The Rio Grande drainage basin in Colorado is bound by the San Juan Mountains to the west, the Sangre de Cristo Range to the north and east, the Culebra Range to the southeast, and the Colorado-New Mexico state line to the south. Between the mountains lies the San Luis Valley, an expansive, generally flat area with an average elevation of 7,500 feet and precipitation of less than eight inches per year. Despite the low precipitation, agriculture has long been the basis of the Rio Grande basin economy. Principal crops are potatoes, followed by alfalfa, native hay, barley, wheat, and small vegetables like lettuce, spinach and carrots. Mountainous areas of the basin are forested and sparsely populated.

The northern third of the valley is a closed basin, meaning runoff from the surrounding mountains and diversions from the Rio Grande recharge the basin's two stacked aquifers, known as the unconfined and confined aquifers, rather than contributing or returning to the Rio Grande. Irrigated agriculture in the Rio Grande Basin relies on well pumping from the aquifers as well as surface deliveries from the Rio Grande and Conejos River. These diversions are both applied directly to crops and, in the closed basin, recharged into the unconfined aquifer.

The Rio Grande Compact establishes Colorado's obligations to ensure water delivery at the New Mexico state line with some allowance for credits and debits via accounts in Elephant Butte Reservoir. The compact dictates that Colorado calculate its delivery obligation based on the flow at indexed stations, which effectively caps Colorado's allowable consumptive use even in wet years. Key future water management issues in this basin center around sustainability of the groundwater supply, but also include maintaining and providing domestic supply for new growth and operating within the constraints of the Rio Grande Compact.

RIO GRANDE


District 25
San Luis Creek
285
69
MOFFAT
Saguache Creek
District 27
17
San Luis Creek
112
150
MONTE VISTA
15
ALAMOSA
370
District 35
Trinchera Creek
Terrace Reservoir
Trinchera Creek
District 21
Alamosa La Jara
SAN LUIS
District 24
Culebra Creek
District 22
Conejos River

4.7 RIO GRANDE BASIN RESULTS

4.7.1 BASIN CHALLENGES

Key future water management issues in this basin center around sustainability of the groundwater supply, but also include maintaining and providing domestic supply for new growth and operating within the constraints of the Rio Grande Compact. These challenges are described in the Colorado Water Plan and are summarized below.

Table 4.7.1 Key Future Water Management Issues in the Rio Grande Basin

Agriculture	Environment and Recreation	Municipal and Industrial	Compacts and Administration
• Groundwater use for agriculture is currently at unsustainable levels. • Community-based solutions offer best hope of minimizing effects of reducing irrigated acres.	• The Rio Grande 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.	• All cities and towns are supplied by groundwater wells and must comply with the State Engineer's Well Rules and Regulations. • Growth of commercial uses throughout the basin, new homes near Alamosa, and second homes in the surrounding mountains are creating a need for additional water supplies and well augmentation.	• The Rio Grande Compact and sustained drought make the objective of groundwater sustainability difficult.
• Groundwater is a key component of water supply in the basin for both M&I and agriculture. Groundwater management presents an ongoing challenge.			

