning efforts since 2003.

2000

2002

MAJOR DROUGHT

The 2002-2003 drought and the 2002 Hayman Fire (Colorado's largest fire) trigger legislative action that focused on water supply planning and statewide collaboration.

2004

SWSI I

The first Statewide Water Supply Initiative (SWSI I) provided quantification of current and future water needs through 2030.

2005

WATER FOR THE 21st CENTURY ACT

The Water for the 21st Century Act created the nine basin roundtables and the Interbasin Compact Committee (IBCC) in an effort to build more collaborative cross-basin water planning.

2007

SWSI II

The second phase of SWSI (SWSI II) established technical roundtable groups for Conservation, Alternative Agriculture Water Transfers, Environment and Recreation, and Water Supply Gaps.

2010

SWSI 2010

SWSI 2010 incorporated SWSI II work group findings, analyzed future water needs through 2050, and served as the technical foundation for the Colorado Water Plan.

2015

THE COLORADO WATER PLAN

The Colorado Water Plan (Water Plan) brought together statewide planning objectives and local implementation activities under a common banner.

2017

RIPPLE EFFECTS

Provided an update of progress made toward meeting the actions and objectives of the Water Plan.

2019

TECHNICAL UPDATE

In keeping with goals of the Water Plan to update SWSI efforts, the Technical Update launched in Summer 2019.

2020

NEXT STEPS

Building on 2018-2019 BIP update scoping, basins will work with the CWCB to use the methodologies, findings and recommendations from the Technical Update to revise BIPs and update the Water Plan.

Moving Forward Under the Colorado Water Plan

Colorado water users understand that making specific predictions of future conditions is impossible. From precipitation to population, there are any number of possible shifts that could significantly impact water availability. Being responsive to these drivers of change requires thoughtful planning and adaptive management. This involves using the best data available to predict a range of variant futures, which helps ensure Colorado's water planning is robust and flexible enough to address future concerns. The five planning scenarios identified in the Colorado Water Plan were born from this effort and were developed through an iterative process with the basin roundtables and the IBCC.

Holistic Planning

Colorado recognizes the evolutionary nature of water resource planning and implementation. The two are not mutually exclusive, and occur simultaneously at several scales. Colorado's cyclical, statewide planning process is made up of three phases:

A **Analysis and Technical Update Phase** – includes the statewide Analysis and Technical Update to the Water Plan with standard tools, datasets, and analyses quantifying future supplies, demands, and resource gaps.

B **Basin Plan Update Phase** – includes local, basin-wide planning conducted through BIP updates that integrate information from the analysis phase and work to identify projects that address gaps and other priority basin needs.

C **Comprehensive Update Phase** – includes the Water Plan update itself with a focus on metrics, goals, timelines, and strategies that honor the values in the Water Plan and work toward implementation.

These phases occur cyclically and are, by design, iterative. To that end, the Water Plan process in its entirety (phases A, B, and C) are constantly being updated, planned for, and implemented. Each phase works in concert to refine the understanding of existing and future gaps in water supply and to identify solutions for addressing these gaps.

1.1.2 Advanced Methodologies and Refined Objectives

Advanced Methodology

The Technical Update addresses a variety of questions using new TAG-supported methodologies and analysis tools. The analysis leverages the State's 25+ year investment in Colorado's Decision Support Systems (CDSS), which has made significant gains in basin modeling since SWSI 2010. Use of CDSS and more robust modeling has been incorporated into the new analysis methodologies.

The new analysis tools help prepare for the future in a more robust manner; however, more in-depth modeling capabilities also help us shed light on new questions that previous SWSI studies were not able to accurately integrate or fully consider, such as potential effects of climate change, variable hydrology, and water rights. At the same time, several new planning concepts are being incorporated into the Technical Update that were not part of prior versions of SWSI. Most notably, incorporating the scenarios in the Water Plan offers a new way of evaluating Colorado's water needs that is significantly different from earlier versions of SWSI. A shortlist of key differences in this Technical Update and SWSI 2010 follows:

- **Scenario planning and adaptive management**

  The Colorado Water Plan developed five plausible water supply/demand year 2050 scenarios that consider varying levels of high-impact drivers such as population increase, agricultural water needs, adoption of conservation measures, social values, and climate conditions. These scenarios are foundational to the analyses and modeling in this Technical Update.

- **Climate change impacts to demand and supply**

  Climate change is a consideration in three of the five planning scenarios described in the Colorado Water Plan. The Technical Update evaluates how potential impacts from climate change affect flows, diversions, crop demand, reservoir storage and more through the use of StateMod water allocation models and StateCU consumptive use models that have been fully developed in most basins. These CDSS modeling tools enable analysis of variable supply and demand conditions and provide a broader view of gaps and how they may vary in response to changing supply and demand drivers.

- **Agricultural diversion demand gaps**

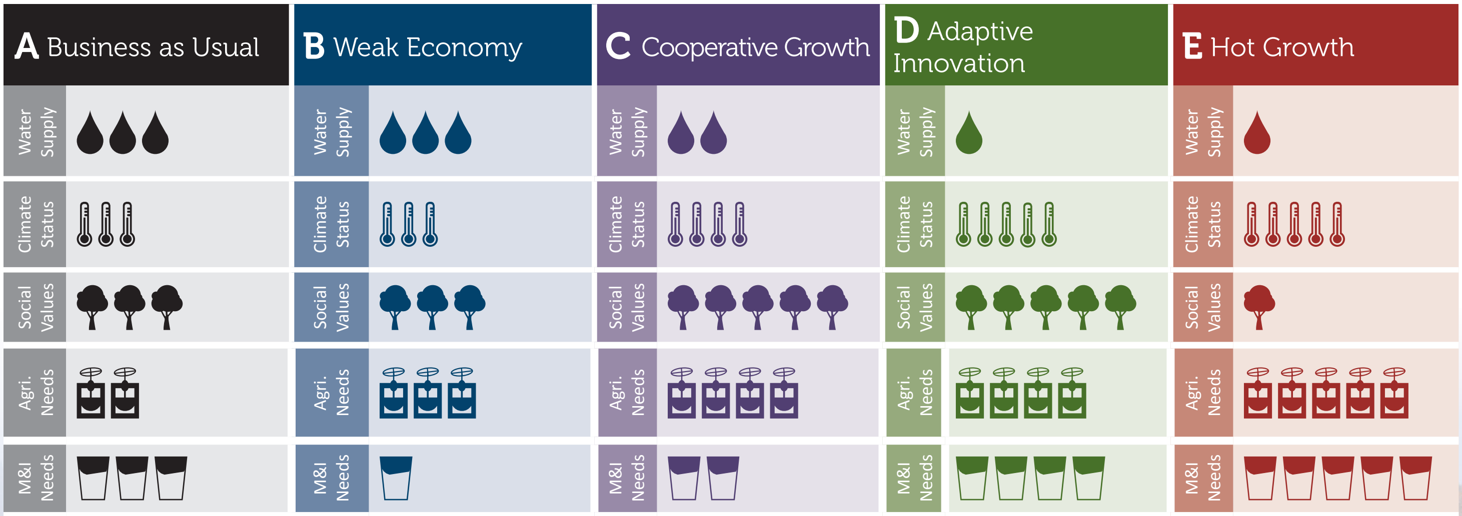
  The SWSI 2010 update quantified historical, field-level agricultural water shortages by comparing crop water demands with historical water deliveries to farms. The Technical Update takes this a step further by using CDSS consumptive use and water allocation models to estimate agricultural gaps in terms of agricultural diversion demands. Diversion demands account for crop demands, application and conveyance efficiencies, and available supply. As a result, agricultural gaps are larger than the field-level shortages quantified in SWSI 2010. The previous methodology was updated to provide basin roundtables with information and tools to use in analyzing "what if" scenarios and for evaluating the effectiveness of future projects, and to provide consistency with estimates of municipal and industrial demands.

Refined Objectives

Given the context and the new planning concepts described above, the primary objectives of the Technical Update report are to:

- Update and recharacterize future gaps and the ability to meet municipal, self-supplied industrial, and agricultural water needs. This recharacterization considers variable hydrology and variable demands in the context of five planning scenarios. The results help basin roundtables account for future uncertainties and develop planning strategies to mitigate future shortages.
- Evaluate environmental and recreational flow needs with new tools. The tools include an enhanced database of E&R attributes and a standardized tool for high-level review of future scenario impacts on streamflows.
- Create user-friendly standardized tools and data products for BIP updates, basin-level project and cost planning, and improved communication and outreach—all aimed at helping basins mitigate future shortages.

Figure 1.1.1 CWP Planning Scenarios and Key Drivers Graphical Summary



1.2 TECHNICAL ADVISORY GROUPS AND OUTREACH

The CWCB enlisted TAGs to develop analysis methodologies and modeling inputs in a collaborative manner. Four TAGs were formed consisting of stakeholders, subject matter experts, and basin roundtable members. The TAGs focused on the following four topics:

- Planning Scenarios
- Environment and Recreation
- Municipal and Self-supplied Demands
- Agricultural Diversion Demands

Each TAG evaluated proposed methodologies through a similar process. First, draft methodologies were distributed to TAG members for review. Comments were discussed at length in the first of two TAG workshops. Consultants updated draft methodologies in response to comments and active discussion and then redistributed the revised drafts to TAG members for re-review. A second meeting was held to describe changes to the methodologies and discuss any final concerns. All final technical memoranda were posted to the CWCB website. A list of TAG members, their organizations, and the basins they represent are included in Appendix D.

In addition to TAG meetings, CWCB staff used the following outreach efforts during the Technical Update process:

- Produced easy-to-read fact sheets that summarized proposed Technical Update methodologies
- Presented progress reports at CWCB board meetings and basin roundtable meetings
- Held targeted stakeholder meetings with basin stakeholders (many of whom were TAG members) to obtain basin-specific information to improve modeling input data
- Hosted webinars to present methodologies and results of various Technical Update components
- Gave presentations at water-related forums such as Colorado Water Congress, farm shows, and conventions
- Conducted live polling and surveys at various intervals to allow for real-time feedback throughout the update process
- Updated and maintained website content, including recordings of various meetings
- Sought feedback from the Implementation Working Group—a group convened by the CWCB that includes basin roundtable and Interbasin Compact Committee members—to help inform Technical Update recommendations and next steps.

