RIO GRANDE BASIN ROUNDTABLE

VOLUME 2 • JANUARY 2022

RIO GRANDE

Basin Implementation Plan

RIO GRANDE BASIN IMPLEMENTATION PLAN

Rio Grande Natural Area.
Photo: Heather Dutton

ACKNOWLEDGEMENTS

This updated Rio Grande Basin Implementation Plan (BIP) has been developed as part of the Colorado Water Plan. The Colorado Water Conservation Board (CWCB) provided funding for this effort and countless volunteer hours were contributed by RGBRT members and Rio Grande Basin (the Basin) citizens in the drafting of this BIP.

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Colorado Parks and Wildlife
U.S. Forest Service
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CONTENTS

LIST OF TABLES

Diversion dam on the Rio Grande above Monte Vista. Photo © Adriel Heisey / www.adrielheisey.com

LIST OF FIGURES

Rio Grande below Ute Ridge. Photo © Adriel Heisey / www.adrielheisey.com

ACRONYMS, ABBREVIATIONS, AND WORDS WITH MULTIPLE SPELLINGS

AF	Acre-feet
ARP	Annual Replacement Plan
ASO	Airborne Snow Observatory
AW	American Whitewater
AWDI	American Water Development Inc.
Basin	Rio Grande Basin
BIP	Basin Implementation Plan
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CADSWES	Center for Advanced Decision Support for Water & Environmental Systems
CODOS	Colorado Dust on Snow
CPW	Colorado Parks and Wildlife
CREP	Conservation Reserve Enhancement Program
CSFS	Colorado State Forest Service
CU	Consumptive use
CWCB	Colorado Water Conservation Board
DWR	Division of Water Resources
ESA	Endangered Species Act
HB	House Bill
HCP	Habitat Conservation Plan
ISF	Instream flow
IWR	Irrigation water requirement
LiDAR	Light detection and ranging
Los Sauces	Also spelled La Sauses, Lasauses, and La Sauces
McIntire	Also spelled McIntyre and MacIntire
M&I	Municipal and Industrial
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
PFM	Point Flow Model
RG	Rio Grande
RGBRT	Rio Grande Basin Roundtable
RGDSS	Rio Grande Decision Support System
RGHRP	Rio Grande Headwaters Restoration Project
RGNA	Rio Grande Natural Area
RGNF	Rio Grande National Forest
RGWCD	Rio Grande Water Conservation District
SB	Senate Bill
SLV	San Luis Valley
SLVWCD	San Luis Valley Water Conservancy District
SMP	Stream Management Plan
SWE	Snow water equivalent
TU	Trout Unlimited
TWCD	Trinchera Water Conservancy District
URGWA	Upper Rio Grande Watershed Assessment

USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WFCF	West Fork Complex Fire
WSRA	Water Supply Reserve Account

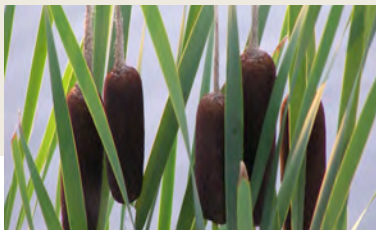
Spring on the conserved Gilmore Ranch, with Mount Blanca beyond. Photo: Rio de la Vista

Center pivots in the San Luis Valley.
Photograph by Dan Downing

1 INTRODUCTION

1.1 : STATE WATER PLAN PROCESS

The original 2015 Rio Grande Basin Implementation Plan (BIP) was developed in response to Governor John Hickenlooper's 2013 Executive Order, which launched a Colorado initiative to identify strategies to address the State's growing water demands. The 2021 BIP is the first update since the original BIP was published in 2015. The Rio Grande Basin Roundtable (RGBRT) is one of nine basin roundtables established by the Colorado Water for the 21st Century Act.



Cattails growing in Rio Grande corridor wetland. Photo: Rio de la Vista

The Colorado Water Conservation Board (CWCB) provided guidance to basin roundtables during the development of the 2015 BIP, stating that:

"The purpose of the Basin Implementation Plans is for each basin [roundtable] to identify projects and methods to meet basin specific municipal, industrial, agricultural, environmental, and recreational needs. The Basin Implementation Plans will inform and help drive Colorado's Water Plan."

The purpose of the Rio Grande BIP remains the same today. The BIP is focused on achieving a balance of competing water needs through cooperative management of water resources. It also identifies the critical water issues facing all who live, work, and recreate in the Rio Grande Basin (the Basin) and proposes ways to address those issues, thereby advancing the statewide mission to ensure:

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

Working within the Rio Grande Basin's water-related challenges will require cooperation of the entire community.

The Basin has a long history of collaborative efforts and successes, focused on addressing the challenges that face the community. The Basin has experienced:

- Prolonged and systemic drought
- Significant decline of the groundwater aquifers that sustain agriculture, towns, and critical ecosystems
- Landscape-scale wildfires
- Forest succession due to diseases and insect outbreaks
- Climate change
- Dust-on-snow
- Lack of a diverse economy
- Degraded and at-risk wildlife habitats
- Aquatic-dependent and terrestrial wildlife being considered for or listed as a "threatened" or "endangered" species under the Endangered Species Act (ESA)
- Rio Grande Compact obligations to downstream states
- Costly and time-consuming permitting of water projects
- Aging irrigation and municipal water infrastructure

The BIP is intended as a framework to guide future decision making and to address water challenges with a balanced, collaborative, and solutions-oriented approach. Using updated data from the 2019 Technical Update to the Colorado Water Plan (Technical Update), water supply and use data were refined and used in this BIP Update to identify viable solutions to the Basin's water needs (see **Volume 1 Section 5 and Appendix A** for detailed information on the updates made to the Rio Grande Technical Update data and supply and demand data). Moving forward, the RGBRT will regularly update the BIP in coordination with the state's other roundtables and the Colorado Water Plan.

Senior water rights irrigate the conserved Gilmore Ranch, along the Rio Grande west of Alamosa. Photo: Rio de la Vista

Water Division 3 meeting in the Rio Grande Basin. Photo: Erich Schlegel

1.2 : BASIN ROUNDTABLE PROCESS

The RGBRT serves as a forum to discuss water-related issues and as an organization through which local entities and water users seek funding for projects. As of May 2021, the RGBRT has secured approximately $13 million from the CWCB's Water Supply Reserve Account (WSRA) statewide account and $3.7 million from the WSRA Basin account funding a total of 85 projects in the Basin. These projects range from studies to infrastructure improvements and river restoration, among others. The funding provided by CWCB through the WSRA has been integral in assisting the Basin to address water needs.

The RGBRT recognizes the value of the BIP as a means to characterize the Basin's agricultural, municipal, industrial, environmental, recreational, and water administration needs and to identify multi-purpose projects that help meet these water needs.

1.3 : ORGANIZATION OF THE BASIN IMPLEMENTATION PLAN - VOLUME 2

Volume 1 of the BIP is an action-oriented document focused on the Basin's current and potential future water challenges and details the projects and strategies the Basin will employ to help meet these challenges. **Volume 2** of the BIP provides background information on the Basin, including the history of water development and water administration, and is organized in the following manner:

Section 1: Introduction. The introduction describes Colorado's Water Plan process and the role of the RGBRT. This section also describes the organization of this Plan.

Section 2: Basin Overview. A general description of the Basin, including geography, land ownership, history of the San Luis Valley, and Basin economy is included in Section 2. This section is intended as a reference guide, with background and supporting information to the BIP. It describes:

- Surface and groundwater resources
- History of water development, including the reservoirs, canals, and well development
- Timeline of the history of water development
- Water rights administration, including the Rio Grande Compact and surface and groundwater administration
- Existing environmental and recreational attributes

Section 3: Rio Grande Basin Goals

Section 4: Basin Water Needs. The Basin's agricultural, municipal and industrial, environmental and recreational, and water administration needs are described in Section 3.

Section 5: Constraints and Opportunities. Section 4 identifies the constraints that limit the ability of the Basin to meet the needs identified in Section 3. This section also discusses opportunities to address the constraints.

Section 6: Path Forward. Section 5 describes the next steps in the implementation of the BIP.

Homesite along Rio Grande in Antelope Park. Photo © Adriel Heisey / www.adrielheisey.com

Ranches and hayfields along the Rio Grande above Del Norte. Photo © Adriel Heisey / www.adrielheisey.com

2 BASIN OVERVIEW

2.1 : BASIN BACKGROUND

The upper Rio Grande Basin in south central Colorado encompasses roughly 7.2% of the state's land (approximately 7,500 square miles). Its borders are defined by the Colorado–New Mexico state line on the south, the La Garita range on the north, the San Juan Mountains and Continental Divide on the west, and the Sangre de Cristo and the Culebra mountains on the east. Snowmelt runoff and summer storms are the main contributors of water supply to the headwaters in the surrounding mountains. Streams and rivers deliver water from the mountains to the San Luis Valley (the Valley). With an average elevation of 7,500 feet, the Valley floor receives an average of less than eight inches of precipitation per year.

Flowering potato plant. Photo: Julie Messick

Basinwide, there is significantly more public land than private land, with the majority of the streams' headwaters in the Rio Grande National Forest (RGNF). In contrast, the majority of the land on the Valley floor is privately owned. In addition to other crops, the Valley has the second-largest production of potatoes in the United States. Areas in the Valley that are not irrigated are mostly classified as shrubland (24%) and grassland (31%). The San Juan, La Garita, and Sangre de Cristo mountain ranges are largely forested.

The existence of the Valley was known to European explorers since the Spanish settled what is now New Mexico in the 1590s, but it was largely ignored due to its isolation and relatively inhospitable environment. At that time, it was a land frequented by various nomadic Indian groups and was of little obvious benefit to settlers. Among the first explorers into the Valley was Diego de Vargas, who entered the region as a show of force, following his defeat of the Pueblo Indians at Santa Fe in 1692. In the early 1800s, fur trappers began passing through the

FIGURE 1.

Map of Rio Grande Basin geography.

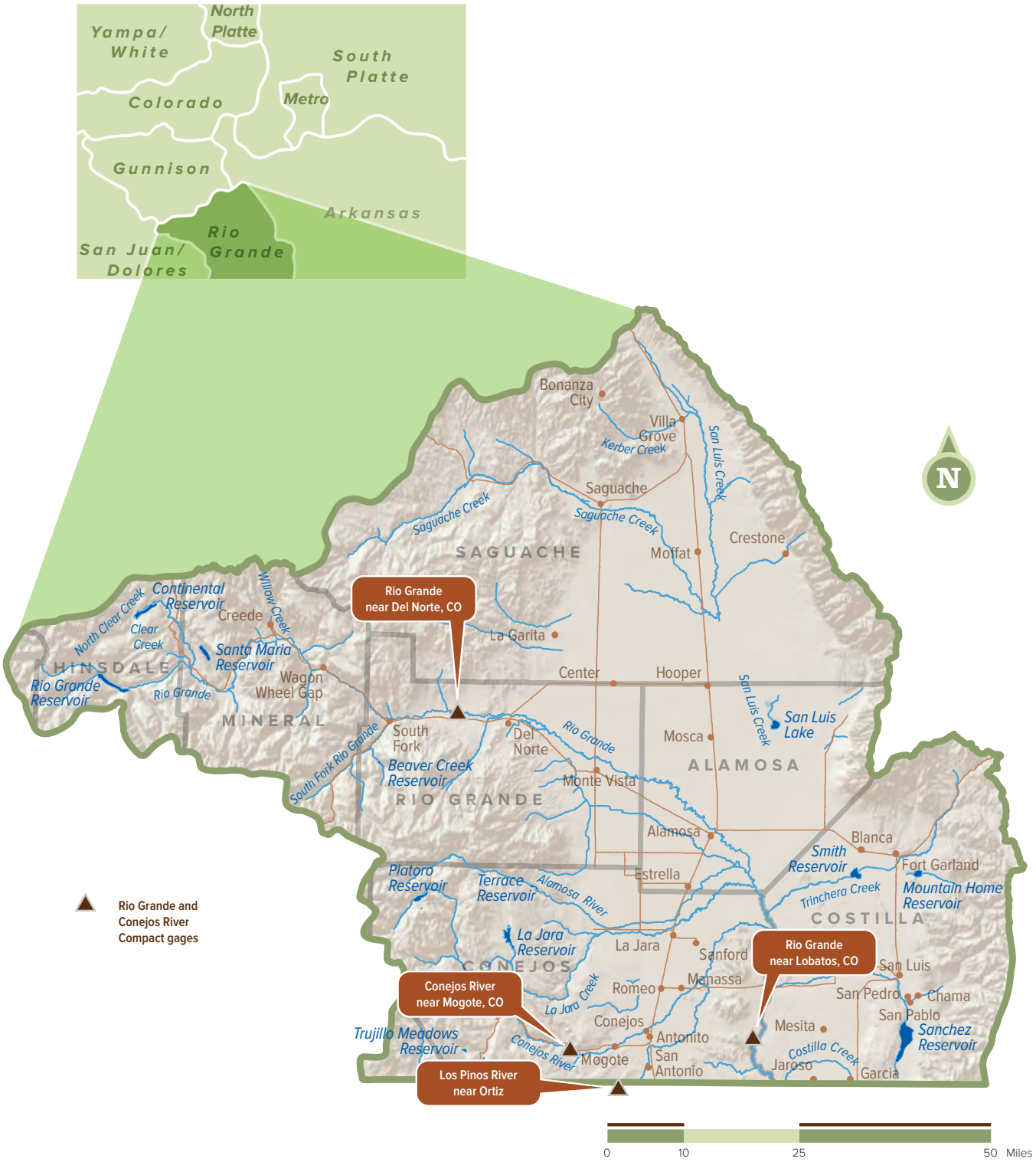


FIGURE 2.

Location and ownership of public lands in the Rio Grande Basin.

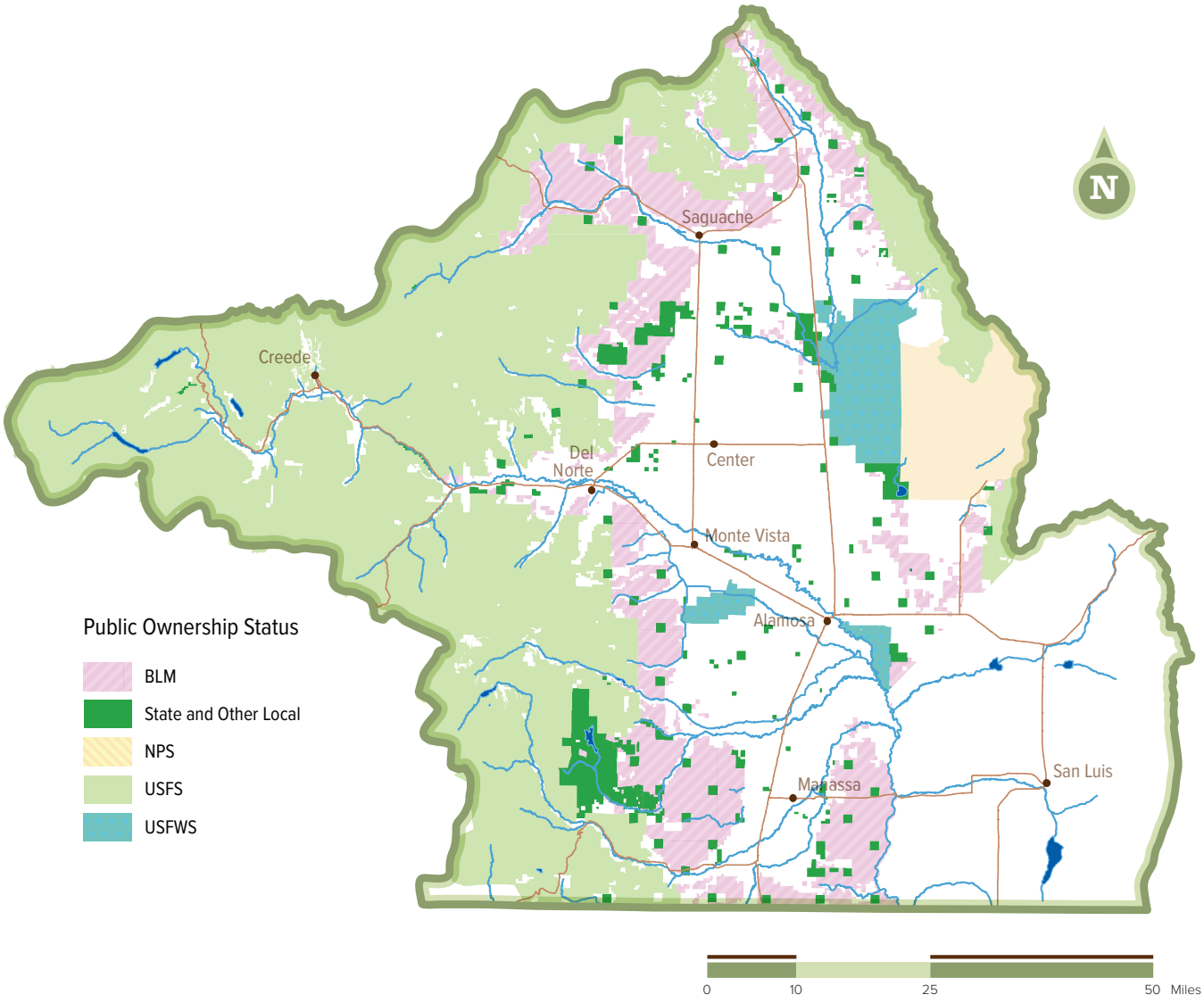


TABLE 1.

Public and private land ownership in the Rio Grande Basin.

Entity	On Fig 2.	Total Area (acres)	Percent of Public Lands	Percent of Total Basin land
Private	-	2,079,235	-	43%
Bureau of Land Management	BLM	499,987	18%	10%
National Park Service (NPS)	NPS	136,766	5%	3%
Rio Grande National Forest	USFS	1,833,316	67%	38%
State of Colorado	State and Other Local	162,424	6%	3%
US Fish and Wildlife Service	USFWS	112,277	4%	2%

Source: Public lands layer from U.S. Fish and Wildlife Service. (The original data set consisted of a merge of 56 Colorado 1:100,000-scale land-ownership maps that were digitized at the USFWS. The hardcopy maps/source materials were provided to the USFWS by the BLM Colorado State Office.)

Valley on their way west to the San Juan Mountains. In 1803, the Louisiana Purchase gave the United States control over vast areas of the West, including parts of Colorado, but not the Rio Grande Basin. In late 1806, under an order from President Thomas Jefferson to explore the Rocky Mountains near Spanish territory, Lieutenant Zebulon Pike and his men entered the Valley, where they set up camp for the winter. In February of 1807, Pike and his men were arrested by the Spaniards for trespassing and taken to Mexico. They were released and returned to the United States in 1810.

Pike was the last recorded explorer in the Valley until 1848. After the Rio Grande Basin became part of the United States territory, John C. Fremont came in search of a rail route through the Rockies. Fremont was followed in 1853 by John Gunnison, who also in search of a rail route. In the 1870s, explorer and surveyor Ferdinand V. Hayden came to Colorado to map the unexplored regions of the territory. His journey took him through the Valley (Simonds n.d.).

By the 1850s, Hispanic settlers from what is now New Mexico had migrated into the Valley to establish small plazas within land grants issued by the New Mexican governor in Santa Fe. These pioneers gave birth to the permanent settling of Colorado, which started in San Luis, Colorado's oldest town (established in 1851).

Nearly 160 years after founding the first permanent settlements in the Valley, today's Hispanic residents retain many of the cultural traits of their forbearers. In three Basin counties, one in three households speak a language other than English, while that figure is one in two in Costilla County. The systems of acequias, or community water systems founded by Hispanic settlers, remain in operation throughout the southern portion of the Basin.

Settlers and immigrants from around the world came to the Basin following the Homestead Act of 1862 and establishment of the railroad. Many put down roots on ranches and farms, setting the stage for the Basin's way of life today. Mormon settlers found a home in the Basin toward the end of the 1870s; their initial settlements at Manassa and Sanford near the Conejos River remain agriculture-based communities. Japanese-Americans from California were drawn to the Basin in the 1920s to grow lettuce, spinach, cauliflower, and carrots, mainly in Conejos and Costilla counties.

The Sangre de Cristo National Heritage Area, designated by the federal Omnibus Public Land Management Act of 2009, encompasses more than 3,000 square miles spanning across Conejos, Costilla, and Alamosa counties. The area contains impressive historic, cultural, and natural treasures. Visitors to this heritage area have the opportunity to experience history in San Luis and impressive natural splendor at the Great Sand Dunes National Park and Preserve. The area includes over 20 cultural properties listed in the National Register of Historic Places (U.S. Department of the Interior, National Park Service n.d.).

2.2 : ECONOMY

Agriculture is the primary economic driver in the Basin, with roughly 515,300 acres of irrigated land. In 2015 alone, the estimated production value of the Valley's top three crops – potatoes, alfalfa and barley – was over $357 million (San Luis Valley Development Resource Group 2019). Agriculture is also the largest source of base jobs in the Valley, accounting for 29% of the Valley's workforce (State of Colorado, Department of Local Affairs, Planning and Management 2017).

Hay is grown in all of the counties that support agriculture (Alamosa, Conejos, Costilla, Rio Grande, and Saguache), with Conejos County being the largest producer. According to United States Department of Agriculture (USDA) statistics the average price of grass hay in the Valley decreased by 20% from 2012 to 2017 and revenue from hay fell by 40%. Prices and production of potatoes in the San Luis Valley showed much less variability between 2012 and 2017, only decreasing slightly in the Valley.

Potato harvest in the San Luis Valley. Photo: Julie Messick

A comparison summary of the total tons produced, acres harvested, total revenue, and gross revenue per ton and acre is shown in Table 2. The gross revenue of all crops included below decreased between 2012 and 2017. This decrease in revenue is likely due in part to the unusually high hay prices in 2012, as a result of the Western U.S. drought. Potatoes grown in the Valley can generate five to ten times the gross revenue per ton of water consumed compared to that of alfalfa. However, potatoes are not a suitable crop in all areas and soil types of the Valley.

TABLE 2. Production and revenue by major crop grown in the San Luis Valley.

	Alfalfa Hay		Grass Hay		Potatoes		Barley		Other Crops (wheat, canola, and oats)	
	2012	2017	2012	2017	2012	2017	2012	2017	2012	2017
Total Tons Produced	458,763	564,120	202,000	141,564	999,000	985,079	120,668	150,742	28,399	22,381
Acres Harvested	136,311	160,874	105,000	80,577	54,000	51,900	44,185	54,199	12,842	11,439
Total Revenue	$94,505,178	$96,464,520	$41,814,000	$25,481,520	$189,810,000	$184,209,773	$27,029,632	$31,848,770	$8,501,544	$5,258,800
Gross Revenue/Ton	$206	$171	$207	$180	$190	$187	$224	$211	$398 (avg.)	$270 (avg.)
Gross Revenue/Acre	$693	$600	$398	$316	$3,515	$3,549	$612	$588	N/A	N/A

Sources: 2017 Colorado Agriculture Census, U.S. Department of Agriculture, Colorado Potato Administration Committee

Fishing on the Rio Grande.
Photo: Rio de la Vista

Regarding inhabitants, the Basin's population overall is currently 46,000 and could increase to approximately 67,000 by 2050, according to population projections discussed in **Volume 1**. Alternatively, the Basin's population could decrease to as few as 42,270. More on population and municipal and industrial demand, supply, and potential water needs can be found in **Volume 1 Section 5**.

The Basin has a thriving tourism industry, much of which is water-dependent, and accounts for 11% of employment in the area. Popular recreational activities include angling, hunting, wildlife and bird watching, winter sports, camping, rafting, paddling, and boating activities — all of which depend on adequate and healthy water resources. The Basin's two million acres of public land — which includes the RGNF, Great Sand Dunes National Park and Preserve, several wilderness areas, wildlife areas and refuges, and the Wolf Creek Ski Area — attract hundreds of thousands of visitors annually. A study conducted by Business for Water Stewardship showed that water-based outdoor recreation contributed $476.5 million dollars to the Basin's economy and resulted in 3,332 jobs, as shown in Table 3 (Business for Water Stewardship 2020). A survey during the 2020 spring sandhill crane migration

showed that the sandhill crane viewing contributed nearly $3.5 million to the local economy, including $118,000 in local taxes (Ciaglo 2021).

TABLE 3. Economic contributions of water-based recreation in the Rio Grande Basin.

Participants (thousands)	Jobs	Output (millions)	GDP (millions)	Wages (millions)	Tax revenue (millions)
623.5	3,332	$476.50	$260.4	$158.8	$69.1

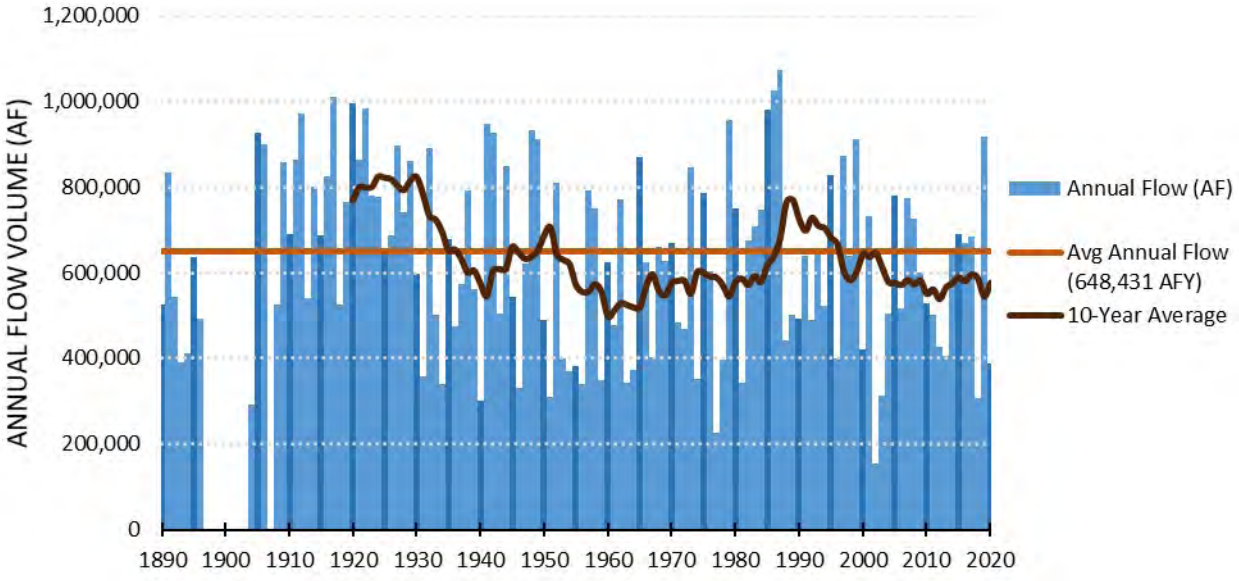
Source: Business for Water Stewardship 2020

Boating the Rio Grande at Lobatos Bridge. Photo: Bethany Howell

2.3 : SURFACE WATER HYDROLOGY AND GROUNDWATER RESOURCES

The Basin experiences highly variable seasonal and year-to-year fluctuations in streamflow. Streams and rivers are fed primarily by snowmelt runoff. To a lesser extent, summer monsoons contribute to regional streamflow. Snowmelt generally begins in late March, with a peak in late May or June. Summer thunderstorms typically last only hours, but can cause dramatic spikes in streamflow rates. A relatively small amount of snowmelt runoff is captured

FIGURE 3. Annual streamflow at the Rio Grande near Del Norte gage from 1890-2020.

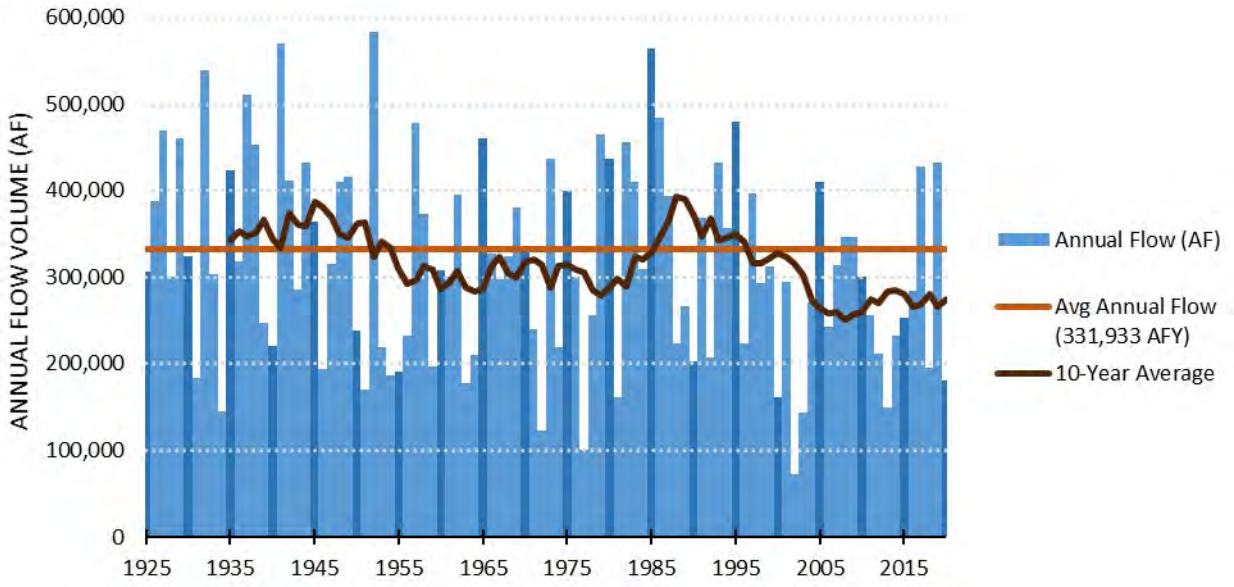


Source: Division of Water Resources 2021

FIGURE 4.

Annual streamflow at the Conejos River Index gages from 1926-2020.

(Conejos River near Mogote, Los Pinos River near Ortiz, and San Antonio River at Ortiz)



Source: Division of Water Resources 2021

in reservoirs located throughout the Basin, to be released later in the season when the water is needed by irrigators. For the most part, water users' surface water diversions for irrigation are dictated by the river flows.

Annual flows of the Rio Grande, which are measured at the Del Norte stream gage, range historically from a high of 1.1 million AF in 1987 to a low of 164,000 AF in 2002, as shown in Figure 3. Flows in the Conejos River system, which are totaled at three stream gages, Conejos near Mogote, Los Pinos, and San Antonio (the Conejos index gages), also vary greatly, as shown in Figure 4. Between 1926 and 2020, the largest flow of the combined Conejos index gages was 583,000 AF in 1952, and the smallest flow was 73,000 AF in 2002, almost an eight-fold difference. Over the last 75 years, the 10-year running average peaked in 1987 for both the Rio Grande main stem and Conejos River, followed by a steady 25-year decline that has continued until present day.

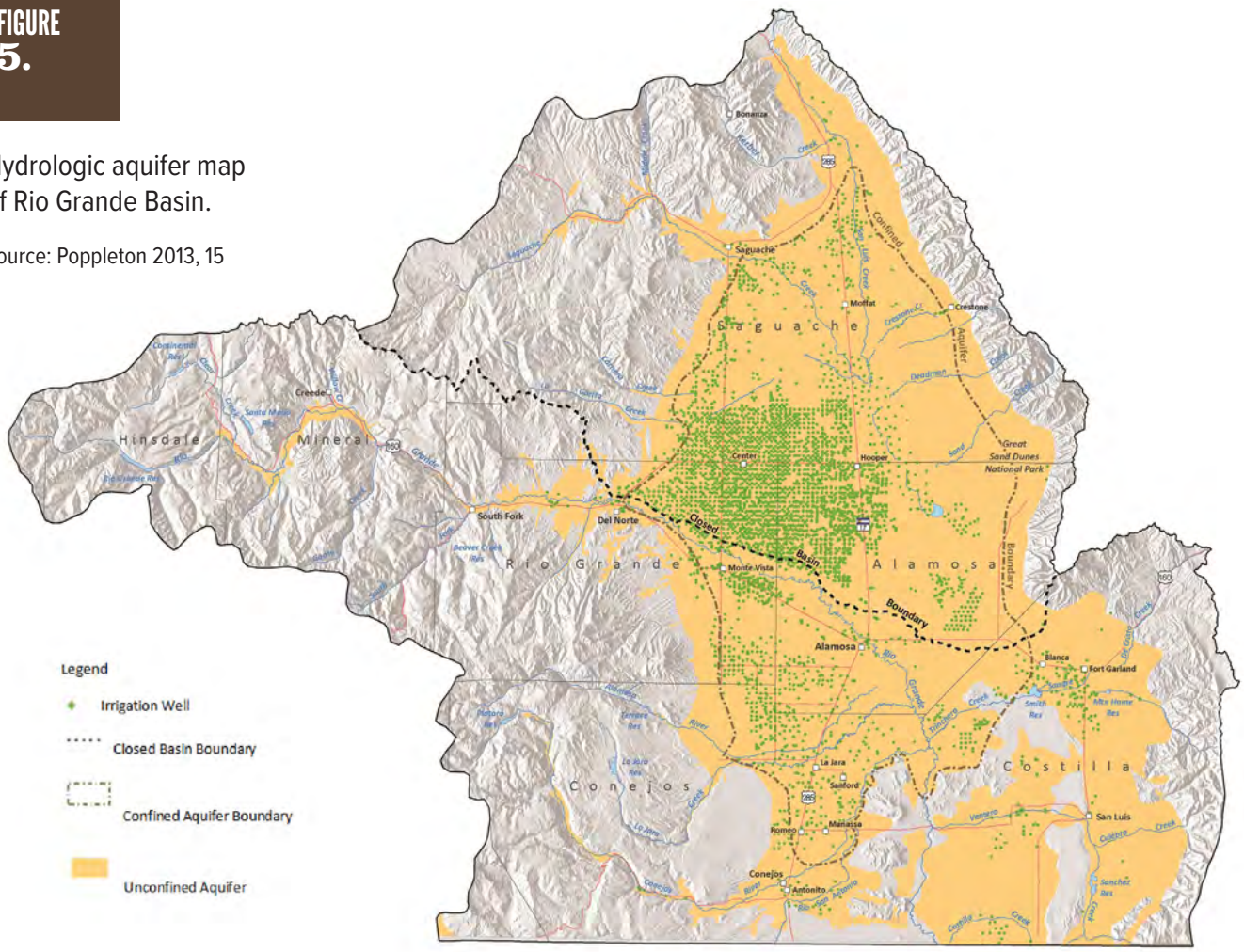
In addition to diversions from rivers and streams, water users draw on two stacked aquifers, known as the "unconfined" and "confined" aquifers. The uppermost aquifer, the unconfined, ranges in thickness from 30–100 feet throughout the Valley and is recharged by precipitation, streams, canal leakage, and return flows from irrigation.

The larger, deeper confined aquifer is separated from the unconfined aquifer by a series of blue clay and basalt layers, and is under artesian pressure. The confined aquifer extends several thousand feet below the surface and is primarily recharged by flows at the rim of the Valley, in areas without basalt or blue clay barriers.

FIGURE 5.

Hydrologic aquifer map of Rio Grande Basin.