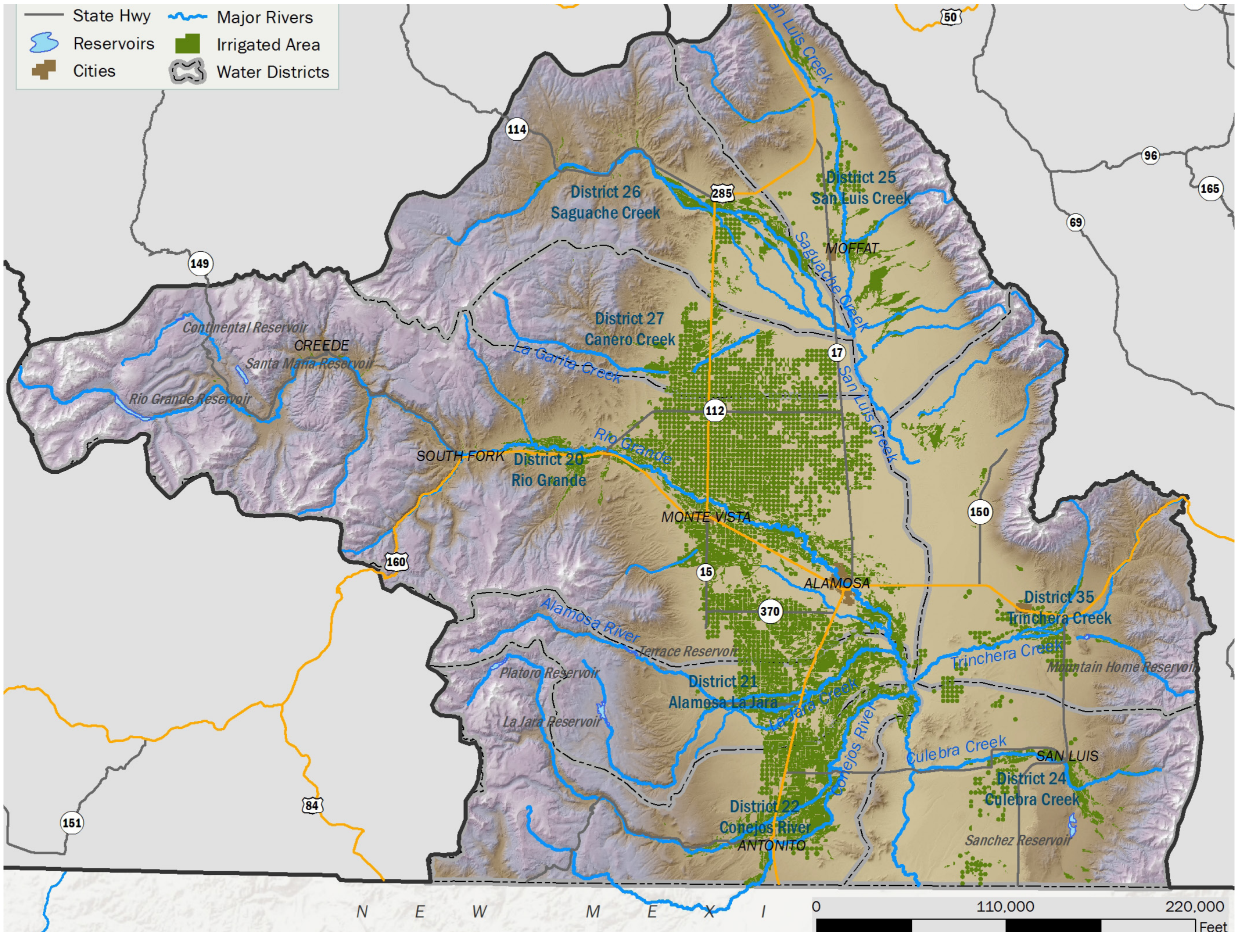


Figure 4.7.1 Map of the Rio Grande Basin

4.7.2 SUMMARY OF TECHNICAL UPDATE RESULTS

Key results and findings of the Technical Update pertaining to agricultural and M&I demands and gaps, as well as findings related to environmental and recreational attributes and future conditions, are summarized below in Table 4.7.2.

Table 4.7.2 Summary of Key Results in the Rio Grande Basin

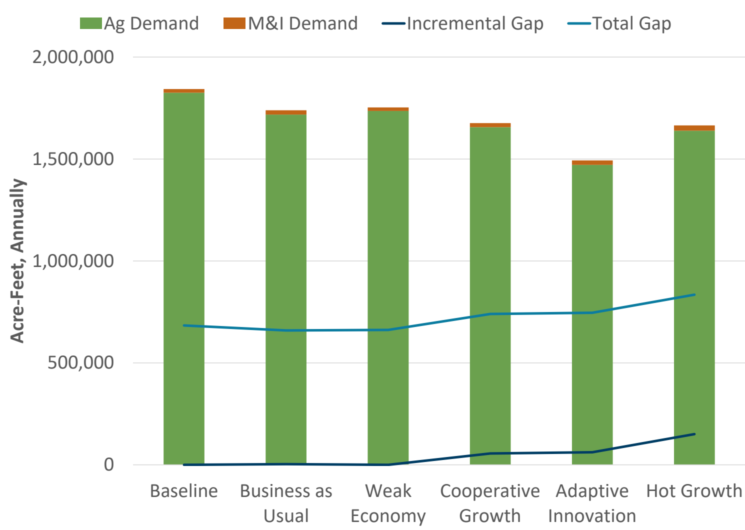
Agriculture	Environment and Recreation	Municipal and Industrial
• Future agricultural demand is lower than baseline, based on current and future acreage reductions due to groundwater administration and need to restore and sustain aquifer levels. • Agricultural demand in the scenarios is related to acreage reductions to offset climate-induced increases in IWR. Demand under Adaptive Innovation is lower than other scenarios, reflecting a higher system efficiency and reduction in IWR from emerging technologies. • As a percentage of demand, the gap is similar for Baseline, Business as Usual, and Weak Economy but larger larger for remaining scenarios despite lower demand.	• Flow magnitude in mountainous areas is not projected to significantly change under climate-impacted scenarios, but the annual hydrograph may shift with earlier snowmelt. Risks to riparian and fish habitat would remain low to moderate in most cases.Mid- and late-summer streamflow is projected to drop substantially in mountainous regions represented in the Flow Tool. Risk to cold water fish may remain moderate but increase in July and/or dry years.	• Both per capita use and total demand are significantly lower in the Technical Update baseline than in the SWSI 2010 baseline. • Aside from *Hot Growth*, outdoor demands are similar for all scenarios. This is due to the scenario pairing of water demand reductions and climate drivers.