SECTION 2
METHODOLOGIES

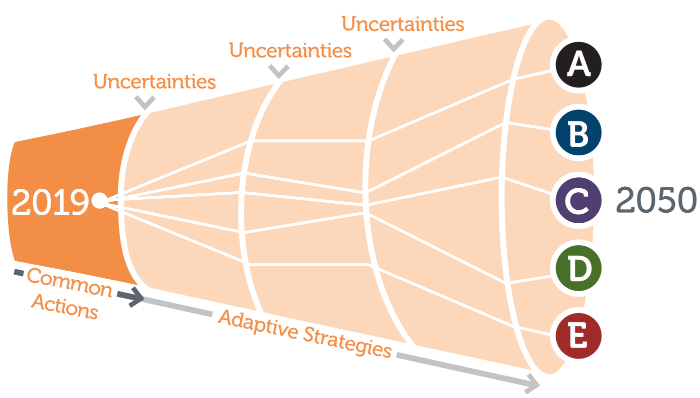
The analysis methodologies used in the Technical Update are summarized in this section. The technical memoranda describing these methodologies can be found in Volume 2. See Appendix A for a comprehensive list of technical memoranda.

2.1 SCENARIO PLANNING

2.1.1 Description of Scenario Planning

Scenario planning is a strategic foresight planning process that acknowledges the future is uncertain. Colorado's Water Plan enlists scenario planning to consider a wide range of possible futures according to the best available science and stakeholder input. The approach embraces inherent uncertainties in future climate conditions, social conditions (such as values and economics), and supply-demand conditions (e.g., energy, agricultural, and municipal needs).

Figure 2.1.1 Illustration of Scenario Planning Concepts



Scenario planning and adaptive management allow decision makers and water users the flexibility to track environmental and social changes over time that provide insights into which future conditions might become more likely as time passes (see Figure 2.1.1). The scenario planning method varies from a more simplistic application of high, medium, and low stress conditions (used in SWSI 2010) by acknowledging that the future holds a degree of uncertainty, depending on a variety of environmental and social drivers.

The scenario planning method includes the following six general steps.

Previous steps conducted by IBCC and described in the Colorado Water Plan	*Steps that are part of this Technical Update*	*Future steps that are to be completed by basin roundtables in BIP updates*
1 Develop expansive list of drivers that can influence future water planning conditions	**4** Quantify future supply and demand conditions for each scenario per identified drivers	**6** Develop projects and strategies that can be used to address gaps for each planning future
2 Identify most uncertain and most important key drivers	**5** Calculate baseline supply versus demand gaps for each scenario without considering future projects or strategies that may address the calculated gap	
3 Develop scenario narratives that define different plausible futures that warrant planning		

2.1.2 Development of the Planning Scenarios

Before developing the Colorado Water Plan, the CWCB initiated a multi-year stakeholder process in conjunction with the nine basin roundtables and the IBCC. Each roundtable developed one or more statewide water supply portfolios to respond to the projected low, medium, or high future water needs of communities. The IBCC subsequently synthesized and reduced the basin roundtable-generated portfolios into a smaller set of 10 representative portfolios to address projected low-, mid-, and high-range M&I water demands. The IBCC then developed a list of the following nine high-impact drivers that could greatly influence the direction of Colorado's water future. Using these drivers, the IBCC developed five scenarios that represent how Colorado's water future might look in 2050, knowing that the future is unpredictable and will contain a mix of multiple scenarios.

1. Population/Economic Growth
2. Social/Environmental Values
3. Climate Change/Water Supply Availability
4. Urban Land Use/Urban Growth Patterns
5. Energy Economics/Water Demand
6. Level of Regulatory Oversight/Constraint
7. Agricultural Economics/Water Demand
8. Municipal and Industrial Water Demands
9. Availability of Water-Efficient Technologies

Signpost Indicators

The adaptive management framework recognizes that the future hinges on how much the drivers (scenario variables) change over time. Major changes in the drivers could tip the still-evolving future toward one scenario or another. The tipping points serve as water management decision points, (i.e., "signposts") that can lead toward the need to implement an alternative portfolio of solutions. Signposts were defined in the Water Plan as decision points that reveal whether past uncertainties now have more clarity. Signposts are a key part of scenario planning, but signpost development was not part of the Technical Update scope. Like project lists, signposts may be unique to regions or specific industries. Signposts could be developed in collaboration with basin planning efforts to identify specific indicators and criteria that signal a need for a new suite of projects or strategies. Alternatively, signposts may be seen as the frequency by which the state and/or basin roundtables evaluate and review key indicators. Section 5 of the Technical Update describes recommendations for the future establishment of signposts.

2.1.3 Description of the Planning Scenarios

The five planning scenarios are summarized in the Water Plan with names portraying each scenario's respective depiction of the future.[1] A summary graphic (see Figure 2.1.2) shows the relative increase and decrease for five main drivers compared to current levels. A full description of each planning scenario follows.

A. Business as Usual. Recent trends continue into the future. Few unanticipated events occur. The economy goes through regular economic cycles but grows over time. By 2050, Colorado's population is close to 9 million people. Single family homes dominate, but there is a slow increase of denser developments in large urban areas. Social values and regulations remain the same, but streamflow and water supplies show increased stress. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation of new water development slowly increases. Municipal water conservation efforts slowly increase. Oil-shale development continues to be researched as an option. Large portions of agricultural land around cities are developed by 2050. Transfer of water from agriculture to urban uses continues. Efforts to mitigate the effects of the transfers slowly increase. Agricultural economics continue to be viable, but agricultural water use continues to decline. The climate is similar to the observed conditions of the 20th century.

B. Weak Economy. The world's economy struggles, and the state's economy is slow to improve. Population growth is lower than currently projected, which is slowing the conversion of agricultural land to housing. The maintenance of infrastructure, including water facilities, becomes difficult to fund. Many sectors of the State's economy, including most water users and water-dependent businesses, begin to struggle financially. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation decreases due to economic concerns. Greenhouse gas emissions do not grow as much as projected, and the climate is similar to the observed conditions of the 20th century.

C. Cooperative Growth. Environmental stewardship becomes the norm. Broad alliances form to provide for more integrated and efficient planning and development. Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development. Coloradans embrace water and energy conservation. New water-saving technologies emerge. Ecotourism thrives. Water-development controls are more restrictive and require both high water-use efficiency and environmental and recreation benefits. Environmental regulations are more protective and include efforts to reoperate water supply projects to reduce effects. Demand for more water-efficient foods reduces water use. There is a moderate warming of the climate, which results in increased water use in all sectors and in turn, affects streamflow and supplies. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.

D. Adaptive Innovation. A much warmer climate causes major environmental problems globally and locally. Social attitudes shift to a shared responsibility to address problems. Technological innovation becomes the dominant solution. Strong investments in research lead to breakthrough efficiencies in the use of natural resources, including water. Renewable and clean energy become dominant. Colorado is a research hub and has a strong economy. The relatively cooler weather in Colorado (due to its higher elevation) and the high-tech job market cause population to grow faster than currently projected. The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand. The warmer climate reduces global food production, which increases the market for local agriculture and food imports to Colorado. More food is bought locally, which increases local food prices and reduces the loss of agricultural land to urban development. Higher water efficiency helps maintain streamflow, even as water supplies decline. The regulations are well defined, and permitting outcomes are predictable and expedited. The environment declines and shifts to becoming habitat for warmer-weather species. Droughts and floods become more extreme. More compact urban development occurs through innovations in mass transit.

E. Hot Growth. A vibrant economy fuels population growth and development throughout the state. Regulations are relaxed in favor of flexibility to promote and pursue business development. A much warmer global climate brings more people to Colorado with its relatively cooler climate. Families prefer low-density housing, and many seek rural properties, ranchettes, and mountain living. Agricultural and other open lands are rapidly developed. A hotter climate decreases global food production. Worldwide demand for agricultural products rises, which increases food prices. Hot and dry conditions lead to a decline in streamflow and water supplies. The environment degrades and shifts to becoming habitat for species adapted to warmer waters and climate. Droughts and floods become more extreme. Communities struggle to provide services needed to accommodate rapid business and population growth. Fossil fuel, the dominant energy source, is supplemented by production of oil shale, coal, natural gas, and oil in the state.

2.1.4 Quantification of High-Impact Drivers in the Scenarios

Quantifying future demands, supplies, gaps, and available water under each of the five scenarios is a foundational task of the Technical Update. While the preceding narrative descriptions provide a qualitative summary, more significant interpretation was needed to determine how technical analyses could quantify the future conditions described in each based on available data and scientific best practices. Figure 2.1.2 summarizes and compares how the drivers varied across the scenarios. A more detailed explanation of how the various drivers were quantified and how the drivers relate to one another and across scenarios is shown in Tables 4 through 8 of Appendix B. The methodology sections and appendices provide more information on specific, quantitative adjustments to the drivers for each scenario and how the adjustments were implemented in various analyses.

Figure 2.1.2 Illustration of High-Impact Drivers Associated with Five Planning Scenarios

Drivers	A Business as Usual	B Weak Economy	C Cooperative Growth	D Adaptive Innovation	E Hot Growth
A. Economy/Population					
B. Urban Land use	No change in density	No change in density	Higher density	Higher density	Lower density
C. Climate Status/Water Supply	Same as 20th century observed	Same as 20th century observed	Between hot and dry and 20th century observed	Hot and dry	Hot and dry
D. Energy Water Needs	Low (no oil shale)	Moderate (no oil shale)	Low (no oil shale)	Low (no oil shale)	High (oil shale)
E. Agricultural Conditions	Total ag water demands decrease • Decrease in irrigated acres due to urbanization • Ag exports and demands lower • Ag is less able to compete with urban areas for water	Total ag water demands slightly decrease • Slight decrease in irrigated acres due to urbanization • Ag exports and demands constant • Ag is less able to compete with urban areas for water	Total ag water demands slightly higher • Slight decrease in irrigated acres due to urbanization • Ag exports down and local demands up • Ag is better able to compete with urban areas for water • Increased ET due to climate change	Total ag water demands slightly higher • Slight decrease in irrigated acres due to urbanization • Ag exports down and local demands up • Ag is better able to compete with urban areas for water • Increased ET due to climate change	Total ag water demands higher • Significant decrease in irrigated acres due to urbanization • Ag exports and demands high • Ag is better able to compete with urban areas for water • Increased ET due to climate change
F. Availability of New Water Efficiency Technology	• M&I Moderate • Ag: Efficiencies are increased	• M&I Moderate • Ag: Efficiencies are increased	• M&I High • Ag: Efficiencies are increased	• M&I High • Ag: Much higher efficiencies are implimented	• M&I Moderate • Ag: Efficiencies are increased
G. Social/Environmental Values	No change	No change	• Increased awareness • Increased willingness to protect environment and stream recreation	• Increased awareness • Increased willingness to protect environment and stream recreation	• Full use of resources • Low willingness to protect environment and stream recreation
H. Regulatory Constraints	Regulation Deregulation No change	Regulation Deregulation No change	Regulation Deregulation Increased	Regulation Deregulation Increased but expedited	Regulation Deregulation Reduced
I. M&I Water Demands	Middle of the five scenarios	Lowest of the five scenarios	Second lowest of the five scenarios	Second highest of the five scenairos	Highest of the five scnarios

2.2 ANALYSIS METHODOLOGIES

TheTechnical Update offers a more scientifically rigorous and robust analysis compared to previous SWSI efforts, which did not include scenario planning, climate change considerations, water rights, or surface water modeling. The Technical Update leverages the state's 25-year investment in CDSS, including StateMod models that connect major waterways and tributaries in Colorado.