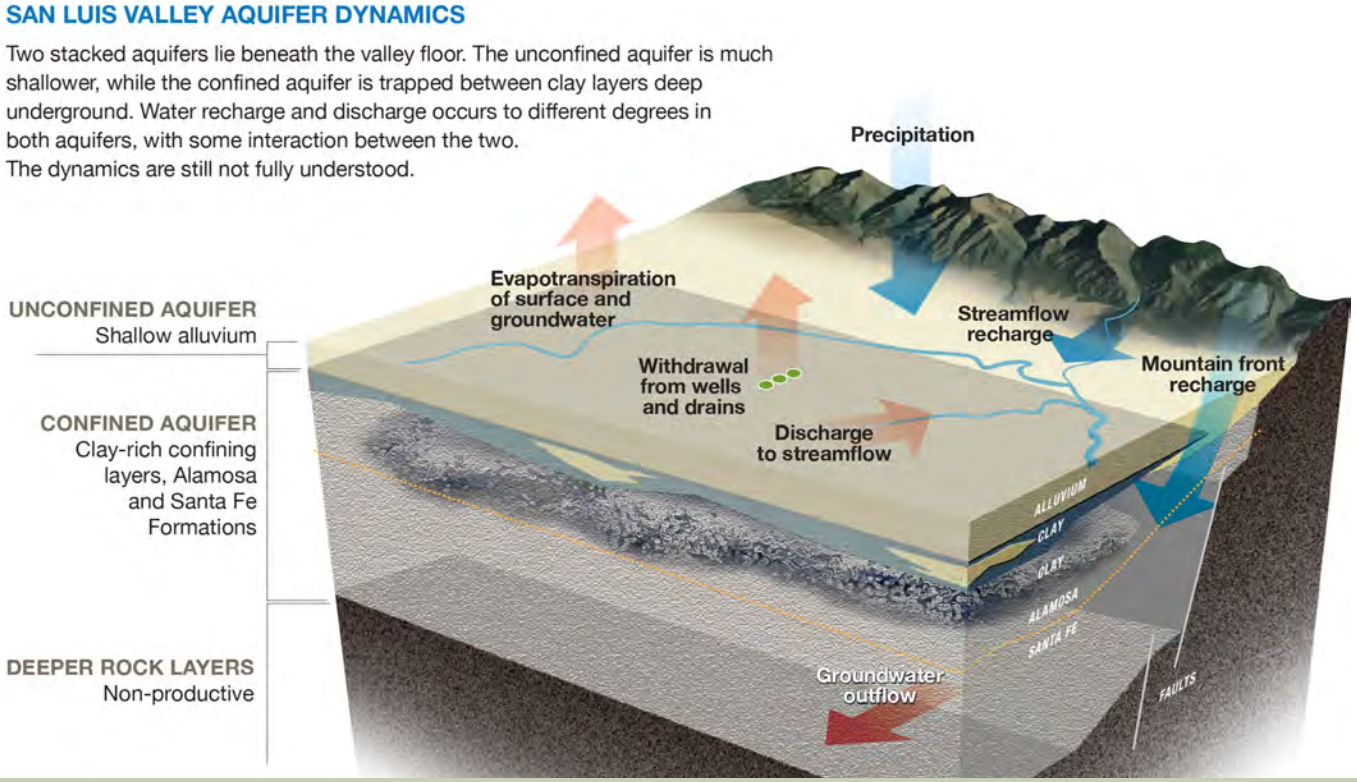
Source: Poppleton 2013, 15



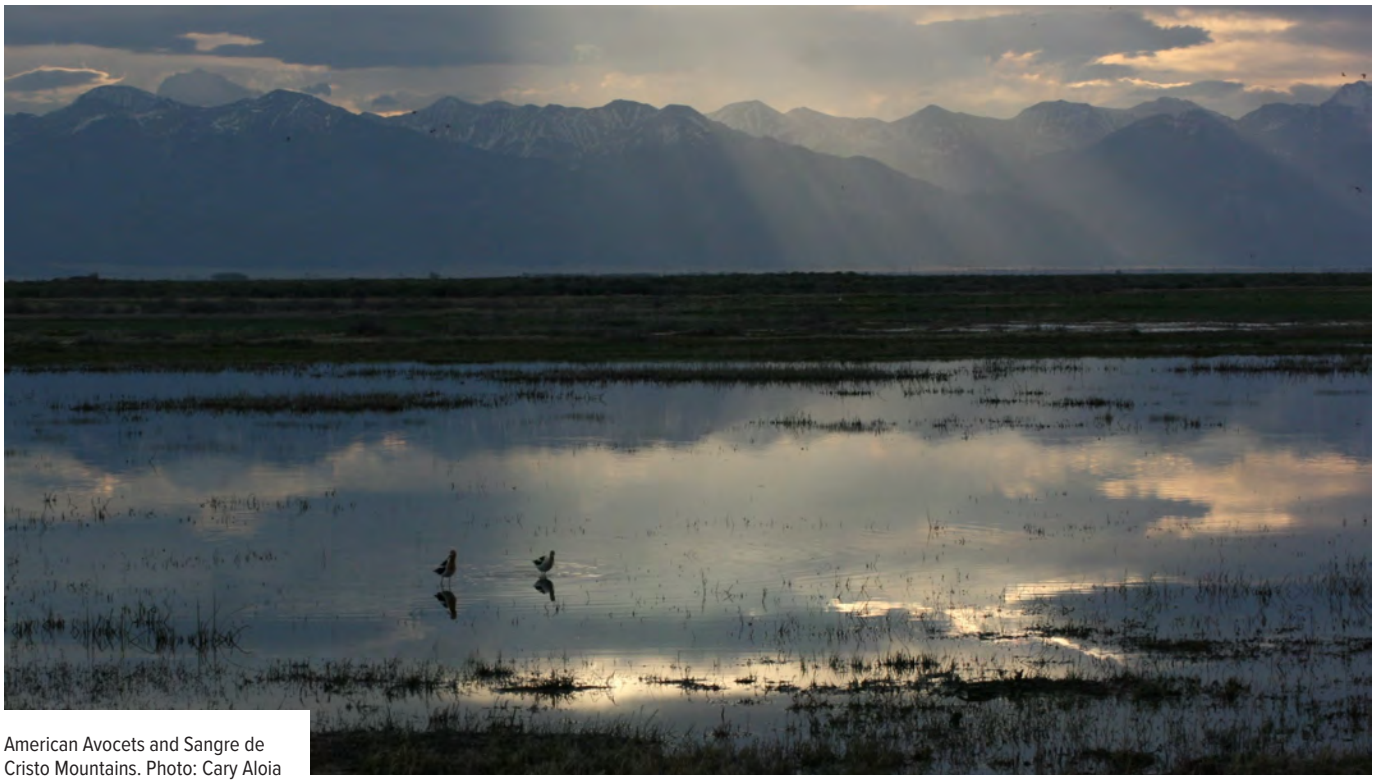
Conejos River west of Antonito, Colorado. Photo © Adriel Heisey / www.adrielheisey.com

FIGURE 6.

Depiction of San Luis Valley aquifer dynamics, including mechanisms of inflows and outflows.

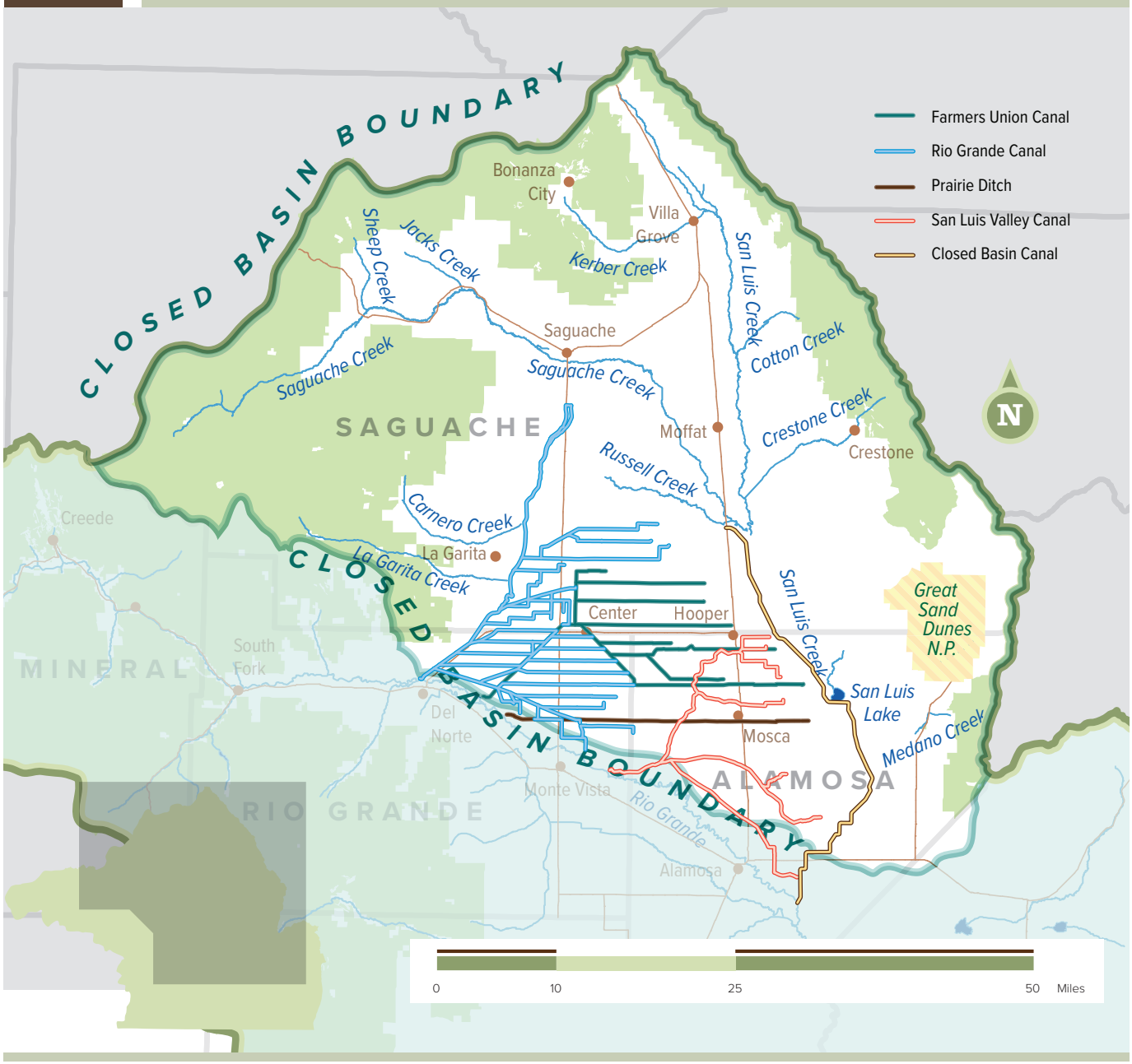


Source: Smith 2013, 25



American Avocets and Sangre de Cristo Mountains. Photo: Cary Aloia

FIGURE 7. Map of Closed Basin area and associated canals.



The general location of the unconfined and confined aquifers is shown in Figure 5. A schematic showing the dynamics of the unconfined and confined aquifers is shown in Figure 6. This figure depicts the general water balance of the aquifers. One additional source of recharge to the unconfined aquifer that is not shown in Figure 6 is return flows from irrigation.

The northern one-third of the basin is a "Closed Basin" (Figure 7) that does not have a natural outlet to the Rio Grande. A hydraulic divide that parallels the Rio Grande from Del Norte to Alamosa one to three miles north of the river provides a buffer between groundwater that is tributary to the Rio Grande and groundwater in the Closed Basin. The extent of the hydraulic divide is the subject of much study and is of great importance with respect to groundwater administration. Although the hydrologic divide prevents surface water from naturally

flowing from the Closed Basin to the Rio Grande, water is transported via the Bureau of Reclamation's (BOR) Closed Basin Project, as described in detail in **Section 2.4.3.2, Closed Basin Project**. The Closed Basin Project obtains its water from the salvaged unconfined aquifer groundwater within the Closed Basin and delivers that water to the Rio Grande via a 42-mile conveyance channel, as shown in Figure 7.

2.4 : HISTORY OF WATER DEVELOPMENT

The Basin has a rich history of water development, with many of the oldest adjudicated water rights in Colorado. The Basin's water development history ranges from the surface water development via canals, ditches, and reservoirs to groundwater development of the unconfined and confined aquifers.

2.4.1 : CANALS AND DITCHES

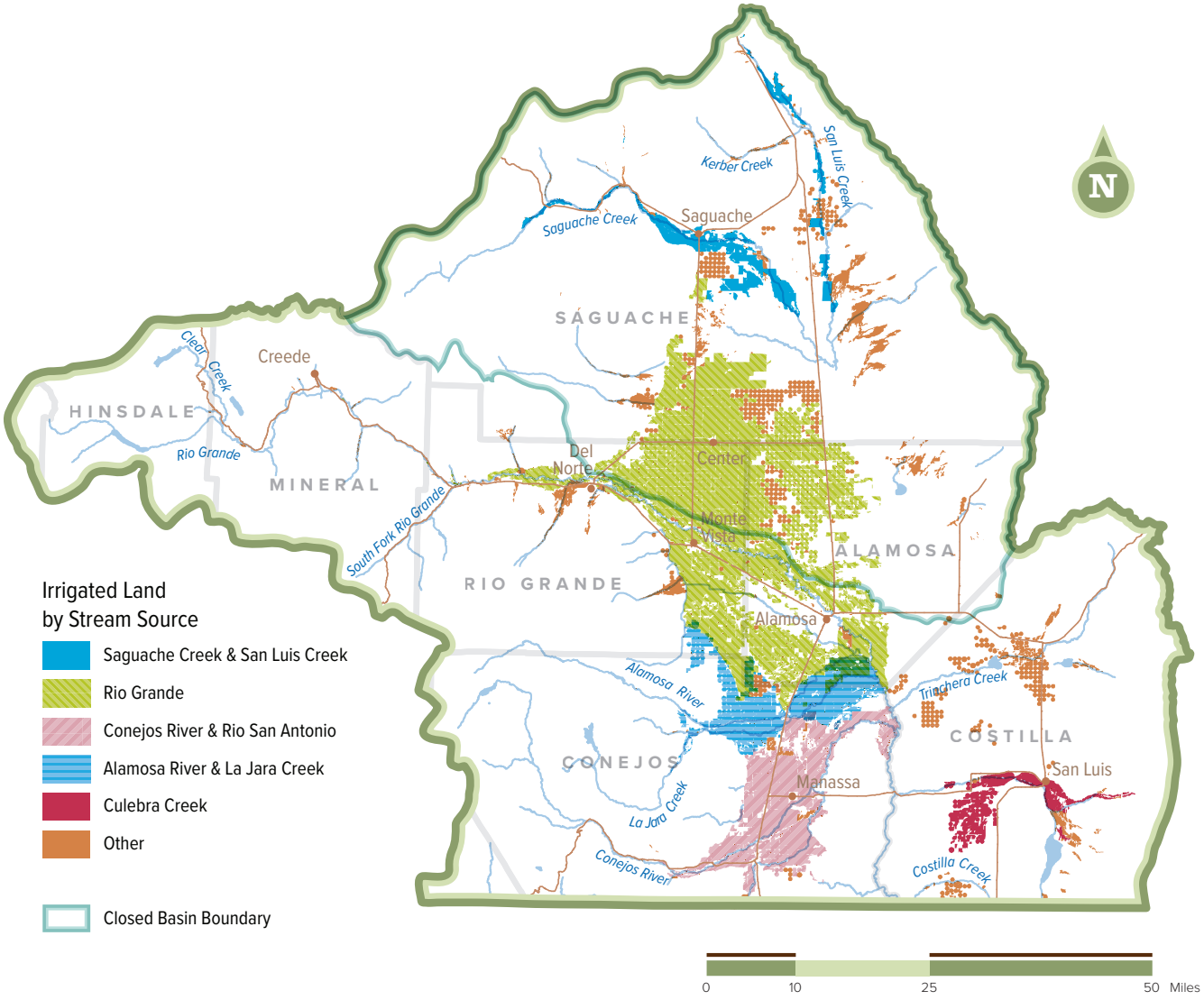
Hispanics from New Mexico settled along the Conejos and Culebra rivers in the 1850s and almost immediately began to develop community water systems known as acequias. Colorado's first surface water right, appropriated in the Basin in 1852, is the People's Ditch near San Luis, which diverts water from Culebra Creek. In 1855, the first diversion from the Conejos River occurred via the Guadalupe Ditch. The first diversion from the Rio Grande main stem occurred in 1866 at the Silva Ditch. By 1870, nearly 50,000 acres in the Basin were irrigated by canals and ditches.

A new wave of settlement and water development occurred in the 1870s. The Denver and Rio Grande Railroad was extended to the Valley in 1879. Over the next 15 years, the number of acres under irrigation rose to nearly 400,000 due to a canal building boom and the construction of nearly 2,000 artesian wells (San Luis Valley Advisory Committee 2013). By 1900, the Basin's streams were over-appropriated, meaning there were more water rights claims

Senior water rights irrigate the conserved Gilmore Ranch, along the Rio Grande west of Alamosa. Photo: Rio de la Vista

FIGURE 8.

Map of service areas of canals and ditches in the San Luis Valley.



than actual available water to satisfy these claims. This led to a recognition of the need to construct reservoirs to capture winter and high flows during runoff. Intense irrigation development continued until there were nearly 700,000 irrigated acres by the 1930s. Today the canals and ditches provide water for farms and ranches, along with wetlands, wildlife areas, and municipal and industrial uses. The areas that can be served by the canals and ditches are shown in Figure 8.

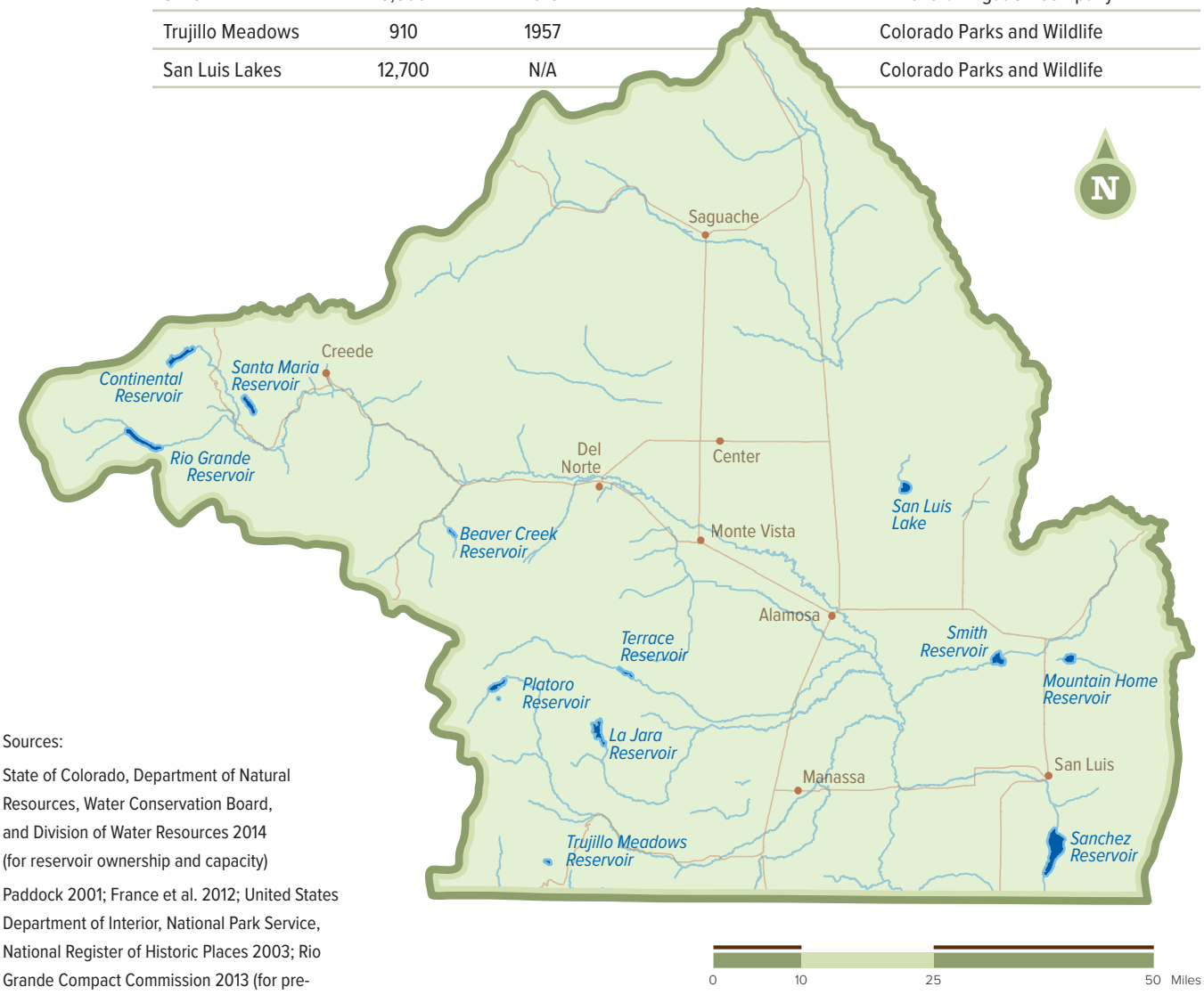
2.4.2 : RESERVOIRS

Basin water users suffered a major setback in the development of water supplies for irrigation in 1896, when the U.S. Secretary of the Interior imposed an embargo on the use of federal rights-of-way for development of water diversion, conveyance, and reservoir facilities on the Rio Grande in Colorado and New Mexico. The embargo, which was prompted by efforts to negotiate a water-use treaty with Mexico, saw certain terms

FIGURE 9.

Major Rio Grande Reservoirs.

Reservoir Name	Capacity (AF)	Year Built	Pre–Compact Reservoir	Ownership
Continental	22,680	1928	X	Santa Maria Reservoir Company
Santa Maria	43,800	1913	X	Santa Maria Reservoir Company
Rio Grande	52,000	1912	X	San Luis Valley Irrigation District
Beaver Park	4,758	1914	X	Colorado Parks and Wildlife
La Jara	14,060	1910	X	Colorado Parks and Wildlife
Mountain Home	17,370	1908	X	Trinchera Irrigation Company
Platoro	59,570	1951		Bureau of Reclamation/CWCD
Sanchez	103,100	1911	X	Sanchez Ditch and Reservoir Company
Terrace	15,180	1912	X	Terrace Reservoir Company
Smith	5,800	1913	X	Trinchera Irrigation Company
Trujillo Meadows	910	1957		Colorado Parks and Wildlife
San Luis Lakes	12,700	N/A		Colorado Parks and Wildlife



Sources:

State of Colorado, Department of Natural Resources, Water Conservation Board, and Division of Water Resources 2014 (for reservoir ownership and capacity)

Paddock 2001; France et al. 2012; United States Department of Interior, National Park Service, National Register of Historic Places 2003; Rio Grande Compact Commission 2013 (for pre-Compact reservoir designation and year built)

relaxed in 1907 and fully lifted in 1925. The relaxing of the embargo in 1907 allowed the completion of several reservoirs in the Basin in Colorado. Several other reservoirs were completed after the embargo was lifted in 1925. These reservoirs include Sanchez, Rio Grande, Santa Maria, Continental, Mountain Home, Terrace, La Jara, and other smaller structures.

Artesian well on Dutton Ranch, near Alamosa. Source: Allen Davey

2.4.3 : GROUNDWATER DEVELOPMENT

Groundwater development in the Valley began with the discovery of the confined aquifer in 1887. By 1891, there were an estimated 2,000 flowing wells in the Valley; by 1904, there were 3,234 flowing wells; and by 1916, there were approximately 5,000 flowing wells in the Valley. That number increased to 6,074 flowing wells by 1936 and to an estimated 7,500 flowing wells by 1958.

Significant development of the groundwater from the unconfined aquifer for irrigation did not begin until the 1930s. While the first irrigation well in the unconfined aquifer was constructed in 1903, there was little or no further development of the unconfined aquifer for irrigation purposes for the next 25 years. The number of wells withdrawing water from the unconfined aquifer increased from 176 in 1936 to approximately 1,300 wells in 1952 and is several times that number today.

Well construction in both the confined and the unconfined aquifers continued until 1972, when the State Engineer imposed a moratorium on the issuance of well permits for new appropriations of groundwater from the confined aquifer and from the unconfined aquifer outside of the Closed Basin. In 1981, the State Engineer imposed a moratorium on the issuance of well permits for new appropriations from the unconfined aquifer in the Closed Basin, effectively ending new appropriations of groundwater in the Valley. In 2003 (revised 2016), the State Engineer issued a policy that declined the issuance of permits to deepen existing wells, to drill supplemental wells, or to drill alternate points of diversion for wells, without the applicant first obtaining a judicial confirmation of the absence of material injury to third parties. The purpose of this policy was to prevent enlarged use of groundwater rights but it has recently been relaxed, allowing some well owners to construct supplemental wells to obtain their full decreed amount of groundwater provided the historical use of the well(s) is not enlarged.

2.4.3.1 CONJUNCTIVE USE OF SURFACE WATER AND GROUNDWATER

Prior to the advent of high-capacity pumps and sprinkler systems, the predominate methods of irrigation were surface application through “flood” irrigating and subirrigating. These methods of irrigation caused the groundwater to build up to within one to three feet of the surface, and water was then allowed to run slowly through small ditches spaced about 16 feet apart. Water from these ditches seeped outward, supplying moisture to the plants. However, this method resulted in over-diversion during the spring snow melt runoff, unduly high water tables, and excessive evaporation and transpiration losses.

In the Closed Basin, the effect of this practice was essentially to create an "artificial" aquifer. With continued large diversions from the Rio Grande via irrigation canals and ditches to the porous and shallow soils in the Closed Basin, the underground basin filled rapidly; the water table rose from depths ranging from 40 feet on the east and 100 feet on the west to a position practically at the surface on the east, bordering the sump, and to a level within 10 to 15 feet of the surface on the west. As a result, much, but not all, of the water in the unconfined aquifer of the Closed Basin resulted from diversions from the Rio Grande.

Because of declining aquifer levels, continued pumping is dependent on compliance with groundwater withdrawal rules.

The practice of subirrigation, however, was not without its drawbacks or its critics. A serious condition soon complicated the situation. It was brought about by the rise in groundwater levels to such an extent that lands in the lower parts of the Valley were becoming seeped, forcing abandonment of acreages along the eastern side of the Closed Basin, with concomitant substitution of lands farther west. This gradual process of abandonment at the east and extension westward continued until it reached the extreme west side of the Valley, while the broad stretches of once-occupied lands to the east were left to revert to their natural state, badly damaged by alkali.

Crop water demands typically continue after the peak surface water flows and diversions have ceased. The use of the unconfined aquifer as a storage reservoir through the practice of subirrigation helped solve the water supply timing problem that otherwise could only be addressed with the Valley's limited reservoir storage. Because the practice of subirrigation maintained an underground water reservoir, water was available to the crops for an extended period.

A combination of factors worked to render subirrigation unfeasible. An extended period of low-water years, the imposition of curtailments on diversions from the Rio Grande to comply with the Rio Grande Compact (see Section 2.5.1), and the development of pumps to extract huge quantities of groundwater were all factors contributing to a lowering of the groundwater table in the Closed Basin area, in turn eliminating the use of subirrigation.

The increased use of wells drilled into the underground aquifers became an important part of the economy of the Closed Basin, and the advent of center pivot sprinklers once again changed the irrigation practices in the Basin. While the earliest use of center pivot sprinkler systems occurred in the Closed Basin area north of the Rio Grande, they are now used throughout the Valley. Sprinkler irrigation is more efficient than flood irrigation, has increased the yield of crops, and reduced losses. Because of declining aquifer levels, continued pumping is dependent on compliance with groundwater withdrawal rules. Just as they have in the past, landowners import water into the Closed Basin from the Rio Grande and use it to recharge the underground aquifers, in effect using these aquifers as storage facilities.

In addition, some farmers use both surface water and groundwater in their sprinkler systems. It is not uncommon to deliver surface water to center pivot sprinklers and use groundwater to supplement the surface water supply in

times of shortage. These practices of conjunctive use of surface water and groundwater are common in much of the Valley, with groundwater recharge being practiced most extensively in the Closed Basin area north of the Rio Grande.

2.4.3.2 CLOSED BASIN PROJECT

When subirrigation practices were still common practice, drains were constructed to carry excess groundwater away from the irrigated lands, returning some water to the Rio Grande. Much of the excess water in the Closed Basin flowed to the sump area on the east side of the Closed Basin and was lost to evaporation and transpiration by native vegetation. Thus, for many years, water users in the Valley discussed the construction of a large open drain to lower water levels in the sump area and return the water to the Rio Grande. This water would have been considered new water that would allow increased consumption of Rio Grande flows in Colorado under both the 1929 Temporary Compact and the Rio Grande Compact (the Compact). As a consequence, Article III of the Compact provides that if water is imported into the Rio Grande from the Closed Basin, Colorado will receive credit for the water as long as the water meets specific total dissolved solids thresholds.

The Closed Basin Project (the Project) is a federal reclamation project that was envisioned prior to 1929, was authorized by the U.S. Congress in 1972, and constructed by the BOR. The project is designed to salvage shallow groundwater from the sump area of the Closed Basin and to deliver that water to the Rio Grande. The project was sponsored and is currently administered by the Rio Grande Water Conservation District (RGWCD). The decree approving the Project authorized diversion of up to 117,000 acre-feet annually for Project priorities and the other authorized uses. The Project consists of 110 wells in the unconfined aquifer, which pump water into a canal for conveyance to the Rio Grande. The Project discharges water into the Rio Grande above its confluence with Trinchera Creek. Water has been available from the Project since 1988. The annual yield from the Project has not met the initial expectations; in recent years, it has produced approximately 14,000 acre-feet, or approximately 13% of the initial projected yield.

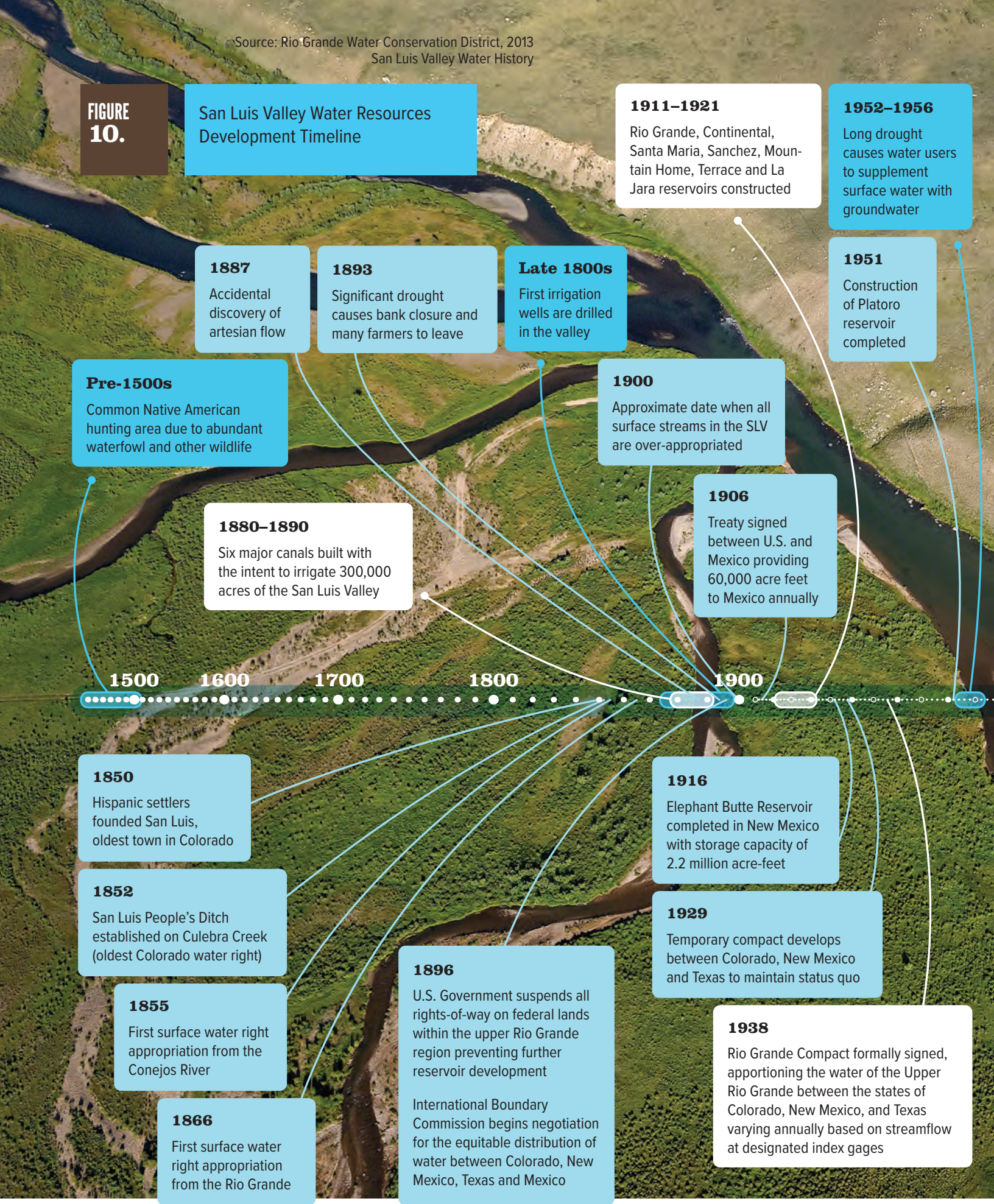
The allocation of the yield of the Closed Basin Project is a central part of current water supply administration in the Valley. Through agreement among major water user groups, the production from the Closed Basin Project was allocated 60% to the Rio Grande and 40% to the Conejos River. This agreement is intended to address, in part, the problem of stream depletions caused by existing well production in the Valley. The allocation of the water between the two rivers mirrors the way in which the Rio Grande Compact allocates separate delivery obligations between the rivers. The allocation agreement has the effect of reducing the burden of curtailment of surface water rights to meet the obligations of the Compact and, hence, a potential reduction of total irrigated acreage.

2.4.4 : TIMELINE OF WATER DEVELOPMENT

The following timeline of water development (Figure 10) shows major events in the Basin. This timeline was developed using significant inputs from RGWCD publications.

Source: Rio Grande Water Conservation District, 2013
San Luis Valley Water History

FIGURE 10. San Luis Valley Water Resources Development Timeline



Pre-1500s
Common Native American hunting area due to abundant waterfowl and other wildlife

1850
Hispanic settlers founded San Luis, oldest town in Colorado

1852
San Luis People's Ditch established on Culebra Creek (oldest Colorado water right)

1855
First surface water right appropriation from the Conejos River

1866
First surface water right appropriation from the Rio Grande

1880–1890
Six major canals built with the intent to irrigate 300,000 acres of the San Luis Valley

1887
Accidental discovery of artesian flow

1893
Significant drought causes bank closure and many farmers to leave

Late 1800s
First irrigation wells are drilled in the valley

1896
U.S. Government suspends all rights-of-way on federal lands within the upper Rio Grande region preventing further reservoir development

International Boundary Commission begins negotiation for the equitable distribution of water between Colorado, New Mexico, Texas and Mexico

1900
Approximate date when all surface streams in the SLV are over-appropriated

1906
Treaty signed between U.S. and Mexico providing 60,000 acre feet to Mexico annually

1911–1921
Rio Grande, Continental, Santa Maria, Sanchez, Mountain Home, Terrace and La Jara reservoirs constructed

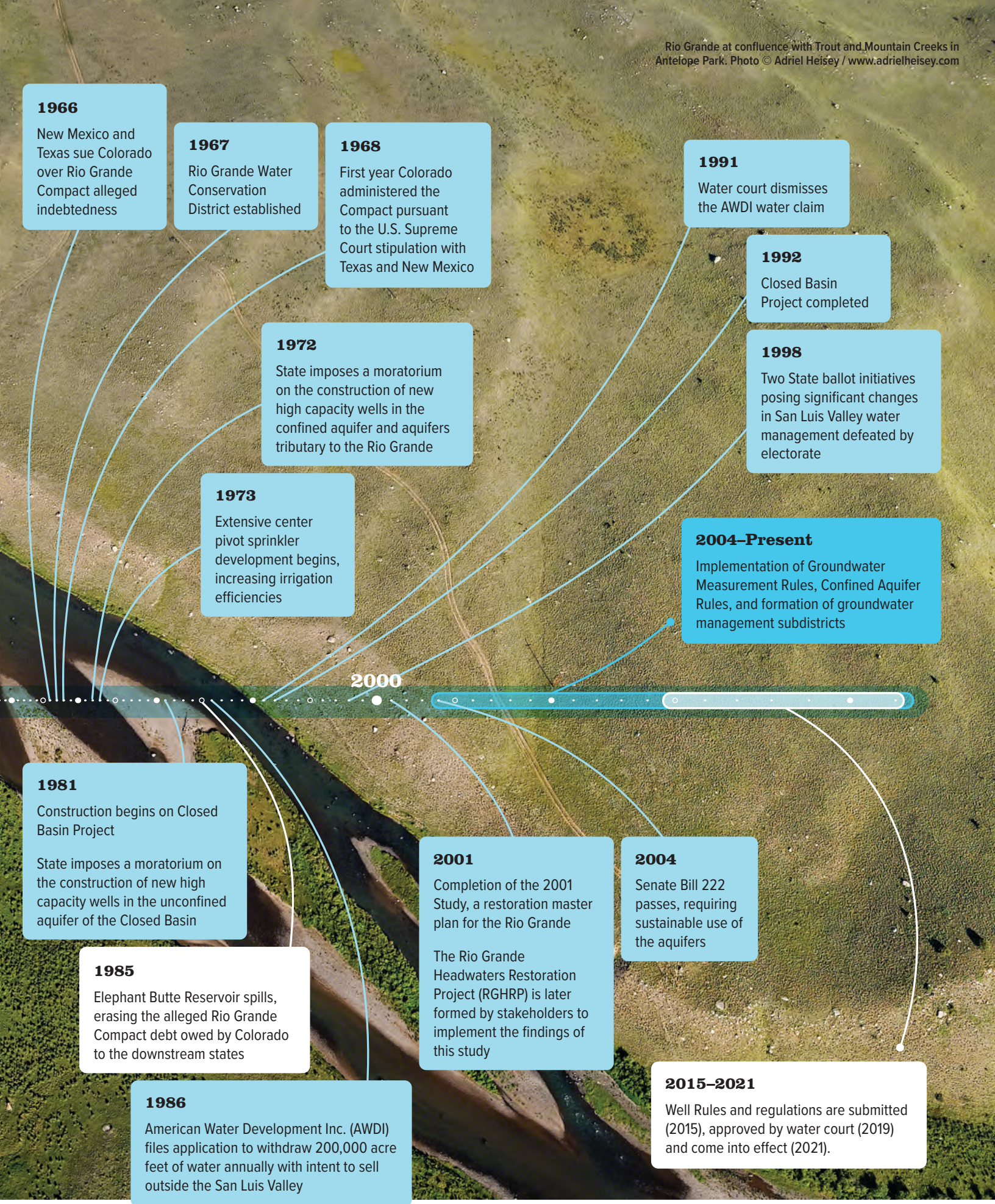
1916
Elephant Butte Reservoir completed in New Mexico with storage capacity of 2.2 million acre-feet

1929
Temporary compact develops between Colorado, New Mexico and Texas to maintain status quo

1938
Rio Grande Compact formally signed, apportioning the water of the Upper Rio Grande between the states of Colorado, New Mexico, and Texas varying annually based on streamflow at designated index gages

1951
Construction of Platoro reservoir completed

1952–1956
Long drought causes water users to supplement surface water with groundwater



Rio Grande at confluence with Trout and Mountain Creeks in Antelope Park. Photo © Adriel Heisey / www.adrielheisey.com

1966

New Mexico and Texas sue Colorado over Rio Grande Compact alleged indebtedness

1967

Rio Grande Water Conservation District established

1968

First year Colorado administered the Compact pursuant to the U.S. Supreme Court stipulation with Texas and New Mexico

1972

State imposes a moratorium on the construction of new high capacity wells in the confined aquifer and aquifers tributary to the Rio Grande

1973

Extensive center pivot sprinkler development begins, increasing irrigation efficiencies

1981

Construction begins on Closed Basin Project

State imposes a moratorium on the construction of new high capacity wells in the unconfined aquifer of the Closed Basin

1985

Elephant Butte Reservoir spills, erasing the alleged Rio Grande Compact debt owed by Colorado to the downstream states

1986

American Water Development Inc. (AWDI) files application to withdraw 200,000 acre feet of water annually with intent to sell outside the San Luis Valley

1991

Water court dismisses the AWDI water claim

1992

Closed Basin Project completed

1998

Two State ballot initiatives posing significant changes in San Luis Valley water management defeated by electorate

2000

2001

Completion of the 2001 Study, a restoration master plan for the Rio Grande

The Rio Grande Headwaters Restoration Project (RGHRP) is later formed by stakeholders to implement the findings of this study

2004

Senate Bill 222 passes, requiring sustainable use of the aquifers

2004–Present

Implementation of Groundwater Measurement Rules, Confined Aquifer Rules, and formation of groundwater management subdistricts

2015–2021

Well Rules and regulations are submitted (2015), approved by water court (2019) and come into effect (2021).