Results describing current and potential future M&I and agricultural demands and gaps are summarized in Table 4.7.3 and in Figure 4.7.2.

Table 4.7.3 Summary of Diversion Demand and Gap Results in the Rio Grande Basin

	Current (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average Annual Demand						
Agricultural (AFY)	1,825,200	1,717,800	1,735,700	1,656,300	1,471,400	1,638,900
M&I (AFY)	17,700	21,100	17,700	20,100	21,700	25,800
Gaps						
Ag (avg %)	37%	38%	38%	45%	50%	50%
Ag (incremental-AFY)	-	-	-	53,500	58,000	142,500
Ag (incremental gap as % of current demand)	-	-	-	3%	3%	8%
M&I (max %)	-	16%	0%	12%	18%	31%
M&I (max-AF)	0	3,400	0	2,400	4,000	8,100

Figure 4.7.2 Summary of Diversion Demand and Gap Results in the Rio Grande Basin



Summary of Environmental and Recreational Findings

- A surface water allocation model was not available in the Rio Grande Basin, so the available flow dataset only includes natural flows and natural flows as impacted by climate drivers in mountainous areas; no management drivers are factored in.
  - » Management drivers impact river flows in areas downstream of mountainous areas in the Rio Grande and Conejos basins. Because a water allocation model that incorporates management is not available, no data-based insights into flow change and risk to non-consumptive attributes could be developed.
- In general, overall peak flow magnitude is not projected to change substantially under climate-impacted scenarios, but the peak may shift to earlier in the year (April/May streamflow magnitude may increase and June streamflow magnitude may decrease). Subsequent risk for riparian/wetland and fish habitat may remain low or moderate in most cases, although there are some indications that risk could increase in smaller streams.
- Mid- and late-summer streamflow is projected to drop substantially in all locations, with July streamflow decreasing 40 to 60 percent on the Rio Grande and tributaries and up to 70 percent on the Conejos River under the “In-Between” and “Hot and Dry” climate projections. Risk to cold water fish due to decreasing streamflow may remain moderate in most years but could be higher in July and/or during dry years.

4.7.3 NOTABLE BASIN CONSIDERATIONS

Section 4.1 described several analysis assumptions and limitations that apply to all basins and should be considered when reviewing and interpreting analysis results. Additional considerations specific to the Rio Grande Basin are listed below:

- The analysis assumed that there is no available water for meeting new uses. As a result, additional future M&I demands contribute directly to gaps.
- Basin stakeholders have cautioned that large reductions in irrigated land could result in socio-economic impacts that cause a reduction of municipal population.
- Stakeholder input was the basis of projected decreases in irrigated land due to groundwater sustainability and climate change.
- The Rio Grande Basin average baseline per capita systemwide demand has decreased significantly from 314 gpcd in SWSI 2010 to approximately 207 gpcd. The BIP was the primary source of water demand data.
- Aquifer sustainability will be a primary focus of future water management strategies and activities in this basin.
- The analysis did not consider specific different types of crops that may be grown in the future under the different scenarios; however, it accounted for future changes in crop types in a general sense in *Adaptive Innovation* and assumed that future crops would have 10 percent lower IWR. This is in line with the Rio Grande BIP recommendation to explore opportunities to reduce pumping through alternative cropping rather than drying up productive farm ground.