Hydrologic modeling allows for detailed temporal (hydrology over time) and spatial (geographic and node-specific) analyses. It incorporates inputs that reflect water availability drivers under a variety of future conditions throughout the state. Additionally, hydrologic modeling provides increased consistency in the representation of municipal and agricultural demand gaps in ways that could not be as equitably modeled in earlier methodologies (i.e., SWSI 2010). The models produce a wealth of time series data and quantifications of "hydrologic gaps" at representative locations under each planning scenario.

2.2.1 Incorporating Climate Change into Scenario Planning

Through an iterative effort with the CWCB, basin roundtables, and the IBCC, three composite climate projections were incorporated into the planning scenarios.[2] Of the five planning scenarios, three include some level of stressed future climate change (*Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth*). The other two planning scenarios (*Business as Usual* and *Weak Economy)* assume similar climate conditions and variability to the observed conditions of the 20th century compared to historical natural flows for the period 1950–2013).

High stress conditions occur when runoff is low and consumptive use is high, whereas low stress conditions occur when runoff is high and consumptive use is low. The consumptive use, in this case, refers to the irrigation need (increased or decreased) for watering crops or other outdoor watering. This is expressed as the irrigation water requirement (IWR), which is synonymous with the term Crop Irrigation Requirement (CIR).

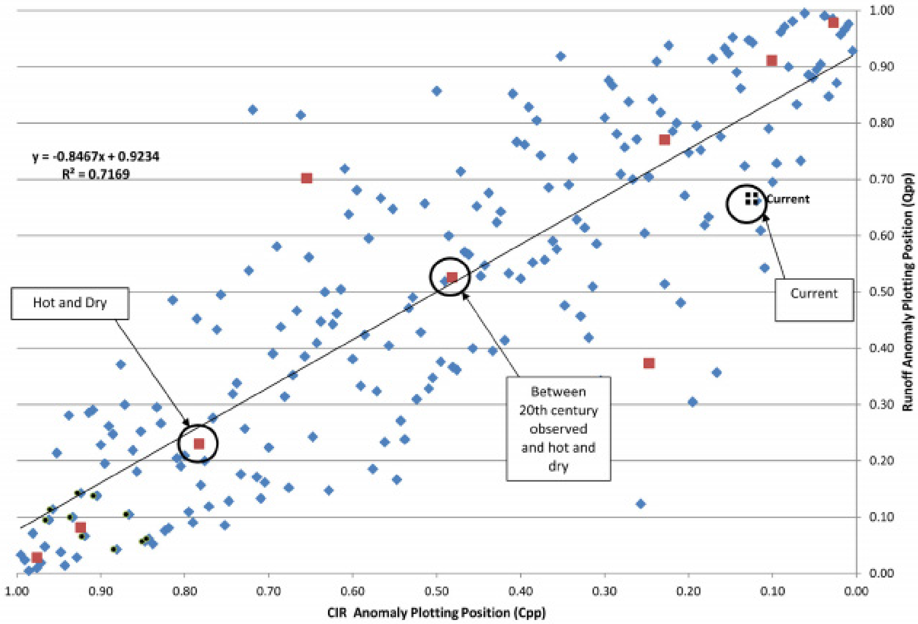
Table 2.2.1 and Figure 2.2.1 map this integration of future climate stress into the Technical Update planning scenarios. More detailed explanations of climate impacts follow and can be found in several documents such as the Colorado Climate Plan, Colorado Water Plan, and the foundational work of the multiphase Colorado River Water Availability Study (CRWAS).

Table 2.2.1 Incorporation of Climate Change into Scenario Planning

CWP Planning Scenario Name	CRWAS Climate Projection Name	Climate Stress Impact on 2050 Future Condition			
		CIR*	Runoff*	Average Annual Temperature[3]	Precipitation Change[3]
Business as Usual	Current	None	None	None	None
Weak Economy	Current	None	None	None	None
Cooperative Growth	In-Between	Moderate (50th percentile)	Moderate (50th percentile)	+ 3.78 °F (+2.0 °C)	5% increase in annual precipitation
Adaptive Innovation	Hot and Dry	High (75th percentile)	Low (25th percentile)	4.15 °F (+2.3 °C)	1% decrease in annual precipitation
Hot Growth	Hot and Dry	High (75th percentile)	(Low (25th percentile)	+ 4.15 °F (+2.3 °C)	1% decrease in annual precipitation

**See Figure 2.3 Plot of Runoff vs. Crop Irrigation Requirement (CIR)*

Figure 2.2.1 Runoff vs CIR Plotting Position



This plot of Runoff vs. CIR uses the Bureau of Reclamation's 200 composite climate scenarios. "Hot and dry" is defined as the 75th percentile of climate projections for crop irrigation requirements (water use), and the 25th percentile for natural flows. In other words, only 25 percent of projections have lower natural flows and 25 percent of projections have higher crop irrigation requirements. "Between 20th century-observed and hot and dry" is defined as the 50th percentile for both natural flows and crop irrigation requirements. This scenario represents the middle of the range in terms of severity. Baseline, or "Current" conditions, which represents no change in runoff or in crop irrigation requirements, fall at roughly the 9th and 67th percentiles; this means that 91 percent of model runs show increases in crop irrigation requirements and about two-thirds show reductions in runoff.

Turning Narrative into Numbers

Understanding how climate change could affect Colorado is key to understanding how to translate climate themes in scenario narratives into quantitative model inputs. In the Technical Update, climate stress is modeled from two dominant perspectives:

1) Supply Perspective: Output from the CRWAS-II project[4] included an extended time series of "natural flow" data developed for numerous locations throughout the state's basins (more than 300 streamflow gage locations statewide). "Natural flow" is the amount of water in the river absent the effect of humans, and serves as the foundational water supply data in the StateMod water allocation models. Although the impacts of climate projections vary across the state, natural flows under the climate projections generally show overall declines and temporal shifts to reflect earlier runoff periods. CRWAS-II project output also included a time series of climate-adjusted hydrology for both the moderate and high climate stress projections (respectively, "In-Between" and "Hot and Dry"). These datasets, also unique at more than 300 gage locations, reflect the relative change streamflow under each climate projection.

2) Demand Perspective: The runoff and IWR factors (jointly "climate factors") from both the "In-Between" and "Hot and Dry" projections reflect increased outdoor evapotranspiration (ET) rates and, therefore, increased IWR. In the Agricultural Diversion Demand methodology (Section 2.2.3) this is represented by IWR numbers that vary monthly, for every model year, for every water district. In the M&I Demand methodology (Section 2.2.4), IWR factors were applied at the county level to represent the average annual change in outdoor municipal demands. It was assumed that indoor demands and non-revenue water are not affected by climate factors.

2.2.2 CDSS Tools

The technical analyses make extensive use of CDSS modeling tools. CDSS is a water management system developed by the CWCB and the Colorado Division of Water Resources. The primary CDSS components used for the Technical Update are as follows:

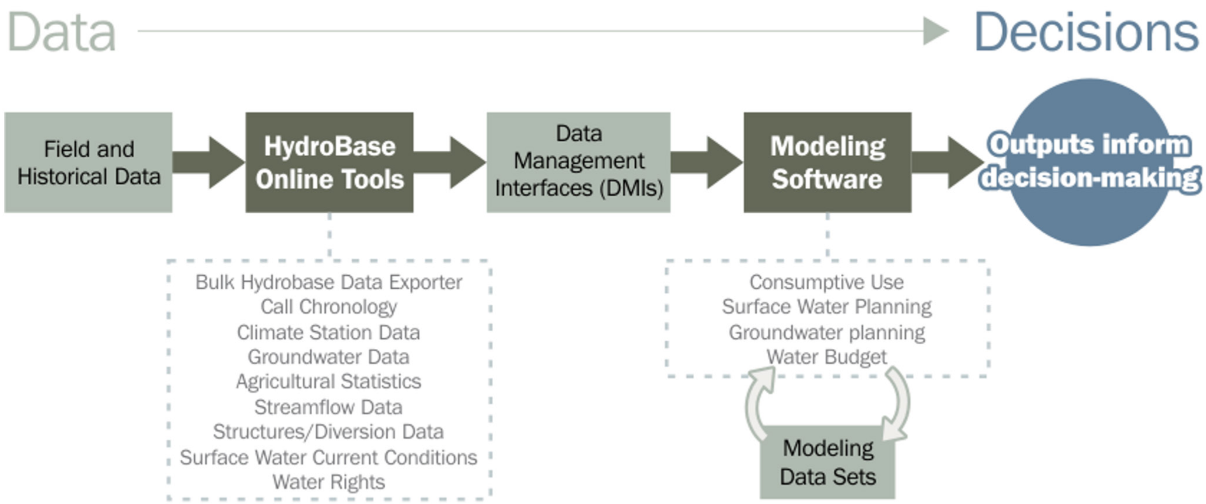
- **HydroBase:** HydroBase contains historical and current water resources data, including streamflow records, historical climate data, diversion records, and water rights.
- **Geographic information system data:** Spatial data includes geographic information system (GIS) layers of diversion locations, irrigated acreage by ditch and crop type, streamflow measurement points, rivers, climate station locations, and ditch locations.
- **Surface water allocation models:** StateMod, the state's water allocation simulation program, analyzes water supplies and water demands and allocates available supply based on water rights, locations of demands, operational protocols, etc. Shortages (gaps) are calculated if supplies cannot fully meet demands. StateMod model datasets are available in most, but not all, of the river basins in the state.

> **BASIN MODELING TOOLS**
>
> Many of the CDSS tools described here were not available for use when SWSI 2010 was being developed. The Technical Update has leveraged Colorado's investment in the CDSS to create a more comprehensive picture of supplies, demands, and gaps under each of the scenarios and under variable hydrologic conditions. The resulting analyses and tools are available for basin roundtables to use in updating their BIPs.

- **Consumptive use models:** StateCU, the state's crop consumptive use model, estimates the amount of water consumed by agriculture. It uses climate data (primarily temperature and precipitation), information on crop types and acreages, and water supply data to generate estimates of irrigation water requirements, consumptive use, irrigation system efficiencies, and agricultural diversion demand. StateCU model datasets are available in most, but not all, of the river basins in the state.