2.5 : WATER ADMINISTRATION

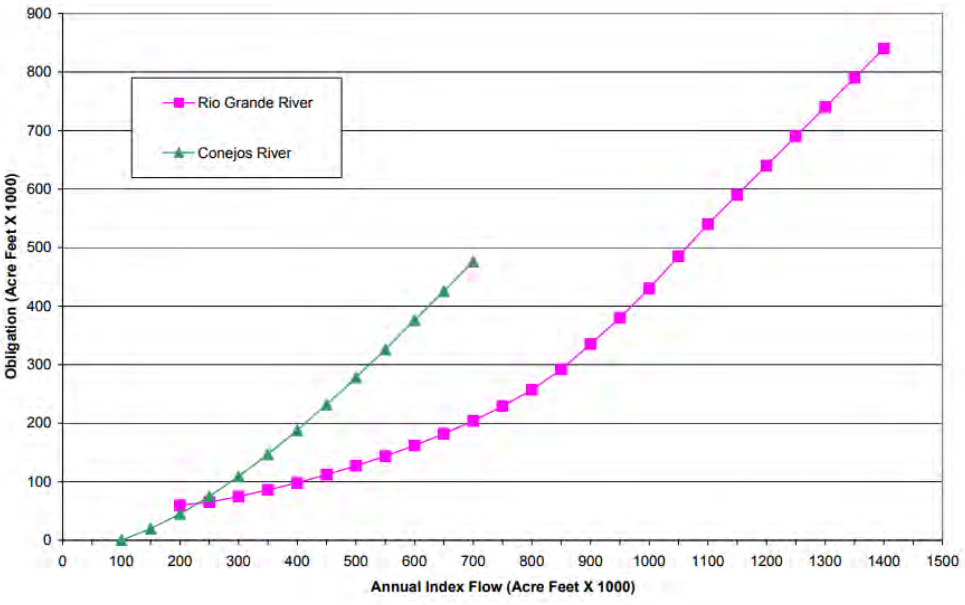
2.5.1 : RIO GRANDE COMPACT

Interstate compacts and international treaties that affect water use in the Basin include the Rio Grande Compact of 1938 (the Compact), the Rio Grande river treaty of 1906 between the U.S. and Mexico, the Rio Grande, Colorado, and Tijuana rivers treaty of 1945 between the U.S. and Mexico, and the Amended Costilla Creek Compact of 1963.

The 1938 Rio Grande Compact equitably apportions the waters of the Upper Rio Grande between Colorado, New Mexico, and Texas. As shown in Figure 11, the schedules of delivery for the Rio Grande and Conejos River are based upon the relationship between inflows at upstream gaging stations and the outflow at downstream gaging stations that generally existed during the Compact study period (1928–1937). For any given annual quantity of inflow at the upstream Compact gaging station, a corresponding amount of outflow is scheduled for delivery at the downstream gaging station(s). However, the Compact does allow for Colorado and New Mexico to under or over-pay their compact obligations in any given year and accrue debits and credits. The relationship between inflow and obligation is not linear — the greater the inflow, the greater the percentage of the inflow scheduled for delivery at the state line. The Rio Grande Compact Commission was established to administer the terms of the agreement. The Commission consists of one representative from each state and a nonvoting federal representative.

FIGURE 11.

Annual Rio Grande and Conejos River delivery obligations based upon measured inflows at index gages, as outlined in the Rio Grande Compact.



Measuring flow. Photo: Rio de la Vista

Surface water on the Rio Grande and Conejos River is administered to keep Colorado in compliance with its Compact delivery obligations. Generally speaking, no surface water diversions are allowed during the non-irrigation season, November 1 to March 31, but reservoirs are allowed to store. During the irrigation season, the Division 3 Engineer for the Colorado Division of Water Resources (DWR) makes an estimate of the annual index flows at the upstream gaging stations using forecasts from the Natural Resources Conservation Service (NRCS), National Center for Atmospheric Research (NCAR), and the National Weather Service (NWS), and an estimate of the amount of compact obligation to be delivered by the Rio Grande and Conejos River. That estimate is usually updated several times per month. With this information, the Division Engineer calculates the percentage curtailment: the amount of inflow at the upstream Compact gaging station that should not be diverted by the Colorado ditches. The curtailment percentage is then applied to and deducted from the amount of inflow available for diversion from the rivers, and that quantity is passed through the system for delivery to the downstream gaging station. This is done on a daily basis throughout the irrigation season to ensure Colorado meets its Compact obligations.

2.5.2 : SURFACE WATER ADMINISTRATION

The Colorado Division of Water Resources Division 3 Engineer administers water within the Basin. Within Division 3, water commissioners are responsible for the day-to-day on-the-ground administration of water rights. Water commissioners for District 20 (Rio Grande main stem) and District 22 (Conejos River) must also administer the Compact curtailment as computed daily by the Division 3 Engineer's staff. Water Districts 25, 26, and 27 drain into the Closed Basin and have no natural surface water outlet to the Rio Grande. Therefore, water rights within these districts are independent of water rights on the Rio Grande and not subject to Compact curtailment. Additionally, the 'normal' flows of the creeks in Water Districts 21, 24, and 35 are not subject to Compact curtailment.

Surface water is administered in accordance with the system of prior appropriation and the Compact. Recognizing that meeting the terms of the Compact is the greatest need, DWR allows remaining water that is available for consumption after curtailment to be utilized in accordance with the priorities of the water rights. As such, many junior water rights receive water only during wet years. If sufficient water to meet the Compact obligations has been delivered to the state line during the irrigation season, DWR may set curtailment to zero. When curtailment is zero, water users are legally able to divert the entire flow of the river, which has historically resulted in dry-up

points along the Rio Grande and the Conejos River systems. During recent years when zero curtailment has occurred, water users and agencies have worked together to reduce dry-up, which is a key goal of the RGBRT.

Rio Grande, Continental, Santa Maria, and Beaver Park reservoirs are the major pre-Compact reservoirs located upstream of the Del Norte gage on the Rio Grande. A pre-Compact reservoir stores under its water rights, when those water rights are in priority, or by exchange. The provisions of the Compact do not alter a pre-Compact reservoir's ability to store water, making these facilities especially valuable infrastructure for the Basin. Storage within post-Compact reservoirs is limited by the provision of Article VII of the Compact. This provision eliminates the ability to store water in post-Compact reservoirs when Rio Grande Project (Elephant Butte and Caballo reservoirs) usable water in storage totals less than 400,000 acre-feet. In times of average or abundant supply in the Basin, this Article may not impair the ability to store native water in post-Compact reservoirs in Colorado, but those reservoirs must also be in priority as to other vested water rights on their stream system within Colorado.

These reservoirs have relatively junior priorities compared with the surface water rights in the Valley and are rarely in priority to store water during the irrigation season except in high runoff periods. Thus, the reservoirs store water primarily in the winter months, with storage normally beginning on November 1 and continuing until the onset of the irrigation season the following spring, typically April 1.

Several ditch systems within the Valley have decrees approved by the Colorado Water Court that allow them to store in-priority, native water temporarily in Rio Grande, Continental, Santa Maria, and Platoro reservoirs. The term "direct flow storage" is commonly used to describe this practice

Platoro Reservoir in the Conejos Basin. Photo: Richard Stenzel

Rio Grande Reservoir in the fall. Photo: Heather Dutton.

of electing reservoir storage instead of headgate diversions under certain decreed conditions. This allows for more efficient use of the water at later times during the year, by better aligning crop demands with water supply.

2.5.3 : GROUNDWATER ADMINISTRATION

Current groundwater administration has its roots in activities that occurred in the 1960s and have developed up to today. One of the principal investigators of the hydrologic systems of the Valley in the late 1960s and early 1970s was United States Geological Survey (USGS) geologist Philip A. Emery. Emery authored a number of the studies that formed the basis of the understanding of the hydrology of the Valley through the mid-1980s.

In 1986, American Water Development (AWDI) sought to develop as much as 200,000 acre-feet annually from the confined aquifer for export out of the Valley. After five years of litigation and a lengthy trial, the case ended badly for AWDI. Cabeza de Vaca and its financial backer, Farallon Capital Management, then bought AWDI's property and began an extensive engineering investigation to try to succeed where AWDI had failed; this new venture was called Stockman's Water. At this juncture, water users from the Valley went to the Colorado General Assembly to seek an alternative to continued litigation to resolve the questions of future use of the confined aquifer.

These efforts resulted in the 1998 adoption of HB 98-1011, which addressed concerns regarding groundwater use in the Valley and, in particular, new uses of the confined aquifer. The Bill recognized that, at that time, there was insufficient comprehensive data of the relationship between the surface streams and the confined aquifer system to permit a full understanding of the effect of the groundwater withdrawals upon the local natural stream and aquifer systems. The Bill required the Colorado State Engineer to promulgate Rules and Regulations governing new withdrawals of groundwater affecting the confined aquifer system. This allows withdrawals only upon an approved plan for augmentation which replaces the new withdrawal of water from the confined aquifer with an equal amount of water introduced into the aquifer. In addition, withdrawals are to occur only in a manner that will protect Colorado's ability to meet Compact obligations and prevent injury to senior appropriators. Also, the Bill requires augmentation plans to "recognize that unappropriated water is not made available and injury is not prevented as the result of the reduction of water consumption by nonirrigated native vegetation."

As a requirement of HB 98-1011, the State Engineer and the Colorado Water Conservation Board began conducting a specific study of the aquifer systems, the Rio Grande Decision Support System (RGDSS) Study. This study involves collection and evaluation of existing data, supplementation of the existing data with new studies, development of several models, and the organization of the data and models into an accessible format. The RGDSS Study has been carried out in phases beginning in 1998 and continues today, as the most comprehensive study of the Valley's geology and hydrology ever undertaken.

As part of the strategy developed by the RGWCD to protect the Valley's aquifers from exploitation, the Basin supported the formation of a national park through the Great Sand Dunes Park and Preserve Act of 2000. The Act expanded the boundary of the former Great Sand Dunes National Monument to better protect the above-ground ecology and the connected groundwater hydrology associated with the dunes. Much of the political

Trinchera Ranch and Blanca Massif. Photo: John Fielder

interest in the boundary expansion was motivated by an overwhelming local desire to protect water resources of the area. In 2008, the State of Colorado granted a water right to the Great Sand Dunes National Park and Preserve for the groundwater beneath its boundaries, which was required by the U.S. Congress in the Act. This was the first in-situ groundwater right issued by the State of Colorado. The water right precludes any withdrawal of water from the aquifers that would cause injury to the Park's environments, which are dependent on the groundwater.

2.5.3.1 DROUGHT OF 2000–2005 AND SENATE BILL 04-222

The period 2000–2003 was the second-driest consecutive four-year period of recorded streamflow on the Rio Grande, exceeded only by the drought of 1953–1956. The year 2002 was the driest year of record on the Rio Grande, falling below the lowest level of the schedule of anticipated deliveries of the Compact. With decreased streamflow came increased reliance on groundwater and the resulting groundwater level declines increased depletions to streamflows. The drought of 2002, combined with a reduction in the Closed Basin Project's yield, renewed the concern of Valley water users over well depletions to both the aquifer systems and the surface streams. The decline in yield of the Closed Basin Project together with the drought showed that the 60/40 agreement (60% of the Closed Basin yield to the Rio Grande and 40% to the Conejos River) was not a complete solution to groundwater problems in the Valley and that other measures would be required to address groundwater overdraft and protect senior water rights from injury caused by groundwater pumping. Currently, the estimated reduction since 1976 in the water storage in the unconfined aquifer of the Closed Basin is close to 1,200,000 acre-feet (RGWCD 2021). Water users in the Valley began discussing ways to protect surface and groundwater supplies in a manner that was less destructive than the examples of groundwater regulation seen in the Arkansas and South Platte basins. This concern resulted in local water users promoting the idea of the Groundwater Management Subdistricts. In 2004, at the urging of water users from the Valley, the Colorado General Assembly enacted SB 04-222 that addresses the application of rules and regulations governing the use of underground water in Division 3.

As the State adopted rules governing the use of groundwater, in recognition of the unique geologic and hydrologic conditions, along with the prevailing conjunctive use practices, the State Engineer was given wide discretion to permit the continued use of groundwater consistent with preventing material injury to senior surface water rights. In regulating an aquifer or system of aquifers, the State Engineer was to apply the following principles:

- Use of the confined and unconfined aquifers shall be regulated so as to maintain a sustainable water supply in each aquifer system, with due regard for the daily, seasonal, and long-term demand for groundwater.
- Fluctuations in the artesian pressure in the confined aquifer system have occurred and will continue to occur in response to climatic

conditions, water supply, and water demands. Such pressure fluctuations shall be allowed with the ranges that occurred during the period of 1978 through 2000. Artesian pressures shall be allowed to increase in periods of greater water supply and shall be allowed to decline in periods of lower water supply in much the same manner and within the same ranges of fluctuation as occurred during the period of 1978 through 2000, while maintaining average levels similar to those that occurred in 1978 through 2000.

- Groundwater use shall not unreasonably interfere with the State's ability to fulfill its obligations under the Compact with due regard for the right to accrue credits and debits under the Compact.
- Water is added to the stream system to assist in meeting the Compact delivery schedules or to replace depletions to streamflows resulting from the use of groundwater.
- The State Engineer is not to curtail pumping from wells in Division 3 that are included in a Groundwater Management Subdistrict with a judicially approved management plan.

Division 3 well rules are intended to prevent injury, provide for sustainable groundwater supplies, and prevent interference with meeting Colorado's obligation under the Rio Grande Compact.

2.5.3.2 GROUNDWATER REGULATIONS FOR EXISTING USES OF GROUNDWATER

As required by SB 04-222, the State Engineer submitted Division 3 Well Rules and Regulations (well rules) in 2015 for existing uses of groundwater. The well rules are to prevent injury to water right holders, provide for sustainable groundwater supplies, and prevent interference with the Compact. In addition to his own professional knowledge and experience, the State Engineer relied upon the data and conclusions of the RGDSS Study in preparing the well rules. The well rules were approved by water court in 2019 and came into effect on March 15, 2021. The rules require non-exempt well owners to meet one of the following options:

- Join a Groundwater Management Subdistrict
- Have a court approved Plan of Augmentation or Substitute Water Supply Plan for their well
- Shut off and cease use of their well

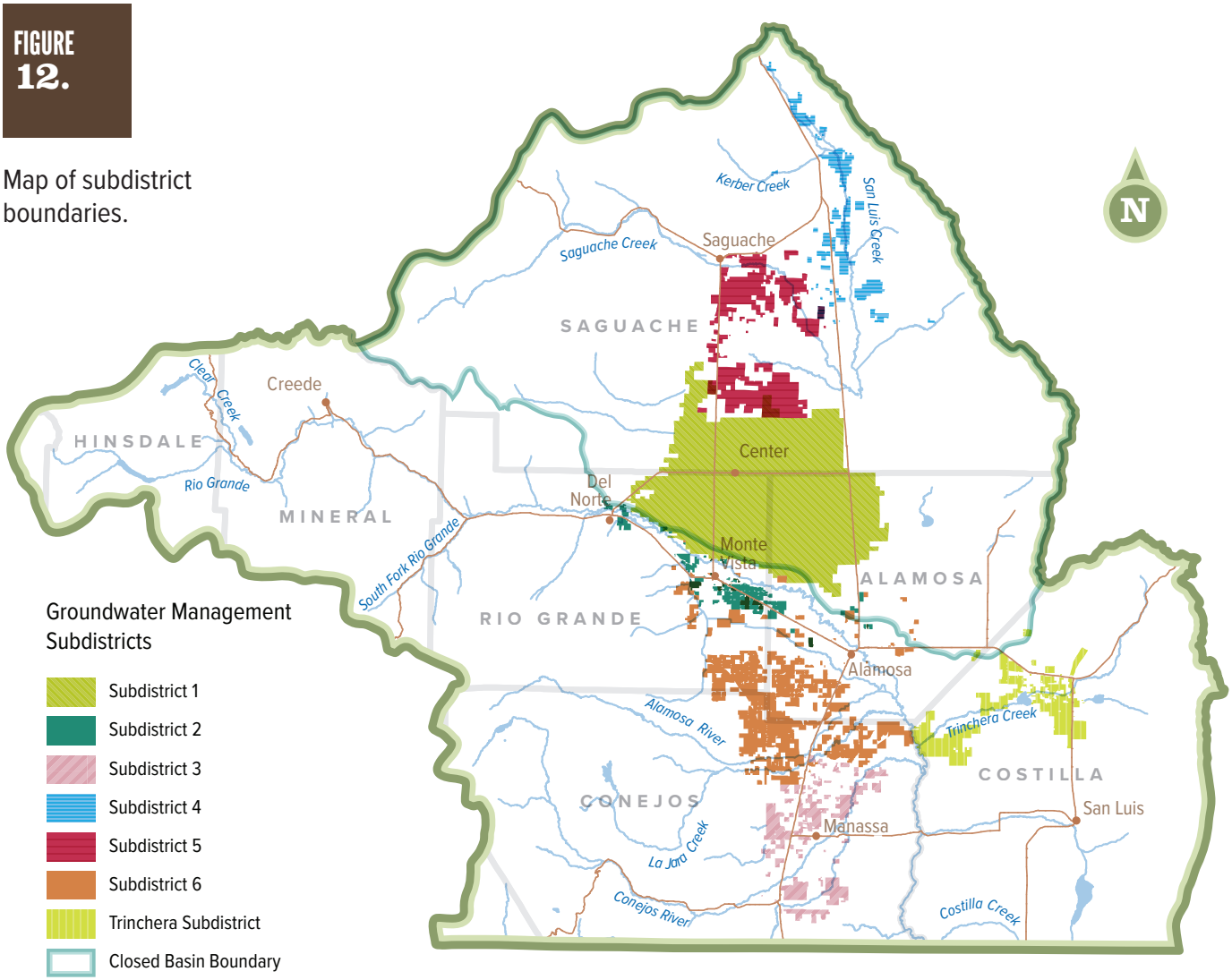
2.5.3.3 GROUNDWATER MANAGEMENT SUBDISTRICTS

The well rules resulted in a mandate to achieve sustainable aquifer levels. Groundwater Management Subdistricts (Subdistricts), which were enabled with the passage of SB 04-222, are currently a primary mechanism for achieving aquifer sustainability. Six subdistricts of the RGWCD were created and the Trinchera Groundwater Management Subdistrict, overseen by the Trinchera Water Conservancy District (TWCD), was also formed. The boundaries of each subdistrict represent distinct hydrologic and geologic regions within the San Luis Valley. For example, Subdistrict No. 1 is located in the heavily irrigated area north of the Rio Grande within the Closed Basin, while Subdistrict No. 2 (Rio Grande alluvial) occupies a smaller area adjacent to the Rio Grande. A map of subdistrict boundaries is shown in Figure 12.

Each subdistrict functions under guidance from its Board of Managers with oversight from the RGWCD and TWCD, respectively, and is composed

FIGURE 12.

Map of subdistrict boundaries.



of well owners within the subdistrict boundary. The overall objectives of the subdistricts are to replace injurious depletions to surface water rights, and ultimately achieve aquifer sustainability. The subdistricts use a system of self-regulation, including economic-based incentives that promote responsible irrigation water use and management and ensure the protection of senior surface water rights. The RGDSS groundwater model is capable of quantifying the impact of groundwater withdrawal on aquifer dynamics as well as surface water (stream) depletions. The model shows that well pumping causes injurious depletions to surface water users due to stream depletions. Subdistricts are also responsible for remedying these depletions, either through the addition of water to the river system, or by providing water or other payment to the injured water right owner. The RGWCD and TWCD are actively working with all subdistricts to promote sustainability of the Valley's complex aquifer system and to prevent material injury to senior surface water rights while ensuring continued economic viability of the Valley's agricultural practices.

2.6 : ENVIRONMENTAL AND RECREATIONAL RESOURCES

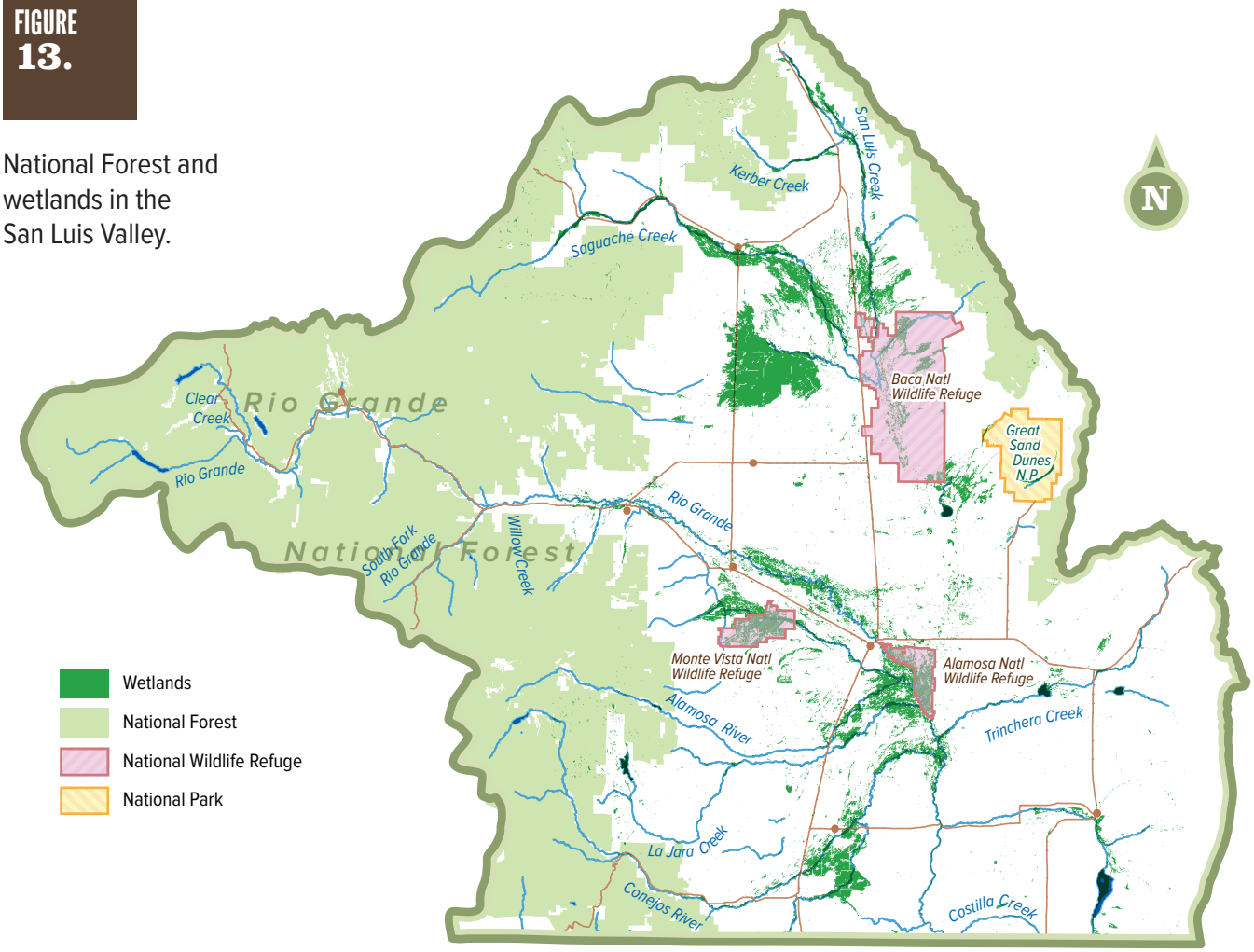
Rio Grande near South Fork, Colorado. Photo: Richard Stenzel.

2.6.1 : KEY ENVIRONMENTAL ATTRIBUTES

In addition to the substantial public lands of the RGNF and the BLM, the Basin is home to the Great Sand Dunes National Park and Preserve, the Alamosa, Monte Vista, and Baca national wildlife refuges, many state wildlife areas, and other state lands. The Valley's extensive wetlands and riparian habitats support at least 13 threatened and endangered species and over 160 species of birds, ranging from the iconic greater sandhill crane to the endangered southwestern willow flycatcher. While working farms and ranches support a rural way of life and produce food and fiber, many private lands also provide critical wildlife habitat. Healthy watersheds and the Valley's underground aquifers are crucial to sustaining biodiversity and habitat, wetland and riparian ecosystems, and diverse recreational opportunities that are inherently important to sustaining a vibrant and resilient local economy.

FIGURE 13.

National Forest and wetlands in the San Luis Valley.



2.6.2 : WATERSHED HEALTH

The RGNF is home to the headwaters of the Rio Grande and Conejos River high in the San Juan Mountains. The RGNF encompasses 1.84 million acres, 38% of the Basin's land area. Currently, the ecosystems within the RGNF are being affected by a variety of factors, including infestations of spruce bark beetles, wildfire, and climate change. The spruce bark beetle has affected the most acres but additional bark beetles such as Douglas-fir, mountain pine, fir engraver, and ips affect other trees species. The effects of these disturbances on the health of the watershed are a cause of serious concern, as the health of the upland forests directly impacts the health of the Rio Grande, Conejos River, and their tributaries in upper reaches. To better understand watershed health concerns and improve conditions, several watershed assessments and stream management plans (SMPs) were recently completed. The Upper Rio Grande Watershed Assessment (URGWA), the Comprehensive Willow Creek Watershed Planning Project, and the Rio Grande, Conejos River, and Saguache Creek SMPs were completed between 2018 and 2020. Collectively, these planning efforts detail forest and watershed health issues and provide a set of projects and actions to improve conditions.

2.6.3 : RIPARIAN AREAS

The Basin's rivers and streams provide the backbone for the communities, economies, and ecosystems of the Valley. Many of the farms and ranches situated along riparian corridors and ditches rely on surface irrigation and often provide seasonal wildlife habitat by flooding meadows and hay fields. Groundwater irrigators benefit from the recharge provided to the aquifers by streamflows and diversions into recharge zones.

The Basin contains thousands of miles of riparian areas — lands located directly adjacent to a river, stream, or lake — which serve important functions as transition areas between aquatic and terrestrial ecosystems. Naturally functioning riparian areas significantly affect and improve the health of surrounding lands and the entire ecosystem of the Basin. They perform integral hydrologic and chemical functions that act as filters for pollutants, erosion control, flood control, and recharge aquifers (Mitsch and Gosselink 1993; Niemuth et al. 2004). Many of the riparian areas in the Valley have been degraded over time and no longer optimally perform these important ecosystem functions.

Efforts to restore impaired riparian areas have resulted in improved water quality, enhanced fish and wildlife habitat, improved groundwater recharge, flood mitigation and sediment transport, protection of private property, and socioeconomic values associated with agriculture, tourism, and recreation. The RGBRT has a long track record of supporting river restoration projects through the Rio Grande Headwaters Restoration Project. Historic mining impacts are being addressed with the support of the RGBRT on the Alamosa River, Willow Creek, and Kerber Creek.

A frosty Rio Grande.
Photo: Heather Dutton

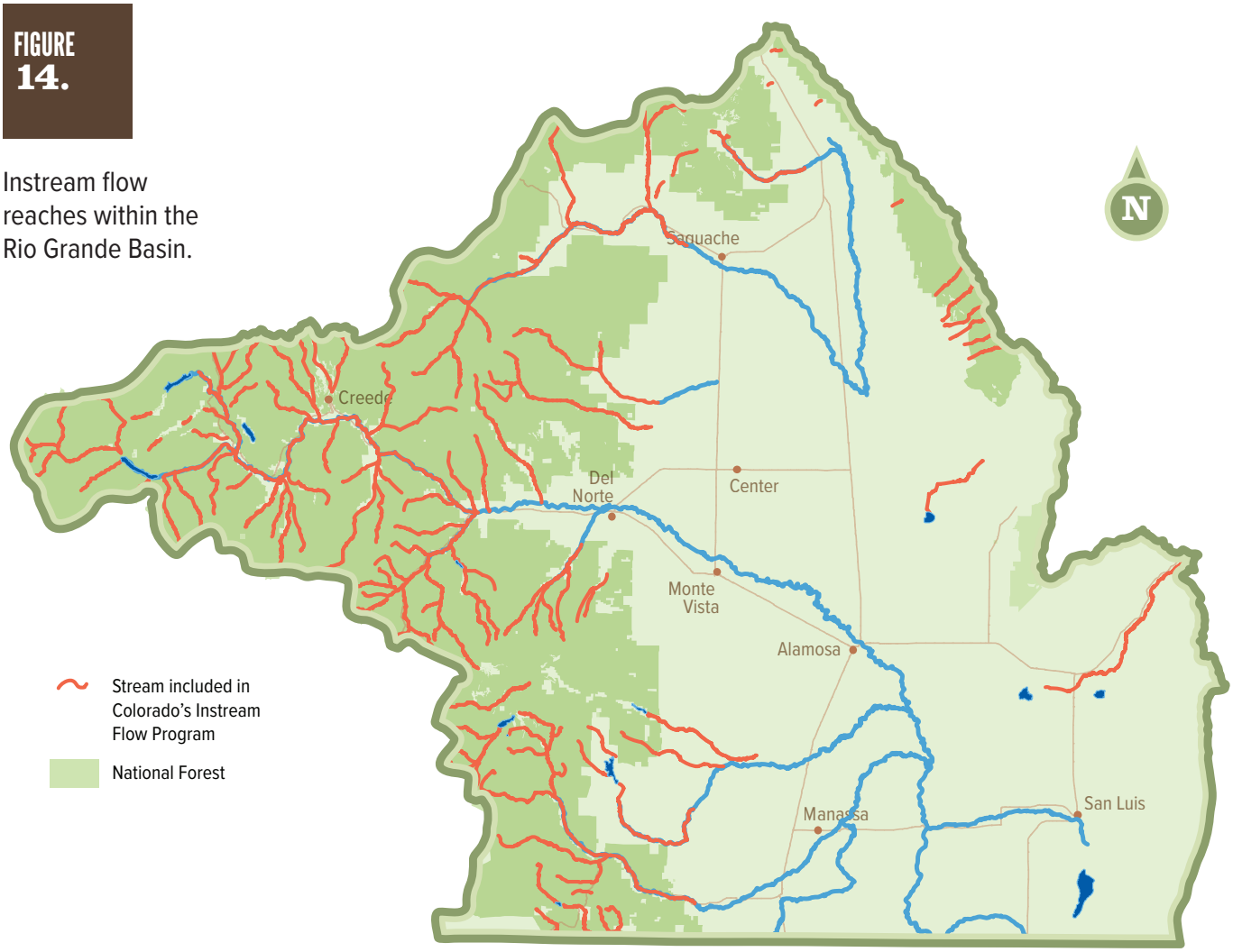
2.6.4 : INSTREAM FLOW PROTECTIONS

Recognizing the value of environmental habitats and recreational activities as well as the importance of maintaining natural flows for agriculture, the RGBRT regards instream flows (ISFs) as multi-purpose attributes. ISFs are nonconsumptive water rights that are held exclusively by the CWCB for minimum flows between specific points in-channel through a reach of stream or in natural lakes to maintain water levels. ISF rights are administered within the State's priority system to protect against injury to senior water users at any point within the reach and to legally preserve, protect, or improve the natural environment to a reasonable degree. Existing ISFs occur mainly in the headwater streams and rivers, including the Rio

Grande, Conejos, and Alamosa rivers. In addition to CWCB ISFs, the U.S. Forest Service was decreed 252 Federal Reserved Water Rights in 2000 under Case No. 81-CW-183 (Consolidated) (DC 2000). These federal water rights apply to every major stream within the RGNF in the Basin. Collectively, there are currently almost 1,000 miles of instream flow protections in the Basin. Finally, in 2008, Colorado's Water Court recognized a unique groundwater right for the Great Sand Dunes National Park and Preserve (U.S. Department of Justice 2013). The groundwater right requires sustained aquifer levels around the Park in order to protect its unique hydrology. Rivers and streams with CWCB instream flow designations are shown in Figure 14 (RGNF federal water rights are not included on the map).

FIGURE 14.

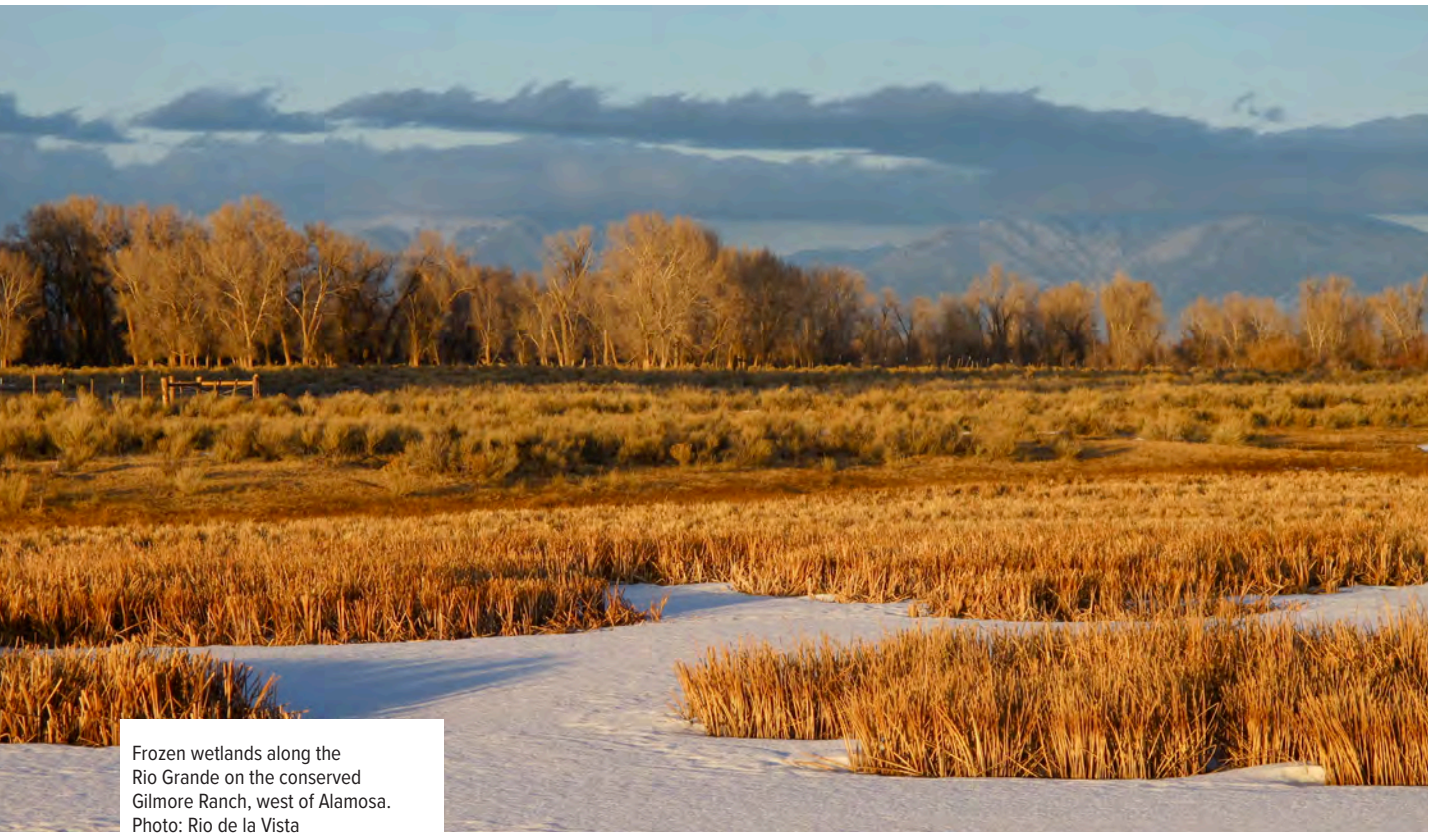
Instream flow reaches within the Rio Grande Basin.



2.6.5 : WETLANDS

Naturally functioning wetlands provide many ecosystem services, which significantly affect and improve the health of surrounding lands and the entire ecosystem of the Basin. Similar to riparian areas, wetlands perform integral hydrologic and chemical functions that act as filters for pollutants, erosion control, flood control, and recharge aquifers (Mitsch and Gosselink 1993; Niemuth et al. 2004).