4.7.4 AGRICULTURAL DIVERSION DEMANDS

Agricultural Setting

Irrigated acreage in the Rio Grande Basin, particularly in the San Luis Valley, is inherently tied to the basin's unique surface and groundwater supplies. Surface water supplies diverted from streams fed by snowmelt are highly variable from year to year, with annual runoff in high flow years yielding up to eight times[11] more than in drought years. Groundwater from the upper unconfined aquifer and the deeper confined aquifer provides a more consistent irrigation supply. Although recharge to the unconfined aquifer occurs relatively quickly, decades of withdrawals greater than recharge have severely depleted it. Although the deeper confined aquifer supplies fewer wells than the unconfined aquifer due to its depth, it also experiences withdrawals that exceed recharge. Daily administration of the Rio Grande Compact, which primarily restricts surface water diversions through curtailment to meet compact deliveries, further impacts water availability in the basin. Surface and groundwater supplies combined support the irrigation of approximately 515,000 acres in the basin, predominantly in potatoes, grass, alfalfa, and small grains; however, the future of agriculture in the basin is threatened by more frequent periods of drought and declining aquifer levels.

Spurred by the drought in the early 2000s, declining levels of the unconfined aquifer in the Closed Basin, reduced confined aquifer pressure valleywide, and passage of Senate Bill 04-222 mandating the promulgation of groundwater rules and regulations by the Division of Water Resources (DWR), the Rio Grande Water Conservation District (RGWCD) created the first Special Improvement District of the Rio RGWCD (Subdistrict No. 1). Subdistrict No. 1 operates to replace injurious stream depletions caused by the subdistrict wells, recover aquifer levels, and maintain a sustainable irrigation water supply in the unconfined aquifer. The impacts to streams covered by the subdistricts are derived from a basin-wide groundwater model, developed through the Rio Grande Decision Support System (RGDSS).[12]

Subdistrict No. 1 began operations in 2012 and includes approximately 174,000 irrigated acres in the Closed Basin area. Subdistrict No. 2 covering the Rio Grande Alluvium and Subdistrict No. 3 covering the Conejos area began operating in 2019. Subdistricts No. 4, No. 5 and No. 6 covering the San Luis Creek, Saguache, and Alamosa/La-Jara Creek areas, respectively, are under development.

Due to the large amount of acreage in the subdistrict areas, management of these subdistricts will likely shape how irrigated agriculture will look by 2050.

Planning Scenario Adjustments

Section 2 described ways in which inputs to estimates of agricultural diversion demands were adjusted to reflect the future conditions described in the planning scenarios. Adjustments in the Rio Grande Basin focused on urbanization, groundwater sustainability, potential future climate conditions, and implementation of emerging technologies.

Population projections for the basin indicate that under all scenarios except *Weak Economy*, the basin's population will increase modestly and municipal water demands will grow. Irrigated acreage surrounding small towns in the basin is vulnerable to urbanization. For all scenarios other than *Weak Economy*, approximately 4,010 acres were estimated to come out of production due to urbanization of irrigated lands in the basin.

Much more significant are reductions in irrigated acreage to reach water use levels that the aquifers can sustainably support. In total, 40,000 irrigated acres were removed from the Subdistrict No.1 area, and 5,000 irrigated acres were removed across the basin in all planning scenarios.

IWR in the Rio Grande Basin is projected to increase on average by 15 percent under the *In-Between* climate projection and 18 percent on average under the "Hot and Dry" climate projection. Faced with this information, stakeholders in the basin discussed what the ultimate effects on the basin may be if IWR increases to these levels, particularly in light of the Rio Grande Compact. The group decided that as the compact will continue to limit surface water availability, any increase in IWR would likely lead to irrigated acreage being taken out of production because there would not be sufficient surface water supplies to meet these increased demands.

To account for this future potential outcome, it was assumed that the percent increase in IWR by Water District would result in the same percent decrease in irrigated acreage. With basinwide unit IWR historically averaging 2 AF per year and crop consumptive use in the basin historically averaging 1.3 AF per year, this is potentially an underestimate of the total acreage that may come out of production under potential future climate conditions. This approach, however, resulted in the removal of approximately 70,000 acres in *Cooperative Growth* and approximately 81,000 acres in *Adaptive Innovation* and *Hot Growth* across the basin. Note that IWR is reduced by 10 percent in *Adaptive Innovation* to account for technological innovations that may mitigate the increased IWR due to climate adjustments.

Table 4.7.4 summarizes the planning scenario adjustments described above and other adjustments that impact agricultural diversion demands in the various scenarios.