CDSS is foundational for statewide and basinwide water supply planning and establishes a common and accepted framework of information and tools to facilitate informed decision making. CDSS datasets and tools have been developed for use in the West Slope (Colorado; Yampa/White; Gunnison; San Juan/Dolores), North Platte, Rio Grande (consumptive use datasets only), and South Platte basins, and are being developed for the Arkansas Basin. State agencies, water users, and managers in these basins increasingly rely on CDSS as a common and efficient means for organizing, accessing, and evaluating a wide range of information and alternative water management strategies and decisions. Figure 2.2.2 illustrates the types of data and models available in CDSS and how data are incorporated and flow through the tools to facilitate informed decision making.

Figure 2.2.2 How Data and CDSS Tools Foster Informed Decision Making



2.2.3 Agricultural Diversion Demands

Agricultural demands in SWSI 2010 primarily reflected the consumptive use for crop irrigation at the field level. SWSI 2010 agricultural demands did not consider irrigation inefficiencies and ditch losses that occur as surface water diversions and/or pumped groundwater supplies are conveyed and applied to the crop. The Technical Update methodology, by accounting for crop consumptive needs plus irrigation inefficiencies, reflects the total amount of water needed to meet agricultural demands and allows for direct comparison between agricultural and municipal demands in the modeling. The updated methodology also provides information and tools for basin roundtables to use in evaluating the effectiveness of future agriculture projects. The Technical Update methodology described below was used to estimate diversion demands to meet the full irrigation needs of crops.

The Technical Update defines the current agricultural diversion demand as the amount of water that needs to be diverted or pumped to meet the full crop irrigation water requirements associated with the current levels of irrigated acreage, assuming historical climate conditions continue. In other words, the methodology assumes that irrigators will, regardless of a given delivery method's efficiency level, seek to divert enough water to meet their crops' full ET need (noting that under a range of climate patterns in water-short systems, the amount of water irrigators seek to divert is not always available). Current demand serves as the "baseline" for the Technical Update analysis and can be used to estimate the change from current to future conditions. To estimate potential future diversion demands, irrigated acreage, climate conditions, and efficiencies associated with the current agricultural diversion demand were adjusted by various factors to estimate the demands associated with the five planning scenarios that serve as the basis for the Technical Update analyses.

The results of the analyses are projected agricultural diversions and pumping required to meet the full crop requirement for each planning scenario (referred to as agricultural diversion demand). Agricultural diversion demands were incorporated into the water allocation models, which were used to determine how much water is available to meet the demands. Shortages to the agricultural diversion demands in the model are defined as an "agricultural gap".

Current Agricultural Diversion Demand

The approach used to develop the current agricultural diversion demand for the Technical Update varied based on the available data and the type of supplies (groundwater or surface water) used to meet the demand in each basin. The CWCB has developed crop consumptive use datasets using CDSS's StateCU modeling platform for most basins in the state. Two consumptive use datasets have been created for basins with full CDSS development:

ONGOING AGRICULTURAL SHORTAGES

Irrigators in many basins have historically operated under shortage conditions and currently experience a water supply gap in many or most years.

- **Historical Dataset.** This dataset reflects historical conditions and considers historical irrigated acreage, cropping, and climate variability. It also includes estimates of IWR associated with historical agricultural diversion demand using average system efficiency.
- **Baseline Dataset.** This dataset reflects current conditions assuming that variability in climate and hydrologic drivers will be similar to what has occurred in the past. This dataset considers current irrigated acreage and historical climate variability, and includes estimates of IWR associated with current agricultural diversion demand using average system efficiency.

For basins with both historical and baseline datasets, the following approach was used to develop the irrigated acreage, IWR, system efficiencies, and current agricultural demand:

Step	Calculation
1	Extract IWR, reflecting current acreage and crop types, from the most recent Baseline StateCU datasets
2	Develop a representative set of monthly system efficiency values for wet, dry, and average year types for each structure using information from the Historical StateCU datasets
3	Divide the monthly Baseline IWR by either the wet, dry, or average monthly system efficiency values depending on the indicator gage year type to develop the current agricultural diversion demand

The above approach was used for all basins with full CDSS datasets, though some required developing the necessary historical and/or baseline datasets, as summarized below. An additional complication pertained to the use of both surface water and groundwater supplies for irrigation in some basins. In these basins, it was necessary to partition the total agricultural diversion demand into surface diversion demand and groundwater demand. Historical groundwater demands were used to estimate current and future groundwater diversion demand patterns, assuming that the current level of groundwater pumping would likely remain the same or decrease in the future.

The basins for which full CDSS datasets are available include the West Slope basins (Colorado; Yampa/White; Gunnison; San Juan/Dolores) and the North Platte Basin (see Figure 2.2.4). In other basins, the approach was modified, or a different approach was needed based on available datasets and modeling tools. Methodologies are described in detail in Volume 2 of the Technical Update. Methodologies used in basins without full CDSS datasets are briefly summarized below:

- **South Platte and Rio Grande Basins:** Only the historical consumptive use datasets were available from CDSS. Baseline datasets were developed prior to modeling.
- **Republican Basin:** Historical and baseline StateCU models have not been developed in this basin; however, agricultural diversion demand information reflecting groundwater pumping, the source of irrigation in the Republican Basin, was available from the most recent Republican River Compact Administration (RRCA) accounting and model.
- **Arkansas Basin:** Neither historical or baseline StateCU models were available in the Arkansas Basin when the technical analysis began; however, the models are being created as a part of the Arkansas River DSS development project. Historical and baseline StateCU models were developed concurrently with the Technical Update effort and used to estimate agricultural diversion demands.

Projected Agricultural Diversion Demands in the Planning Scenarios

The Technical Update focused on several factors that can be consistently and quantitatively applied to adjust the agricultural diversion demand in each planning scenario. While there are many different factors that can impact the future of agriculture in Colorado (changing climatic conditions, new irrigation technologies, innovative crop hybrids, market fluctuations), the impact of these factors is difficult to quantify or predict with reasonable certainty. The agricultural factors that were quantified in the Technical Update are described as follows.

- **Urbanization.** Urbanization of irrigated agricultural lands will reduce agricultural demands. The approach to evaluating the impact of urbanization relied on mapping current irrigated lands, current municipal boundaries, and basinwide population projections to determine the amount of irrigated acreage that would likely be dried up and urbanized within each basin by 2050. The analysis assumed if mapped irrigated lands fall within or are directly adjacent to mapped municipal boundaries, the irrigated lands will be urbanized by 2050; however, if population projections suggested that no local increase in population will occur in a scenario, then it was assumed that irrigated lands would not be urbanized in those locations in that basin for that scenario.
- **Planned Agricultural Development Projects.** The BIPs developed by each of the basin roundtables described their current agricultural needs as well as each basin's future agricultural goals and approaches to meeting those goals. The North Platte and Yampa basins included a goal to increase agriculture in their basins by putting new lands under production. Irrigated acreage in these basins was projected to increase based on their planned agricultural projects.
- **Groundwater Acreage Sustainability.** A large portion of irrigated acreage in Colorado relies on groundwater supplies, primarily in the South Platte, Republican, Arkansas, and Rio Grande basins. Sustaining these groundwater supplies, both in terms of physical and legal availability, is necessary for preserving groundwater-irrigated acreage. If groundwater levels or augmentation supplies cannot be sustained, irrigated acreage served by groundwater in these basins will likely decrease in the future.
- **Climate.** Factors reflecting increases in IWR due to a potentially warmer and drier future climate were applied in *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth*. Background on climate adjustments are provided in Section 2.2.1.

■ POTENTIAL FOR BUY & DRY

In addition to urbanization, irrigated acreage in the South Platte and Arkansas basins is anticipated to decline resulting from permanent agricultural-to-urban water right transfers (widely known as "Buy and Dry"). Meetings were held with stakeholders to estimate these future declines in the five planning scenarios.

- **Emerging Technologies.** Emerging agricultural technologies will play a significant role in future water use. Instrumentation, automation, and telemetry have improved irrigation efficiency and scheduling in many areas of Colorado and will likely continue to improve. Efficiency improvements in delivery and application of water through drip irrigation, more efficient sprinklers, ditch lining, or enclosing open ditches (or additional adoption of these technologies) may reduce water supply shortages and/or reduce the amount of water diverted or pumped. Innovations in crop hybrids have resulted in more drought tolerance while preserving or increasing yields. Two adjustments were made to provide perspective on the potential effect of these emerging technologies in the five planning scenarios:
    - » *Sprinkler Development.* The South Platte and Arkansas basins have experienced significant conversion of flood irrigation (less water efficient) practices to center-pivot sprinklers and drip irrigation systems (more water efficient) for the past several decades. Discussions with stakeholders in the basin indicated a continued likelihood of this development to varying degrees in the five planning scenarios.
    - » *Technological Innovations.* The *Adaptive Innovation* planning scenario narrative contemplates future technological innovations that mitigate potential climate-change-related increases in irrigation demand and decreases in supply. To implement this narrative in the agricultural diversion demand methodology, the impact of contemplated technological innovations was translated as reductions to IWR and improved water delivery efficiencies.

Agricultural Diversion Demand Calculation Process

In general, the adjustment factors discussed in the previous section impact either the acreage, IWR, or efficiency components of the agricultural diversion demand analyses. The following general approach was used to integrate the planning scenario factors and develop the planning scenario agricultural demand.

STEP	ADJUSTMENT	DETAILS
1	Adjust acreage by the urbanization, planned agricultural projects, and groundwater acreage sustainability factors	Using the current irrigated acreage as a starting point, irrigated acreage was increased or decreased in each basin using the acreage values associated with each factor.
2	Calculate adjusted IWR	Revise the consumptive use datasets developed for the current agricultural diversion demand effort with the adjusted acreage and simulate the models to calculate the adjusted IWR for each planning scenario in each basin.
3	Adjust the IWR by the Climate factor	Multiply the adjusted IWR from Step 2 by the adjustment factors associated with the climate change projection pertaining to each planning scenario.
4	Adjust the system efficiency by the Emerging Technologies factor	Using the historical wet, dry, and average monthly system efficiencies as a starting point, increase the system efficiency of each irrigation ditch by 10 percent. This occurs only in the *Adaptive Innovation* scenario.
5	Develop the agricultural diversion demand for the five planning scenarios	Divide the climate-adjusted IWR from Step 3 by system efficiency values to develop the agricultural diversion demand for each planning scenario.

Assumptions and Limitations

The following assumptions and limitations should be considered when reviewing the agricultural diversion demand methodologies and results:

- **Comparison to Historical Diversions.** The current agricultural diversion demands are not directly comparable to historical diversions, because historical diversions reflect changing irrigation practices, crop types, and acreage, as well as physical and legal water availability shortages.
- **Irrigated Acreage Assessments.** The current agricultural diversion demand analysis relies on the irrigated acreage assessments developed by the CWCB and DWR, generally performed every five years. While the assessments are being continually improved, some acreage delineation inconsistencies and incorrect assignment of water supplies remain.