The Basin has several types of wetlands, the most abundant being freshwater emergent, which comprises 90% of the total wetland acreage. While many of these wetlands are seasonal and connected to agriculture, there are large complexes of perennial wetlands on the Valley floor that are largely owned and managed by the Colorado Parks and Wildlife, U.S. Fish and Wildlife Service, and Bureau of Land Management. These wetlands provide outstanding habitat for migrating birds, wetland vegetation, and other dependent species. Many of the public wetland complexes have been designated and recognized as regional and national areas of significance, supporting specific birds and habitat types. For example, Blanca Wetlands is an Audubon Important Bird Area and Russell Lakes state wildlife area is a National Natural Landmark. The 2019 San Luis Valley Wetland and Wildlife Conservation Assessment analyzed changes in wetlands and agriculture to guide cooperative conservation goals for monitoring, management, and land conservation throughout the San Luis Valley for natural resource agencies and organizations. The extent of wetlands and surface water was modeled from 1984 to 2017 using remote sensing and Landsat satellite imagery. The



Frozen wetlands along the Rio Grande on the conserved Gilmore Ranch, west of Alamosa. Photo: Rio de la Vista

assessment and supporting documents include a compilation of historic and current information related to wetland extent, water use, and wildlife use.

2.6.6 : KEY SPECIES

The diversity and abundance of wetlands and riparian areas located throughout the Valley makes it a vital area for wetland-dependent birds in Colorado. The wetlands and riparian zones along the Rio Grande, Conejos River, and their many smaller tributaries are important to over 75% of the area's wildlife species, including 13 state and federal threatened, endangered, and species of special concern, as well as over 160 species of birds.

The Basin's wetlands provide important habitat for a wide range of migrating, nesting, and wintering bird species, including the endangered southwestern willow flycatcher and the entire Rocky Mountain Population of greater sandhill cranes during their spring and fall migration. Birds, along with a variety of wildlife that includes fish and amphibians, such as boreal toads, also depend upon these resources annually. Three fish species are at risk in the Basin: the Rio Grande cutthroat trout, Rio Grande chub, and Rio Grande sucker. In October 2014, the Rio Grande cutthroat trout was determined to be "not warranted" for listing under the Endangered Species Act by the USFWS. However, all three species have seen a reduction in populations due to predation and competition from non-native fish species. Fish habitat in the Basin is threatened by river and stream modification from activities such as recreation, road construction, other land use activities, and historic mining.

Numerous river and stream corridors are included in designated areas of important seasonal habitat and/or winter range habitat for elk, deer, and moose. The specific species discussed in the BIP represent the key species that serve as indicators of healthy habitats and populations of other species, given their similarities in relation to resource needs; however, this list is not intended to be exhaustive of all species of concern. Additional discussion

The wetlands and riparian zones along the Rio Grande, Conejos River, and their many smaller tributaries are important to over 75% of the area's wildlife species, including 13 state and federal threatened, endangered, and species of special concern, as well as over 160 species of birds.

From left: Great Horned Owl, photo: Rio de la Vista; greater sandhill cranes, photo: Cary Aloia; Elk stags, photo: Erich Schlegel

Visitors enjoy Medano Creek flowing through the Great Sand Dunes National Park. Photo: Rio de la Vista

of the needs of key species can be found in **Section 4.3.4: Habitat Needs for Sensitive Species (Threatened, Endangered, Candidate, and Indicator Species).**

2.6.7 : RECREATION

The Basin's thriving tourism industry, much of which is water dependent, accounts for 11% of employment in the area. The Basin is largely ringed by the RGNF and large areas of BLM lands. In addition, it is home to the Great Sand Dunes National Park and Preserve, the Alamosa, Monte Vista, and Baca national wildlife refuges, many state wildlife areas, and other state lands. The Basin's nearly million acres of public land and associated wilderness areas, wildlife areas and refuges, and Wolf Creek ski area, annually attract hundreds of thousands of visitors to the region. Popular recreational activities include angling, hunting, wildlife and bird watching, winter sports, camping, rafting, paddling, and boating activities. All depend on adequate and healthy water resources.

2.6.7.1 WATERFOWL HUNTING

The Valley floor is well known for early-season waterfowl hunting opportunities that are enjoyed by residents from all over the state. It is recognized that quality, public-land waterfowl hunting opportunities are extremely limited in Colorado, and the Basin has over half a dozen state wildlife areas, USFWS refuges, and BLM land that provide such opportunities.

2.6.7.2 ANGLING

The Basin has excellent fishing opportunities, from many high-altitude streams and lakes to the Gold Medal Waters of the Rio Grande and superb fishing on the upper Conejos River. Colorado Parks and Wildlife offers extensive information about fishing opportunities, including an interactive fishing atlas map, at http://ndismaps.nrel.colostate.edu/fishingatlas/.

Rio Grande cutthroat trout.
Photo: Kevin Terry

2.6.7.3 BOATING IN THE RIO GRANDE BASIN

Boating (in kayaks, duckies, dories, canoes, rafts, etc.) largely occurs on the upper reaches of the Rio Grande, beginning in the RGNF from below Rio Grande Reservoir and extending to below South Fork. Above South Fork, the river flows through public and private lands, with several boating access points. Increasing boat access and passage through diversion structures is an ongoing process in the community.

Stillwater boating occurs at many of the small conservation pools and larger reservoirs in the Basin. Rio Grande, Continental, Beaver Park, Big Meadows, Road Canyon, Terrace, and Platoro reservoirs provide high-mountain public access boating opportunities in the San Juan Mountains. Most boaters fish for trout while enjoying these settings. Additional boating and fishing for warm-water species occurs on the east side of the Basin at Mountain Home, Sanchez, and Smith reservoirs. When conditions allow, San Luis Lakes State Park has been a site for water sports since the 1920s; water skiing, motor boating, personal watercraft, fishing, sailing, and windsurfing are popular there when water levels are adequate.

American Bittern.
Photo: Cary Aloia

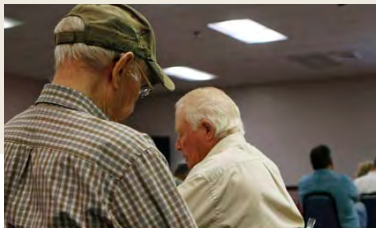
2.6.7.4 BIRDING TRAILS AND WATCHABLE WILDLIFE

Watching wildlife often takes place while residents and visitors to Colorado choose to recreate in such activities as hiking, boating, and horseback riding. The recreational, watchable wildlife opportunities in the Basin are limitless and almost impossible to track in terms of recreational user-days.

San Luis People's Ditch, the oldest water right in Colorado. Photo: Rio de la Vista

3 RIO GRANDE BASIN GOALS

The Rio Grande Basin Implementation Plan Steering Committee, Subcommittees, and RGBRT identified 5 goals for the Plan. These goals focus on the most important aspects of the Basin: a resilient agricultural economy, watershed and ecosystem health, sustainable groundwater resources, encouragement of projects with multiple benefits, and the preservation and improvement of recreational activities. The Basin goals ultimately strive for a resilient and healthy watershed and economy for generations to come.



Water Division 3 meeting in the Rio Grande Basin. Photo: Erich Schlegel

To provide a roadmap to measure success in meeting existing and future water needs, each goal is paired with implementation techniques, including tasks, projects and methods, and other steps needed to achieve the goal and result in measurable outcomes.

For more detailed information on the Basin's goals, anticipated outcomes, and supporting strategies to achieve the goals, see **Volume 1 Section 4.**

RIO GRANDE BASIN GOALS

The Basin Roundtable and its partners work toward:

Healthy watersheds that provide critical ecosystem services, are resilient to disturbances, and benefit from ongoing efforts to protect water sources, improve water quality, enhance aquatic, riparian, wetland, and upland habitat, and maintain connected ecosystems.

Aquifers with sustainable supplies of groundwater for farmers and ranchers, towns, and wildlife habitat.

Vibrant and resilient agriculture, recreation, municipal, and industrial economies that support thriving communities.

Water administration that is adaptive, flexible, and creative while complying with state statutes and the doctrine of prior appropriation, and fully utilizing Colorado's compact entitlements under the Rio Grande and Costilla Creek compacts.

Engaged and informed citizens who understand the scope and urgency of local, state, and regional water issues and participate in robust and diverse educational opportunities.

Big Meadows Reservoir.
Photo: Heather Dutton

4 BASIN WATER NEEDS

The Basin has a finite and fluctuating supply of water, which is predicted to decrease in the future. Because the Basin's water needs are intertwined, cooperative efforts to maximize the benefits to the multiple needs identified in the BIP will be critical going forward. See **Volume 1 Section 5** for updated information and data from the 2019 Technical Update and detailed water supply and demand analyses.

Hay bales in the San Luis Valley. Photo: Rio de la Vista

4.1 : AGRICULTURAL NEEDS

In Colorado, over 80% of water use is for agriculture. In the Basin, agricultural water use is approximately 99% of total use. The local economy is driven by agriculture; therefore, meeting the agricultural water needs is critical not only for individual farm operators, but also for the entire Basin.

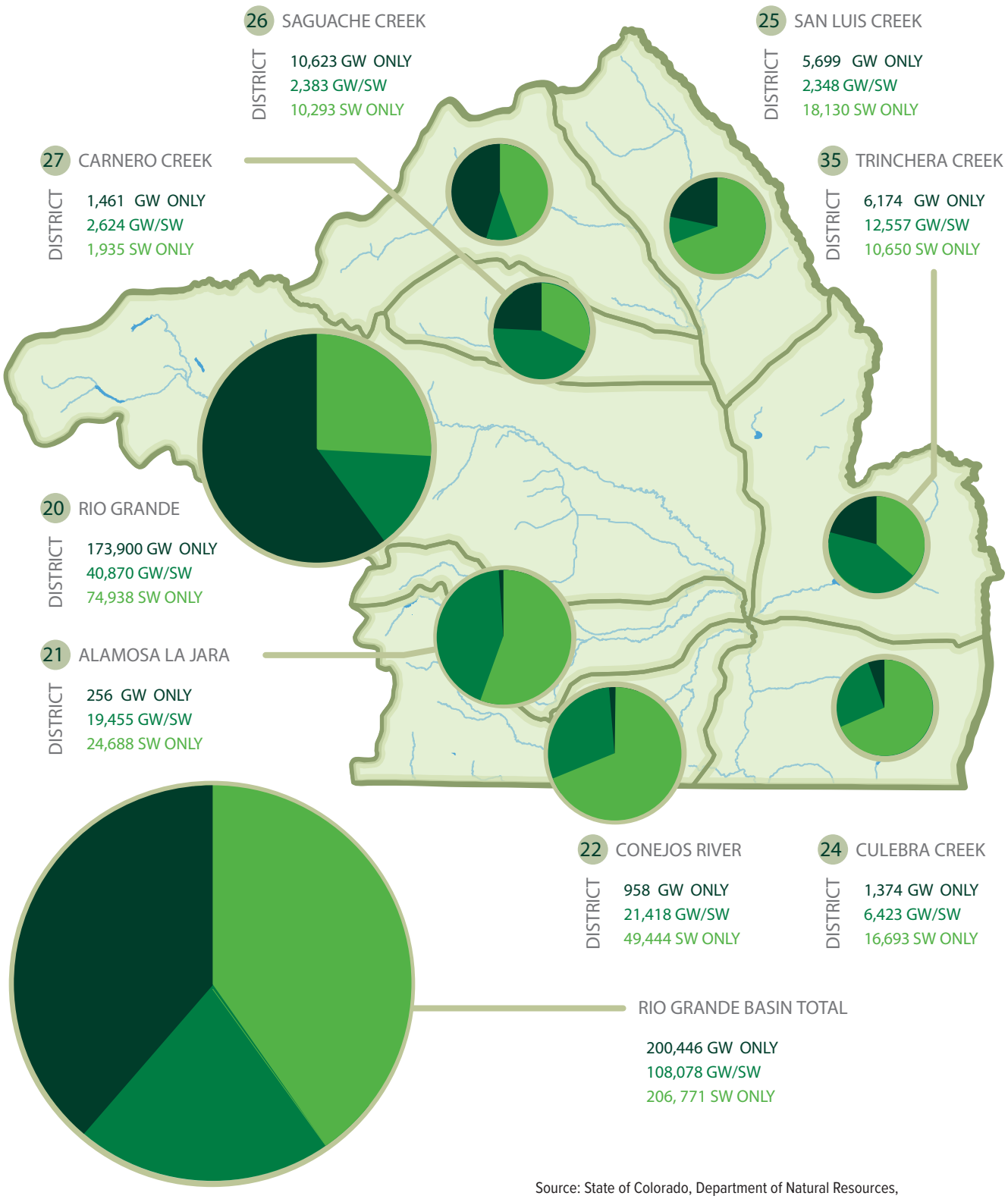
As of 2010 the Basin has approximately 515,300 acres irrigated through surface water, groundwater, or a combination of the two, as shown in Figure 15. Agricultural producers rely on irrigation water from both surface and groundwater sources and the use of groundwater is vitally important to sustain agricultural production on farms in the Closed Basin.

Irrigation return flows to the Rio Grande. Photo: Heather Dutton

FIGURE 15.

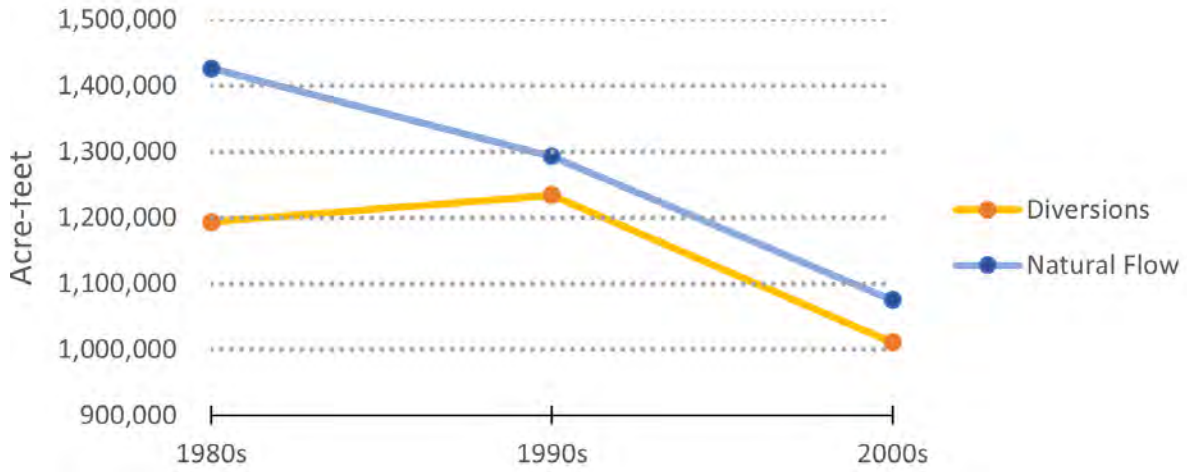
Irrigated acreage in Rio Grande Basin water districts.

Irrigation by groundwater (GW), surface water (SW), or both (GW/SW).



Source: State of Colorado, Department of Natural Resources, Division of Water Resources 2012 (RG2012 StateCU)

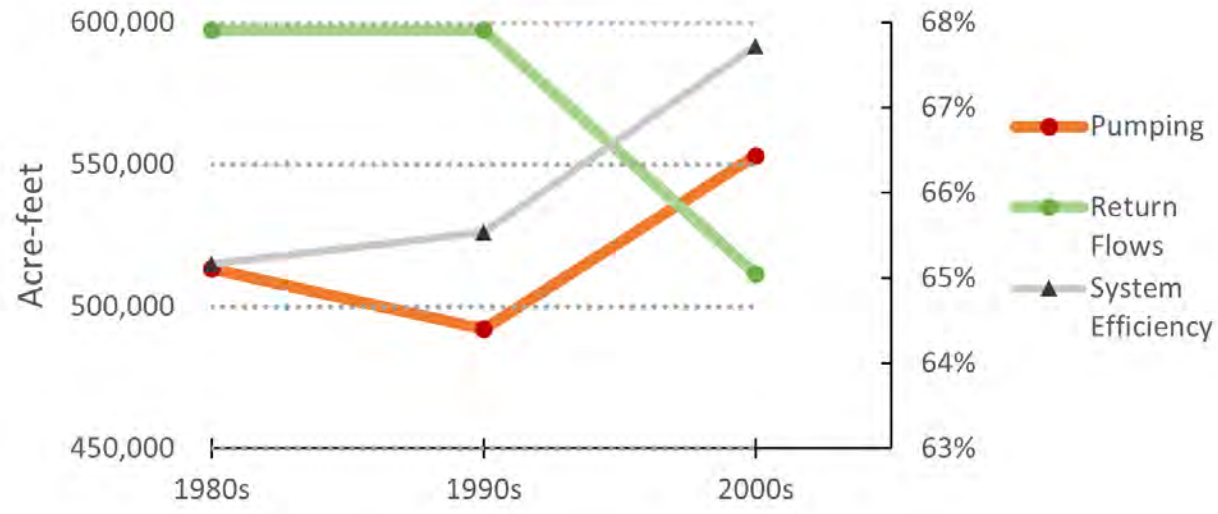
FIGURE 16. Basinwide decadal average streamflow and surface water diversions from 1980 - 2010.



4.1.1 : PHYSICAL SHORTAGES AND IRRIGATION TRENDS

Surface water supplies (i.e., natural flow) are increasingly variable and have declined in recent decades, as shown in Figure 16. With less surface water available, producers have relied less on surface water diversions (Figure 16) and increasingly on groundwater withdrawals, as shown in Figure 17. Increased use of groundwater and sprinklers, rather than flood irrigation, has resulted in an overall increase in system-wide agricultural water use efficiency (Figure 17).

FIGURE 17. Basinwide decadal average well pumping and volume of return flows from 1980 - 2010.



Harvesting potatoes.
Photo: Julie Messick

The Basin is water-short; demand for water exceeds the available supply. For more specific information on water shortages, see Volume 1.

Because groundwater and surface water are connected, increased well pumping has led to a further reduction in streamflow (i.e., natural flow). The combination of reduced surface water diversions and increased pumping and water use efficiency has led to a reduction in return flows, as shown in Figure 17. See **Volume 1, Section 5** for more information on agricultural water use.

The Basin is water-short, meaning that demand for water exceeds the available supply. Only the most senior surface water rights holders consistently receive a full surface water supply that is sufficient to meet the potential consumptive use of their crops. Throughout the Basin, water users rely on groundwater to supplement surface water supplies, and, in some cases, groundwater is the only source of water. Many irrigators utilize surface water when available but rely on groundwater or subirrigation later in the summer when surface water supplies have decreased after the spring runoff. Physical shortages occur when there is less irrigation water applied to a crop than the crop could potentially consume through evapotranspiration—the amount of water taken up by the roots, used for plant growth, and transpired. The combination of the relatively short runoff period, requirements of Compact administration, and water rights priorities may result in some water users receiving only a few days of annual surface water supply. The importance of a supplemental groundwater supply is further evidenced by the fact that during times of drought, the irrigated acreage of lands served by surface water decreases much more sharply than lands that have access to groundwater.

4.1.2 : AGRICULTURAL INFRASTRUCTURE NEEDS

Functional reservoirs and irrigation infrastructure are critical for meeting agricultural water needs in the Basin. The Basin's reservoirs are critical to providing water supply for irrigation and meeting replacement of well pumping depletions in time, place, and amount. While great progress has been made to retrofit reservoirs, reservoir infrastructure repair needs remain. Rehabilitation of reservoirs dams, spillways, and outlet works is necessary to provide water storage capacity to meet agricultural and other needs as well as to ensure public safety.

A need also exists to improve aging and poorly functioning agriculture diversions and headgates along Basin rivers and streams. Many diversion structures have outlived their engineered life or were never engineered. A significant number of diversion dams are "push-up dams," meaning the ditch companies use heavy equipment to push river bottom materials to form diversion dams each year, incurring high annual maintenance costs. The old irrigation infrastructure can impact fisheries, riparian areas, recreation, Compact administration, and diversion efficiency. Projects that improve agriculture infrastructure can have great benefits to surrounding riparian areas and fisheries, and facilitate new recreation opportunities. The Rio Grande Headwaters Restoration Project is working with ditch companies on the Rio Grande and Conejos River to pursue projects that benefit multiple users and needs.

A need exists to improve aging and poorly functioning agriculture diversions and headgates along Basin rivers and streams.

As discussed in **Section 4.4.1: Surface Water Issues**, headgate automation and accurate ditch measurement are important components of upgrading agricultural irrigation infrastructure. Headgate automation improves diversion accuracy and reduces operational needs while accurate water diversion measurement allows water managers to administer water rights

William Stewart Ditch headgate and feeder ditch. Photo: Daniel Boyes

more efficiently. Similarly, as noted in **Section 5.2.3: Improving Streamflow Forecasting**, improved streamflow forecasting will help water users and managers in the Basin immensely. Water managers rely on accurate streamflow forecasts to administer water rights and inform planning throughout the basin.

4.2 : MUNICIPAL AND INDUSTRIAL NEEDS

The combined municipal, rural residential, industrial, and commercial water use, which is primarily met with confined aquifer pumping, represents a very small part of water use in the Basin. In 2015, the Basin's population was approximately 46,000. Future population scenarios are outlined in **Volume 1**.

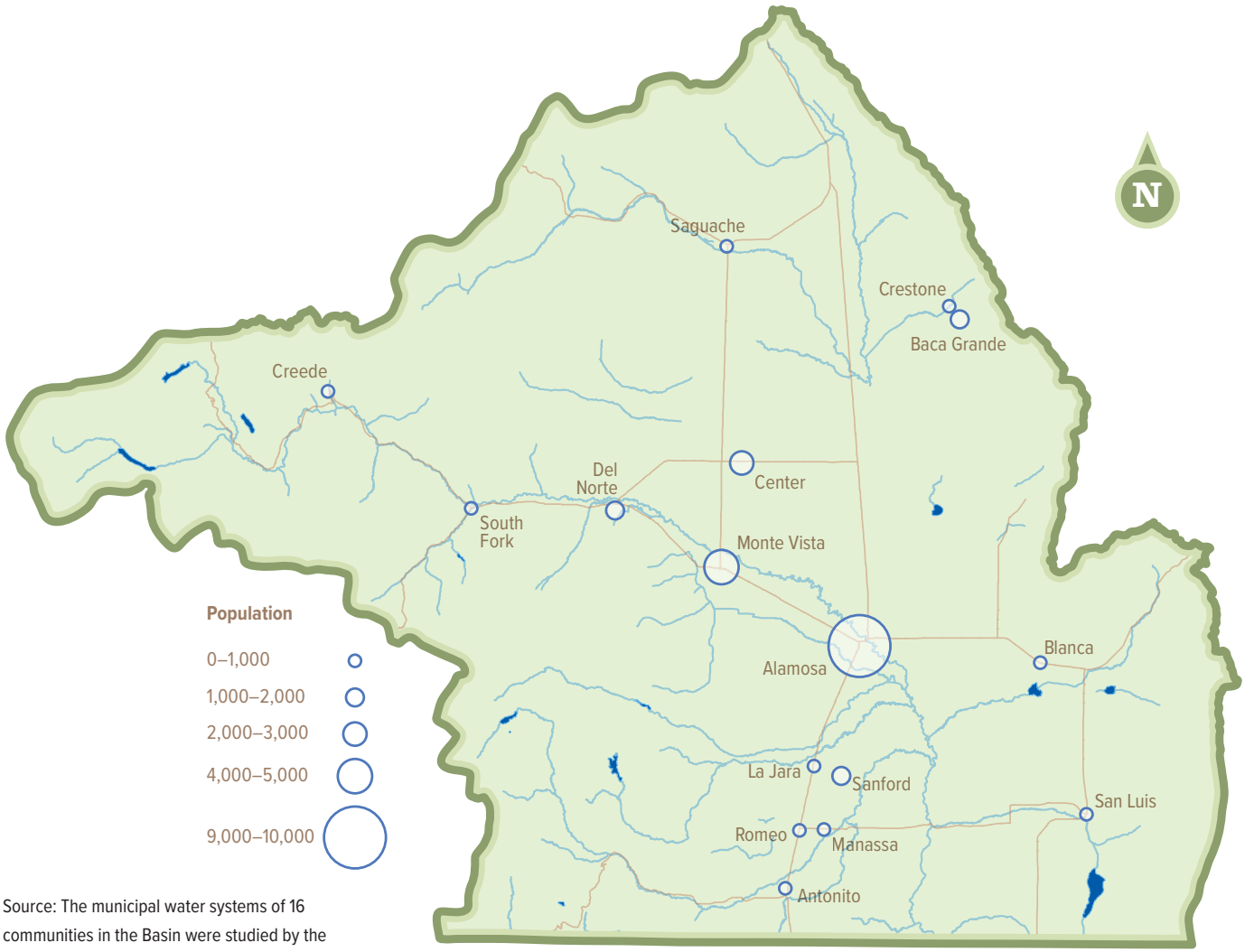
Due to the relatively minor water use represented by municipal users, there is little pressure for water conservation as a new water supply strategy. However, as municipal water rates increase to fund needed capital improvements and provide for augmentation supplies, the response to higher rates will tend to reduce water use. Municipalities are also beginning to implement water efficiency strategies, particularly for outdoor irrigation.

The municipal water systems of 16 communities in the Basin, shown in Figure 18, were evaluated and municipal officials interviewed, where possible. In general, the municipal water systems of many of the communities are antiquated and in need of major and costly repair, replacement, and/or upgrades within the next 10 years. The water quality of the wastewater discharges nominally meet current Colorado Department of Public Health and Environment discharge permit standards. If new and more stringent requirements are imposed for arsenic and other water quality standards, few of the towns have the ability or are prepared to fund the capital improvements required to upgrade the water and wastewater systems. Funding sources for municipal water and wastewater treatment improvements are not as readily available as for other types of water projects. For the majority of towns, the existing treated water infrastructure is believed to have adequate capacity to meet the treated water demands for the foreseeable future. A few of the towns, including Sanford, Romeo, and Baca Grande, may require the development of additional water resources in the future.

The towns that pump from unconfined or confined aquifer wells are required to replace their well pumping depletions to rivers and streams. Most of the towns have already joined a Subdistrict to fulfill augmentation requirements and will continue to acquire augmentation supplies in the future.

In addition to water for municipal needs, industrial water uses are primarily for fisheries, aquaculture, and agricultural product processing. Water for solar power generation is minimal.

FIGURE 18. Municipal water systems in the Rio Grande Basin.



Source: The municipal water systems of 16 communities in the Basin were studied by the M&I Subcommittee, either by canvassing City officials or by researching municipal situations.

TABLE 4. Summary of water supply, infrastructure, and water rights for Basin towns.

Town	Current Population (Estimate)	Sources of Physical Supply: Confined Wells	Sources of Physical Supply: Unconfined Wells	Sources of Physical Supply: Alluvial Wells/ Surface Water Rights	Supply Availability: Adequate Physical Supply	Supply Availability: Adequate Legal Supply	Infrastructure Assessment: Water Treatment/ Distribution Infrastructure	Infrastructure Assessment: Wastewater Treatment Infrastructure	Comments
Alamosa	9,441	X			Yes	Yes	Upgrades needed - replacement of water mains and meters	Upgrades needed - sewer lift station improvements	The City's stormwater management infrastructure is currently being assessed and improvement needs are expected.
Monte Vista	4,445	X	X		Yes	Yes	Upgrades needed - replacement of select water mains and service lines	Upgrades needed - wastewater treatment system improvements to reduce heavy metal discharge	The City's well augmentation is currently being finalized and is expected to be approved in the near future.
Center	2,230	X			Yes	Yes	Good - upgrades recently completed, including installation of a new water tower	Good	
Del Norte	1,547			X	Yes	Yes	Unknown - the Town's water mains and other service infrastructure are currently being assessed; improvement needs are anticipated	Good	
Manassa	993	X			Yes	Yes	Upgrades needed - distribution system improvements, such as installation of variable frequency drive (VFD). Other distribution system upgrades recently completed, including new generators and replacement of chlorination system	Upgrades needed - installation of wastewater treatment pond liner; collections system improvements, including raising manholes to reduce inflow and infiltration	
Sanford	1073	X			Yes	Yes	Acceptable	Acceptable	
La Jara	817	X			Yes	Yes	Good - upgrades recently completed, including installation of a new water distribution lift station.	Upgrades needed -construction of a new wastewater treatment pond and aeration system	There are concerns regarding potential water supply disruptions in the event of a fire. This potential risk is currently being assessed.
Antonito	656	X		X	Yes	Yes	Good - upgrades recently completed, including water mains replacement	Good - wastewater treatment facility recently upgraded	The Town receives a portion of its water from a surface water ditch, which will require regular maintenance in the future.

table continues

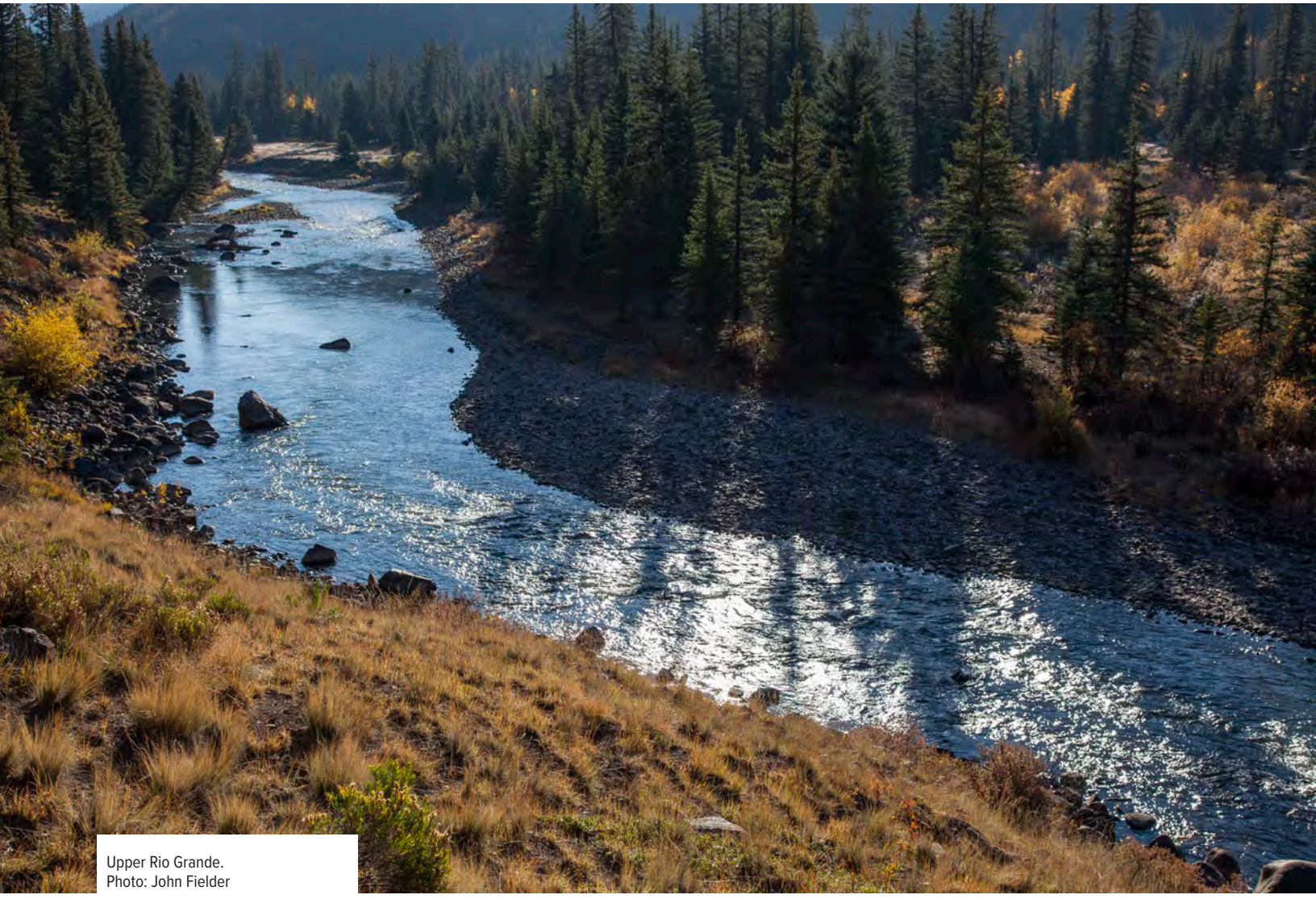
continued

TABLE 4. Summary of water supply, infrastructure, and water rights for Basin towns.

Town	Current Population (Estimate)	Sources of Physical Supply: Confined Wells	Sources of Physical Supply: Unconfined Wells	Sources of Physical Supply: Alluvial Wells/ Surface Water Rights	Supply Availability: Adequate Physical Supply	Supply Availability: Adequate Legal Supply	Infrastructure Assessment: Water Treatment/ Distribution Infrastructure	Infrastructure Assessment: Wastewater Treatment Infrastructure	Comments
San Luis	672	X			Yes	Yes	Acceptable	Upgrades needed - installation of wastewater treatment pond liner	
Saguache	455	X			Yes	Yes	Upgrades needed - replacement of water main valves; completion of systemwide leak detection test	Upgrades needed - the chlorination house needs to be upgraded.	The Town owns surface water irrigation rights that are currently being used to replace depletions caused by its well pumping.
Romeo	400	X			Yes	Yes	Upgrades needed - water storage tank repair; replacement of water mains	Upgrades needed - wastewater treatment facility improvements	The Town owns surface water rights that are used for irrigation.
South Fork	335			X	No	Yes	Upgrades needed	Upgrades needed	The Town is currently developing a water distribution and sewer system and continues to seek additional water supplies to ultimately achieve water infrastructure capable of supporting future growth.
Blanca	380	X			Yes	Yes	Good	Good	
Creede	345			X	Yes	Yes	Good - the City's water mains, curbside shutoff valves, and fire hydrants were replaced in 2013.	Upgrades needed - collections system improvements	
Crestone	198	X			Yes	Yes	Good	See below	The Town's wastewater treatment is served by Baca Grande.
Baca Grande	1450	X			Yes	Yes	Upgrades needed - distribution system repairs to address excessive leakage; replacement of asbestos concrete water mains	Unknown - currently evaluating upgrade needs	

4.3 : ENVIRONMENTAL AND RECREATIONAL NEEDS

The Basin has an abundance of terrestrial and aquatic wildlife populations, rare and important habitats, diverse ecosystems, and exceptional recreational opportunities. However, the increasingly water-short nature of the Basin makes sustaining these attributes challenging. Stakeholders will continue to work together to protect and enhance the needs of ecosystems, species and their habitats, and recreation areas of concern in the Basin. **Volume 1 Section 5** discusses a technical approach to the evaluation of the future and potential risks to environment and recreational attributes in the Basin.



Upper Rio Grande.
Photo: John Fielder

4.3.1 : WATERSHED HEALTH AND ECOSYSTEM FUNCTIONS

The high mountains of the Basin make up the watershed, which collects snowpack, the primary source of water supply, and produces water for water users downstream of Colorado. In addition to supplying water, the watershed provides critical ecosystem services, such as forests and rangelands, healthy soils and riparian areas, and critical habitat to area wildlife and fish.

Because the majority of the upper watersheds are forested, forest health is a key concern. The forests within the RGNF are in a **seral stage** transition following recent landscape-scale disturbances, such as wildfires, long-term drought, and current beetle and disease outbreaks. Additional threats to the forests include invasive species, climate change, and future land use changes. As such, it is important to improve the **resistance** to and **resiliency** prior to and following disturbances to watershed functions to protect the water supply source. Resilience can be added into the system by improving the diversity of species and age classes of forest stands, identifying areas where risks to critical water supply, storage, and conveyance facilities can be reduced or mitigated, restoring ecosystem functions through forest and riparian restoration projects, and conserving habitat and associated water rights in key areas.

Seral stages are distinct plant and animal communities that, occur during ecosystem succession.

Resistance is the ability of a system to absorb the impacts from a disturbance while retaining essential processes, such as supplying water, providing habitat, maintaining floodplain function, and preserving healthy soils.

Resiliency is the ability of a system to recover from disturbance, such as drought, fire, spruce bark beetle outbreak, or climate change.

4.3.2 : RIPARIAN NEEDS

Many riparian areas in the Basin are in need of additional efforts to improve and safeguard the critical ecosystem functions they provide. Several watershed and stream management plans are driving improvement projects in key riparian systems in the Basin. Riparian restoration and stabilization projects are needed to maintain and improve riparian habitat, water and sediment conveyance, stream bank stability, and floodplain function. Improvements to water quality that is impaired due to historic mining is another significant need; Willow Creek, Kerber Creek, and the Alamosa River

Erosion along the Rio Grande, near Alamosa. Photo: Heather Dutton.

continue to be impacted from mining runoff, which affects habitat, recreation, water supplies, and agriculture users.

4.3.3 : WETLAND NEEDS

Many types of wetlands with differing needs and water regimes exist in the Basin. Wetland systems, including riparian areas, require flood and drought in order to maintain the health, quality, and diversity of the wetland. A significant number of wetlands are tied to the unconfined aquifer, including those that exist as backwater sloughs along the Rio Grande and Conejos River corridors; thus, they are affected by fluctuating groundwater levels. Many of the large complexes of perennial wetlands in the Valley are actively managed, and, in some areas, water is supplied through irrigation wells to mimic natural processes that no longer occur due to extensive alterations to the ecosystem. As such, these areas will be impacted by groundwater rules and regulations, and the managing agencies will have to comply with subdistrict rules or obtain augmentation plans.

Though much has already been accomplished, additional efforts to protect and revitalize riparian areas and wetlands are underway to sustain and improve water quality, groundwater recharge, floodplain function, and critical bird, fish, and wildlife habitats. Many past successes have been multi-faceted to protect and restore a variety of wetland types on both private and public lands. This approach will continue to guide the Basin's future efforts.