Table 4.7.4 Planning Scenario Adjustments for Agricultural Demands in the Rio Grande Basin

Adjustment Factor*	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Change in Irrigated Land due to Urbanization	4,010 Acre Reduction	-	4,010 Acre Reduction	4,010 Acre Reduction	4,010 Acre Reduction
Change in Irrigated Land for Groundwater Sustainability	45,000 Acre Reduction	45,000 Acre Reduction	45,000 Acre Reduction	45,000 Acre Reduction	45,000 Acre Reduction
IWR Climate Factor	-	-	15% 70,000 Acre Reduction	18% 81,000 Acre Reduction	18% 81,000 Acre Reduction
Emerging Technologies	-	-	-	10% IWR Reduction	-

**See section 2.2.3 for descriptions of adjustment methodologies and assumptions*

Agricultural Diversion Demand Results

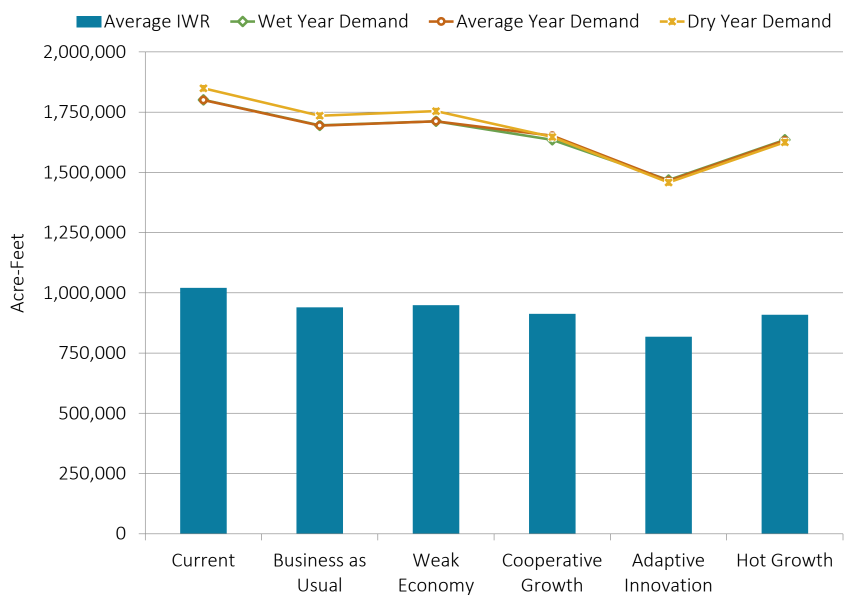
Table 4.7.5 and Figure 4.7.3 summarize the acreage, IWR, and the agricultural diversion demand for surface water supplies in the Rio Grande Basin for current conditions and the five planning scenarios. All scenario demands are lower than Baseline, because of irrigated acreage reduction to better manage the aquifer. Demand in climate impacted scenarios (*Cooperative Growth*, *Adaptive Innovation* and *Hot Growth*) is no higher than in *Business as Usual* and *Weak Economy* because compensating reductions in irrigated acreage are assumed to be implemented.

Table 4.7.5 Summary of Agricultural Diversion Demand Results in the Rio Grande Basin

	Current (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Irrigated Acreage (acres)	515,300	466,300	470,300	396,500	385,200	385,200
Average IWR (AFY)	1,021,000	940,000	949,000	913,000	818,000	909,000
Total Surface and Groundwater Diversion Demand						
Average Year (AFY)	1,800,000	1,694,000	1,712,000	1,652,000	1,465,000	1,632,000
Wet Yr. Change	0%	0%	0%	-1%	0%	0%
Dry Yr Change	3%	2%	3%	0%	-1%	0%

Average agricultural diversion demand was calculated using the average hydrologic years (i.e. years classified as neither wet or dry) from 1950-2013

Figure 4.7.3 Agricultural Diversion Demands and IWR Results in the Rio Grande Basin



4.7.5 Municipal and Self-Supplied Industrial Diversion Demands

Population Projections

The Rio Grande Basin currently includes less than 1 percent of the statewide population. Between the years 2015 and 2050, it is projected to change from approximately 46,000 people to between 42,000 and 67,000 people in the low and high growth projections, respectively. This ranges from an 8 percent decrease in population to an increase of 46 percent. Table 4.7.6 shows how population growth is projected to vary across planning scenarios.

Table 4.7.6 Rio Grande Basin 2015 and Projected Populations

Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
46,000	55,100	42,300	52,100	63,000	67,300

Current Municipal Demands

Approximately 79 percent of the baseline municipal demands were derived from BIP data, which represents the highest reliance on BIP data for any basin in the state. Data from WEPs represent demands for another 9 percent of the population, requiring about 12 percent of the basin's baseline population demands to be estimated (see Figure 4.7.4).