■ CROP TYPE CONSIDERATIONS

Note that future crop types were not adjusted in the planning scenarios but could be during the BIP update process if roundtables would like to evaluate changes in diversion demand from different cropping patterns.

- **Recharge Demands.** A small number of irrigation systems in the Rio Grande Basin have decrees allowing preferential use of groundwater supplies while diverting surface water for on-farm aquifer recharge. Although the structures are legally allowed to use either surface or groundwater supplies on their acreage, designating their agricultural diversion demand as a groundwater demand for the Technical Update efforts is consistent with their current irrigation practices.
- **Shoulder Season Irrigation Practices.** The agricultural diversion demand approach relies on IWR and historical system efficiencies from wet, dry, and average year types to capture the variability of irrigation practices across changing hydrologic conditions. Although this approach allows for estimating demands that can vary based on IWR, it may not fully capture the agricultural diversion demand associated with irrigation practices during months when the IWR is very low or zero (e.g., early-season diversions associated with "wetting up" a ditch).
- **Agricultural Diversion Demands.** The agricultural diversion demand is defined as the amount of water that would need to be diverted or pumped to meet the full crop irrigation demand but does not reflect nor consider the common practice of re-diverting irrigation return flows many times within a river basin. As such, it is not appropriate to assume the total demand reflects the amount of native streamflow that would need to be diverted to meet the full crop irrigation demand.
- **Pumping Estimates.** Groundwater withdrawals have been metered and recorded in recent years, but records are generally not available over a long historical period. As a result, it was necessary to estimate groundwater-only and supplemental irrigation (co-mingled) supplies. In basins with CDSS models, pumping was initially estimated based on IWR in the StateCU datasets and then adjusted to account for historical restrictions to pumping. This approach holds supplemental/co-mingled pumping to current levels, which leaves any change of agricultural diversion demand (positive or negative) in the five planning scenarios a change in surface water agricultural diversion demand.
- **Planning Scenario Adjustments.** The five planning scenarios describe plausible futures with characteristics that require several adjustments to agricultural diversion demands; however, some of the agricultural drivers in the scenario narratives were not explicitly represented in the analyses as they could not be defensibly quantified (examples include narrative commentary on food security, crop type, and future agricultural economies). It is difficult to isolate the impact of a specific adjustment because the adjustments tend to compound and overlap within a planning scenario. If water resources planners are interested in the impact of an individual adjustment, they are encouraged to obtain the consumptive use datasets and implement the adjustments in a stepwise fashion, analyzing the results after each adjustment is implemented.

2.2.4 M&I Demands

The M&I demands were prepared on a spatial and temporal scale in ways that could be incorporated into the hydrologic modeling of future demand and supply scenarios. As with SWSI 2010, the methods used in this approach are for general statewide and basinwide planning and are not intended to replace demand projections prepared by local entities or for project-specific purposes.

Where the Technical Update uses M&I demands across five scenarios and a much more robust calculation, SWSI 2010 used a more simplistic approach that is worth explaining for context. In SWSI 2010, municipal/industrial demands were defined as water uses typical of municipal systems (including residential, commercial, light industrial, non-agricultural irrigation, non-revenue water, and firefighting) and a baseline was developed by multiplying the Colorado State Demography Office (SDO) population projections by per-capita rate of use.

Like SWSI 2010, the Technical Update uses population multiplied by per-capita rate of use (in terms of gallons per capita per day or "gpcd") in preparing a range of possibilities that reflect the uncertainties in future municipal demands.

Municipal Demand = (population) x (gallons per capita per day)

Unlike SWSI 2010, the Technical Update provides projected demands in the year 2050 for five future scenarios that each include a different level of conservation and water management that is characteristic of the scenario as defined in the Water Plan. The potential impact from drivers of climate, urban land use, technology, regulations, and social values are incorporated into the municipal demand projections through adjustments to the current gpcd rate of use.

2050 PROJECTIONS

Projected M&I demands reflect anticipated conditions in the year 2050. Demands for time periods between now and 2050 were not estimated. See Section 3 for more explanation.

The Water Plan provides relative rankings of M&I water use in the planning scenario narratives (see Figure 1.1.1 in Section 1.1.2). These rankings influenced the municipal demand projections. The rankings provide direction for how the combinations of M&I drivers affect the future volumetric demands under each scenario. They were interpreted to apply to average annual statewide volumetric demands rather than per capita demands. The rankings heavily influenced, and in some cases constrained, the combinations of drivers and population used in each scenario.

Description of Municipal Demand Methodology

Municipal diversion demands were calculated based on the factors described below.

Population

A unique population and growth pattern projection for the year 2050 was prepared for each planning scenario, as further described in the *Updated Population Projections for Water Plan Scenarios* (see Volume 2) and summarized in Table 2.2.2. The population projections were informed by the planning scenario narratives in the Water Plan.

The SDO forecast was adopted as the "medium" projection in Table 2.2.2. The variances around the SDO forecast assumed for other scenarios were estimated from the historical population growth experience of the state and each of its basins. Three sets of initial projections, with some modifications to the distribution of growth within the state, were then used to develop population forecasts consistent with the five planning scenarios.

Table 2.2.2 2050 Population Projections used for Five Planning Scenarios

	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Population Projection	Medium	Low	Medium, Adjusted	High, Adjusted	High

Only three pieces of information were required to develop probabilistic estimates of the potential range surrounding the "median" population projections produced by the SDO. The information requirements were:

- The compound average annual growth rate implied by the SDO forecast
- The historical standard deviation in population growth rates by decade
- The historical compound average annual growth rate for the area being projected

The following sequence of steps was used to implement the analysis:

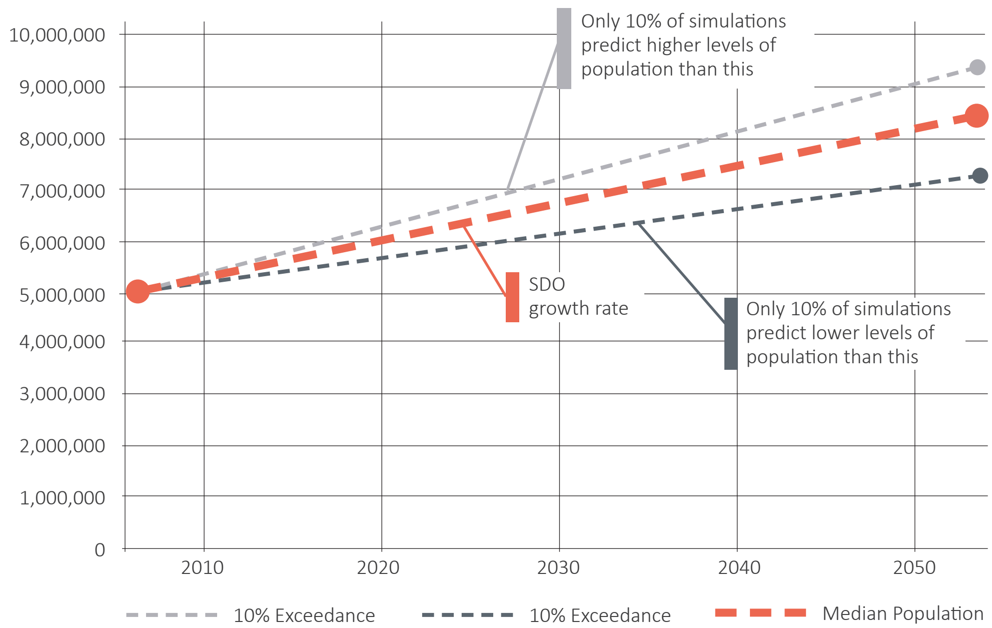
STEP	CALCULATION	DETAILS
1	Calculate median compound average annual growth rate	Calculated for the state and each basin based on the 2017 SDO projections through 2050.
2	Estimate the standard deviation in future growth rates	Based on historical standard deviation and historical and projected compound growth rates.
3	Use Monte Carlo techniques to simulate alternative future populations for each area based on baseline compound average annual growth rate and estimated standard deviation in growth rates by decade	Simulations result in thousands of alternative future populations derived from above for the state and each basin in 2050.
4	Select "High Growth" and "Low Growth" projections	CWCB selected the 10 percent exceedance probability for the "high growth" projections and the 90 percent exceedance probability for the "low growth" projections (see Figure 2.2.3).

Baseline Water Demands

Baseline municipal water demands were prepared by county, on a per-capita and volumetric basis. One of the key objectives for the Technical Update was to maximize the use of new data that were not available for SWSI 2010. The baseline (circa 2015) demands were prepared for each county using the following four data sources:

1. Data reported to the CWCB by water providers pursuant to House Bill 2010-1051[5]
2. Municipal water efficiency plans (WEP)
3. Targeted water provider outreach
4. Basin Implementation Plans

Figure 2.2.3 Projected Population Growth Through 2050



Per Capita Water Demand Projections. Projected future per capita rates of water demand in gpcd were calculated for each county by adjusting the baseline gpcd values by future demand drivers representing urban land use, technology, regulations, and social values. The potential future impact of these drivers on each of the five water demand categories was evaluated and values were developed that considered the planning scenario descriptions in the Water Plan and with input from the M&I TAG.

The residential indoor demand category was adjusted for each planning scenario to a fixed gpcd value, while percentage adjustments were applied to the other demand categories (positive values created an increase in gpcd and negative values a decrease in gpcd). The adjustment values are shown in Table 2.2.3. The adjusted future indoor and outdoor gpcd rates[6] were used to represent all new population (associated with new construction) and a portion of the existing population reflected by the adoption rates shown in Table 2.2.4 (associated with retrofits); the remainder of the existing population continues at the baseline gpcd rate. The resulting future gpcd rates used in demand modeling, therefore, include the combined effects of active and passive conservation.

Table 2.2.3 Municipal Per Capita Rate Adjustments for Planning Scenarios

Demand Category	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Residential Indoor (gpcd)	42.4	42.4	36.4	33.3	42.4
Non-Residential Indoor	0%	-5%	-10%	-10%	+5%
Outdoor	0%	-5%	-15%	-20%	+5%
Non-Revenue Water	0%	+5%	0%	-5%	0%

Table 2.2.4 Municipal Adoption Rates Applied to Indoor and Outdoor Demand Categories for Planning Scenarios

	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Adoption Rate	50%	40%	60%	70%	60%

Climate

Changes in climate primarily influence outdoor aspects of municipal demands due to impacts on landscape vegetation irrigation water needs. These impacts are typically associated with warmer temperatures that increase evapotranspiration (ET) rates and lengths of growing seasons, which increase the landscape irrigation water demand and consumptive use. For the Technical Update, it was assumed that indoor demands and non-revenue water are not affected by climate changes. ET change factors developed under the CRWAS Phase II (See Section 2.2.1) were used to estimate the impacts of changing climate on future outdoor demands for the Technical Update. These factors were applied to outdoor demands at a county level to represent the average annual change in outdoor demand in the year 2050 due to the climate status.