Greater sandhill cranes on the Monte Vista National Wildlife Refuge. Photo: Rio de la Vista.

4.3.4 : HABITAT NEEDS FOR SENSITIVE SPECIES (THREATENED, ENDANGERED, CANDIDATE, AND INDICATOR SPECIES)

The BIP recognizes that addressing the water and habitat needs of specific species will inherently address the needs of many others. Therefore, completed projects that benefit threatened, endangered, candidate, or indicator species have high value toward improving environmental attributes.

Past estimates indicate there are approximately 200,000 acres of nationally and internationally important wetlands in the Basin, much of which is sustained by the Valley's underlying aquifers and/or irrigation for agricultural and/or wildlife purposes.

The following bird species are currently listed as endangered or threatened by State or federal agencies, or are proposed for listing as a candidate species or as a species of concern: the southwestern willow flycatcher, yellow-billed cuckoo, sage thrasher, snowy plover, and Gunnison sage grouse. The Basin provides important habitat for these species, and significant associated water needs exist in order to sustain populations; a variety of efforts are underway to address these needs.

Basin entities have partnered with the USFWS to provide long-term protection of the southwestern willow flycatcher and yellow-billed cuckoo through a regional Habitat Conservation Plan (HCP). The HCP process was initiated by the RGWCD in 2004 and is a partnership with the State of Colorado and Alamosa, Conejos, Costilla, Rio Grande, Saguache, and Mineral counties. The HCP is a community-based plan to conserve endangered species while allowing private land use and management to continue. Without the HCP, Basin landowners could be regulated under the Endangered Species Act. The HCP ensures protection of the two bird species by maintaining a bank of sufficient quality habitat. Meanwhile, landowners are authorized to modify habitat through routine agriculture operations, community infrastructure maintenance, and riparian restoration and conservation.

Basin entities are also working to address the needs of the Rio Grande cutthroat trout, the Rio Grande chub, and the Rio Grande sucker, which face decline due to habitat loss, competition with non-native fish species, hybridization with rainbow trout (the cutthroat trout), persistent drought, wildfire, climate change, and disease. Also, the boreal toad has experienced dramatic population declines over the past two decades from infections of chytrid fungus and loss of habitat. Recovery and regeneration of the boreal toad habitat is tied with forest recovery and will require overall and brood-rearing habitat protection on public lands as well private lands where boreal toads occur.

The Basin's rivers and streams provide the backbone for the communities, economies, and ecosystems of the Valley.

Mule deer in the Alamosa Valley.
Photo: Juanjo Sergura

Boating the Rio Grande past the conserved Rocky River Ranch, west of Del Norte. Photo: Rio de la Vista

4.3.5 : RECREATIONAL NEEDS — ENSURE PROTECTIONS, RESTORATION, WATER, AND ENHANCEMENT OF FACILITIES

The Basin has exceptional recreation attributes on both public and private lands. Through watershed and stream management planning efforts, stakeholders have identified ways to build upon the existing amount and quality of recreational opportunities. Many projects have been identified to improve recreational infrastructure, including river access and rectification of river hazards, and to restore riparian, wetland, and aquatic habitats.

Many projects that would benefit recreational needs may benefit other sectors as well. In addition to meeting agricultural and water administration needs, the rehabilitation of aging diversion structures and headgates (see Section 4.1.2) can be implemented to improve fisheries, riparian areas, and recreation through the addition of boat and fish passages, where appropriate. In general, boat passages are supported by the surrounding community and are part of a larger recreation plan. Fish passage should be incorporated with consultation from CPW, as fish barriers are needed in some locations to protect high-quality fisheries from predatory species. Projects that enhance riparian, wetland, and aquatic habitat are a great asset to angling and wildlife viewing, provide a boost in recreational opportunities, and should be pursued in conjunction with infrastructure improvements.

Spawning Rio Grande cutthroat trout at Haypress Lake on Humphreys Ranch, high in the Goose Creek corridor. Photo: Rio de la Vista

4.4 : WATER ADMINISTRATION NEEDS

The future management and administration of surface and groundwater is critical to the long-term viability of the Basin's water resources.

4.4.1 : SURFACE WATER ISSUES

As discussed in **Section 2.5.1** and **Section 2.5.2**, compliance with the Compact is the Basin's first priority regarding surface water administration. As has been demonstrated in the past, the support of this effort has come from multiple sources and through multiple projects:

- Riparian restoration, reducing sediment loading that increases the ability of Rio Grande and Conejos River to transport sediment loads through the system (Rio Grande Headwaters Restoration Project).
- Installation of automated headgates on diversions to ensure irrigators are diverting only their legal entitlement of irrigation water. This has occurred on the Rio Grande and Conejos River (Conejos Water Conservancy District).
- Application of data collection and subsequent diversion control, allowing water administrators to have greater control of the allocation of irrigation water within the legal limits. This has occurred on the Conejos River.
- Consolidation of headgates is planned on the Conejos River and will be implemented, when appropriate, on streams throughout the Basin. Again, these projects provide the opportunity to simplify Compact administration.

- Improvement in streamflow forecasting. New radar technology is being applied in an attempt to improve snowpack data collection and streamflow forecasting on the Rio Grande and Conejos River. The forecasts are used for Compact administration.
- A commitment in the Basin to support the Division Engineer in the administration of the Compact. Opportunities will continue to be identified to carry on this effort.

These projects are examples of efforts to improve water resources in the Rio Grande while improving the ability of the Basin to meet its Compact obligations. Further multi-discipline efforts are needed and will continue to be a RGBRT priority, as the ability to manage surface water supplies is projected to become increasingly difficult.

The critical need for accurate streamflow forecasting has become more apparent as drought has continued, snowpacks have declined, and runoff becomes less predictable.

Recent years have highlighted the critical need for accurate streamflow forecasting. This need has become more apparent as drought has continued, snowpacks have declined, and runoff becomes less predictable. Accurate streamflow forecasts can enhance administration of the Compact by minimizing over- and under-deliveries to downstream states, better predicting Compact curtailments, and minimizing stream dry-ups. Efforts have been made to apply new technologies to snowpack measurements, including depth and snow water equivalent (SWE), from which the subsequent streamflow forecasting is determined. The work to date has included initiatives by local water users, the DWR, and CWCB, who in turn have engaged the NOAA National Severe Storms Laboratory (NSSL), NCAR, NASA and the Airborne Snow Observatory (ASO), and researchers from the University of Oklahoma. The use of radar measurements, LiDAR data collection, and snow depth measurements from the ASO have been conducted in the Conejos River watershed and incorporated into NCAR's WRF-Hydro model to forecast flows. This pilot project has illustrated the benefits of such data collection and is expected to continue and be applied throughout the Basin. The Conejos pilot project also proved the need for a permanent Basinwide radar system, which was installed in 2019. The RGBRT will continue to support these efforts to improve the accuracy and consistency of streamflow forecasting.

Flexible administration and operation of reservoirs that allow for partnerships to be implemented are needed to enhance the ability to store water for Compact, agricultural, municipal and industrial, and environmental and recreational needs, and to provide for retimed releases to meet multiple purposes while protecting downstream water rights. A diverse group of Basin stakeholders are working together to maximize the benefits of reservoir storage and releases and continue to identify and implement new opportunities for such arrangements. Again, it will be the role of the RGBRT to assist in identifying such opportunities and facilitate their implementation.

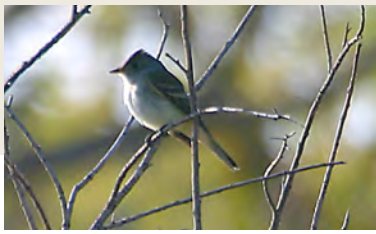
4.4.2 : GROUNDWATER

As discussed in **Section 2.5.3.3: Groundwater Management Subdistricts**, groundwater users across a spectrum of disciplines are working to reach sustainable aquifer levels. This is being accomplished through meeting the requirements of SB 04-222, the Division 3 Well Rules and Regulations, and the seven established Groundwater Management Subdistricts throughout the Valley. The RGBRT will continue to support the efforts to attain sustainability of both the confined and unconfined aquifers to support the long-term viability of the Basin's associated agricultural, environmental, and recreation economies.

Winter snowpack on Montezuma Peak in the San Juans. Photo: Heather Dutton

Rio Grande and center-pivot hayfield, just above Del Norte. Photo © Adriel Heisey / www.adrielheisey.com

5 CONSTRAINTS AND OPPORTUNITIES



Southwestern willow flycatcher at McIntire-Simpson BLM property. Photo: BLM

The Basin will face several key challenges with respect to water management into the future.

- Groundwater is a key component of water use in the Basin for M&I, agriculture, and many areas of wildlife habitat; groundwater use is at unsustainable levels and its management presents an ongoing challenge.
- There may be significant economic impacts from reduced agriculture in light of reduced groundwater and surface water supplies.
- The Compact is increasingly difficult to administer with the effects of prolonged and lingering drought, changes to runoff timing and amounts, and other environmental factors impacting surface water supplies.
- Drought, climate change, wildfires, dust on snow, and forest succession due to diseases and insect outbreaks impact hydrology within the Basin.
- Residential, commercial, and industrial growth is creating a need for augmentation water supplies to replace depletions associated with these uses.
- Aquatic-dependent wildlife species are being considered for or already listed as a threatened or endangered species under the Endangered Species Act.

Planning for future modified water availability in light of these constraints will be an ongoing challenge.

5.1 : CONSTRAINTS

The constraints identified in this section of the Plan describe the Basin's current and anticipated water-related challenges. Future, unforeseen constraints may emerge that influence the development of projects and methods to meet the needs identified in this Plan.

5.1.1 : RIO GRANDE COMPACT

The Rio Grande Compact plays a central role in the administration of water in the Basin. See **Section 2.5.1: Rio Grande Compact** and **Section 2.5.2: Surface Water Administration** for a brief history and description of administration of the Compact. The Compact requires a portion of the annual flow in the Rio Grande and Conejos River be delivered to New Mexico, where it is further distributed to Texas and Mexico. The amount of water that must be delivered is determined by a sliding scale, with increasing delivery requirements as the total streamflow increases. The Compact requires deliveries to New Mexico regardless of changes to Basin hydrology or climate; thus, meeting the Compact obligations in a potentially drier future will create further decreases in surface water supplies.

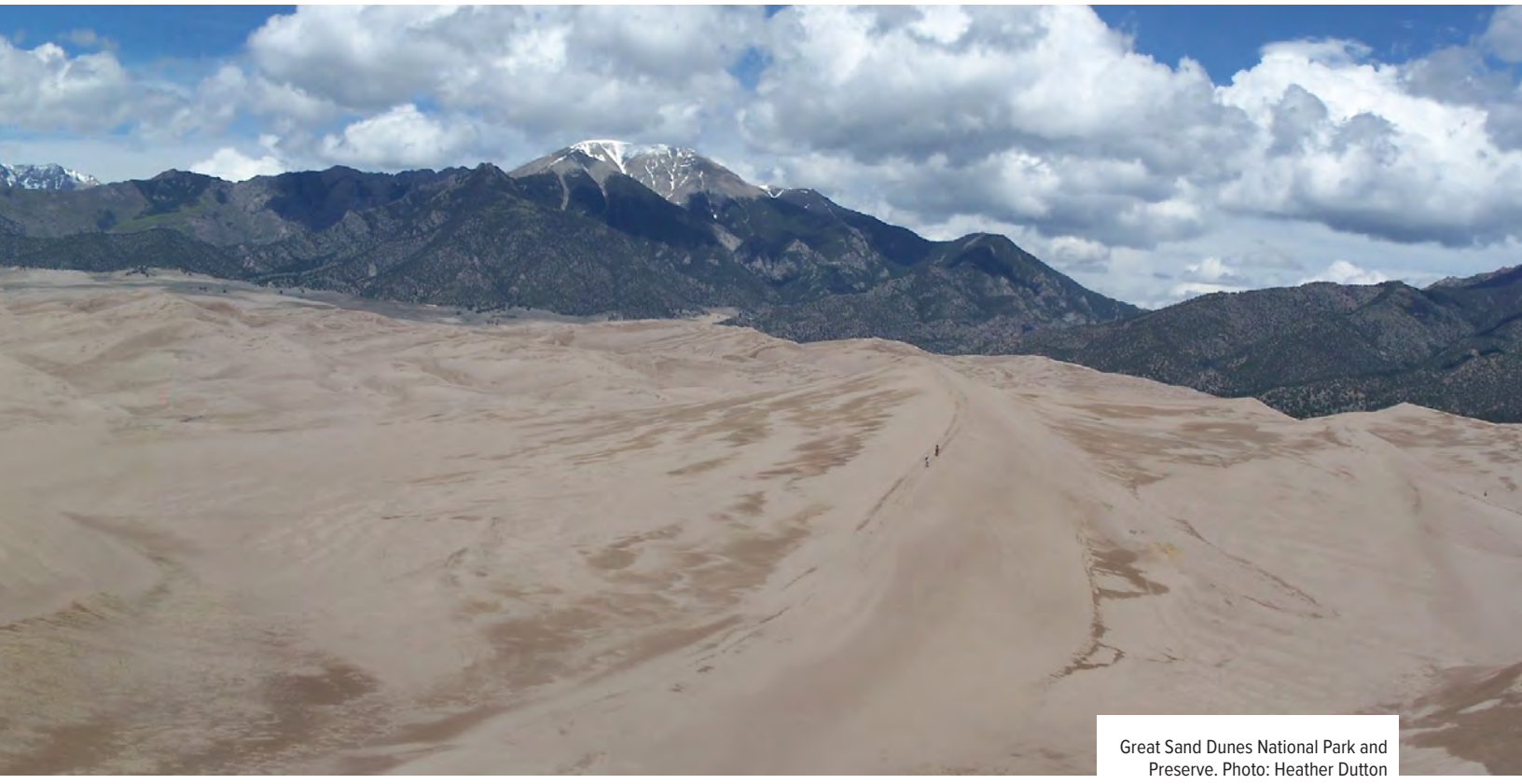
Meeting Rio Grande Compact obligations in a potentially drier future will create further decreases in surface water supplies.

5.1.2 : FACTORS AFFECTING HYDROLOGY

5.1.2.1 PROLONGED AND LINGERING DROUGHT

An extended drought that began in 2002 and, with the exception of a few wet years, continues into 2021, has resulted in significantly lower snowpack accumulation and runoff in the Basin than the long-term historical average. For example, the average river flow at Del Norte since 2000 has been 14% lower than the long-term historical average. Some climate change scenarios indicate that flows could decrease by 30% from the long-term average (see **Section 5.1.2.5: Climate Change** for additional detail).

Over the past 20 years, this decline has led to over-reliance on groundwater, depletion of the aquifers, and the urgent need to rebalance water uses to achieve a sustainable water supply. If the flows in the Rio Grande and Conejos River continue at the 2000 to 2020 levels, the water available for aquifer recharge will be further reduced, along with increased demand on groundwater. See **Section 2.5.3: Groundwater Administration** and **Section 5.1.3: Aquifer Sustainability** for additional information about the impacts of changes in flows and Compact deliveries on the groundwater resources in the Basin. **The effects of prolonged and lingering drought have broad implications for water management and have also been contributing factors to erratic wildfire behavior, beetle outbreaks, and dust on snow events. Although both wildfire and insect-induced forest mortality are naturally occurring events and important aspects of forest ecology in western US forests, recent periods of extreme drought, combined with poor forest management practices, has likely caused these natural phenomena to become much more disruptive than they would be otherwise.**



Great Sand Dunes National Park and Preserve. Photo: Heather Dutton

West Fork Complex Fire near Del Norte. Photo: Travis Smith

Little Squaw Canyon after the West Fork Complex Fire. Photo: Heather Dutton

5.1.2.2 FOREST FIRES

Across the West, wildfires are increasing in size and frequency. With historic suppression of fires, reduced numbers of forest thinning and logging projects, and chronic insect outbreaks, heavy fuel loads exist. As such, wildfires are burning at a higher intensity and causing more severe impacts to watersheds. Research and recent fire history predict an increase in the geographic extent, intensity, and length of fire seasons.

Two large wildfires have impacted the Rio Grande Basin in recent history. In 2013, the West Fork Complex Fire (WFCF) burned 109,500 acres, with roughly 88,000 acres on the RGNF and 21,500 on the San Juan National Forest. In 2018, the Spring Fire burned a total of 108,045 acres, 25,970 of which were in Costilla County and 82,075 of which were in Huerfano County.

In addition to public safety and private property concerns, these large wildfires raised concern for damage to natural resources within the Basin. The WFCF raised significant concern regarding impacts to water supplies, as the fire was situated at the headwaters of the main stem of the Rio Grande and many of its major tributaries.

Wildfires have several impacts upon hydrology and water quality. As has been documented in other post-wildfire landscapes, snowpack, spring runoff levels, and timing of flows will likely be altered by a lack of overstory vegetation to gather and shade ground snowpack, and by the black, charred backdrop that increases solar intensity and melting. On the other hand, lack of vegetation reduces evapotranspiration, which results in greater infiltration.

5.1.2.3 BEETLE KILL

Beetle infestations in Colorado's forests result in complex impacts to hydrology and other watershed characteristics. Spruce bark beetles, native to the RGNF, have killed vast spruce forests in headwaters areas. The beetles kill the trees by burrowing under bark and eating through the vital layers of xylem and phloem. This causes a break in these layers of vascular tissue, inhibiting their ability to transport water and nutrients and resulting in the tree's death.

An adult spruce beetle bores into the bark of a spruce. Source: Grand Mesa Uncompahgre and Gunnison National Forests

Between 2005 and 2012, 480,000 acres of the RGNF have been impacted by spruce beetles or other beetles and diseases. This equates to approximately 85% of the total spruce-fir forest, as shown in Figure 19. In 2013 alone, the infestation on the RGNF expanded an additional 98,000 acres, as detected by a Colorado State Forest Service (CSFS) forest health aerial survey. Over the past four years, the rate of spruce beetle and other insect infestations has declined significantly because the majority of the spruce-fir forests and Engelmann spruce components of mixed conifer forests have been infested on the RGNF.

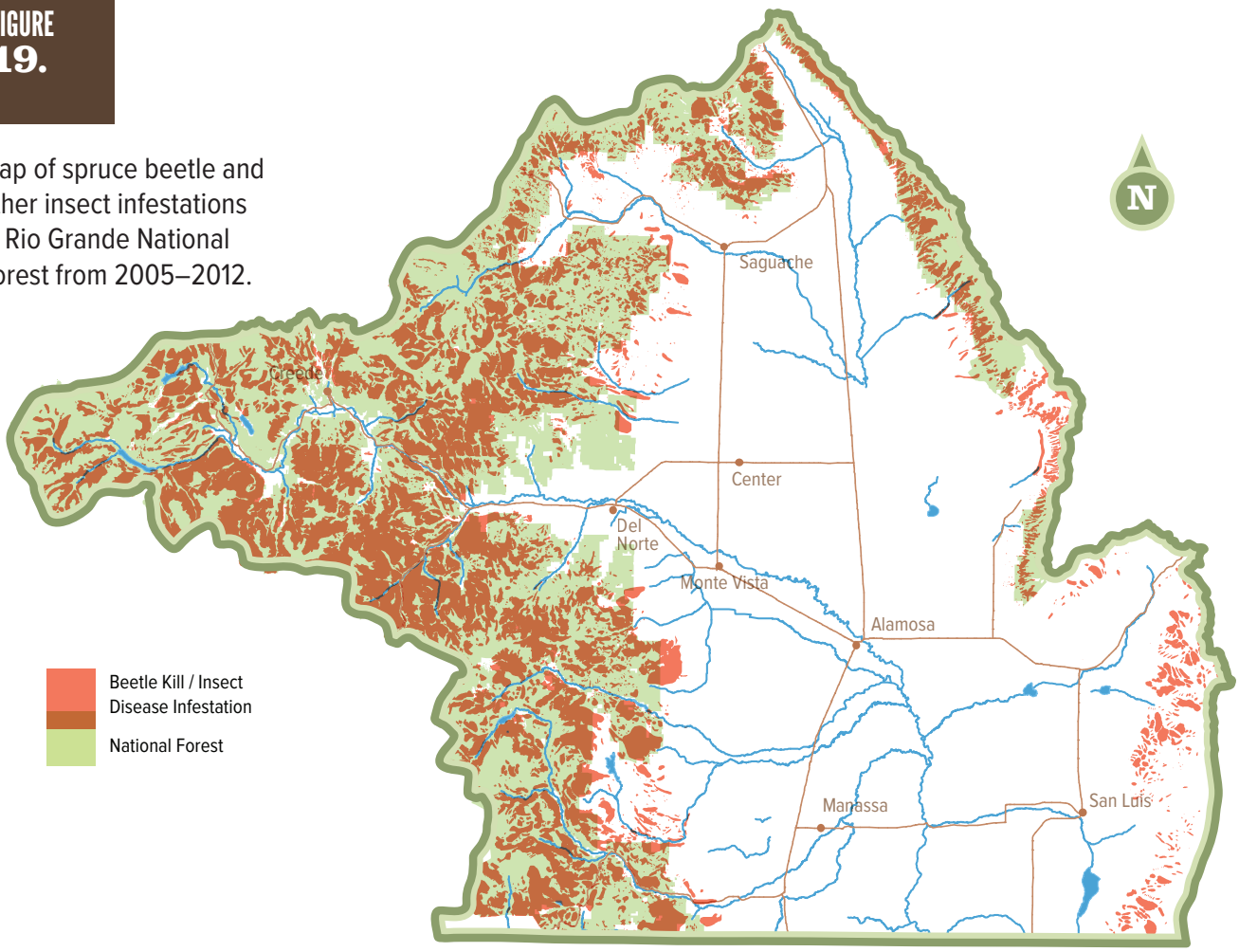
Beetle kill in the Rio Grande National Forest. Photo: US Forest Service

The hydrologic impacts of landscape-scale changes in forest condition, such as die-offs from beetle infestations, can last for decades. Similar to the impacts of wildfire, the impact of beetle-killed forests is significantly less overstory, leading to changes in snowpack accumulation and rate of melt, ablation, infiltration, evapotranspiration, and rate of runoff. However, the patchwork nature and slower disturbance timeline of beetle infestations and resulting forest succession may reduce the magnitude of these impacts to the hydrologic regime.

There is a great deal of interest in the impacts of bark beetles on fire regimes in Colorado forests. It is believed that the severe drought, high temperatures, high wind, and stand structure of the dead spruce impacted behavior of the 2013 WFCF on the RGNF and the San Juan National Forest. The spruce beetle-killed forests burned at a much hotter level, and fires moved from ground to the crown at a much faster rate than observed in live forests. A GIS analysis of the WFCF completed for the 2015 BIP indicated that 67% of the low-intensity burned area had beetle infestation, while 87% of the medium- and high-intensity burned areas had beetle infestation.

FIGURE 19.

Map of spruce beetle and other insect infestations in Rio Grande National Forest from 2005–2012.



5.1.2.4 DUST ON SNOW

Dust on snow at the top of Red Mountain Pass. Photo: Steve Vandiver

Dust on snow has long been a phenomenon occurring in Colorado. However, deteriorating range conditions in upwind and source locations (both outside of and within Colorado) have increased severity of dust on snow events, and recent studies are revealing the extent of its impacts. Initiated by strong winds, desert dust blows into the Colorado high country and settles in layers on the snowpack in the headwaters of river basins. As temperatures warm in the spring, these layers emerge, and snow covered with dark particles absorbs more of the sun's rays and melts faster than clean white snow. Exacerbating the problem, the dust layers grow darker and more concentrated as the snow beneath them melts, thus accelerating the runoff rate even more as the sun's intensity grows with the approach of summer. Dust on snow has significant impacts on runoff, evapotranspiration, and snow cover, including:

- More absorption of solar radiation from dust on snow can shorten snow cover by several weeks.
- Shortened snow cover causes peak runoff to occur an average of three weeks earlier.
- A longer snow-free season results in earlier plant germination and increases evapotranspiration losses.
- Evapotranspiration losses are estimated to decrease annual runoff by 5% of the annual average flow.
- The highest snow accumulation areas show the greatest sensitivity in date of snowpack disappearance.

Dust on snow in the Rio Grande headwaters. Photo: Heather Dutton

The source of dust that deposits on snow in the Rio Grande headwaters comes from a complex mixing from multiple source areas, with the Four Corners region being an important source of dust. No data have been published at this time, but the Colorado Dust on Snow (CODOS) program collects dust from snow sites and performs chemical analysis to tie the dust back to samples collected by USGS in the Colorado Plateau source area. Similarly, the Valley is a source of dust for other parts of Colorado, including the western side of the Sangre de Cristo mountain range.

Dust on snow is a current problem within the Basin. Furthermore, studies show that future climate changes will also impact snowmelt and runoff. To evaluate combined dust on snow and climate change impacts, Deems et al. (2013) compared combinations of dust and climate scenarios to the medium dust historical scenario that represents current conditions. The Deems et al. (2013) model results show that a future, warmer climate has a substantial impact on snow cover duration relative to the current climate and dust environment. The study further suggests that earlier runoff as a result of dust on snow will continue under future climate scenarios, but the effects of climate change and dust on snow are not completely additive. For example, if dust on snow results in a two-week-earlier runoff and climate change results in a three week-earlier runoff, the combined effect will be significant, but likely less than the inferred five-week sum.

5.1.2.5 CLIMATE CHANGE

Climate change describes the observed and projected trends and variability associated with long-term weather patterns. The Basin hydrology is driven predominately by precipitation and temperature. Over many decades, decision making and policy for water management have been based upon existing hydrology. With changes already being observed and climate change science suggesting even greater change, new decision-making protocols and policy should consider the best available science, forecasts, and understanding of uncertainty in order to minimize negative impacts from these changes in hydrology.

Studies suggest that Basin climate change impacts include decreased precipitation and snowfall, earlier snowmelt, and increased evaporation. Furthermore, as temperature increases, climate projections indicate that the ratio of precipitation falling as rain-to-snow, will likely shift toward more rain and less snow (Elias et al. 2015). Because the Basin's hydrology is primarily snowmelt-driven, this shift from snow to rain will have significant impacts on natural flow regimes. For example, increased precipitation in the form of rain paired with higher air temperature will increase the rate of evapotranspiration, resulting in less water reaching streams and contributing to streamflow (Chavarria and Gutzler 2018). Studies also suggest this shift will cause less predictable, "flashier" streamflow and a reduction in the natural snowpack reservoir will accelerate the trends of decreasing annual streamflow, earlier peak flow, and lower late summer flow. The overall predicted result is reduced streamflows, an increase in stream water temperatures, increased

Studies suggest that impacts include decreased precipitation and snowfall, earlier snowmelt, and increased evaporation. See Volume 1, Section 5: Demand, Supply, and Potential Water Needs, for more potential future impacts of climate change on the Basin's water resources.

evapotranspiration and subsequent irrigation requirements, shortages to water users, and reduced recharge and subsequent groundwater levels.

The Upper Rio Grande Impact Assessment (Dagmar and Vaddey 2013) was performed by the BOR in partnership with Sandia National Laboratories and the U.S. Army Corps of Engineers to assess the impact of climate change on the Upper Rio Grande Basin from the headwaters in Colorado to Caballo Reservoir in south central New Mexico. The report's findings show impacts to the Rio Grande and Conejos systems. Key results from the report include:

- Flows at the index stream gages (Rio Grande near Del Norte, Conejos River near Mogote, Los Pinos River near Ortiz, and San Antonio River at Ortiz) will decrease by approximately one-third overall by 2100.
- The peak flows will shift to earlier in the year — from June to May.
- Fewer water rights are served on average as a result of the decreased flow.
  - From 1950 to 1999, the average junior-most water right to be served in June on the Rio Grande was a 1910 priority, whereas by 2100 it is anticipated to be an 1890 priority.

5.1.2.6 SUMMARY OF FACTORS AFFECTING HYDROLOGY

The current factors affecting hydrology, combined with the projected impacts of climate change, can lead to cascading impacts. For example, more intense droughts and higher temperatures lead to a greater moisture deficit in the region's forests. Trees that are not receiving adequate water are more susceptible to beetle infestations, and infected weakened and dead trees may increase the intensity of wildfires. Climate change may add compounding effects to areas already infested with bark beetles, including even earlier runoff and smaller runoff amounts. The combination of faster and increased snowmelt due to dust on snow, direct climate warming impacts on snow accumulation, and the rate and timing of snowmelt threaten an amplified impact on snowpack. As a result of potential changes in snowmelt and streamflows/runoff, aquatic organisms will be under additional stress. These potential impacts are discussed in detail in **Volume 1, Section 5: Demand, Supply, and Potential Water Needs**. An overview of the impacts on hydrology from these factors — dust on snow, beetle kill, forest fires, and climate change — is provided in Figure 20.

Photo: Rio de la Vista

The current factors affecting hydrology, combined with the projected impacts of climate change, can lead to cascading impacts.

FIGURE 20

Summary schematic of environmental impacts on hydrology.

FACTOR	Forest Fires — immediate impact	Beetle Kill — red and grey phases	Dust on Snow	Climate Change
IMPACT ON...				
Timing of Runoff Flow and Peak Runoff	EARLIER Increased, up to 2–3 weeks earlier	EARLIER Up to 1 week earlier in the red phase due to decreased albedo	EARLIER 3–6 weeks earlier for UCRB	EARLIER Up to 1 month earlier (from June to May)
Volume of Runoff Flow	INCREASE Increased, varies by watershed, climate and fire severity, but up to 100 times those previously recorded	MIX Undetermined. Higher rates of sublimation and increased sunlight penetration, but up to 5% rise in streamflow due to forest canopy loss, offset by increased growth rate of surviving understory trees, patchwork nature of infestations, slow progression of tree death and decomposition	DECREASE Reduce by about 5% due to evapotranspiration, does not include sublimation for UCRB	DECREASE Decrease by approximately 1/3 overall at the index gages and by 50% at the Lobatos Gage by 2100
Snow Accumulation	INCREASE	INCREASE Grey Phase - 5%–15% more total snow accumulation	No Impact	DECREASE Projected to decline by 10-20% by 2050 in Colorado
Water Infiltration	DECREASE Reduced, dead trees do not consume as much water, higher instances of sediment loading	INCREASE Increased or No change, surviving trees can grow up to 3x faster in beetle kill conditions, up-taking 3x more water	No Impact	MIX Undetermined, maybe earlier or later due to several factors
Time of Snow Disappearance	EARLIER several weeks earlier and more rapid	EARLIER	EARLIER 50–43 days earlier, shortened duration of snow cover	EARLIER Earlier up to 1 month, similar to peak runoff
Data Sources:	Gleason et al. 2012; Neary et al. 2011	Gordon et al. 2014	Deems et al. 2013; Landry 2014	Llewellyn and Vaddey 2013

5.1.3 : AQUIFER SUSTAINABILITY

Confined aquifer well development began in the 1870s with the discovery of the relatively shallow artesian system. By the turn of the century it was reported that there were more than 2,000 small artesian flowing wells in the valley. Well development in the unconfined aquifer of the Basin began in the 1920s with scattered development across the Basin. In the late 1930s new well development increased significantly, and by 1952 there were 1,300 large capacity unconfined aquifer wells in the Basin. Today there are over 6,000 irrigation, commercial, and municipal wells in Division 3 in the confined and unconfined aquifers combined. This well development led to extensive groundwater use and over appropriation, eventually resulting in the need for groundwater withdrawal rules and regulations. Because the sustained and lingering drought since 2002 has not been matched with a decline in agricultural consumptive use, use of the aquifers in several areas of the valley is currently unsustainable.

As aquifer levels declined, the Basin has realized both the practical and legal needs to restore and sustain the aquifer levels that support the many important attributes of the region. As discussed in **Section 2.5.3: Groundwater Administration**, Basin groundwater users are required by law to restore and maintain the aquifer at sustainable levels. Great strides have been made, including the formation and operation of subdistricts, also described in **Section 2.5.3**. However, in some subdistricts, meeting aquifer sustainability requirements and replacing stream depletions is a significant challenge and will require significant reductions in pumping. In addition to agricultural well users, cities and towns supplied by groundwater wells are also subject to the well rules and must join a subdistrict or enroll in an approved augmentation plan to remain in compliance.

Based on the estimated current average annual over-draft of the Basin's aquifers, many water users may be required to reduce consumptive use. Along with this reduction, the Basin will see a decrease in agricultural production

Confined well discharge to ditch. Photo: Kelly DiNatale

which will have ripple effects throughout the Basin's overall economy. Deeper groundwater levels also translate into higher pumping costs and lower well yields, which further stress agricultural producers. However, with the restoration of the aquifers to a sustainable level, this stress may be lessened.

As described in section **2.5.3.3: Groundwater Management Subdistrict**, well pumping causes injurious depletions to surface water users due to surface water (stream) depletions, as modeled by the RGDSS. Subdistricts replace these depletions per their Annual Replacement Plan (ARP), which helps maintain streamflows. Replacement of depletions and working toward aquifer sustainability is also critically important to many surface and subsurface hydrologic features of the Basin, such as the hydrology of the Great Sand Dunes, the health of countless wetland complexes, and the ability of producers to harvest hay and graze livestock in historically subirrigated pastures. Wetlands and other groundwater-dependent wildlife habitat, including habitat in many state, federal, and private lands, depend upon aquifer sustainability. Any further withdrawals will impact wildlife, especially migratory birds.

5.1.4 : FUNDING

The Basin has a history of positive cooperation in protecting water resources and implementing water-related projects.

Funding of water projects, both in the Basin and statewide, will continue to be a significant challenge. Regardless, implementation of the projects identified in **Volume 1** is critical. The Basin has a history of positive cooperation in protecting water resources and implementing water-related projects. Multi-purpose projects and public/private partnerships that provide multiple benefits have a strong track record of success and broad-based support for securing funds and achieving implementation. Many Basin entities have succeeded in obtaining such funding as State and federal grants, loans, donations, and in-kind contributions; they will continue to seek diverse support for needed projects. The RGBRT will also continue to encourage cooperative projects and diversified funding.

5.2 : OPPORTUNITIES

The opportunities identified in this section of the BIP are meant to describe potential currently known Basin opportunities. These are not meant to limit projects that can address future, unforeseen opportunities, but rather are intended to give only an overview of current circumstances and how they may be addressed. For more information on future strategies and the Basin's vision for a sustainable water future, see **BIP Volume 1, Section 6: Strategic Vision for the Future.**

5.2.1 : GROUNDWATER MANAGEMENT SUBDISTRICTS

As discussed in **Section 2.5.3: Groundwater Administration** and **Section 5.1.3: Aquifer Sustainability**, Groundwater Management Subdistricts were enabled in 2004 with the passage of Senate Bill 222 (SB 04-222). The Bill addressed declining aquifer levels in the Valley and potential injury to senior water rights caused by stream depletions from well pumping in the Basin. With the approval and of well rules, well users are now required to replace injurious depletions, calculated by the RGDSS model, by joining a subdistrict or entering into plan of augmentation for their well. In an effort to comply with SB 04-222 and the Division 3 well rules, groundwater users in the Basin have formed seven Groundwater Management Subdistricts to replace depletions, reduce pumping, and achieve aquifer sustainability.

The Groundwater Management Subdistricts represent a proactive opportunity for water users to avoid potentially onerous administration or the significant expense of decreeing individual augmentation plans for their individual wells. Subdistricts continue to be an important strategy for attaining aquifer sustainability while maintaining a robust agricultural economy.

5.2.2 : ADDITIONAL USES FOR BASIN RESERVOIRS

Coordinated operation of reservoirs in the Basin will improve the management of surface water resources. The continued cooperation of reservoir owners to optimize storage and release opportunities will help meet agricultural demands, enhance river flows to meet environmental needs, increase recreational opportunities, provide a reliable supply of augmentation

Rio Grande Reservoir.
Photo: Rio de la Vista

water for agricultural, domestic, and M&I users, and assist in Compact compliance. The rehabilitation of existing reservoirs is necessary to maintain the safety and long-term viability of these facilities. There are opportunities through cooperation to improve the operation of the pre- and post-Compact reservoirs in the Basin in a way that achieves multiple benefits. Pre-Compact reservoirs are beneficial for fully developing and retiming Compact deliveries, groundwater augmentation, and other water deliveries from State agencies.

5.2.2.1 STORAGE IN PRE-COMPACT RESERVOIRS

There are four pre-Compact reservoirs located in the Basin upstream of Del Norte: Rio Grande, Santa Maria, Continental, and Beaver Park. When these reservoirs store in-Basin supplies, they do not trigger a delivery obligation until the water is released and passes the Del Norte gage. The storage in these reservoirs can be used to manage Compact deliveries to prevent over-delivery and provide for a more consistent and equitable curtailment. These reservoirs can also meet other water needs through cooperative storage agreements. In some cases, use of post-Compact reservoirs for timed releases is also possible.

Benefits of cooperative storage agreements may include:

- Direct flow storage for agricultural users
- Storage for Groundwater Management Subdistricts, an important component of annual replacement plans to meet stream depletions
- Storage to towns, the San Luis Valley Water Conservancy District, and other users to provide for augmentation of out-of-priority well pumping depletions
- Opportunities for improved water administration with more consistent curtailment percentages, creating potential equity among all water users

Rio Grande enters Rio Grande Reservoir.
Photo © Adriel Heisey / www.adrielheisey.com

- Maximizing the beneficial use of water within Colorado within the legal framework of the Compact
- Limiting the potential for over-delivery by holding over water until the next water year if Compact deliveries will be satisfied
- Retiming releases to provide for instream environmental and recreational benefits while protecting downstream water rights
- Consistent curtailment and elimination of over-delivery, minimizing the dry-up of the Rio Grande by creating a live stream all the way to the state line

Maintaining a live stream and eliminating dry-up locations, in addition to the environmental and recreational benefits, ensures the ability to maintain deliveries to downstream users in the Basin and Compact deliveries by not having to replenish the stream alluvium that was drained during periods of dry-up.