The BIP data did not include breakdowns of water use by demand category. Because there was insufficient demand category data available to apply county-specific distributions, the statewide weighted average demand category distribution was used for the Rio Grande Basin, as shown on Figure 4.7.5.

Figure 4.7.4 Sources of Water Demand Data in the Rio Grande Basin

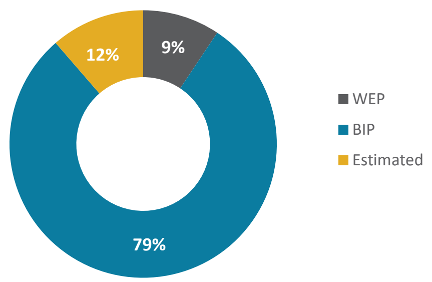
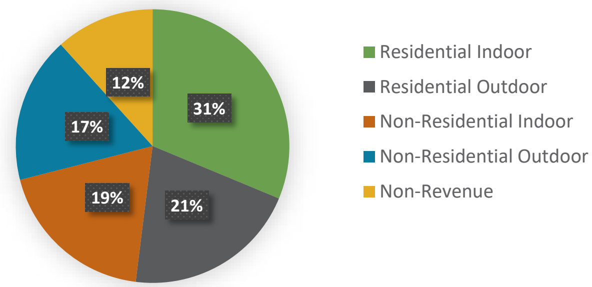


Figure 4.7.5 Categories of Municipal Water Usage in the Rio Grande Basin



Projected Municipal Demands

Figure 4.7.6 provides a summary of per capita baseline and projected water demands for the Rio Grande Basin. Systemwide, projected per capita demands decrease relative to the baseline except for *Hot Growth*. Residential indoor demand is generally the greatest demand. Outdoor demands increased significantly for *Hot Growth*, due to a general increase in outdoor demands coupled with the "Hot and Dry" climate.

The Rio Grande Basin municipal baseline and projected diversion demands provided in Table 4.7.7 show the combined effect of population and per capita demands. Municipal demands are projected to change from approximately 11,000 AFY in 2015 to between 9,000 and 16,000 AFY in 2050. Alamosa County accounts for around one-third of the baseline demand, followed by Conejos and Rio Grande counties, each at about one-quarter of the basin demand.

Figure 4.7.6 Rio Grande Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category (pgcd)

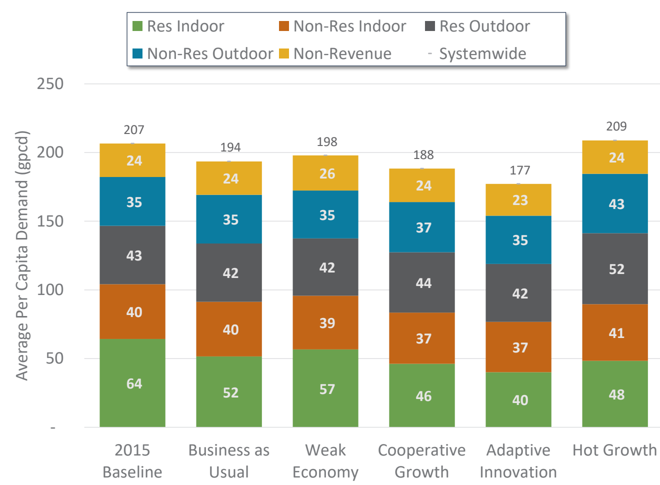
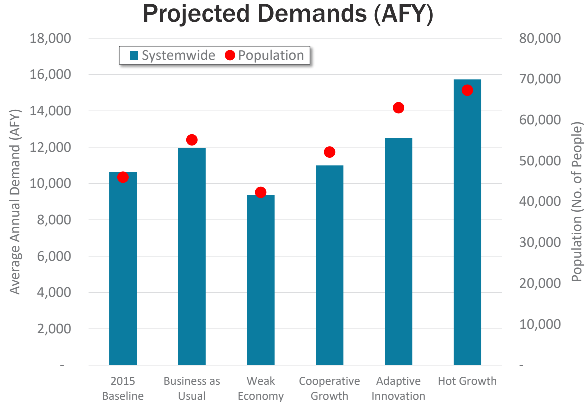


Table 4.7.7 Rio Grande Basin Municipal Baseline and Projected Demands (AFY)

Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
10,600	11,900	9,400	11,000	12,500	15,700

Figure 4.7.7 Rio Grande Basin Municipal Baseline and Projected Demands (AFY)



The baseline and projected demand distributions are shown in Figure 4.7.7, which also shows how the population varies across scenarios. All of the projection scenarios except for the *Weak Economy* result in an increase in systemwide demand relative to the baseline.