Municipal Demand Calculation Process

The calculation process for developing current and future municipal demands for the five planning scenarios is summarized below:

STEP	CALCULATION
1	Using water provider population, distributed water and customer water use data, prepare one population-weighted average current gpcd for each county
2	Disaggregate the representative current gpcd value into the appropriate sectoral uses
3	Adjust the current disaggregated gpcd values using the methodologies described in the sections above to prepare future gpcd values for each county under each of the five planning scenarios
4	Apply climate change factors to the 2050 outdoor municipal demand projections in *Cooperative Growth*, *Adaptive Innovation* and *Hot Growth*

Description of Industrial Demand Methodology

The Water Plan provides some narrative guidance regarding effects on self-supplied industrial (industrial) demands under the five planning scenarios, although less specific than for the municipal demands. New and updated information related to current and projected industrial demands is limited. Based on published references and data collected through outreach with the M&I TAG, SWSI 2010 values were updated where possible and appropriate as follows:

- Large Industry: Baseline large-industry demands for facilities represented in SWSI 2010 were updated using either BIP data, recent data from existing hydrologic models, or interpolated values between 2008 and 2035 in SWSI 2010. Technical Update values vary by scenario as shown in Table 2.2.5. Large industry demands in Jefferson County were not varied by scenario.

CLIMATE SHIFTS

Climate change could impact SSI water needs like thermoelectric generation, snow making, etc. Analyzing the potential impacts of climate change on the various sectors of SSI water demands would require a more complex evaluation than could be conducted in this round of Technical Update work but could be considered in future iterations or BIP updates.

- Snowmaking: Baseline demands were updated based on current snowmaking acres for each resort[7] and water use factors from SWSI 2010 and are in line with the linear increase from 2008 through 2050 reported in SWSI 2010. SWSI 2010 projections represent the best available information for *Business as Usual* demands in 2050. As with SWSI 2010, snowmaking demands are not varied by scenario for the Technical Update, in part, due to uncertainty regarding the effects of climate change.
- Thermoelectric: Baseline and *Business as Usual* thermoelectric demands for 10 of the thirteen facilities included were updated using data provided by M&I TAG participants. Baseline and *Business as Usual* demands for one facility were based on information from the Yampa-White-Green BIP. SWSI 2010 values were used to define Baseline and *Business as Usual* demands for the remaining two facilities where no updated information was available. Thermoelectric demands for all facilities were varied by scenario according to the factors in Table 2.2.5.
- Energy Development: Baseline energy development demands were updated using either BIP data or interpolating between 2008 and 2035 values used in SWSI 2010. Demand projections in the Rio Grande Basin were based on information from the BIP and did not vary by scenario. Demands in all other basins were based on low, medium, and high projections from SWSI 2010.

Table 2.2.5 Adjustments to SSI Demands for Each Planning Scenario

SSI Category	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Large Industry	-	-10%	0%	0%	10%
Snowmaking	-	0%	0%	0%	0%
Thermoelectric	-	-5%	10%	-5%	10%
Energy Development	SWSI 2010- Medium	SWSI 2010- Medium	SWSI 2010- Low	SWSI 2010- Low	SWSI 2010- High

Assumptions and Limitations

- The projected demands represent potential demands under conditions described for each scenario; however, they do not necessarily represent the full potential for water management strategies under each scenario (e.g., more aggressive active conservation programs). Basins may continue to develop water conservation efforts as part of existing and future projects that reduce consumption.
- Erroneous or suspect reported non-revenue water loss values were adjusted, using stakeholder input where possible, to provide a reasonable range of planning values for several water providers. An emphasis should continue to be placed on improving this data and understanding the associated real and apparent losses.
- Aside from the climate driver described above, per capita drivers were not modified by basin or county. Drivers were applied using the same values and methodology for each county and are intended to prepare a scenario planning approach that can be further customized at the basin level.
- Planning scenarios do not include acute drought response efforts like imposing restrictions, so comparing to other areas of the country (e.g., Southern California) is not appropriate if their current demands reflect not only aggressive active conservation, but also imposed restrictions.
- Demand projections were prepared using the same adoption rate for indoor and outdoor demands and for residential and non-residential demands. The adoption rate should be further investigated at a local level because it is highly influenced by new construction and active water conservation programs. The adoption rate also encompasses effects from the persistence of demand reductions associated with indoor and outdoor uses.
- The per capita gpcd metric is being used as a projection tool for this statewide planning project, even in areas with a significant influence from non-permanent residents, such as mountain resort communities, and is not applicable as a comparison tool between communities. It is not appropriate to compare a gpcd value from areas that have a significant influence from tourism and non-permanent residents to areas that have a primarily year-round, residential type of population. Specific characteristics about each community need to be understood when interpreting per-capita demand data.
- Urban land use changes have the potential to significantly affect future municipal (primarily outdoor) and agricultural demands. The range of impacts may not be fully reflected in the Technical Update municipal and agricultural demand projections, primarily due to a lack of information available for use in statewide planning projections. Future demand projections may be improved by collecting service area delineations and density information regarding developed and irrigated, landscaped areas under current conditions and anticipated for the future planning year (i.e., 2050).

- The climate factor adjustments described above represent the average annual change in 2050 for the climate represented in each scenario. Outdoor demands will vary annually and monthly, and this type of annual variability is not included in the hydrologic modeling for the Technical Update. This could be incorporated into future technical updates.
- The adjustments assume that amount and type of vegetative cover and irrigation methods and management remain the same in the future as today.
- The methodology assumes that the percentage reduction of current to future outdoor use found from existing programs (20 to 30 percent) remains possible and representative of the potential percentage reductions under scenarios that include climate change; however, some communities are already struggling to support healthy landscapes in response to utility rate increases. Active management will likely be required to maintain healthy landscapes in a hotter and drier future or landscapes may need to change.

2.2.5 Hydrologic Modeling and Analysis

The water supply modeling focused on physical streamflow, water available to meet projected or new demands, and the agricultural and M&I gap under a variety of hydrological conditions. While surface water availability in SWSI 2010[8] represented the amount of unappropriated streamflow that may be developed in the future in basins with available streamflow, it also found that the groundwater supplies were generally declining, and the discussion regarding these supplies focused on sustainability (as opposed to supplies that may be developed in the future). The Technical Update provides more in-depth analyses of current and climate-adjusted hydrology and analyses of water availability to meet future projected agricultural and municipal diversion demands. The analyses, discussed in more detail below, relies primarily on water allocation models to simulate how climate-adjusted hydrology will impact the existing demands, supplies and gaps, and what unappropriated supplies may be available to meet the future projected demands.

Modeling Period

The hydrologic models use 1975 to current-year (models vary in the most recent year of data depending on the basin) as the reference modeling time period, because existing transbasin diversion projects were, in general, fully operational by the mid-1970s. In addition, record keeping and data describing diversions (of all kinds) in years prior to the 1970s are of relatively low quality in some basins. Models simulating the planning scenarios use 1975 to current-year water supplies (in some scenarios, adjusted for climate change impacts), current administrative practices and infrastructure, and projected demands. The 1975 to current-year period of record provides a robust variety of hydrological conditions (i.e., high flow years and extended droughts) over which the planning scenarios can be analyzed.

Methodology to Develop Current Water Supply

Current water supply information consists of physical streamflow and water availability at key locations throughout the modeled basin. The bulk of the analysis of current water supplies relies on models and data developed under the CDSS program. In basins where the CDSS program has not been fully implemented, the methodology for those basins was modified to use available water supply information. The sections below discuss the specific methodologies that were used to evaluate current water supplies for each basin.

CDSS Basin Water Supply

StateMod water allocation models are available for several of the basins through the CDSS program (see Figure 2.2.4). For basins with full CDSS model development, two water allocation datasets were developed:

- Historical Dataset. Historical model datasets allocate water to meet historical agricultural and municipal diversion demands in each basin. They contain historical diversions and pumping that reflect administrative and operational constraints on water supply as they occurred over time. The historical models were calibrated by comparing historical measured diversions, reservoir contents, and streamflow to simulated results. Model adjustments were made until there was adequate correlation between the measured and simulated data. They are an appropriate dataset to assess historical conditions in basins over an extended period of time.
- Baseline Dataset. Baseline model datasets allocate water to meet current agricultural and municipal diversion demands assuming recent historical climatic and hydrologic conditions will continue into the future. Baseline models reflect current administrative, infrastructure, and operational conditions overlaid on the hydrology of the entire study period. For example, the model could include the operation of an existing reservoir constructed in 1985, but it would be simulated using hydrology reflective of 1975 to 2013 conditions. Baseline datasets and models are appropriate to use for "what if" planning scenarios.

For basins with both historical and baseline datasets, the following approach was used to develop the current water supply information:

Step	Procedure
1	Incorporate current agricultural diversion demands into the Baseline models.
2	Incorporate current M&I diversion demands.
3	Simulate the models.
4	Extract the monthly physical streamflow and water availability at key locations in each basin.
5	Summarize the agricultural gap and crop demand gap by Water District and by basin for on average and for critically dry years. No M&I gaps occur under current conditions.
6	Summarize total storage by water district and by basin over the modeled period.

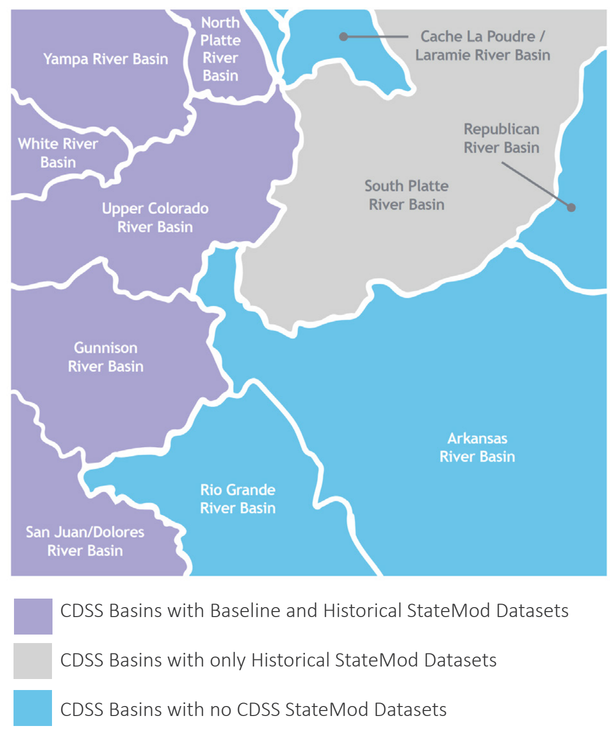
Non-CDSS Basin Water Supply

As shown in Figure 2.2.4, StateMod water allocation models have not yet been developed for the Arkansas, Republican, Rio Grande, and Cache La Poudre/Laramie basins. As these regions are generally water supply limited, a water allocation model may not be necessary to understand future water availability in the basin. Historical data can be used to estimate current water supplies in the basin at a level sufficient for the Technical Update planning effort. Current water supply information in these basins was developed primarily using historical data:

- Current physical streamflow was based on historical data from key streamflow gages.
- Current water availability was set to zero.
- Current agricultural gap was based on historical consumptive use analyses and estimated as the difference between the current agricultural diversion demand and the historical pumping (in the Republican Basin) or the historical diversions and pumping (in the Arkansas and Rio Grande basins) on average and for critically dry years.
- Current M&I gap was set to zero, assuming the M&I demands are fully satisfied under current conditions.