The Rio Grande Cooperative Project and the Winter Flow Program, both of which involve a diverse set of partners, have demonstrated that cooperative agreements among reservoir owners, State agencies, water rights holders, and environmental interests can result in benefits to multiple parties.

5.2.2.2 AUGMENTATION DELIVERIES AND FLEXIBLE WATER STORAGE AND SHARING AGREEMENTS

As described above, non-exempt well users throughout the Basin are required to provide replacement water for well pumping depletions. Pumping from a confined or unconfined aquifer well results in stream impacts that are lagged over many months or years depending on the location of the well and geology in the region. Under Colorado water law, any legally injurious lagged stream impacts must be replaced or augmented to the stream at the time and location of the impact. Currently, most well users, including agriculture and environmental irrigators, towns, and industrial users that pump groundwater, have joined one of the seven subdistricts in the Basin, which provide augmentation water for those wells. Additionally, the San Luis Valley Water Conservancy District (SLVWCD) provides augmentation water for many non-irrigation wells.

The use of reservoirs throughout the Basin is critically important for Subdistricts and other entities to replace stream depletions.

The reservoirs in the Basin can act as regulating vessels for delivery of the augmentation water to specific streams. Augmentation supplies can be stored in reservoirs and then released at the rate, in the amount, and to the location of the stream impact. The use of reservoirs throughout the Basin is critically important for Subdistricts and other entities to replace stream depletions. Whenever possible, water rights owners and Basin stakeholders work together to deliver augmentation water at times when increased streamflow has the greatest benefit for aquatic organisms and recreation. Flexible and adaptive water administration are also discussed in **Volume 1, Section 4: Updated Goals and Objectives.**

Doppler on wheels deployed during the late summer of 2013. Photo: Joshua Wurman, Center for Severe Weather Research

5.2.3 : IMPROVING STREAMFLOW FORECASTING

Accurate measurement and prediction of streamflow are critically important to Basin water users, particularly for annual Rio Grande Compact administration and daily determination of curtailment on diversions for the Rio Grande and Conejos River, as described in **Section 2.5.1: Rio Grande Compact**. Ideally, these forecasts should be based on accurate estimates of snowfall, careful monitoring of the water content and behavior of snowpack, and a good understanding of snowmelt, runoff, and streamflow. However, the ability to accurately collect all of these data is limited. **Section 2.5.2: Surface Water Administration**, describes how the DWR uses the forecast to estimate Compact deliveries and set curtailment. **Section 4.4: Water Administration Needs** describes the need for improved forecasting.

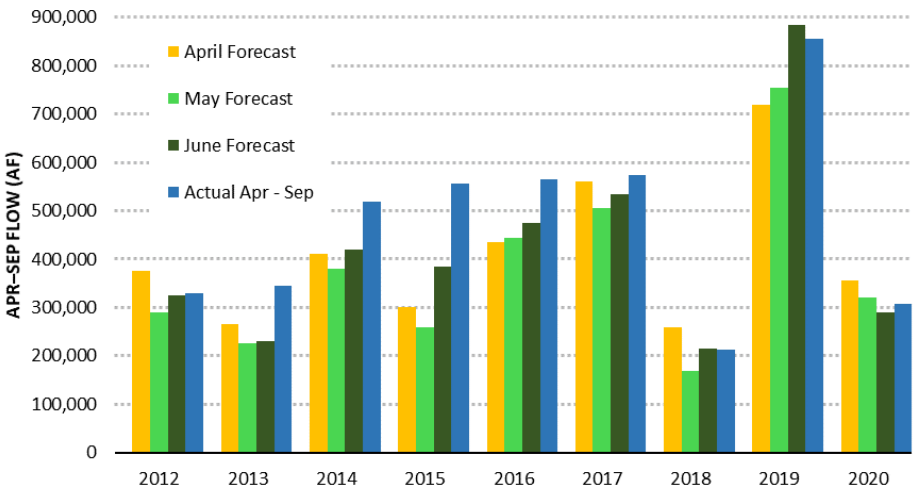
An overestimation of streamflow, leading to a higher-than-required curtailment through peak runoff, may result in reduced opportunities for junior water rights to divert and/or reservoirs to store. In the Rio Grande, this can mean less water diverted into the Closed Basin for groundwater replenishment. On the Conejos, it can result in lost opportunities to implement direct flow storage in the Platoro Reservoir for release to irrigators later in the season. Eliminating the risk of over-delivery through improved streamflow forecasting will also minimize the dry-up of the river that often occurs in late summer or fall when it appears an over-delivery may occur.

If the streamflow forecast is too low, the curtailment will be set low, as the delivery as a percentage of the index gages is less at lower streamflows. If it is determined after runoff that there is a chance for under-delivery under the Compact, the curtailment may be increased. Since the flows are lower after runoff, the increased curtailment is more likely to affect senior water rights holders. Improving streamflow forecasting in the Basin could prevent such issues. To understand how forecasts can be improved, the difference between

FIGURE 21.

NRCS-forecasted and actual April–September flow at the Rio Grande near Del Norte gage.

Sources: U.S. Department of Agriculture, Natural Resources Conservation Service, National Water and Climate Center n.d.; Division of Water Resources 2021.



streamflow forecasts and actual streamflow was compared. The years 2006 through 2012 are shown in Figure 21, revealing large discrepancies between forecasted and actual April through September flow at the Rio Grande near Del Norte gage.

Improved streamflow forecasting would be very beneficial to water users in the Basin. The Division Engineer's office would also have better data for its water administration decisions and determining curtailment percentages. The Conejos Water Conservancy District conducted a pilot study that generates streamflow forecasts using the National Weather Service hydrologic models to better understand forecast errors and uses data on snow-covered areas collected by the Airborne Snow Observatory (ASO) to improve snow modeling and water supply forecasts. As described in **Section 4.4: Water Administration Needs**, the Alamosa Doppler radar station installed in 2019 plays an important role in streamflow forecasting. Basin stakeholders will continue to support these investigations and the continued improvement of streamflow forecasting tools.

5.2.4 : IMPROVING WATERSHED HEALTH

The upper Rio Grande watershed encompasses forests, rangelands, wetlands, riparian areas, and farmlands. Currently, these ecosystems are threatened by water scarcity, erosion, insect outbreaks, wildfire and ensuing floods, decreased biodiversity, and drought. Potential post-wildfire floods and erosion also pose a threat to river function, water quality, and downstream habitats. Despite potential threats from catastrophic wildfire, a recent study of water quality, aquatic insects, and hydrologic impacts from the West Fork Complex fire showed that the impacts were short-lived (Rust et al. 2019).

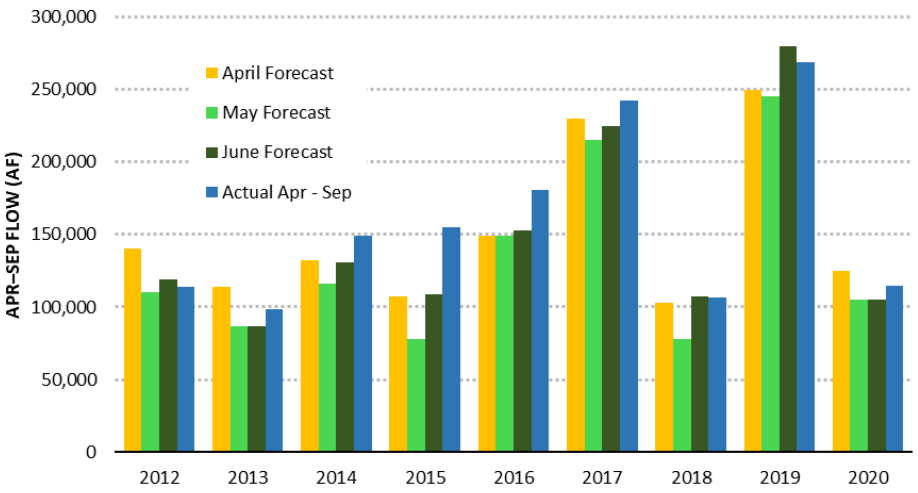


FIGURE 22.

NRCS-forecasted and actual April–September flow at the Conejos River near Mogote gage.

Sources: U.S. Department of Agriculture, Natural Resources Conservation Service, National Water and Climate Center n.d.; Division of Water Resources 2021.

Beetle-infested spruce forest.
Photo: Heather Dutton.

As outlined in several stream and watershed plans, such as the Upper Rio Grande Watershed Assessment (URGWA), the 2020 Rio Grande National Forest Land Management Plan, and the Rio Grande, Conejos River and Saguache Creek SMPs, opportunities exist to enhance the health of the watershed through projects that target improving forest resiliency, safeguarding water supplies, and protecting public safety by altering forest stand structure to include multi-aged trees and building fuel breaks to reduce fire risk. Other opportunities include enhancing soil health by improving grazing management on rangelands and building organic matter on farms to increase the water-holding capacity and resiliency.

5.2.4.1 IMPROVING FOREST HEALTH

In order to protect the ecosystem services offered by healthy watersheds, such as water supplies and wildlife habitat, projects can be completed to improve public and private forests in the Basin. Management prescriptions vary depending on the species composition and age class of the forest. Ponderosa pine and mixed-conifer forests would benefit from thinning and prescribed fire in order to maintain greater space between trees and frequent burning, as was typical historically. Subalpine spruce-fir forests evolved to grow for long periods of time, up to 400 years, before regenerating through a stand-replacing event, such as a fire, blow down, or insect infestation. While the spruce-fir forests on the RGNF are within the range of the historic disturbance regime, it is unprecedented for a stand of this size to die all at once. It is assumed that drought and climate change have stressed the trees to the point that they are more susceptible to beetle infestations, and a higher proportion of trees have been affected. While this may be the natural progression of the forest, there is concern from land managers and local entities that the massive spruce die-off will lead to significant changes in the watershed. For example, loss of canopy cover could change snowpack accumulation and rate of melt, increase infiltration, and reduce evapotranspiration. It is unknown how these changes will impact the overall amount and timing of inputs to the local water budget. Additionally, there is concern that the dead and dying trees may impact infrastructure, such as power lines, and lead to erratic fire behavior that may inhibit the ability of crews to protect communities while maintaining escape routes and safety zones during wildfires.

Therefore, there are numerous opportunities to improve forest and watershed health by building fire breaks, creating patches of differing age classes, and clearing dead trees from critical infrastructure, such as power lines, roads, and reservoirs. With 85% of the RGNF affected by beetle infestations, there is

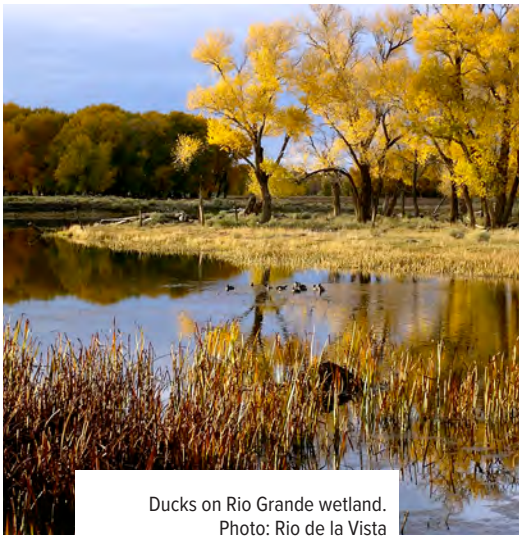
Farmland and riparian areas along the Rio Grande in the San Luis Valley. Photo: Erich Schlegel

regional interest in utilizing standing dead trees as a way to remove hazards from the forest while improving the local economy. Findings from a study by the USFS suggest that an opportunity exists to harvest beetle-killed trees, resulting in the benefit of dampening the behavior and intensity of potential future wildfires through reduced fuel loading and tree densities.

The RGNF and CSFS are working to improve forest health and resiliency on public and private lands, respectively. The 2020 Rio Grande National Forest Land Management Plan includes multiple forest treatment objectives with the ultimate goal of improved forest health.

5.2.4.2 IMPROVING WETLANDS AND RIPARIAN HEALTH

Implementation of strategies to improve riparian areas and wetlands in the Basin are aimed at enhancing existing conditions, restoring historical conditions, or shifting conditions toward a new habitat type to help meet limited resources. Many opportunities and ongoing projects exist to improve the Basin's riparian areas. The condition of many of the Basin's streams and riparian areas has been documented by the Rio Grande, Conejos River, and Saguache Creek SMPs, the URGWA, the 2016 Rio Grande Natural Area (RGNA) River Condition Assessment, and the Rio Grande Headwaters Restoration Project 2001 Study. Guided by these assessments, the Rio Grande Headwaters Restoration Project (RGHRP) works with a variety of partners to improve the Rio Grande's riparian areas, habitat, floodplain function, ability to supply agriculture users, and opportunities for recreation. Many other entities, such as NRCS, CPW, USFWS, USFS, BLM, Headwaters Alliance, Alamosa Riverkeepers, Willow Creek

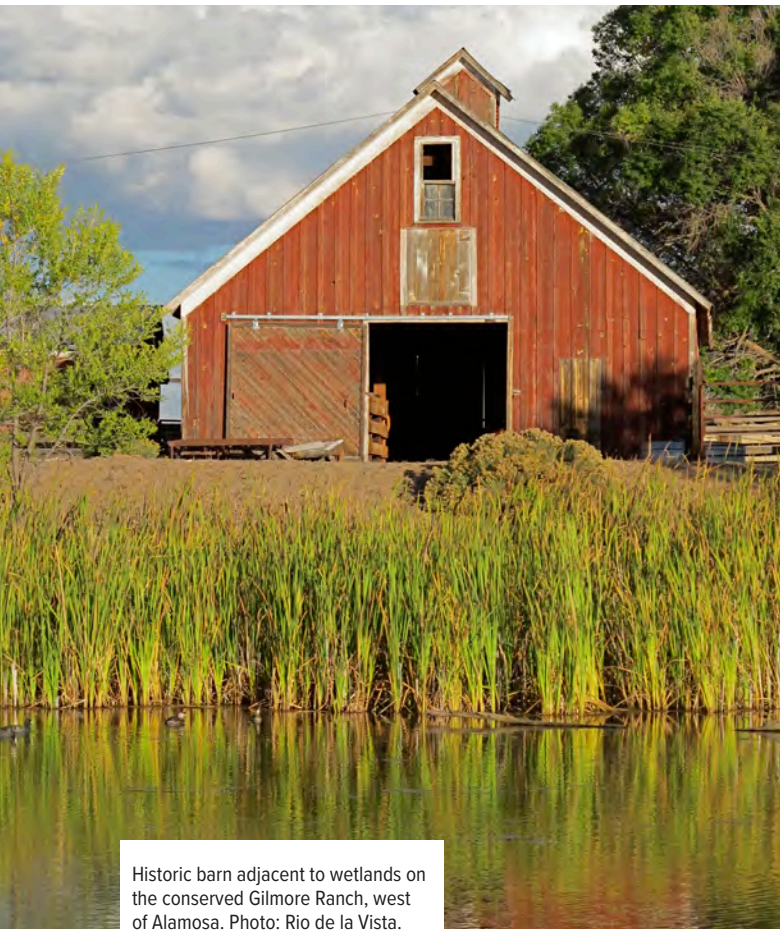


Ducks on Rio Grande wetland. Photo: Rio de la Vista

Southwest Conservation Corp members planting willows. Photo: Heather Dutton

Reclamation Committee, Rio Grande Headwaters Land Trust, and Trout Unlimited (TU) are also developing and implementing wetland and riparian improvement projects.

To help guide cooperative conservation goals for wetland monitoring, management, and conservation throughout the San Luis Valley, the San Luis Valley Wetland and Wildlife Conservation Assessment (Assessment) was completed in 2019. The Assessment details the history of changes in wetlands across the SLV and provides recommendations for natural resource agencies and organizations. Limited water resources have been identified as one of the biggest threats to maintaining and conserving existing wetlands across the SLV. Recommendations in the Assessment include prioritizing cooperative efforts/projects across management boundaries to provide wetland resources, expanding partnerships, and recognizing wetland conservation on private lands for supporting over 75% of the existing wetlands in the Valley. The Assessment identifies the following key components for successful project planning: restoration and enhancement projects that mimic natural processes, that exist in historic wetland locations, that have been identified as resilient over time, and that encompass larger landscapes. These projects may utilize a wide variety of management strategies that promote dynamic conditions for healthy habitats from aquatic to terrestrial ecosystems. Comprehensive plans that incorporate multiple landowners/agencies may include evaluation of current infrastructure that could be replaced or removed depending on available water resources and objectives for the area. Continued adaptive management of wetlands based on documentation of strategies/projects, climate, limited resources, and cooperative efforts will be an important aspect to successfully providing healthy habitat for wildlife needs into the future.



Historic barn adjacent to wetlands on the conserved Gilmore Ranch, west of Alamosa. Photo: Rio de la Vista.

5.2.4.3 CONSERVATION EASEMENTS

Colorado's projected population growth will result in further land development for residential, commercial, and industrial uses, and pressure to transfer water from agriculture to meet the water needs of the growing population. Voluntary, incentive-based conservation of private land is one tool that communities have available to work with willing landowners. Conservation easements secure key lands from future development and tie water rights to the land. This is especially effective on sites where agriculture and important wildlife habitat converge. Conserving intact functioning ecosystems and critical water sources on private land is a key objective in the Basin. Wetland habitat in the Basin is often found on private lands where ranchers irrigate native hay meadows and pastureland for livestock. Conservation of

these wetland habitat types can help ensure proper drying and flooding cycles while maintaining historic water use patterns in wetland basins that are beneficial to wildlife.

Land conservation is a relatively new practice in the Basin, and most conservation easements have been completed since 2000. During this short time frame, close to 300,000 acres of land have been protected. Citizens in the Basin understand that the rural way of life, agricultural economy, and extensive wildlife habitat make the area unique, and they seek to protect these attributes. They recognize that conservation easements are a voluntary tool to keep working farms and ranches and water rights intact, along with protecting critical wildlife habitat.

5.2.5 : INNOVATIONS IN AGRICULTURAL PRODUCTION

Agriculture is the primary economic driver in the Basin. Potatoes, alfalfa, grass hay, canola, oats, quinoa, carrots, lettuce, spinach, honey, wheat, garlic, hemp, and pumpkins are crops grown in the Valley.

The amount of water available to irrigators is projected to decrease, as discussed extensively in both Volume 1 and 2 of the BIP, which will require agriculture producers to reduce consumptive use.

Every generation of agriculture producer in the San Luis Valley has learned to adapt to variability in water supplies. It will be critical to the future of the Basin that agriculture water users find innovative ways to meet the challenges of our time. The water saving measures will vary across the region and be influenced by farm or ranch type, water supplies, location, and other management factors.

Field of canola near Center, Colo. Photo: Julie Messick

Haying on the conserved Shadow Ranch, south of Monte Vista. Photo: Rio de la Vista

Producers may utilize many different techniques to reduce water use such as:

- Changes in crop type:
  - Less water intensive crops.
  - Fewer acres of higher value crops.

- Improvements in water management infrastructure:
  - Improved water diversion and conveyance structures.
  - Improved water application by nozzles, goosenecks, or other methods.
  - Using irrigation scheduling and soil moisture sensors.

- Reducing erosion and Improving soil health:
  - Adding green manure or cattle grazing to the crop rotation.
  - Applying compost.
  - Improving rangeland management.
  - Leaving crop residue over winter and spring months.
  - Improving ground cover.

- Rotational Fallowing
  - Water sharing agreements.

- Permanent Fallowing
  - Groundwater Conservation Easements.

- Participating in Groundwater Management Subdistrict Programs
  - Conservation Reserve Enhancement Program (CREP).
  - Well purchase program.
  - Pumping incentives.

For more information on these and other strategies to reduce water agricultural water use, see **Volume 1 Section 6**.

It will be critical to the future of the Basin that agriculture water users find innovative ways to meet the challenges of our time.

Spuds! Photo: Heather Dutton

5.3 : RIO GRANDE BASIN PLANNING MODELS AND TOOLS

Multiple models and tools have been developed in the Basin to model surface water resources for planning purposes. Collectively, these tools can be used to help Basin stakeholders plan for future conditions and manage water storage and release for multiple needs, including enhancing streamflow for recreational boating and aquatic life.

5.3.1 : STREAM MANAGEMENT PLANS

The Rio Grande, Conejos River, and Saguache Creek SMPs resulted in the development of point flow models (PFMs) for multiple locations on each stream. The PFMs used existing stream gage data and diversion records to calculate daily flows between 1998 and 2017 for each location. The PFMs categorized hydrological year types as dry, average, or wet. Additionally, flow targets to support aquatic life were calculated for each SMP reach. Using the PFMs, the frequency at which aquatic flow targets are met during dry, average, and wet year types was determined. This data is now being used by water managers to manage water storage and release to meet aquatic flow targets more often. This information has proven to be very useful, and opportunities exist to replicate these methods on other streams.

5.3.2 : BOATABLE DAYS

As part of the Rio Grande, Conejos River, and Saguache Creek SMPs, a Boatable Days analysis was completed by American Whitewater (AW) for eleven reaches of the Rio Grande and Conejos River. AW worked with

Rio Grande near Rio Grande Canal headgate. Photo: Arista Hickman

TU, RGHRP, commercial outfitters, and local boaters to determine flow preferences for each stream reach. Using flow preference thresholds and the SMP PFMs, the number of boatable days associated with dry, average, and wet year types were calculated for each reach (Table 5). Similar to aquatic flow targets, flow preferences from the Boatable Days study can be used by water managers to time reservoir releases for maximum recreational benefit.

TABLE 5.

Boatable Days falling within each acceptability category calculated for reaches within the assessment area for typical dry, average, and wet hydrological year types.

Reach	River	Description	Acceptability Category	Dry Year	Average Year	Wet Year
1	Rio Grande	Rio Grande Reservoir to Mouth of Box Canyon	Lower Acceptable	38	38	40
			Optimal	0	25	43
			Upper Acceptable	0	0	0
			Total Days	38	63	83
2	Rio Grande	Box Canyon to Deep Creek/Creede	Lower Acceptable	17	11	24
			Optimal	21	52	59
			Upper Acceptable	0	0	0
			Total Days	38	63	83
3	Rio Grande	Creede to Wagon Wheel Gap	Lower Acceptable	43	62	31
			Optimal	56	80	59
			Upper Acceptable	0	17	21
			Total Days	99	159	111
4	Rio Grande	Wagon Wheel Gap to South Fork	Lower Acceptable	101	111	82
			Optimal	54	67	48
			Upper Acceptable	2	30	35
			Total Days	157	208	165
5	Rio Grande	South Fork to Del Norte (Hwy 112)	Lower Acceptable	54	56	74
			Optimal	119	127	87
			Upper Acceptable	12	26	19
			Total Days	185	209	180
6	Rio Grande	Alamosa to Lasauses	Lower Acceptable	47	146	204
			Optimal	0	1	45
			Upper Acceptable	0	0	0
			Total Days	47	147	249
7	Rio Grande	Lasauses to Lobatos Bridge	Lower Acceptable	0	39	74
			Optimal	0	0	47
			Upper Acceptable	0	0	0
			Total Days	0	39	121

continued

TABLE 5.

Boatable Days falling within each acceptability category calculated for reaches within the assessment area for typical dry, average, and wet hydrological year types.

Reach	River	Description	Acceptability Category	Dry Year	Average Year	Wet Year
8	Rio Grande	Lobatos Bridge to Lee Trail, NM	Lower Acceptable	7	137	141
			Optimal	0	46	95
			Upper Acceptable	0	0	2
			Total Days	7	183	238
9	Conejos River	Platoro Reservoir to South Fork Conejos	Lower Acceptable	53	56	44
			Optimal	0	17	31
			Upper Acceptable	0	0	0
			Total Days	53	73	75
10	Conejos River	S. Fork Conejos to Hwy 17 Bridge	Lower Acceptable	53	56	44
			Optimal	0	17	31
			Upper Acceptable	0	0	0
			Total Days	53	73	75
11	Conejos River	Hwy 17 to Mogote Campground	Lower Acceptable	29	30	40
			Optimal	29	59	64
			Upper Acceptable	0	0	0
			Total Days	58	89	104

Adams State Adventure Program raft trip - Rio Grande near Hwy 142 Bridge. Photo: Curt Howell

5.3.3 : RIO GRANDE AND CONEJOS RIVER RIVERWARE MODEL

A surface water model was developed for the 2015 BIP to characterize constraints and opportunities that face the Basin in the future, including identification of supply and demand imbalances. An existing RiverWare model that was developed as part of the Rio Grande Cooperative Project was adapted for use on the Rio Grande and Conejos River systems, incorporating data developed through the RGDSS, where available and appropriate.

RiverWare is a river and reservoir modeling platform developed by the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) at the University of Colorado (http://www.riverware.org). Through the Basin modeling effort, characteristics of the Basin with regards to hydrology, physical infrastructure, water rights, demands, and legal and administrative policy are captured. The model allows for the assessment of future conditions, including:

- climate change
- wildfires
- dust on snow events
- infrastructure projects
- changed water rights
- changes in administrative policy

Flexibility in the RiverWare modeling platform allows for simulation of variable reservoir operations and administration of the Rio Grande Compact. The Rio Grande Basin Planning Model simulates multiple reservoir accounts in the Rio Grande, Continental, Santa Maria, Beaver Park, and Platoro reservoirs. The model also incorporates much of the logic used by the Division Engineer to determine the Compact curtailment. Despite the differences between modeled and historical curtailment, the model matches the Division Engineer's ability to deliver an appropriate amount of water annually to New Mexico under the terms of the Rio Grande Compact.

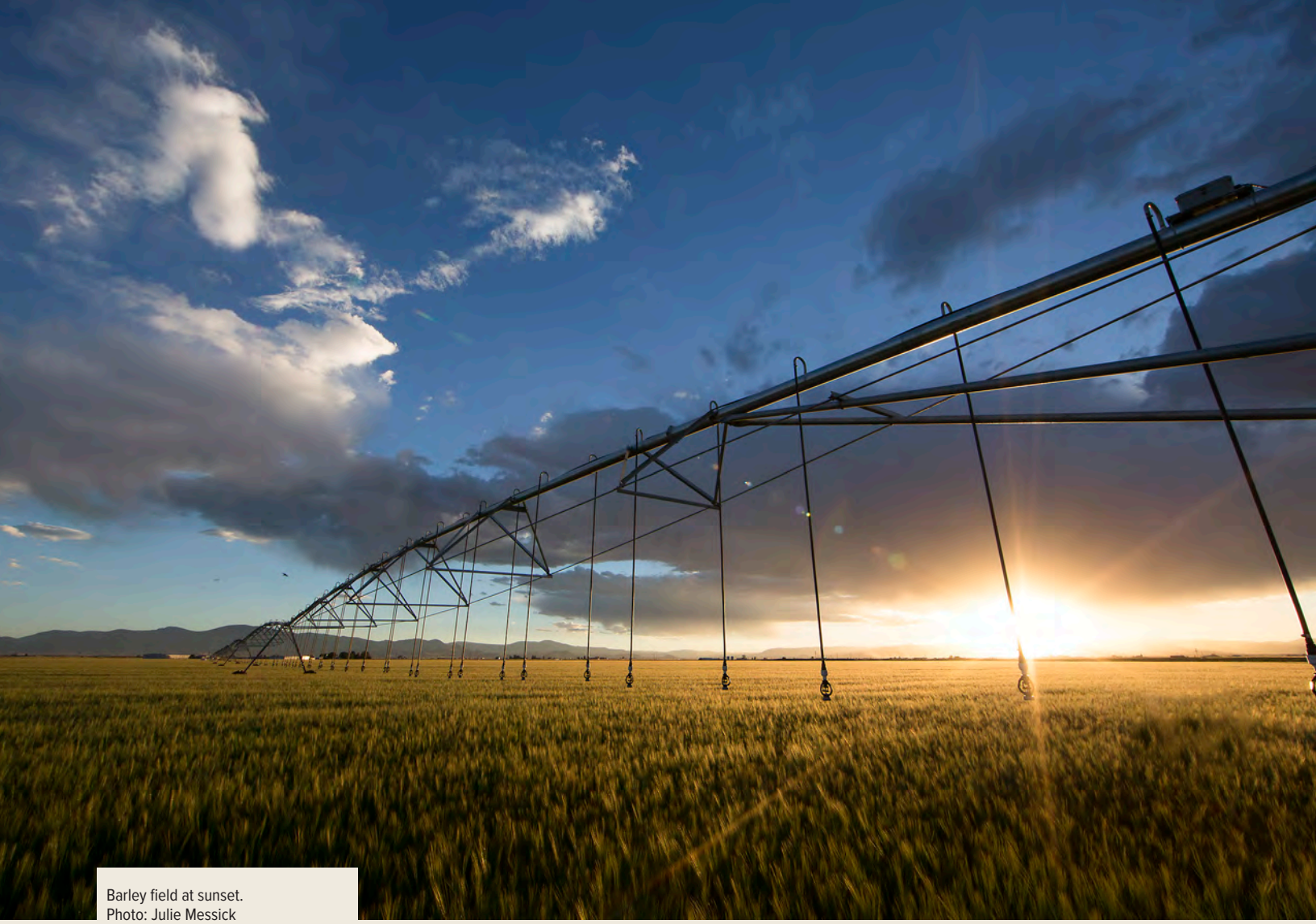
6 THE RIO GRANDE BASIN PATH FORWARD

Sandhill cranes flying over the San Luis Valley. Photo: Julie Messick

As described in Volume 1 Section 6, the Rio Grande BRT, stakeholders, and the community will employ adaptive strategies that promote resilience and allow for flexible water-sharing agreements to help meet the basin's current and future water needs. The ongoing economic prosperity of this unique region, the health of its environment and wildlife habitat, and the development of recreational opportunities for the community all depend upon implementation of the BIP's recommended strategies, detailed in **Volume 1**, to protect and optimize the use of the Basin's water.

Benefits from successful implementation of the BIP also extend beyond the Basin. Agriculture in the Basin produces the highest per acre revenue of any basin in the state, while the environmental and recreational attributes are of local, national, and international importance. Financial support from the State of Colorado, federal agencies, and private and public sources will be necessary to implement the projects and strategies outlined in **Volume 1**.

As the San Luis Valley communities address the obstacles to protecting and enhancing the Basin's water values, new challenges will arise. For this reason, the BIP is dynamic and will adapt as future opportunities and constraints present themselves. The primary goal of the RGBRT and the BIP is to create a sustainable water future. The strategies identified in the BIP for responsible stewardship of the Basin's water resources will help achieve that future and aim to preserve a balance of water uses and needs that will benefit generations to come.



Barley field at sunset.
Photo: Julie Messick

The Basin Roundtable and its partners aim to maintain vibrant local economies and communities, healthy watersheds, and sustainable aquifers for future generations through flexible water sharing agreements, water education, proactive water resources management, and project implementation.

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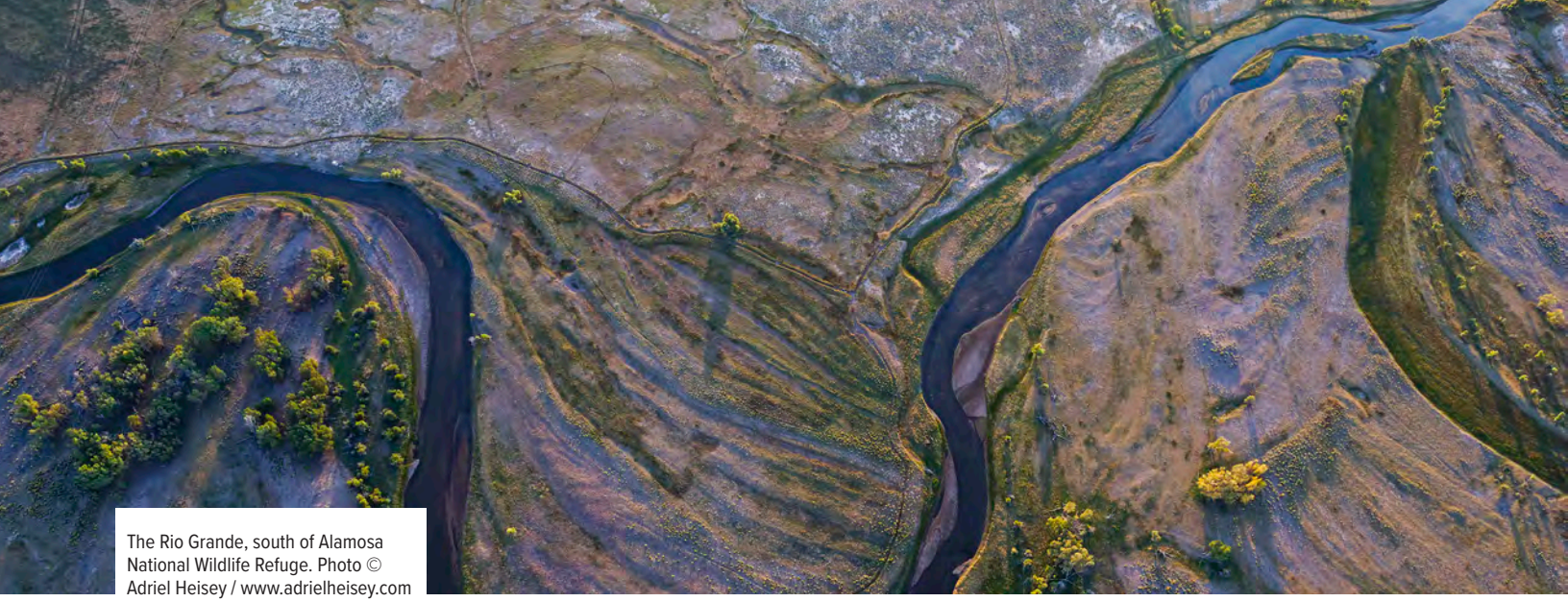

The Rio Grande, south of Alamosa National Wildlife Refuge. Photo © Adriel Heisey / www.adrielheisey.com

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Ranches and hayfields below South Fork. Back cover: Confluence of the Conejos River (right) with the Rio Grande (left) east of La Jara, Colorado, looking south. Photos © Adriel Heisey / www.adrielheisey.com

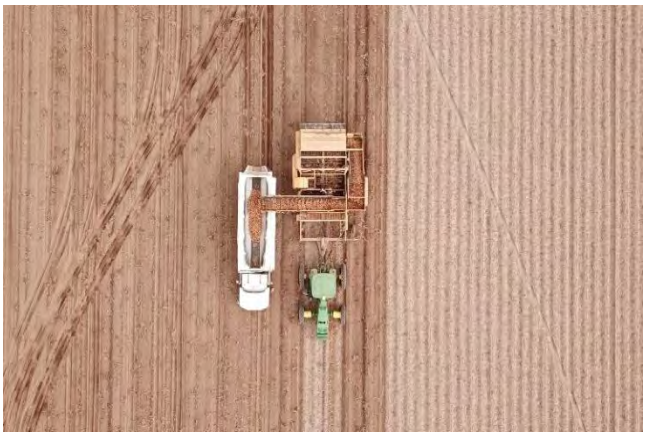
RIO GRANDE BASIN ROUNDTABLE

American Avocet. Photo: Cary Aloia.