DECREASING GPCD

The Rio Grande Basin average baseline per capita systemwide demand decreased from 314 gpcd in SWSI 2010 to approximately 207 gpcd.

Self-Supplied Industrial Demands

The Rio Grande Basin includes about 4 percent of the statewide SSI diversion demand. SSI demands in this basin are associated with Large Industry (fish and aquaculture, agricultural product processing) and Energy Development (solar power generation and future oil and gas development), with no demands projected for the thermoelectric sub-sector. A minor amount of snowmaking occurs in the basin, but the required amount of water is insignificant compared to other SSI demands, and it was not considered in the demand analysis. Basin-scale SSI demands are shown in Figure 4.7.8 and tabulated in Table 4.7.8.

Figure 4.7.8 Rio Grande Basin SSI Baseline and Projected Demands (AFY)

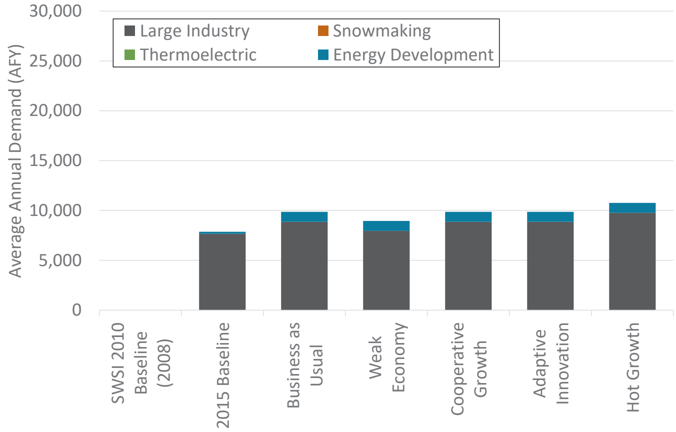


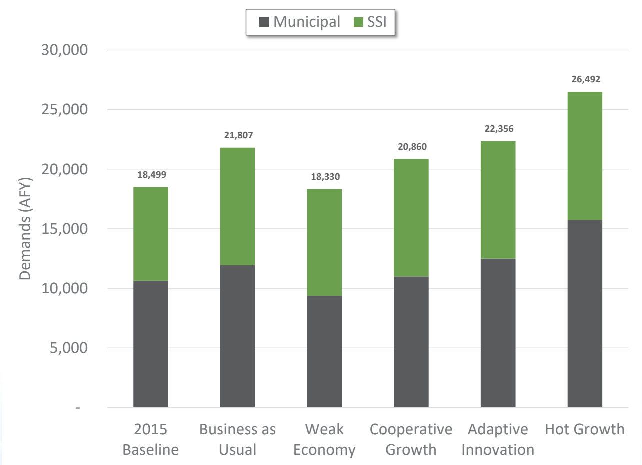
Table 4.7.8 Rio Grande Basin SSI Baseline and Projected Demands (AFY)

Sub-sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Large Industry	7,660	8,860	7,960	8,860	8,860	9,760
Snowmaking	0	0	0	0	0	0
Thermoelectric	0	0	0	0	0	0
Energy Development	200	1,000	1,000	1,000	1,000	1,000
Sub-Basin Total	7,860	9,860	8,960	9,860	9,860	10,760

Total M&I Diversion Demands

Rio Grande Basin combined M&I demand projections for 2050 range from approximately 18,000 AFY in *Weak Economy* to 26,000 AFY in *Hot Growth*, as shown in Figure 4.7.9. SSI demands account for about 40 to 50 percent of the M&I demands. On a basin scale, the demand projections follow the statewide sequence of the scenario rankings described in the CWP.

Figure 4.7.9 Rio Grande Basin Municipal and Self-Supplied Industrial Demands



4.7.6 Water Supply Gaps

The agricultural and M&I diversion demands were compared against available water supply for current conditions and the five planning scenarios.

Agricultural

Because the Rio Grande Compact limits agricultural water use and because the system is over appropriated, current water supply was assumed to be equal to historical diversions and pumping, with no additional supply available. The current agricultural gap was estimated as the difference between the current agricultural diversion demand and historical diversions and pumping for wet, dry, and average years.

INCREMENTAL GAP

The incremental agricultural gap quantifies the degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.