Although the methodologies for estimating current water supplies in each of these basins differs from the basins with CDSS models and datasets, they provide appropriate estimates of physical streamflow, water availability, and gaps for current conditions for comparison to the five planning scenario results.

Figure 2.2.4 CDSS and Basin Modeling Map



Methodology to Develop Planning Scenario Water Supply

The planning scenario water supplies were estimated using an approach similar to that used to estimate the current water supplies. For planning scenario water supplies, agricultural and municipal diversion demands reflective of 2050 conditions specific to each of the five planning scenarios were used as was, in some scenarios, climate-adjusted hydrology. Once the planning scenario datasets were developed, results were compared to the current water supply to assess the impact of the projected demands and hydrology.

CDSS Basin Methodologies

The baseline StateMod datasets developed for the current water supply analysis served as the starting point for the planning scenario datasets. The following steps were taken to develop the planning scenario StateMod datasets and ultimately the water supply information:

Step	Procedure
1	Incorporate the appropriate planning scenario agricultural diversion demands into the planning scenario models.
2	Incorporate the appropriate planning scenario M&I diversion demands into the planning scenario models.
3	Incorporate the appropriate climate-adjusted natural flow into *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth*. Note that *Business as Usual* and *Weak Economy* reflect current (or recent historical) hydrology.
4	Run the planning scenario models.
5	Extract the monthly physical streamflow and water availability at key locations in each basin.
6	Summarize the M&I gap by water district and by basin on average and for very dry years.
7	Summarize the agricultural gap and crop demand gap by water district and by basin on average and for very dry years.
8	Summarize total storage by water district and by basin over the modeled period.
9	Estimate the amount of water available from changed irrigation water rights associated with land undergoing urbanization
10	Estimate the transbasin import reductions due to changes in physical or legally available supply in the exporting basin.

The planning scenario StateMod datasets incorporate the projected hydrology and demands with the baseline representation of the basins' infrastructure and operations. Adjustments to other modeling parameters, such as order of supplies used to meet municipal diversion demands or alternative methods for conveying water, were not made in the planning scenario datasets under this effort. In addition, the models utilize existing infrastructure to the full operational potential, and no adjustments were made to limit those operations. For example, in planning scenarios that contemplate lower water supplies, simulated reservoir storage may be drawn down to lower levels and on a more frequent basis than has occurred historically. While reservoirs are being simulated within their existing operational constraints in the models, it is possible that water providers would obtain additional storage or other water rights in a drier future rather than consistently operating existing facilities at low levels.

Non-CDSS Basin Methodologies

The absence of basinwide planning models in some basins limited the options to evaluate the projected demands and hydrology. As a result, the existing analysis tools are not conducive to implementing the "what-if" planning scenario conditions; however, they do provide information on the basin operations which were used in developing the planning scenario water supply information. Various qualitative and quantitative methods were used to develop the planning scenario water supply information in these basins as described:

- **Republican Basin.** For the Republican Basin, the current level of appropriated groundwater supplies serves as the maximum available water supply in the basin into the future and assumes that no unappropriated surface or groundwater supplies will be available. Projected water supplies in the Republican Basin were estimated as follows:
  - » Current irrigation practices, in which irrigators pump less than the full amount needed by the crops, was assumed to continue into the future based on discussions with stakeholders in the basin. The current agricultural gap percentage was used to estimate the planning scenario gaps, and associated crop demand gaps, on average and for critically dry years.
  - » Planning scenario water availability was set to zero.

FREE RIVER

Some water users (primarily agriculture) have historically supplemented their water rights with additional diversions under free river conditions. The modeling assumes this will continue. As a result, available free river is first allocated to agriculture and then to other water rights. Basin roundtables could propose future projects to allocate available free river to meet M&I needs.

- » Any projected planning scenario M&I demand greater than current M&I demand was assumed to be a gap due to lack of future water availability. Planning scenario M&I gaps were estimated as the difference between the planning scenario M&I demand and the current M&I demand on average and for very dry years.

- **Arkansas and Rio Grande Basins.** The *Business as Usual* and *Weak Economy* scenarios do not include climate-adjusted hydrology or demands, therefore the anticipated changes in these scenarios result from changes in M&I demands and irrigated acreage, respectively. The approach to develop water supply information in these basins included the following assumptions:
  - » Water availability was set to zero.
  - » Historical agricultural shortages are expected to continue into the future, exacerbated by reduced supplies under climate-adjusted hydrology.
  - » Current pumping levels serve as the maximum groundwater supply available to meet projected demands.
  - » Any groundwater supplies associated with the removal of irrigated acreage due to groundwater sustainability adjustments remain in the aquifers and are not available to offset gaps experienced by other demands in the basin.
  - » Any projected planning scenario M&I demand greater than current M&I demand was assumed to be a gap, due to lack of future water availability.[9]

  In general, the current agricultural gap was used as the basis for the planning scenario agricultural gap, and further reductions in supplies due to climate-adjusted hydrology were applied to gaps. In each planning scenario, the average reduction in streamflow at indicator gages throughout the basin was used to increase the agricultural gap in *Cooperative Growth, Adaptive Innovation*, and *Hot Growth*. The M&I gap was based on the difference between the current M&I demand and the planning scenario M&I demand, assuming no additional supplies are available to meet the increased demand. Simulated streamflow under the planning scenarios with climate-adjusted hydrology was not available; however, the change in runoff (i.e., natural flow), both magnitude and timing, between current conditions and climate-adjusted conditions is provided to reflect the general impact of these projected hydrology adjustments.

- **Cache la Poudre and Laramie Basins.** Although these basins do not have the full suite of CDSS modeling tools available, model results from neighboring sub-basins with similar levels of irrigated acreage, M&I demands, storage, and transbasin supplies were used to inform and adjust the results in these basins. The planning scenario agricultural gaps in these basins were based on the current agricultural gap and then adjusted based on the gap results from neighboring sub-basins in each planning scenario. The planning scenario M&I gap in these basins was assumed to be similar to M&I gaps experienced in neighboring sub-basins, particularly in sub-basins where municipal supplies are generally similar and consist of sources like Colorado-Big Thompson supplies, changed water rights, and storage. The outflow from the Cache La Poudre River to the South Platte River was based on historical streamflow for *Business as Usual* and *Weak Economy* and adjusted with the hydrology factors in planning scenarios with climate-adjusted hydrology. The planning scenario water supply information from the Cache La Poudre and Laramie basins was then incorporated into the overall South Platte and North Platte Basin results, respectively.

Assumptions and Limitations

- Basinwide Planning Model: A primary objective of CDSS is to develop water allocation models that can be used to evaluate potential future planning issues or management alternatives based on Colorado water law at a regional level. The level of detail regarding representation of hydrology, operations, and demands in the model is appropriate for the Technical Update efforts. The models operate on a monthly time-step and, therefore, do not capture daily changes in streamflow, routing of reservoir releases, or daily accretions or depletions to the river system. One hundred percent of the consumptive use demands are represented in the model, and many are represented with their individual water rights and operations. Smaller streams are not individually represented in the model; rather the demands and contributing inflow from those tributaries are grouped and represented on larger tributaries in the model. Information used in the modeling datasets is based on available data collected and developed through CDSS, including information recorded by the State Engineer's Office. The model datasets and results are intended for basinwide planning purposes.
- Model Calibration: Each water allocation model undergoes calibration, in which the model developer adjusts model inputs to achieve better agreement between the simulated and measured streamflow, diversions, and reservoir contents. The model builds on historical water supply information, and if information is missing, errant, or there are data inconsistencies, the model cannot be well calibrated and cannot accurately predict future conditions. The models are only as good as the input.
- Representation of Water Supplies and Operations: The baseline models reflect one representation of waer users' operations associated with their current infrastructure. The representation in the model is intended to capture their typical operations; however, they are simplified and do not reflect the full suite of operations generally available to larger water providers. This representation may not capture operational adjustments or agreements implemented during drought conditions, or the maximum operational flexibility of using water supplies from multiple sources. In addition, the model allocates water according to prior appropriation, and non-decreed "gentlemen's agreements" are generally not represented in the models.

- Groundwater Pumping Levels/ Transbasin Diversions: The models reflect current levels of groundwater pumping and transbasin diversions. Noting that administration of groundwater pumping shifted due to the mid-2000s drought, post-drought groundwater pumping levels were used in the baseline and planning scenario models. Similarly, the historical transbasin diversions were used in the baseline and planning scenario models. Transbasin diversions are based on many factors, including water availability and storage in both the source and destination basins, demands, other water supplies available to the water provider, and other operational considerations like water quality. Projecting how these factors may change under the 2050 planning scenarios was beyond the Technical Update scope; therefore, transbasin diversions were set to historical levels.
- Interstate Compacts. The Technical Update modeling only takes into account Compact administration where a Compact is currently being actively administered. It does not account for or make assumptions relating to how potential future administration could occur where a Compact is not currently being administered.
- Solutions/Projects: The Technical Update is intended to develop water supply and gap information that can be used by basin roundtables for future planning efforts, including the development of potential solutions to mitigate gaps. The models can be used to evaluate the effectiveness of a future solution, though future projects and/or solutions are not currently included in the models.
- Urbanization: As agricultural lands are urbanized, the irrigation supplies on those lands could potentially be transferred to other uses, such as municipal or industrial; however, the transfer of these supplies is subject to a variety of unknowns such as seniority, type of water supply, location of supply relative to the demand, and willingness to change the use of water through water court. Potentially available supplies from urbanized agricultural lands were quantified after gap calculations were conducted and are not considered in the gap; however, the supply potentially available from these lands is described in each basin (see Section 4) and can be applied to gaps at the discretion of basin roundtables in their BIP updates.

2.2.6 Environment and Recreation

The methodologies described in this section informed the development of tools to help basin roundtables update their BIPs and evaluate and prioritize future environment and recreation projects.

NONCONSUMPTIVE USES

In prior SWSIs, the term “nonconsumptive” referred to “environment and recreation” data sets and analyses. For the purposes of the Technical Update these two terms can be viewed as interchangeable; however, the phrase “environment and recreation” (or E&R) will be used moving forward.