Rio Grande Basin Implementation Plan

VOLUME 2, APPENDIX A: Future Rio Grande Basin Projects

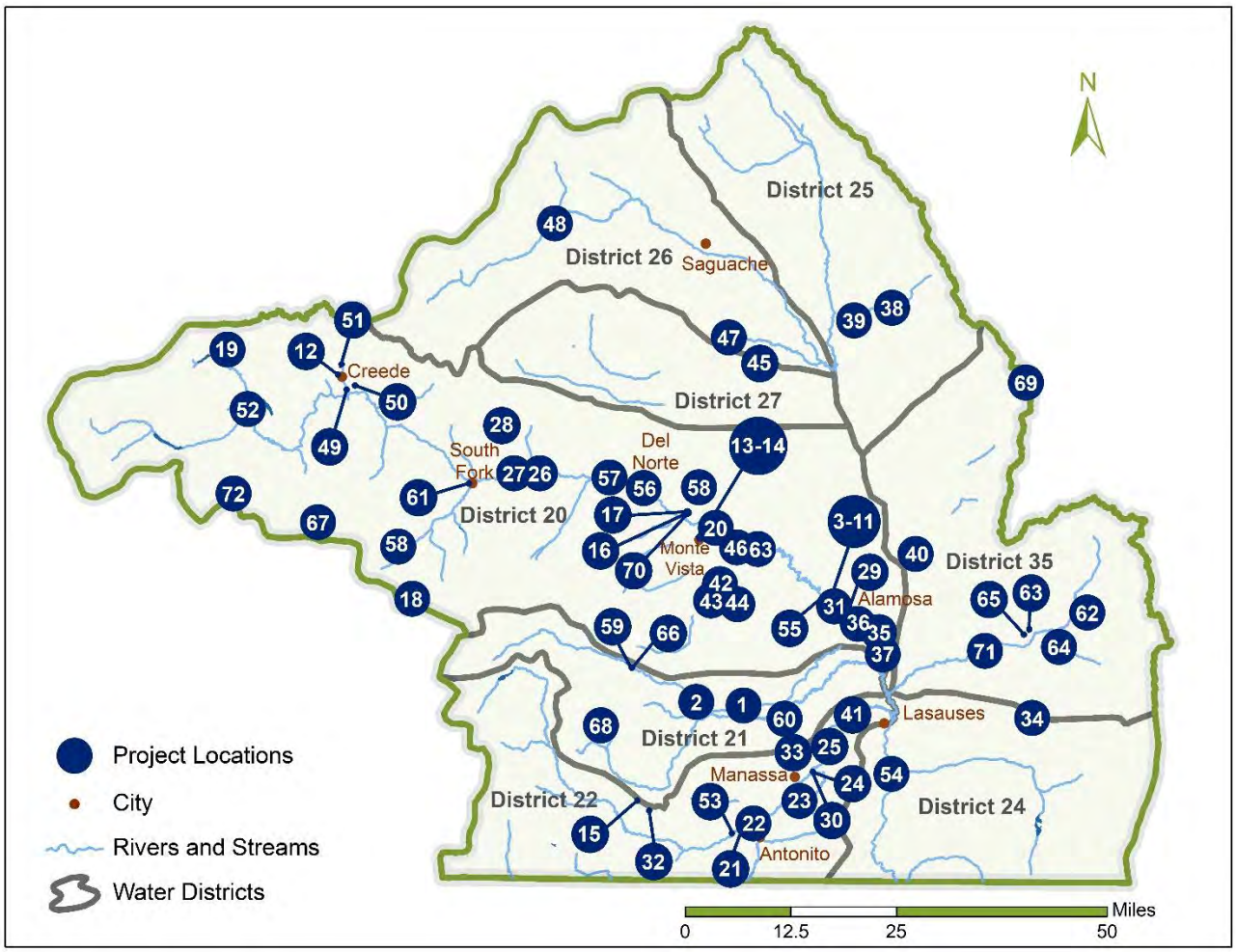
January 2022

Front Cover Photos (clockwise, from top to bottom): *Black-necked stilts loafing (Cary Aloia), Potato harvest (Sinjin Eberle), Town of Del Norte (Heather Dutton), Boating the Rio Grande at Lobatos Bridge (Bethany Howell)*

Projects List Summary and Map

As part of the Rio Grande Basin Implementation Plan (BIP) Update, BRT partners from across the Basin submitted projects. A total of 72 new projects were submitted, with this document providing summaries of each project. The map below shows the locations of future projects identified during the BIP. An interactive map showing future project locations, photos, and other details can be explored within the BIP Update StoryMap, available at the following link: https://arcg.is/014DvX. Additionally, overall project statistics, including total cost, are outlined in Volume 1 of the Rio Grande BIP.



Acronyms

AF	Acre-feet per year
CFS	Cubic feet per second
LF	Linear feet

**All project photos courtesy of Project Proponents.*

Project ID: RG-2020-0001

Project Name: Alamosa River Water Delivery Improvement Project – Phase II

Lead Proponent: Alamosa-La Jara Water Conservancy District

Project Description: Phase II of the Alamosa River Water Delivery Improvement Project will build on Phase I by improving the function of numerous Alamosa River irrigation structures. The project will address issues such as deteriorated head-gates, Parshall flumes, and diversion structures as well as provide radar telemetry and/or automated headgates to ditches on the Alamosa River. The project benefits will be provided to ditches in the Alamosa River Watershed and especially to those located in the Alamosa River Water Conservancy District. Key diversions with the most critical needs will be funded in order to make water delivery more accurate and efficient on the whole river system.

Needs Met:

Agriculture: 60%	**M&I:** 0%
Env't. & Recreation: 10%	**Administration:** 30%

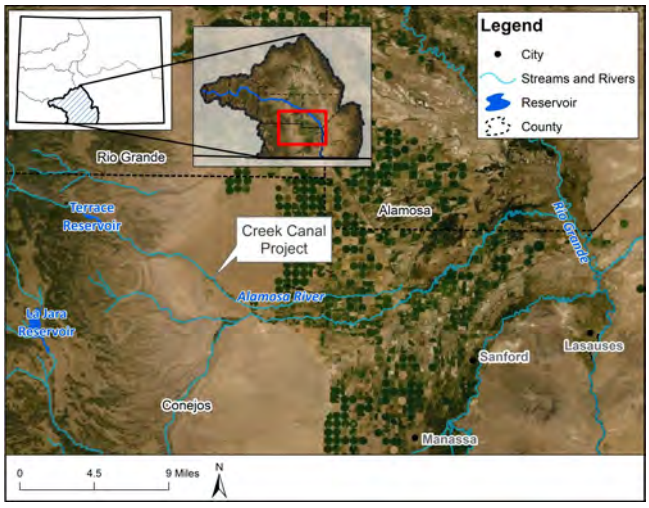
Estimated Cost: $500,000	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:**

Project Name: Creek Canal Pipeline Project

Lead Proponent: Alamosa-La Jara Water Conservancy District

Project Description: In order to improve efficiency, a pipeline will be installed in the Creek Canal. The ~4,500-foot pipeline will have a maximum flow rate of 50 cfs and will have one outlet with a 10 cfs capacity. The project will result in improved ditch efficiency resulting from reduced evaporative loss, the elimination of conveyance loss, and improved measurement capability. Increased efficiency and measurement capabilities will improve Alamosa River water administration and will allow water managers to meet multi-benefit flow needs more often.

Project ID: RG-2020-0002

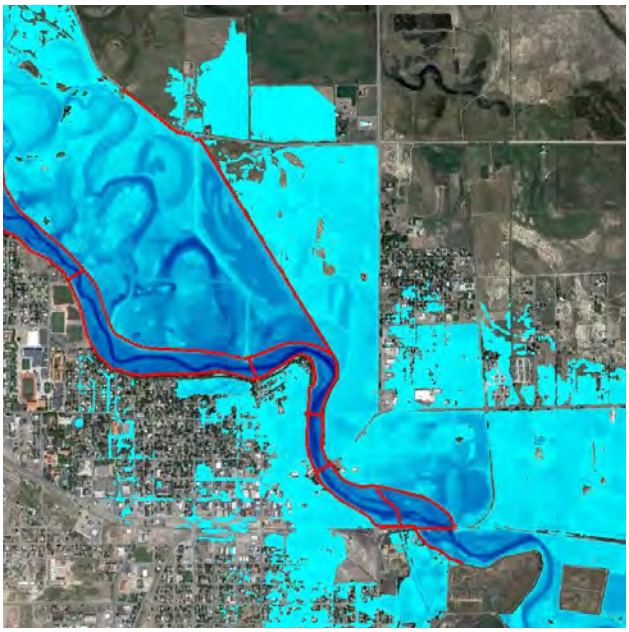


Needs Met:

Agriculture: 90%	**M&I:** 0%
Env't. & Recreation: 0%	**Administration:** 10%

Estimated Cost: $2,270,000	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:** 50 CFS

Project ID: RG-2020-0003



Project Name: Alamosa Levee Recertification and Revitalization

Lead Proponent: City of Alamosa

Project Description: This is a multi-benefit project on the Rio Grande near Alamosa within the Rio Grande Levee System (RGLS). The project aims to mitigate flood risk, enhance recreational opportunities, improve river function and aquatic health, and improve the basin's ability to administer water rights as well as Rio Grande Compact delivery obligations. While completing the required work for the levee recertification, the channel would be re-shaped and deepened, allowing for more water conveyance during high-flow events and also improving aquatic habitat. This project will meet multiple needs and provide benefits for City of Alamosa residents, recreationalists, and the Division of Water Resources.

Needs Met:	
Agriculture: 5%	**M&I:** 60%
Env't. & Recreation: 30%	**Administration:** 5%

Estimated Cost: $5,000,000	**Estimated Yield:** 0 AF
County: Alamosa	**Estimated Capacity:** 21,200 LF

Project Name: Increasing Efficiencies in the Distribution and Collections Systems of Alamosa - Phase 1

Lead Proponent: City of Alamosa

Project Description: The City has multiple opportunities to improve efficiency and water quality with water in its collection and distribution systems. These opportunities are phased into three separate projects.

Phase 1: Asbestos Clay and Cast-Iron Water Line Replacement Program

Phase 2: Remote Water Metering Program

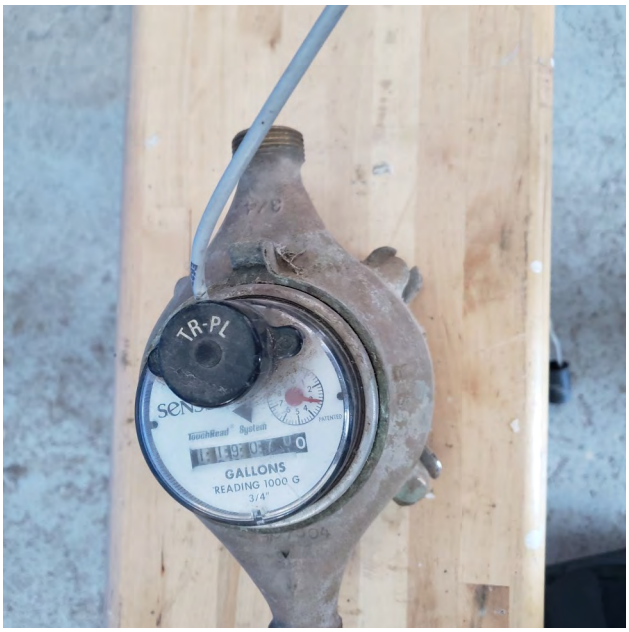
Phase 3: Sanitary Sewer Lift Stations

Project ID: RG-2020-0004

Needs Met:	
Agriculture: 0%	**M&I:** 95%
Env't. & Recreation: 0%	**Administration:** 5%

Estimated Cost: $6,573,600	**Estimated Yield:**
County: Alamosa	**Estimated Capacity:** 16.6 miles

Project ID: RG-2020-0005



Project Name: Increasing Efficiencies in the Distribution and Collections Systems of Alamosa - Phase 2

Lead Proponent: City of Alamosa

Project Description: The City has multiple opportunities to improve efficiency and water quality with water in its collection and distribution systems. These opportunities are phased into three separate projects.
Phase 1: Asbestos Clay and Cast-Iron Water Line Replacement Program
Phase 2: Remote Water Metering Program
Phase 3: Sanitary Sewer Lift Stations

Needs Met:	
Agriculture: 0%	**M&I:** 95%
Env't. & Recreation: 0%	**Administration:** 5%

Estimated Cost: $800,000	**Estimated Yield:** 134 AF
County: Alamosa	**Estimated Capacity:** 1.9 miles

Project Name: Increasing Efficiencies in the Distribution and Collections Systems of Alamosa - Phase 3

Lead Proponent: City of Alamosa

Project Description: The City has multiple opportunities to improve efficiency and water quality with water in its collection and distribution systems. These opportunities are phased into three separate projects.
Phase 1: Asbestos Clay and Cast-Iron Water Line Replacement Program
Phase 2: Remote Water Metering Program
Phase 3: Sanitary Sewer Lift Stations

Project ID: RG-2020-0006

Needs Met:	
Agriculture: 0%	**M&I:** 95%
Env't. & Recreation: 0%	**Administration:** 5%

Estimated Cost: $3,135,000	**Estimated Yield:** 0 AF
County: Alamosa	**Estimated Capacity:**

Project ID: RG-2020-0007

Needs Met:

Agriculture: 0%	**M&I:** 95%
Env't. & Recreation: 0%	**Administration:** 5%

Project Name: Producing a Master Infrastructure Plan for the City of Alamosa - Phase 1

Lead Proponent: City of Alamosa

Project Description: The City of Alamosa (City) has grown quite a lot over the past few years, and as growth occurs to the west, existing downstream infrastructure will be less able to accommodate new growth. The extent of this issue is unknown, and a system-wide study is needed for both the collection and distribution systems. Without a Master Infrastructure Plan, the City will face having to either slow or halt all development to the west or deal with potential consequences to existing services. This would have disastrous effects on the City and local economy. The first phase of this project has just been put out to bid, and will analyze the collection (sewer) system. The second phase will analyze the distribution system (water). The final phase will analyze the storm sewer needs.

Estimated Cost: $119,000	**Estimated Yield:** NA
County: Alamosa	**Estimated Capacity:** NA

Project Name: Producing a Master Infrastructure Plan for the City of Alamosa - Phase 2

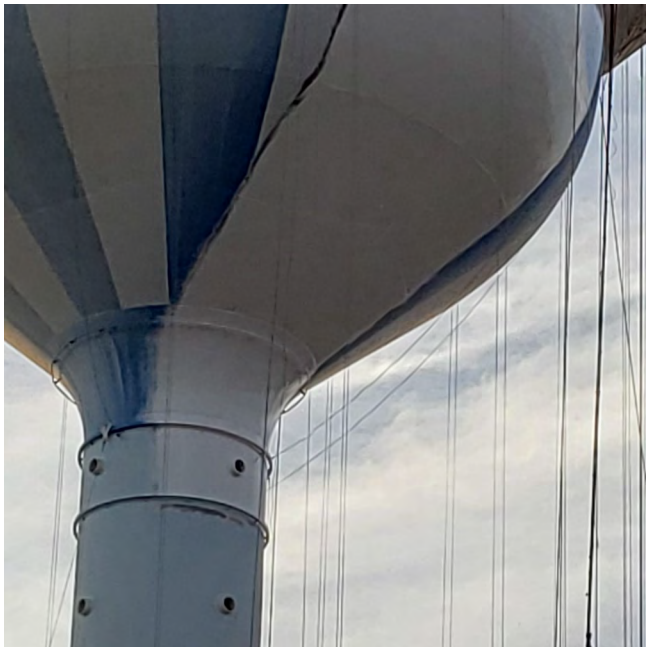
Lead Proponent: City of Alamosa

Project Description: The City of Alamosa (City) has grown quite a lot over the past few years, and as growth occurs to the west, existing downstream infrastructure will be less able to accommodate new growth. The extent of this issue is unknown, and a system-wide study is needed for both the collection and distribution systems. Without a Master Infrastructure Plan, the City will face having to either slow or halt all development to the west or deal with potential consequences to existing services. This would have disastrous effects on the City and local economy. The first phase of this project has just been put out to bid, and will analyze the collection (sewer) system. The second phase will analyze the distribution system (water). The final phase will analyze the storm sewer needs.

Needs Met:

Agriculture: 0%	**M&I:** 95%
Env't. & Recreation: 0%	**Administration:** 5%

Project ID: RG-2020-0008



Estimated Cost: $150,000	**Estimated Yield:** NA
County: Alamosa	**Estimated Capacity:** NA

Project ID: RG-2020-0009

Project Name: Producing a Master Infrastructure Plan for the City of Alamosa - Phase 3

Lead Proponent: City of Alamosa

Project Description: The City of Alamosa (City) has grown quite a lot over the past few years, and as growth occurs to the west, existing downstream infrastructure will be less able to accommodate new growth. The extent of this issue is unknown, and a system-wide study is needed for both the collection and distribution systems. Without a Master Infrastructure Plan, the City will face having to either slow or halt all development to the west or deal with potential consequences to existing services. This would have disastrous effects on the City and local economy. The first phase of this project has just been put out to bid, and will analyze the collection (sewer) system. The second phase will analyze the distribution system (water). The final phase will analyze the storm sewer needs.

Needs Met:	
Agriculture: 0%	**M&I:** 95%
Env't. & Recreation: 0%	**Administration:** 5%

Estimated Cost: $200,000	**Estimated Yield:** NA
County: Alamosa	**Estimated Capacity:** NA

Project Name: Studying Existing Turf Irrigation and Implementing Efficiencies in the City of Alamosa - Phase 1

Lead Proponent: City of Alamosa

Project Description: Approximately 50% of Alamosa's water usage goes towards outdoor irrigation. The recently completed Alamosa Water Efficiency Plan set two goals to make our outdoor water usage more efficient. Phase 1 will complete a feasibility study to look at the irrigation and water usage of city parks, the back 9 holes of Cattails golf course, and potentially Alamosa State University. This study would propose and design more efficient irrigation systems, reduced waste, etc. Based on the above study, Phase 2 would replace irrigation infrastructure and implement irrigation scheduling/ timing/updates to Systems.

Project ID: RG-2020-0010

Needs Met:	
Agriculture: 0%	**M&I:** 75%
Env't. & Recreation: 20%	**Administration:** 5%

Estimated Cost: $50,000	**Estimated Yield:** NA
County: Alamosa	**Estimated Capacity:** NA

Project ID: RG-2020-0011

Project Name: Studying Existing Turf Irrigation and Implementing Efficiencies in the City of Alamosa - Phase 2

Lead Proponent: City of Alamosa

Project Description: Approximately 50% of Alamosa's water usage goes towards outdoor irrigation. The recently completed Alamosa Water Efficiency Plan set two goals to make our outdoor water usage more efficient. Phase 1 will complete a feasibility study to look at the irrigation and water usage of city parks, the back 9 holes of Cattails golf course, and potentially Alamosa State University. This study would propose and design more efficient irrigation systems, reduced waste, etc. Based on the above study, Phase 2 would replace irrigation infrastructure and implement irrigation scheduling/timing/updates to Systems.

Needs Met:

Agriculture: 0%	**M&I:** 75%
Env't. & Recreation: 20%	**Administration:** 5%

Estimated Cost: $164,500	**Estimated Yield:** 20 AF
County: Alamosa	**Estimated Capacity:** 135 AF

Project Name: City of Creede Collection System I&I Improvement Project – Phase 1c

Lead Proponent: City of Creede

Project Description: Pursuant to the City of Creede's 2015 Discharge Permit, the city is required to address high inflow and infiltration (I&I (i.e., leaky pipes)) and elevated levels of cadmium and zinc. Evidence suggests that the city's wastewater collection system (sewer system) has been found to contain leaks throughout. The Collection System I&I Improvement Project Summary memorandums prepared by SGM, Inc. outline the process, recommendations and budgetary considerations to systematically replace Creede's sewer system using a 3-phased approach.

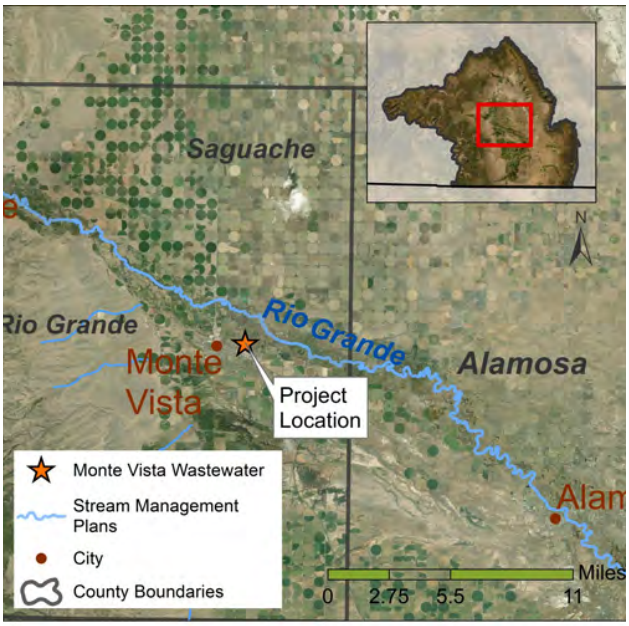
Project ID: RG-2020-0012

Needs Met:

Agriculture: 0%	**M&I:** 85%
Env't. & Recreation: 10%	**Administration:** 5%

Estimated Cost: $685,768	**Estimated Yield:** 0 AF
County: Mineral	**Estimated Capacity:** 2,500 LF

Project ID: RG-2020-0013



Project Name: Monte Vista Municipal Wastewater Treatment Plant Improvement Project

Lead Proponent: City of Monte Vista

Project Description: The City of Monte Vista's recently completed Master Plan (MP) identified municipal water infrastructure repair and improvement needs. The MP identified the need to rehabilitate the City's existing wastewater treatment system and lagoons. The City of Monte Vista's WWTP Improvement Project will implement the recommended improvements to the City's municipal water treatment system. The project will involve construction of a new treatment plant with a mechanical treatment system and the decommission of the existing lagoons, thereby bring all flows to the single new plant.

Needs Met:	
Agriculture: 0%	**M&I:** 80%
Env't. & Recreation: 10%	**Administration:** 10%

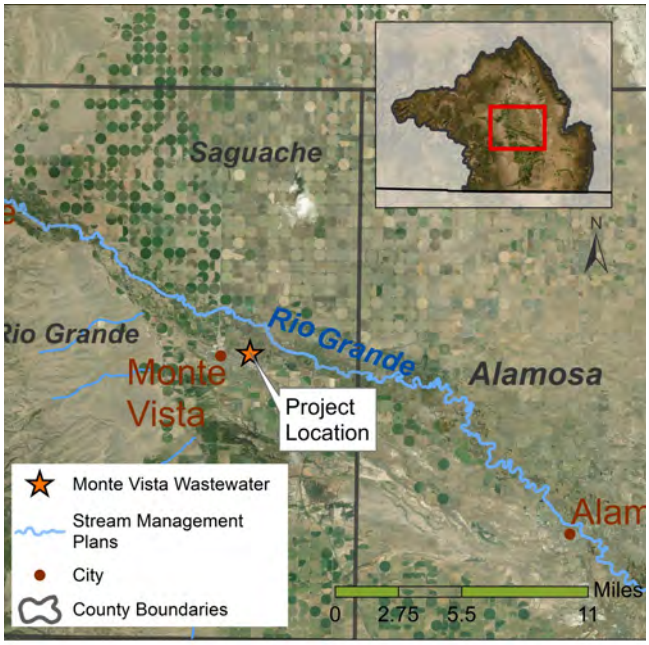
Estimated Cost: $27,000,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:**

Project Name: Monte Vista Water Distribution Improvement Project - Phase 1

Lead Proponent: City of Monte Vista

Project Description: The City of Monte Vista's recently completed Master Plan (MP) identified municipal water infrastructure repair and improvement needs. Multiple repair and improvement needs were identified related to the City's existing water supply distribution network. Phase 1 of the Monte Vista Water Distribution Improvement Project will implement the identified projects to improve the City's municipal water distribution system. Existing asbestos and cast iron water distribution lines need to be replaced because of their age and lack of durability. The project will result in the replacement of approximately 1.5 miles of existing water lines with new lines. The project will increase water use efficiency by reducing leakage and water system loss.

Project ID: RG-2020-0014



Needs Met:	
Agriculture: 0%	**M&I:** 90%
Env't. & Recreation: 0%	**Administration:** 10%

Estimated Cost: $5,000,000	**Estimated Yield:** 1 AF
County: Rio Grande	**Estimated Capacity:** 1.5 miles

Project ID: RG-2020-0015

Project Name: Conejos Ranchland Initiative

Lead Proponent: Colorado Open Lands

Project Description: Conejos Ranchland Initiative properties are some of the oldest ranches and permanent settlements in all of Colorado, encompassing approximately 6 miles of active channels on the Alamosa River, Conejos River and Rio San Antonio along with many oxbows and associated wetland areas. This project will establish conservation easements on these historic ranches, protecting historically significant agricultural landscapes and ecosystems while furthering numerous federal and state policies. Additionally, these easements will have a degree of flexibility that allows landowners and water management districts to work together to ensure the long-term viability of the area's water resources.

Needs Met:	
Agriculture: 50%	**M&I:** 0%
Env't. & Recreation: 10%	**Administration:** 40%

Estimated Cost: $3,000,000	**Estimated Yield:** 9,000 AF
County: Conejos	**Estimated Capacity:** 9,000 AF

Project Name: Helping Communities Understand the Values of Private Land Conservation Using Environmental Social Goals

Lead Proponent: Colorado Open Lands

Project Description: The need to increase public participation in environmental decision-making is receiving renewed attention at all levels of government. However, there are few approaches to evaluating these processes that address the question: What are we getting from public participation? To answer this question, the project will use a framework that evaluates the outcomes of participatory processes based on a set of "social" goals including: 1) educating the public; 2) incorporating public values, assumptions, and preferences into decision making; 3) increasing the substantive quality of decisions; 4) fostering trust in institutions; 5) reducing conflict; and 6) making decisions cost-effectively.

Project ID: RG-2020-0016

Needs Met:	
Agriculture: 40%	**M&I:** 15%
Env't. & Recreation: 15%	**Administration:** 30%

Estimated Cost: $10,000,000	**Estimated Yield:** NA
County: NA	**Estimated Capacity:** 2,500 people

Project ID: RG-2020-0017

Project Name: San Luis Valley River & Aquifer Recovery & Enhancement (RARE) Partnership Implementation

Lead Proponent: Colorado Open Lands

Project Description: This project works to address the decline in both the confined and unconfined aquifers by collaborating with private landowners and partners to reduce groundwater consumptive use through flexible and multi-benefit solutions. Colorado Open Lands will engage with the Rio Grande Headwaters Land Trust (RiGHT) and other major water entities in the San Luis Valley to first identify interested landowners whose wells have a substantial impact on aquifer levels, then work towards mitigation using approaches such as conservation easements, water covenants, or leases.

Needs Met:	
Agriculture: 50%	**M&I:** 0%
Env't. & Recreation: 10%	**Administration:** 40%

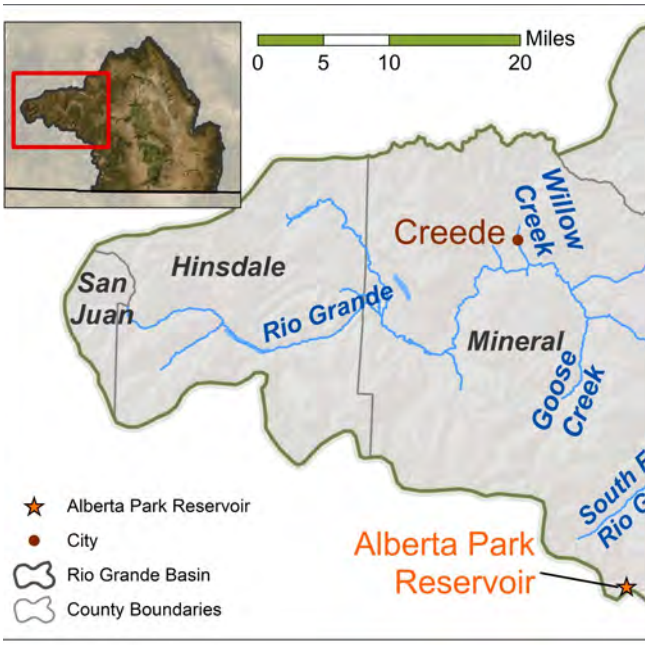
Estimated Cost: $10,000,000	**Estimated Yield:** 9,000 AF
County: NA	**Estimated Capacity:** 9,000 AF

Project Name: Alberta Park Reservoir Dam Improvement Project

Lead Proponent: Colorado Parks and Wildlife

Project Description: Alberta Park Reservoir is a pre-compact reservoir located in Mineral County south of Highway 160 near the top of the watershed on an unnamed tributary of Pass Creek. The reservoir's decreed uses include storage and irrigation. The Alberta Reservoir dam is currently classified as conditionally satisfactory, but future improvements are needed. The extent of the problem is not known but Colorado Parks and Wildlife (CPW) suspects that a full replacement of the dam may be necessary. CPW continues to monitor the dam and will conduct geotechnical studies in summer 2021 to evaluate options.

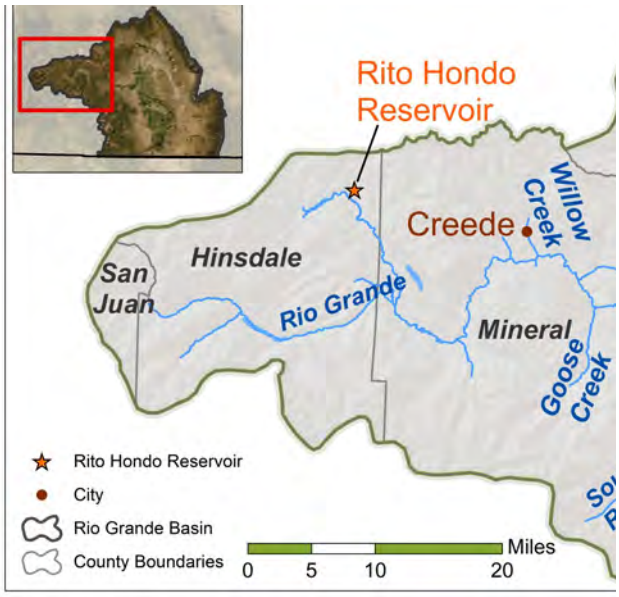
Project ID: RG-2020-0018



Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 60%	**Administration:** 40%

Estimated Cost: $7,500,000	**Estimated Yield:** 0 AF
County: Mineral	**Estimated Capacity:** 597.5 AF

Project ID: RG-2020-0019



Needs Met:

Agriculture: 0% **M&I:** 0%

Env't. & Recreation: 60% **Administration:** 40%

Project Name: Rito Hondo Reservoir Dam Improvement Project

Lead Proponent: Colorado Parks and Wildlife

Project Description: Rito Hondo Reservoir is an on-channel reservoir in Hinsdale County. The reservoir's decreed uses include recreation (angling) and storage/ release of water for fisheries and habitat both in the reservoir and downstream. When Colorado Parks and Wildlife (CPW) last refilled the reservoir, the dam experienced widespread saturation and seepage which resulted in CPW drawing it down to prevent the possibility of failure. The reservoir has now been empty since July, 2000. The State Engineer's Office reclassified the dam as a high hazard with a zero storage restriction. The new classification changed the design criteria to be more protective of life and property below the dam. The dam safety team is currently assessing the issues and developing a potential path forward which will likely involve the construction of a new dam and spillway.

Estimated Cost: $8,500,000	**Estimated Yield:** 561 AF
County: Hinsdale	**Estimated Capacity:** 561 AF

Project Name: Billings Ditch Rehabilitation Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Billings Ditch irrigates 3,403 acres of agricultural land. Its headgate and diversion dam are in poor condition, facing issues including sediment and debris accumulation, high maintenance needs, difficulty diverting full decree at low flows, and channel and bank instability. This project will address these issues through the replacement of the structure's headgate and diversion dam as well as bank stabilization and riparian vegetation restoration. The diversion dam will be a grouted rock structure with a low flow channel for improved sediment transport. A sluice gate adjacent to the new headgate and trash rack will also be installed to mitigate debris issues. The measurement flume will also be realigned to improve measurement accuracy.

Needs Met:

Agriculture: 60% **M&I:** 0%

Env't. & Recreation: 30% **Administration:** 10%

Project ID: RG-2020-0020

Estimated Cost: $500,000	**Estimated Yield:** 238 AF
County: Rio Grande	**Estimated Capacity:** 2,600 LF

Project ID: RG-2020-0021

Project Name: Chacon Ditch No. 1 Improvement Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Chacon Ditch No. 1 is located on the Conejos River upstream of Guadalupe and supplies water to 286 acres of agricultural land. The structure functions poorly. Includes streambank stabilization, riparian revegetation, and headgate replacement at the Chacon Ditch No. 1. Project benefits include bank stabilization and improved natural channel processes, riparian vegetation condition, and water quality.

Needs Met:	
Agriculture: 60%	**M&I:** 0%
Env't. & Recreation: 30%	**Administration:** 10%

Estimated Cost: $75,000	**Estimated Yield:** 20 AF
County: Conejos	**Estimated Capacity:** 150 LF

Project Name: Conejos River at Guadalupe - Stream and Riparian Restoration

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: During a high flow event in spring 2019, the Conejos River near the town of Guadalupe experienced significant erosion and lateral migration. Erosion and migration are now threatening the integrity of County Road H as well as the County Road 13 bridge, which is just downstream. If additional erosion and/or migration occurs, the road and bridge may be damaged and, during a high flow event, the river will flood Guadalupe. This project will improve floodplain connection, natural channel processes, riparian vegetation condition, and water quality through streambank stabilization and riparian revegetation. Project benefits include improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality.

Project ID: RG-2020-0022

Needs Met:	
Agriculture: 10%	**M&I:** 25%
Env't. & Recreation: 55%	**Administration:** 10%

Estimated Cost: $100,000	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:** 825 LF

Project ID: RG-2020-0023

Project Name: Conejos River Partnership Project – Phase II

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: Phase II of the Conejos River Partnership Project (CRPP) will build on Phase I by improving the function of two Conejos River irrigation diversion structures while simultaneously providing aquatic habitat and riparian benefits. The project will address issues at the Mecitos Ditch and William Stewart Co Irrigation Ditch, which irrigate 1,459 and 981 acres of agricultural land, respectively. To address these issues, this project will improve the diversions and headgates for both ditches and restore an estimated 313 linear feet of stream adjacent to the Mecitos Ditch and 622 linear feet adjacent to the William Stewart Ditch, for a total of 935 linear feet.

Needs Met:

Agriculture: 40%	**M&I:** 0%
Env't. & Recreation: 40%	**Administration:** 20%

Estimated Cost: $588,500	**Estimated Yield:** 218 AF
County: Conejos	**Estimated Capacity:** 935 LF

Project Name: Cottonwood Ditch Improvement Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Cottonwood Ditch is located on the Conejos River just downstream of the Rio San Antonio confluence and supplies water to 543 acres of agricultural land. This project will include headgate replacement and diversion improvements, including bank stabilization and riparian revegetation. Project benefits include bank stabilization, enhanced aquatic habitat, and improved natural channel processes, riparian vegetation condition, and water quality.

Project ID: RG-2020-0024

Needs Met:

Agriculture: 60%	**M&I:** 0%
Env't. & Recreation: 30%	**Administration:** 10%

Estimated Cost: $175,000	**Estimated Yield:** 0 CFS
County: Conejos	**Estimated Capacity:** 200 LF

Project ID: RG-2020-0025

Project Name: East Bend Ditch Improvement Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The East Bend Ditch is located on the lower Conejos River and supplies water to 265 acres of agricultural land. This project involves bank stabilization and riparian revegetation surrounding the diversion dam. It will also include installation of a trash rack and adjustments to the headgate and adjacent sluice gate. Project benefits include bank stabilization, enhanced aquatic habitat, and improved natural channel processes, riparian vegetation condition, and water quality.

Needs Met:	
Agriculture: 60%	**M&I:** 0%
Env't. & Recreation: 30%	**Administration:** 10%

Estimated Cost: $85,000	**Estimated Yield:** 0 CFS
County: Conejos	**Estimated Capacity:** 430 LF

Project Name: Ehrowitz Ditch Improvement Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Ehrowitz Ditch diverts water off of the Rio Grande to supply water to 287 acres of agricultural land. The Ehrowitz Ditch diversion is in poor condition and the streambanks surrounding the structure are unstable. The project will result in an improved diversion dam capable of delivering water at all flows while maintaining fish and boat passage. The project will also include stream restoration surrounding the structure. This project is a partnership between the Colorado Rio Grande Restoration Foundation and Ehrowitz Ditch shareholders.

Project ID: RG-2020-0026

Needs Met:	
Agriculture: 50%	**M&I:** 0%
Env't. & Recreation: 40%	**Administration:** 10%

Estimated Cost: $100,000	**Estimated Yield:** 59 AF
County: Rio Grande	**Estimated Capacity:** 450 LF

Project ID: RG-2020-0027

Project Name: Minor Ditch Improvement Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Minor Ditch diverts water off of the Rio Grande to supply water to 1,006 acres of agricultural land. The Minor Ditch headgate is in poor condition and the streambanks surrounding the structure are unstable. This project will address channel migration through streambank stabilization and improve the Minor Ditch headgate while maintaining fish and boat passage. This project is a partnership between the Colorado Rio Grande Restoration Foundation and the Minor Ditch shareholders.

Needs Met:	
Agriculture: 50%	**M&I:** 0%
Env't. & Recreation: 40%	**Administration:** 10%

Estimated Cost: $150,000	**Estimated Yield:** 99 AF
County: Rio Grande	**Estimated Capacity:** 400 LF

Project Name: Rio Grande National Forest Wet Meadow Restoration Project - Phase 2

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: This project is a partnership between the US Forest Service and the Colorado Rio Grande Restoration Foundation to improve the ecological health and function of high elevation wet meadow habitat across the Rio Grande National Forest. The project will result in the restoration of 10 stream miles and 400 acres of riparian and wetland habitat through low-tech stream restoration methods and riparian revegetation. Restoration efforts will benefit watershed health, riparian corridors, and native aquatic species such as the Rio Grande Cutthroat Trout. The project will engage volunteers and community members throughout project monitoring and implementation.

Project ID: RG-2020-0028

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $60,000	**Estimated Yield:** 0 AF
County: NA	**Estimated Capacity:** 400 acres

Project ID: RG-2020-0029

Project Name: Rio Grande Riparian Stabilization Project - Phase 6

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Colorado Rio Grande Restoration Foundation will partner with private landowners along the Rio Grande to complete targeted restoration including channel shaping and the installation of rock barbs and woody root wads to improve aquatic habitat, stabilize streambanks, and reconnect the river to the floodplain and riparian areas. This work will build upon previous phases with the overall goal of improving the health and resilience of the Rio Grande in Alamosa and Rio Grande Counties.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $600,000	**Estimated Yield:** 0 AF
County: NA	**Estimated Capacity:** 10,560 LF

Project Name: Trogillio Ditch Improvement Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Trogillio Ditch is located on the Conejos River near the Rio San Antonio confluence and supplies water to 254 acres of agricultural land. The structure functions poorly. This project includes Trogillio Ditch diversion and headgate replacement, streambank stabilization, and riparian revegetation both upstream and downstream of the diversion. Project benefits include bank stabilization, enhanced aquatic habitat, and improved natural channel processes, riparian vegetation condition, and water quality.