Background on E&R Database and Enhancements for Technical Update

Beginning with the original SWSI phases and continuing through and beyond the SWSI 2010 process, the basin roundtables first identified E&R needs, then developed and refined mapping and evaluation tools, and subsequently identified projects to address those needs. The evolution of addressing E&R issues in the state is described in the graphic below. The Technical Update advances the development of tools that can be utilized by the basin roundtables in identifying E&R needs and providing support for E&R projects and methods.

SWSI I & II

Developed E&R mapping tools.

SWSI 2010

BRTs used E&R mapping tools to develop maps for each basin showing E&R focus areas. BRTs identified projects and methods to meet E&R needs and developed maps showing: location of projects/methods, status of projects/methods, E&R focus areas that have projects/methods completed or in progress.

Post-SWSI 2010

Developed nonconsumptive needs assessment database (NCNAdb), which contains nonconsumptive attributes, projects and associated protections.

Technical Update Enhancements for E&R Database

The Technical Update focused on enhancing the Nonconsumptive Needs Assessment database (NCNAdb, now referred to as the E&Rdb). The E&Rdb was updated and will allow the CWCB and basin roundtables to better leverage E&R data, streamline data entry and reporting, and promote collaboration based upon common, consistent and reliable technology and processes. Building on the technical foundation of the existing NCNAdb, several improvements were implemented that serve to accomplish the goals described in Table 2.2.6.

Table 2.2.6 Enhancement Goals and Actions for the E&Rdb

Overall Goal	Action and Results
Enhanced Technical Foundation	Data loading processes are consistent and streamlined to add efficiency and improve data quality.
	Implement the Source Water Route Framework as a common spatial unit to provide statewide consistency.
Engaging and Meaningful User Experience	Develop Excel-based templates for data entry to improve uniformity of data and add efficiency.
	Develop standard reports to enhance consistency of data retrieval.
	Provide mapping data on the CDSS MapViewer to increase ease of use and enable visualization of database content.
	Develop a user manual and identify potential improvements through user feedback.
Integration into Colorado Water Planning Process	Improve database content and expand to include project identification, project descriptions, dates, etc. making it more useful and meaningful for planning purposes.

Updating the spatial unit of analysis was an important aspect of enhancing the technical foundation of the E&Rdb. The update occurred because of the retirement of the USGS stream segment-based spatial unit called the common ID (COMID), which had been used in the NCNAdb. The Source Water Route Framework (SWRF), a Colorado-specific spatial dataset, was included as a spatial unit of analysis for the updated E&Rdb. The updated E&Rdb also relies on the USGS's National Hydrography Dataset (NHD). Data in the database can be queried by hydrologic unit code (HUC) and/or stream segment.

Improvements were also made to the data in the E&Rdb. The prior NCNAdb included more than 100 E&R attributes compiled through stakeholder outreach in each basin. The original attributes were reviewed and quality checked to identify repetitive or unreliable data sources and datasets. Closely related attributes that provided repetitive or overlapping data were consolidated into a single attribute. Additionally, previous attributes that did not have public data sources or datasets available to confirm spatial data were archived and not included in the updated attribute list. Several attributes were also renamed to better reflect the dataset and simplify database development. The final 58 attributes were grouped into several "macro" categories that help increase organization of the E&Rdb and provide a foundational set of attributes for the E&R Flow Tool (described below).

Background on Flow Tool and Enhancements for Technical Update

In addition to the updated E&Rdb, the Technical Update includes an E&R Flow Tool (Flow Tool) designed to assess flow conditions and associated ecological health at selected nodes in each basin. The Flow Tool will serve as a resource to help basin roundtables refine, categorize, and prioritize their current portfolio of E&R projects and methods and to better understand risks to ecological attributes based on possible future flow conditions under each planning scenario.

Prior to the Technical Update, the CWCB funded the development and testing of a tool known as the Watershed Flow Evaluation Tool (WFET). To date, the WFET has been applied in the Colorado and Yampa-White-Green basins. The WFET offers an approach to conducting a watershed-scale, science-based assessment of flow-related ecological risk throughout a basin, particularly when site-specific studies are sparse.

Also prior to the Technical Update, the Historical Streamflow Analysis Tool (HSAT) was developed and made available for use in the first round of BIPs and emphasized the evaluation of hydrologic variability at gage locations across Colorado. The user interface includes a simple dropdown menu and the output included automatically generated tables and plots. Many of the basic flow summaries included in the HSAT were carried forward into the Flow Tool.

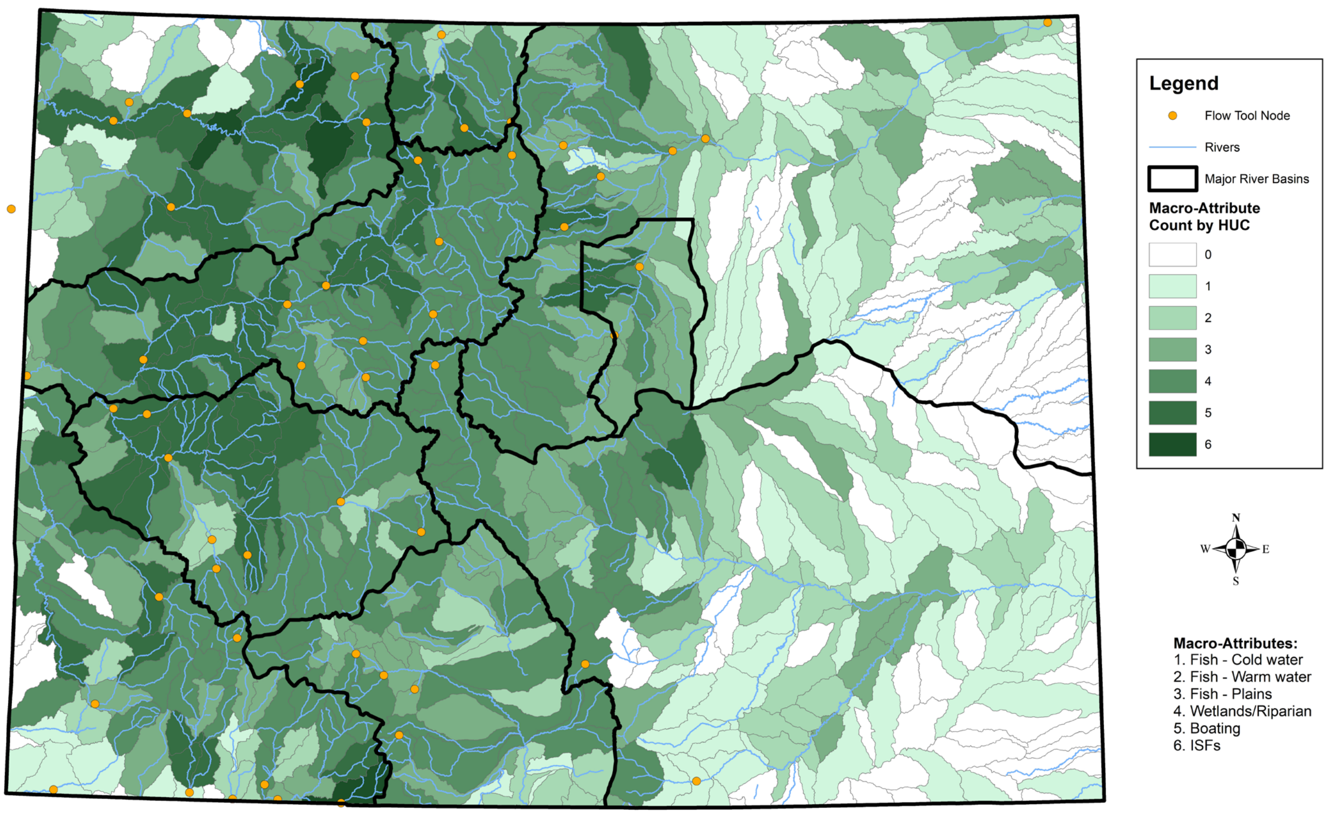
Methodology Description

The Flow Tool is built on a legacy of stakeholder involvement and was created through a methodology that was developed collaboratively with the E&R TAG and builds on the previous E&R tools described above. The Flow Tool was designed to incorporate and compare modeling output from the five planning scenarios against baseline (existing) and naturalized (unimpaired) flow condition scenarios. Key outputs include a comparison of monthly flow regimes relative to ecological-flow indicators, building off the WFET.

The Flow Tool uses monthly streamflow output from CDSS water allocation models. The Excel-based tool was designed to incorporate and compare modeling output from the five planning scenarios against historical gage data and the baseline/current conditions scenario. Key outputs include a comparison of monthly flow regimes relative to ecological-flow indicators.

The Flow Tool analyzes and produces data for 54 pre-selected model nodes corresponding to stream gages (see Figure 2.2.5). The nodes included in the Flow Tool were selected for inclusion based on a number of factors. Gages were reviewed to determine available attribute data (where key E&R attributes were located and concentrated within a basin [darker shaded HUCs in Figure 2.2.5]), to consider spatial coverage across basins, and to assess data availability.

Figure 2.2.5 Nodes in Flow Tool



The Flow Tool estimates the response of E&R attributes in rivers under various hydrologic scenarios. The flow-ecology relationships in the Flow Tool were first developed as part of the WFET and were patterned after similar relationships that have been developed across the globe to inform water management. Flow-ecology quantifies the relationship between specific flow statistics (e.g., average magnitude of peak flow, the ratio of flow in August and September to mean annual flow) and the risk status (low to very high) for E&R attributes under the flow scenario being analyzed. Data-derived relationships have been developed for riparian/wetland plants (cottonwoods), coldwater fish (trout), warmwater fish (bluehead sucker, flannelmouth sucker, and roundtail chub), and Plains fish. Other metrics were developed with basic, well-established relationships between hydrology and stream ecology. Relationships for recreational boating were developed with stakeholders during WFET development.

The Flow Tool compares historical gage records to current-conditions-modeling-output and planning-scenario-modeling-output. The comparison provides insights on where and how much monthly flow regimes are expected to change relative to ecological flow indicators related to macro-attribute categories discussed above. This comparison also highlights areas where future E&R projects and protections could be beneficial. Basin roundtables will then be able to apply their own analysis (and preferences) to determine the best way to meet these E&R needs.

Flow Tool Limitations

While the Flow Tool is intended to provide data for use in planning E&R projects and methods, it should be noted that it is not prescriptive. Tool output is currently limited to monthly timesteps, and does not designate gap values nor provide basis for any regulatory actions. The Flow Tool does not identify areas where ecological change may be associated with factors other than streamflow, nor detail results as accurately as a site-specific analysis. The tool does not evaluate potential shifts in flooding magnitude and frequency that could result from climate change.