Project ID: RG-2020-0030

Needs Met:	
Agriculture: 60%	**M&I:** 0%
Env't. & Recreation: 30%	**Administration:** 10%

Estimated Cost: $250,000	**Estimated Yield:** 30 AF
County: Conejos	**Estimated Capacity:** 350 LF

Project ID: RG-2020-0031

Project Name: Westside Ditch Improvement Project

Lead Proponent: Colorado Rio Grande Restoration Foundation

Project Description: The Westside Ditch diverts water off of the Rio Grande to supply water to 1,898 acres of agricultural land. The ditch's diversion dam functions poorly and creates a barrier to boat passage as well as fish passage at low flows. Additionally, limited flow capacity at the diversion disrupts natural sediment transport regimes and contributes to water conveyance challenges for Colorado's water administrators during high water periods. To address these issues, this project will replace the existing diversion dam and incorporate fish and boat passage. Having adequate flow capacity at this structure would improve sediment transport processes and help Colorado meets its Rio Grande Compact water delivery obligations. The project would enhance recreational boating opportunities and improve overall river health.

Needs Met:

Agriculture: 40%	**M&I:** 20%
Env't. & Recreation: 40%	**Administration:** 0%

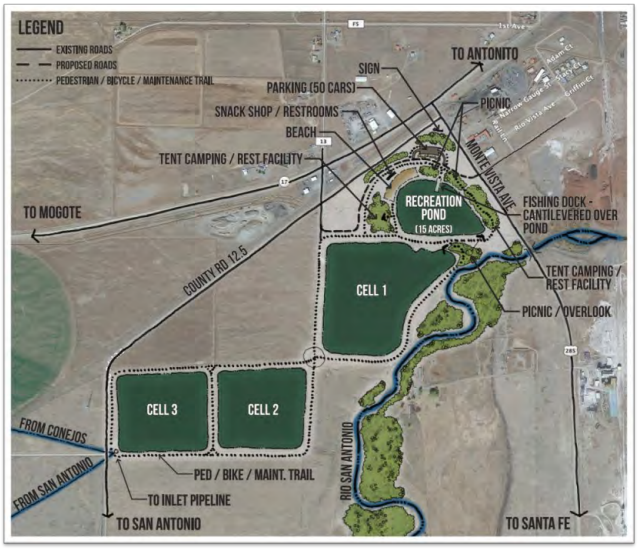
Estimated Cost: $250,000	**Estimated Yield:** 149 AF
County: Alamosa	**Estimated Capacity:** 350 LF

Project Name: Conejos Cooperative Storage Project

Lead Proponent: Conejos Water Conservancy District

Project Description: The Conejos Water Conservancy District is seeking to study and ultimately build a new water storage facility within the Conejos River System, specifically to benefit the water users on the Rio San Antonio.

Project ID: RG-2020-0032



Needs Met:

Agriculture: 50%	**M&I:** 10%
Env't. & Recreation: 15%	**Administration:** 25%

Estimated Cost: $6,000,000	**Estimated Yield:** 1,900 AF
County: Conejos	**Estimated Capacity:** 1,900 AF

Project ID: RG-2020-0033

Project Name: Manassa Land and Irrigation Conveyance Project

Lead Proponent: Conejos Water Conservancy District

Project Description: Manassa Land and Irrigation Company is seeking to make improvements to its conveyance and delivery system to increase efficiency. Improvements will include an analysis of existing conveyance ditches, recommended structural improvements, and implementation of identified improvements. Improvements are expected to included pipelines and other efficiency improvements.

Needs Met:	
Agriculture: 75%	**M&I:** 10%
Env't. & Recreation: 5%	**Administration:** 10%

Estimated Cost: $8,000,000	**Estimated Yield:** 1,400 AF
County: Conejos	**Estimated Capacity:** 22,000 AF

Project Name: Upper Culebra Watershed Assessment – Project Implementation

Lead Proponent: Costilla County Conservancy District

Project Description: This stakeholder driven watershed assessment encompasses the Upper Culebra Basin, from the headwaters on Culebra Peak to the valley at San Acacio. Environmental challenges facing the watershed include extended drought, forest fire potential, extensive beetle kill, water quality impairments, endangered species, degraded habitat, and other anthropogenic impacts. The UCWA will assess the ecological condition of the Upper Culebra watershed by collecting, compiling, and analyzing a wide variety of data. This data will provide partners with a resource to prioritize, secure funding for, and implement projects to improve the health and resiliency of the watershed.

Needs Met:	
Agriculture: 25%	**M&I:** 25%
Env't. & Recreation: 25%	**Administration:** 25%

Project ID: RG-2020-0034

Estimated Cost: $10,000,000	**Estimated Yield:** 1,000 AF
County: Costilla	**Estimated Capacity:** 1,000 AF

Project ID: RG-2020-0035

Project Name: Alamosa NWR – Mumm Well Restorations

Lead Proponent: Ducks Unlimited, Inc.

Project Description: This Project involves restoring natural water movement and hydrologic conditions on the Alamosa NWR by modifying and removing water infrastructure around Mumm Well. Previously installed infrastructure, including a ditch and levee, restricts natural sheetflow and impounds water, causing habitat that was historically seasonal wetlands and uplands to be replaced with undesired perennial wetland species. Removal of these structures, as well as increasing the capacity of a culvert under a necessary service road, will restore natural sheetflow and allow natural vegetation to reestablish without compromising accessibility.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $325,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 1,070 acres

Project Name: Alamosa NWR – Rio Grande Riparian Restorations

Lead Proponent: Ducks Unlimited, Inc.

Project Description: Riparian habitat on Alamosa National Wildlife Refuge is in a degraded condition due to hydrologic alterations, past livestock grazing, and current browsing by native ungulates such as elk. It is also suspected that due to changes in average annual snowpack, groundwater levels adjacent to the Rio Grande are often insufficient to maintain adequate hydrological conditions within the root zones of willows and cottonwoods. This Project involves installing water diversion structures out of the Chicago Ditch to maintain adequate hydrologic conditions within the root zone of willow and cottonwood, thus promoting their growth, spread, and persistence. Elk exclosures will also be installed to reduce browsing pressure.

Project ID: RG-2020-0036

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $150,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 100 acres

Project ID: RG-2020-0037

Project Name: Alamosa NWR – Units C1, T, O and Restorations

Lead Proponent: Ducks Unlimited, Inc.

Project Description: The hydrology in the Alamosa National Wildlife Refuge has been highly altered both prior to and after refuge establishment. This project will install new water control/diversion structures within Units C1, T, O, and P, substantially improving their ability to provide water to natural wetland areas. These changes will also improve the quantity and quality of wetland vegetative conditions within these areas. Along with these additions, the elimination of irrigation on natural upland habitats will result in the reestablishment of upland vegetation communities and a long-term decrease in invasive plants, reducing the amount of labor and financial resources currently devoted to invasive plant control.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $175,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 1,700 acres

Project Name: Baca NWR – Crestone Creek Riparian Restorations

Lead Proponent: Ducks Unlimited, Inc.

Project Description: This Project will construct additional elk exclosures along Crestone Creek to reduce browsing pressure from the large populations of elk present within the Baca National Wildlife Refuge. These exclosures will help protect and restore riparian habitat by allowing species such as willow and cottonwood to better establish while also reducing the need for other more intensive elk management techniques.

Project ID: RG-2020-0038

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $60,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 1 stream mile

Project ID: RG-2020-0039

Project Name: Baca NWR – Wet Meadow Restorations

Lead Proponent: Ducks Unlimited, Inc.

Project Description: Installation of new water control/diversion structures in appropriate locations will facilitate the delivery of water directly into the upper areas of natural wetland flowpaths, resulting in greater efficiency of water use (more water being delivered to natural wetland areas) and improved habitat conditions, including vegetation quality and decreased invasive species presence. This, along with the removal of water control/diversion structures and ditches located on higher ground (natural upland habitat), will allow areas to revert to a vegetation community typified by upland habitat, benefitting upland wildlife species.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $450,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 8,000 acres

Project Name: McIntire Springs – Riparian Restorations

Lead Proponent: Ducks Unlimited, Inc.

Project Description: This project proposes the rehabilitation of all priority wells on the Blanca Wildlife Habitat Area and the re-construction of critical water delivery infrastructure. Ducks Unlimited will work with BLM, CPW and local constituents to develop a plan of restoration, perform the requisite engineering and permitting activities, and, within three years, perform construction to rehabilitate the infrastructure. Project activities include re-drilling and re-casing wells such that they meet permitted production limits; installation of appropriate measurement devices; re-construction and armoring of well outlets, emplacement of anti-erosion measures, recontouring of ditch runs and banks, and installation of modern water management infrastructure.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Project ID: RG-2020-0040

Estimated Cost: $400,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 500 acres

Project ID: RG-2020-0041

Project Name: McIntire-Simpson – Riparian Wetland Restorations

Lead Proponent: Ducks Unlimited, Inc.

Project Description: Water control and management is required to ensure the continued health and sustainability of wetland and riparian habitats found on the McIntire-Simpson property. Degraded infrastructure is threatening the ability to support both species sought by federal wildlife managers and recreational waterfowling. DU, in collaboration with BLM and local stakeholders, will review, design, permit and construct water infrastructure rehabilitations such that decreed water rights are put to the most efficient use in creating riparian and wetland habitat. Project activities will include re-construction of water diversion and conveyance infrastructure, installation of required measurement structures, fencing, and earth-moving deemed necessary to increase habitat functionality on the site.

Needs Met:

Agriculture: 0% **M&I:** 0%

Env't. & Recreation: 100% **Administration:** 0%

Estimated Cost: $250,000	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:** 250 acres

Project Name: Monte Vista NWR – Spring Creek Restoration

Lead Proponent: Ducks Unlimited, Inc.

Project Description: The historic channel of Spring Creek has experienced significant incision, in some places to a depth of over 2 meters. Ditches in the area (Sanderson Ditch, Spring Creek Ditch) also contribute similar challenges to hydrology. Restoration of a meandering, shallow creek and removal of the ditches (i.e., filling them in) will greatly reduce the drainage of surface and sub-surface water in the entire area, improving vegetative conditions. Reduced drainage and improved water holding capability within the floodplain and adjacent wetland areas will improve water efficiency and vegetation quality for nesting waterfowl. Finally, the installation of a new water diversion structure and measurement flume will give refuge staff the flexibility to direct water into Unit 9 or maintain water flows into Spring Creek and its associated floodplain.

Project ID: RG-2020-0042

Needs Met:

Agriculture: 0% **M&I:** 0%

Env't. & Recreation: 100% **Administration:** 0%

Estimated Cost: $500,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 2.5 stream miles

Project ID: RG-2020-0043

Project Name: Monte Vista NWR – Units 14, 15 and 16 Restoration

Lead Proponent: Ducks Unlimited, Inc.

Project Description: Control structures for units 14, 15 and 16, which facilitate water delivery into the natural wetland flowpath, are old, dilapidated, and under-sized, resulting in inadequate flows of water. Consequently, much of the water backs-up, flows into a ditch, and by-passes the flowpath completely. Replacing the existing water control structure with one that allows all the water to flow into the natural wetland flowpath will result in greater efficiency of water use. In addition to this replacement, removal of the system of levees within the area will eliminate the flooding of former upland habitats and restore sheetflow and hydrological connectivity. As a result, the quality and extent of desirable short-emergent vegetation for nesting waterfowl and other waterbirds within the natural wetland flowpath will improve.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $500,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 3,860 acres

Project Name: Monte Vista NWR – Units 18 and 24 Restoration

Lead Proponent: Ducks Unlimited, Inc.

Project Description: Natural wetland flowpaths are compromised by dilapidated levees and numerous small drains. These drains now severely impact groundwater levels and cause the drainage of surface water flows in adjacent natural wetland areas. Consequently, it has become extremely difficult to maintain adequate surface and sub-surface hydrologic conditions. Removal of the surrounding drains will eliminate the continued drainage of surface water flows in desired locations. Additionally, removal of sections of small water delivery ditches will eliminate the flooding of natural upland habitats, allowing these areas to revert to historic vegetative communities (upland shrub). Bowen drain will be maintained and improved, allowing what is known as Bowen Pond (an important white-faced ibis breeding location) to remain.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Project ID: RG-2020-0044

Estimated Cost: $250,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 700 acres

Project ID: RG-2020-0045

Project Name: Northern SLV Water Table Study on Conserved Lands

Lead Proponent: Ducks Unlimited, Inc.

Project Description: Utilizing existing piezometers, an aquatic study will be initiated in the Closed Basin area on public and conserved lands along current and historic drainages between RLSWA and the Baca NWR in 2020 and 2021. Locations for future piezometers will be determined during the 2020-21 field effort to help understand annual water table fluctuations, the connectivity of the system, and the impact of different water uses. This understanding will help guide how agencies and landowners can work together to help maintain a higher and more stable water table. This study would also help to show how different management strategies in Sub-district #1 are affecting water tables across land ownership.

Needs Met:	
Agriculture: 40%	**M&I:** 0%
Env't. & Recreation: 40%	**Administration:** 20%

Estimated Cost: $50,000	**Estimated Yield:** NA
County: Saguache	**Estimated Capacity:** NA

Project Name: Rio Grande State Wildlife Area – Wetlands and Water Restoration

Lead Proponent: Ducks Unlimited, Inc.

Project Description: This Project will improve water control infrastructure efficiency and effectiveness, enhancing and restoring 80 acres of wetland habitats across the Rio Grande State Wildlife Area. Current infrastructure is difficult to maintain, in poor condition, and is poorly designed. Primary objectives include increasing the amount of shallowly flooded habitat for migrating waterbirds and wildlife, improving waterfowl hunting opportunities, and increasing the health of wetlands for a variety of wildlife including species of concern and threatened and endangered species.

Project ID: RG-2020-0046

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $325,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 80 acres

Project ID: RG-2020-0047

Project Name: Russell Lakes State Wildlife Area – Wetlands and Water Restoration

Lead Proponent: Ducks Unlimited, Inc.

Project Description: This project is the second and final phase of a project located on the RLSWA, which is a mitigation site for the Closed Basin Project and managed by CPW. The first phase was completed in 2016 and created shallowly flooded wetlands that have been utilized by a wide variety of birds. A total of 650 acres are included within this project's scope, which incorporates the confluence of the 3 branches of the historic Russell Creek drainages, wetlands, and associated upland habitat. The primary objective is to increase available resources for a majority of priority waterfowl species through a more efficient use of water resources in the late winter, spring, and early summer.

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $325,000	**Estimated Yield:** 0 AF
County: Saguache	**Estimated Capacity:** 80 acres

Project Name: Upper Saguache Creek Bank Stabilization and Restoration

Lead Proponent: Ed Nielsen

Project Description: The landowner aims to complete targeted restoration including channel shaping and the installation of rock barbs and woody root wads to improve aquatic habitat, stabilize streambanks, and reconnect the river to the floodplain and riparian areas. The work will reduce erosion and increase alluvial water storage, resulting in improved water quality and sustained base flows in the Creek. This work will build upon previous restoration work on the Creek with the goal of improving the health and resilience of Saguache Creek while reducing landowner maintenance.

Project ID: RG-2020-0048

Needs Met:	
Agriculture: 50%	**M&I:** 0%
Env't. & Recreation: 50%	**Administration:** 0%

Estimated Cost: $350,000	**Estimated Yield:** 0 AF
County: Saguache	**Estimated Capacity:** 800 LF

Project ID: RG-2020-0049

Project Name: Lower Willow Creek Floodplain Stream Restoration, Habitat Enhancement and Recreational Development Project

Lead Proponent: Headwaters Alliance

Project Description: HWA has selected a Design Firm to create a 60% design for restoration and reclamation work on the full reach of the lower Willow Creek floodplain. This design will attend to regulatory requirements related to legacy mining impacts, stabilize stream banks to ensures floodplain connectivity, revegetate the riparian corridor, and improve water quality to support Brown trout in lowest stretch of reach, resulting in an ecologically functioning floodplain. Recreational use will also be a key aspect to create a non-motorized use only trail from town to the Rio Grande. This project will also maintain existing water rights and seek to protect and integrate key City municipal water system infrastructure where possible.

Needs Met:

Agriculture: 0%	**M&I:** 20%
Env't. & Recreation: 75%	**Administration:** 5%

Estimated Cost: $1,200,000	**Estimated Yield:** 0 AF
County: Mineral	**Estimated Capacity:** 1.7 miles

Project Name: Mineral County Water Use Project

Lead Proponent: Headwaters Alliance

Project Description: There is an absence of land and water use planning in Mineral County and an associated lack of data. This project seeks to better inform water use and water contribution to the Rio Grande across Mineral County (both main stem and South Fork of the Rio Grande) by pulling together existing documentation and modeling data. Additional needs will be identified upon evaluation of the above. Strategies for obtaining further data will likely include the Rio Grande Tributary Stream Flow Project.

Project ID: RG-2020-0050

Needs Met:

Agriculture: 10%	**M&I:** 40%
Env't. & Recreation: 40%	**Administration:** 10%

Estimated Cost: $65,000	**Estimated Yield:** NA
County: Mineral	**Estimated Capacity:** 561,920 acres

Project ID: RG-2020-0051

Project Name: North Creede Stream Stability and Flood Mitigation

Lead Proponent: Headwaters Alliance

Project Description: Headwaters Alliance will be releasing an RFP requesting designs for improvements along the North Creede reach of the main stem of Willow Creek from just above the flume at the north end of Creede to above the confluence of East and West Willow Creek. This will be part of the Comprehensive Willow Creek Watershed Planning Project, a multi-partner project funded largely by CWCB and administered by Headwaters Alliance.

Needs Met:

Agriculture: 0%	**M&I:** 40%
Env't. & Recreation: 50%	**Administration:** 10%

Estimated Cost: $475,000	**Estimated Yield:** 0 AF
County: Mineral	**Estimated Capacity:** 0.5 miles

Project Name: Upper Rio Grande Tributary Flow Volume Project

Lead Proponent: Headwaters Alliance

Project Description: This Project will install an updated and operational stream gage on Willow Creek to collect stream flow data. Future project scoping includes planning and implementation of stream gages on other key tributaries in the Upper Rio Grande Watershed, providing valuable data to inform water management and education.

Project ID: RG-2020-0052

Needs Met:

Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 75%	**Administration:** 25%

Estimated Cost: $96,000	**Estimated Yield:** NA
County: Mineral	**Estimated Capacity:** NA

Project ID: RG-2020-0053

Needs Met:	
Agriculture: 60%	**M&I:** 0%
Env't. & Recreation: 40%	**Administration:** 0%

Project Name: Mefford Ranch Bank Stabilization/Stream Restoration

Lead Proponent: Mefford Ranch

Project Description: Stabilize outer bank on a 90 degree bend on the Conejos River approximately 200 yds upstream of the Guadalupe Ditch feeder channel by constructing 4 barbs along the outer bank of the sharp bend. As noted in the Conejos Stream Management Plan, the Guadalupe Ditch feeder channel (Priority No. 1) will be bypassed by the river if bank erosion continues. Stream restoration upstream and downstream of the bend will also be undertaken to improve reach stability and fish habitat. The river had been historically dredged leaving high berms (now failing) that prevent the river from accessing the rivers natural flood plain. Reconnecting the river to its floodplain will help to reduce future bank erosion on the bend and create low flow fish habitat. Low flow fish habitat will help mitigate future effects of climate change as the Basin continues to see below-average precipitation.

Estimated Cost: $75,000	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:** 2,640 LF

Project Name: Rio Grande Natural Area – Rangeland Analysis Platform (RAP) Assessment

Lead Proponent: Salazar Rio Grande del Norte Center at Adams State University

Project Description: Utilize a peer reviewed method to assess riparian and upland riparian habitat within the Rio Grande Natural Area.

Project ID: RG-2020-0054

Needs Met:	
Agriculture: 20%	**M&I:** 0%
Env't. & Recreation: 80%	**Administration:** 0%

Estimated Cost: $25,000	**Estimated Yield:** NA
County: NA	**Estimated Capacity:** NA

Project ID: RG-2020-0055

Project Name: Water Education Initiative: Phase II

Lead Proponent: Salazar Rio Grande del Norte Center at Adams State University

Project Description: Water Education at Adams State University has a vital role to play for both students and the community by offering for-credit water courses and developing new ways of reaching learners of all ages to enhance community water knowledge. As Phase I moves forward, project proponents will seek to build upon successes and explore new ways of educating about the many dimensions and challenges of water, including how to optimize virtual learning.

Needs Met:	
Agriculture: 25%	**M&I:** 25%
Env't. & Recreation: 25%	**Administration:** 25%

Estimated Cost: $100,000	**Estimated Yield:** NA
County: NA	**Estimated Capacity:** NA

Project Name: Farmers Union Canal Headgate Automation Project

Lead Proponent: San Luis Valley Irrigation District

Project Description: The San Luis Valley Irrigation District owns the water rights associated with the Farmers Union Canal which services 62,000 acres within the closed basin area of the San Luis Valley near Center, Colorado. The headgate of the canal is located on the North Branch of the Rio Grande approximately 6 miles east of Del Norte, Colorado. The District has planned on automating the headgates of the canal as similar large canals within the area on the Rio Grande have done to increase headgate diversion efficiency and help meet agricultural, environmental, recreational and supply/demand goals in this area.

Project ID: RG-2020-0056

Needs Met:	
Agriculture: 55%	**M&I:** 5%
Env't. & Recreation: 20%	**Administration:** 20%

Estimated Cost: $39,000	**Estimated Yield:** 595 AF
County: Rio Grande	**Estimated Capacity:** 800 CFS

Project ID: RG-2020-0057

Project Name: North Branch Splitter Rehabilitation Project

Lead Proponent: San Luis Valley Irrigation District

Project Description: The San Luis Valley Irrigation District owns the diversion dam and headgate structure that splits the North Branch of the Rio Grande from the main channel of the Rio Grande located near Del Norte, Colorado. The North Branch Splitter structure services the surface water rights owned by the Farmers Union Canal and some smaller ditches that are located downstream of this structure. The District would like to replace the diversion dam and headgate structure to help meet agricultural, environmental, recreational and supply/demand goals on the North Branch of the Rio Grande.

Needs Met:

Agriculture: 55%	**M&I:** 5%
Env't. & Recreation: 20%	**Administration:** 20%

Estimated Cost: $1,200,000	**Estimated Yield:** 892 AF
County: Rio Grande	**Estimated Capacity:** 1,200 CFS

Project Name: Shaw Reservoir Rehabilitation

Lead Proponent: San Luis Valley Water Conservancy District

Project Description: The project includes rehabilitation of the Shaw Reservoir Feeder Ditch and headgate, which were damaged in the West Fork Complex Fire, upgrading the reservoir outlet works, lining the outlet pipe, and adding automated measurement and controls. This will protect the ability for this pre-compact reservoir and extremely popular recreation asset to fill and operate safely, with greater flexibility. The project is a partnership with SLVWCD, BLM, and Trout Unlimited.

Project ID: RG-2020-0058

Needs Met:

Agriculture: 5%	**M&I:** 25%
Env't. & Recreation: 60%	**Administration:** 10%

Estimated Cost: $370,000	**Estimated Yield:** 400 CFS
County: Mineral	**Estimated Capacity:** 680 AF

Project ID: RG-2020-0059

Project Name: Terrace Reservoir Outlet Works Analysis and Repair- Phase II

Lead Proponent: Terrace Irrigation Company

Project Description: This project involves lining, repairing or the possible replacement of the Terrace Reservoir outlet pipeline.

Testing and Analysis done in Phase I identified three scenarios—cost estimates will depend on the results of ongoing monitoring and analysis done by engineers. The State Dam Safety Inspector is requiring The Terrace Irrigation Company to retain an Engineering firm that specializes in reservoir tunnel pipelines to perform an inspection of the existing outlet works pipe in the dam at the Terrace Reservoir and prepare an analysis describing alternatives to mitigate the corrosion.

Needs Met:	
Agriculture: 70%	**M&I:** 10%
Env't. & Recreation: 0%	**Administration:** 20%

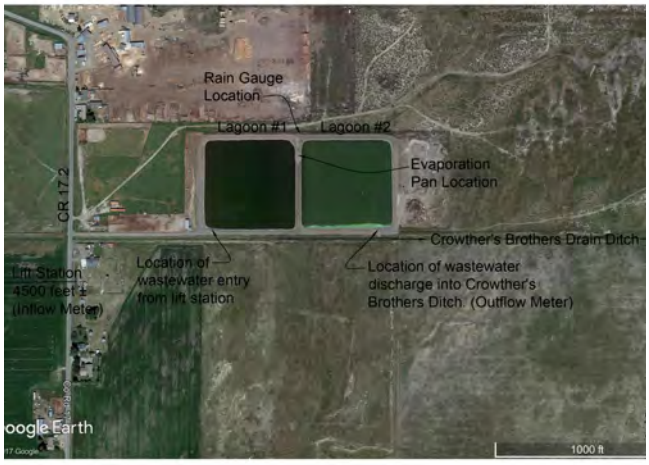
Estimated Cost: $4,500,000	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:** 15,182 AF

Project Name: Town of La Jara Wastewater Treatment Facility Project

Lead Proponent: Town of La Jara

Project Description: The existing wastewater treatment facilities for the Town of La Jara include two facultative lagoons with no mechanical aeration equipment. The ponds were designed in 1970 to have a water depth of 5 feet and a detention time of 50 days for each pond. The discharge permit authorizes La Jara to discharge treated wastewater from the facility through Outfall 001A into the Crowthers Brother's Ditch. The Town received a Notice of Violation/Cease and Desist Order – DO190826-1, for exceeding allowable limits for BOD, TSS, Flow Rate and E. coli. This project would consist of dredging the lagoons and installing a mechanical aeration system and disinfection equipment.

Project ID: RG-2020-0060



Needs Met:	
Agriculture: 0%	**M&I:** 90%
Env't. & Recreation: 0%	**Administration:** 10%

Estimated Cost: $1,541,250	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:** 0 AF

Project ID: RG-2020-0061

Needs Met:	
Agriculture: 0%	**M&I:** 95%
Env't. & Recreation: 0%	**Administration:** 5%

Project Name: Town of South Fork Municipal Water Infrastructure Improvements – Phase 2

Lead Proponent: Town of South Fork

Project Description: This project will result in the development of an updated Master Plan (MP) for the Town of South Fork municipal water system. An updated MP is needed to reflect recently completed projects, including private well and water system acquisitions, as well as future infrastructure improvement and water acquisition needs. The Town recently acquired private water providers and incorporated some of those providers into the Town's central municipal water system. However, the need for additional water supplies was identified and quantified. The updated MP will describe the additional water rights acquisitions needed to satisfy current and future municipal demands as well as physical infrastructure improvements required to develop a robust and sustainable water system for the Town of South Fork.

Estimated Cost: $680,000	**Estimated Yield:** 0 AF
County: Rio Grande	**Estimated Capacity:** 354 AF

Project Name: Indian Creek Ditch Project

Lead Proponent: Trinchera Irrigation Company

Project Description: This Project will Install a 48" PVC pipe in the existing Indian Creek Ditch, which runs from West Indian Creek to Mountain Home Reservoir. The pipeline would be approximately 3,285 feet long and help prevent and mitigate the impact of possible flooding.

Needs Met:	
Agriculture: 70%	**M&I:** 0%
Env't. & Recreation: 20%	**Administration:** 10%

Project ID: RG-2020-0062

Estimated Cost: $435,000	**Estimated Yield:** 317 AF
County: Costilla	**Estimated Capacity:** 900 AF

Project ID: RG-2020-0063

Project Name: Levy Diversion and Headgate Rehabilitation Project

Lead Proponent: Trinchera Irrigation Company

Project Description: This project would consist of the repair or replacement of a 50' x 2' concrete diversion structure and replacement of two 36" manual headgates and two 48" manual headgates with mechanical automated headgates. These existing diversion and headgates service the Levy Diversion. The improved diversion would increase overall function and reduce maintenance needs. Automated headgates would increase diversion efficiency and reduce maintenance by automatically adjusting for diurnal and other flow fluctuations.

Needs Met:	
Agriculture: 75%	**M&I:** 0%
Env't. & Recreation: 0%	**Administration:** 25%

Estimated Cost: $127,812	**Estimated Yield:** 208 AF
County: Costilla	**Estimated Capacity:**

Project Name: Mountain Home Reservoir Spillway Project

Lead Proponent: Trinchera Irrigation Company

Project Description: This project involves filling the washed out area below the Mountain Home Reservoir Spillway with riprap. The area to be filled is approximately by feet, or ~ acres. The washout area is eroding, creating a possible dam safety concern. This project will prevent erosion and mitigate risks associated with the dam.

Project ID: RG-2020-0064

Needs Met:	
Agriculture: 80%	**M&I:** 0%
Env't. & Recreation: 0%	**Administration:** 20%

Estimated Cost: $10,500	**Estimated Yield:** 0 AF
County: Costilla	**Estimated Capacity:** 2 acres

Project ID: RG-2020-0065

Project Name: Ute Creek Parshall Flume Project

Lead Proponent: Trinchera Irrigation Company

Project Description: This project involves the fabrication of an 8 foot Parshall Flume or similar structure along with all associated hardware to measure flows in Ute Creek. This stream gage will improve water administration in Ute Creek and will help water users plan irrigation water usage more efficiently.

Needs Met:	
Agriculture: 80%	**M&I:** 0%
Env't. & Recreation: 0%	**Administration:** 20%

Estimated Cost: $17,500	**Estimated Yield:** 0 AF
County: Costilla	**Estimated Capacity:** 0 AF

Project Name: Alamosa River Instream Flow Restoration

Lead Proponent: Trout Unlimited

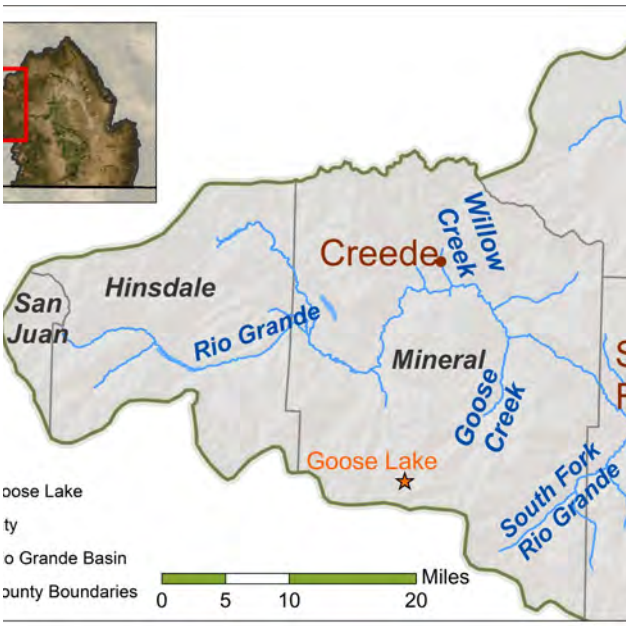
Project Description: The Alamosa River Watershed is a critical tributary in the Rio Grande Basin, providing water for people and farms and ranches. In the upper watershed a mining disaster has led to toxic runoff that severely impacted the watershed. In response there has been an enormous effort to restore the watershed and a master plan was developed. In the master plan, instream flow restoration was identified as a top priority. This project will seek water rights acquisitions and leases to fill a permanently dedicated 2,000 acre-feet of storage space in Terrace Reservoir, to be used for non-irrigation season flow restoration. Releasing water at this time will benefit the environment and recreational fisheries, but also recharge groundwater into the aquifer.

Project ID: RG-2020-0066

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $180,000	**Estimated Yield:** 1,200 AF
County: Conejos	**Estimated Capacity:** 1,200 AF

Project ID: RG-2020-0067



Project Name: Goose Lake Reservoir Management Plan and Repair

Lead Proponent: Trout Unlimited

Project Description: Goose Lake is a high elevation reservoir located within the Weminuche Wilderness of Rio Grande National Forest near Creede, Colorado. The reservoir is part of the conservation pool program with Colorado Parks and Wildlife, whereby Trout Lake is kept full and maintained as a recreational fishery for the public, and in exchange, the water rights owners receive a like amount of water for irrigation, providing multiple benefits to the resource and public. The dam needs repair work, however, there is a sensitive population of Boreal Toads persisting in the pool habitat associated with the dam outlet, and the pool is causing damage to the pipe. This project will develop a management plan that includes protecting the toads, the water right, and the infrastructure.

Needs Met:

Agriculture: 50%	**M&I:** 0%
Env't. & Recreation: 50%	**Administration:** 0%

Estimated Cost: $15,400	**Estimated Yield:** 0 AF
County: Mineral	**Estimated Capacity:** 223 AF

Project Name: Jim Creek Electric Fish Barrier

Lead Proponent: Trout Unlimited

Project Description: Jim Creek is a tributary to La Jara Reservoir in Conejos County, Colorado. Jim Creek is home to a core conservation population of the native Rio Grande cutthroat trout. However, this population is compromised by the invasive Brook Trout. Trout Unlimited and partners have been working since 2014 to protect and restore stream and riparian habitat on Jim Creek. This work has led to substantial recovery in the cutthroat population. This project would install a solar powered electric fish barrier that would prevent fish from the reservoir from entering the creek. With the barrier in place, removal efforts on brook trout will further secure this important fish population.

Project ID: RG-2020-0068

Needs Met:

Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $180,000	**Estimated Yield:** 0 AF
County: Conejos	**Estimated Capacity:** 0 AF

Project ID: RG-2020-0069

Project Name: Medano Ditch Fish Screen

Lead Proponent: Trout Unlimited

Project Description: Medano ditch is a trans-mountain irrigation diversion that diverts water from Medano Creek. The ditch often sweeps the entire flow of the creek and is entraining all life stages of native Rio Grande cutthroat trout, impacting a core conservation population. The project will replace the current head-gate with new infrastructure that prevents fish from entering the ditch without interrupting water diversions to the ditch.

Needs Met:	
Agriculture: 25%	**M&I:** 0%
Env't. & Recreation: 75%	**Administration:** 0%

Estimated Cost: $225,000	**Estimated Yield:** 0 AF
County: Saguache	**Estimated Capacity:** NA

Project Name: Rio Grande Cutthroat Reintroduction Studies

Lead Proponent: Trout Unlimited

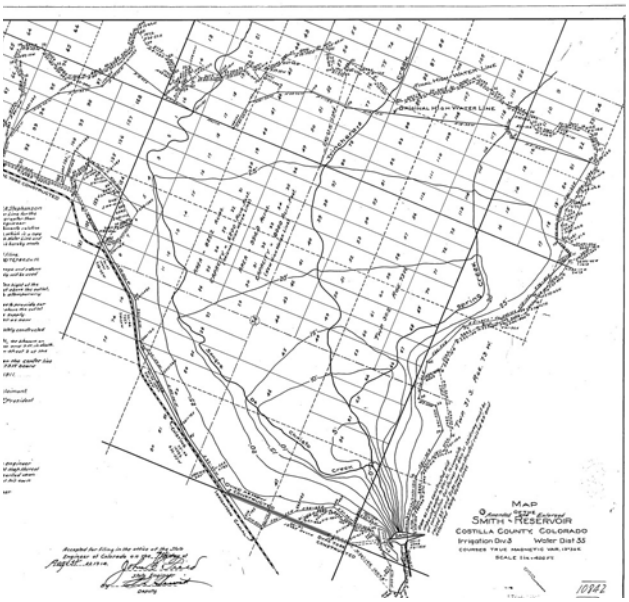
Project Description: The Rio Grande cutthroat trout is native to the Rio Grande and its tributaries in Colorado and New Mexico. This native sportfish only occupies 12 % of its historic range. It is imperative that new populations are reintroduced to the historic range of the species to reverse trends and keep the fish from being listed on the federal endangered species list. A decision matrix was developed in the Upper Rio Grande Watershed Assessment, which guides mangers on which streams are most suitable for reintroduction. After selecting good candidates, the next step is a watershed characterization study that drills into the details of project feasibility. This project will result in characterization studies for potential cutthroat reintroduction sites.

Project ID: RG-2020-0070

Needs Met:	
Agriculture: 0%	**M&I:** 0%
Env't. & Recreation: 100%	**Administration:** 0%

Estimated Cost: $45,000	**Estimated Yield:** NA
County: NA	**Estimated Capacity:** NA

Project ID: RG-2020-0071



Project Name: Smith Reservoir Storage Recovery Feasibility Study

Lead Proponent: Trout Unlimited

Project Description: Smith Reservoir is an irrigation reservoir near Blanca, Colorado in Costilla County. The reservoir also serves the public as a recreational fishery. Colorado Parks and Wildlife maintains a conservation pool of water in Smith Reservoir to sustain the fishery. Over time, the 800 acre-feet conservation pool has silted in from sediment inputs in the upper watershed. This project will investigate options to recover the storage capacity in Smith and assess and mitigate future siltation.

Needs Met:	
Agriculture: 30%	**M&I:** 0%
Env't. & Recreation: 70%	**Administration:** 0%

Estimated Cost: $45,000	**Estimated Yield:** 810 AF
County: Costilla	**Estimated Capacity:** 810 AF

Project Name: Trout Lake Reservoir - Wilderness Infrastructure Repair

Lead Proponent: Trout Unlimited

Project Description: Trout Lake is a high elevation reservoir located within the Weminuche Wilderness of Rio Grande National Forest near Creede, Colorado. The reservoir is part of the conservation pool program with Colorado Parks and Wildlife, whereby Trout Lake is kept full and maintained as a recreational fishery for the public. In exchange, the water rights owners receive a like amount of water for irrigation, providing multiple benefits to the resource and public. The dam needs repair work, the cost of which is being assessed in the fall of 2020.

Project ID: RG-2020-0072

Needs Met:	
Agriculture: 50%	**M&I:** 0%
Env't. & Recreation: 50%	**Administration:** 0%

Estimated Cost: $250,000	**Estimated Yield:** 122 AF
County: Hinsdale	**Estimated Capacity:** 122 AF