The Rio Grande Basin agricultural diversion demands, demand gaps, and consumptive use gaps for the baseline and planning scenarios are presented in Table 4.7.9 and illustrated in Figure 4.7.10. An annual time series of gaps in terms of percent of demand that was unmet is shown in Figure 4.7.11.

Table 4.7.9 Rio Grande Basin Agricultural Gap Results (AFY)

		Scenario					
		Scenario	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand	1,825,200	1,717,800	1,735,700	1,656,300	1,471,400	1,638,900
	Average Annual Gap	683,900	655,800	661,500	737,400	741,900	826,400
	Average Annual Gap Increase from Baseline	-	-	-	53,500	58,000	142,500
	Average Annual Percent Gap	37%	38%	38%	45%	50%	50%
	Average Annual CU Gap	348,300	333,400	336,300	374,600	376,900	419,800
Maximum	Demand in Maximum Gap Year	2,058,800	1,935,400	1,956,200	1,814,100	1,605,700	1,789,700
	Gap in Maximum Gap Year	1,059,702	1,017,391	1,026,351	1,112,661	1,110,956	1,238,485
	Increase from Baseline Gap	-	-	-	52,959	51,254	178,783
	Percent Gap in Maximum Gap Year	51%	53%	52%	61%	69%	69%

Study period for Water Supply Analysis is 1975-2013, reflecting different baseline demand than described in Agricultural Diversion Demands section

Figure 4.7.10 Projected Average Annual Agricultural Diversion Demand, Demand Met, and Gaps in the Rio Grande Basin

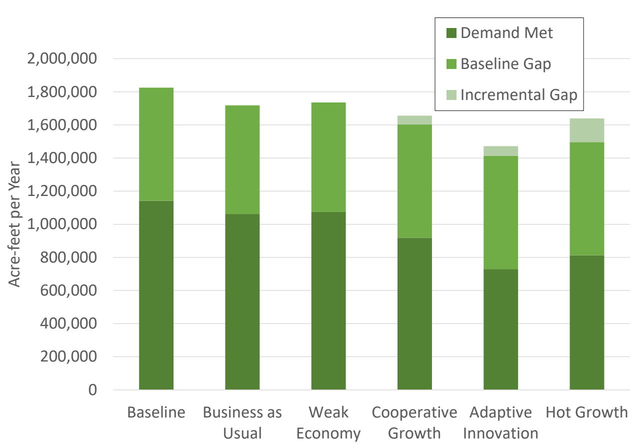
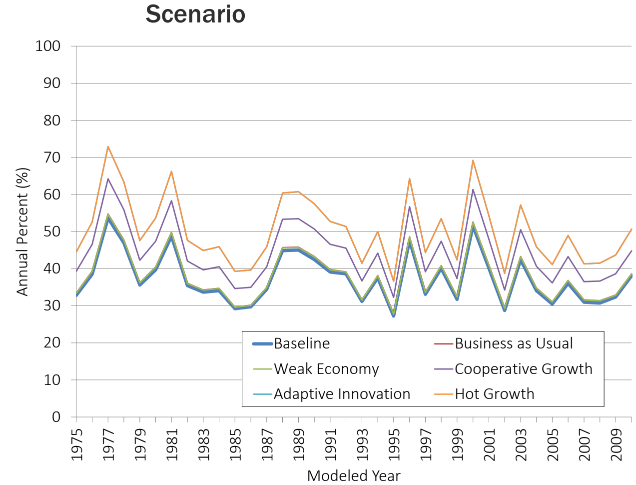


Figure 4.7.11 Annual Agricultural Gaps (expressed as a percentage of demand) for Each Planning Scenario



The following are observations on agricultural diversion demands and gaps:

- *Business as Usual* and *Weak Economy* do not include climate-adjusted hydrology or demands; therefore, changes in these scenarios relative to baseline are related strictly to changes in irrigated acreage and their impact on diversion demands.
- The inclusion of climate-adjusted hydrology and demands in *Cooperative Growth*, *Adaptive Innovation* and *Hot Growth* complicates the analyses for these scenarios. The analysis looked at the projected water supply under different year types available to senior and junior water rights in the basin and identified water rights that may no longer have constant supplies under the projected hydrology.
- Agricultural diversion demand is a major factor in this basin, with M&I demand only 1 to 1.5 percent of agricultural demand.
- Although agricultural diversion demand is expected to fall, gaps in excess of 650,000 AFY persist regardless of the planning scenario. Between 38 and 50 percent of agricultural demand is projected to be unmet in the planning scenarios.
- Despite reduced demand, the size of the gap is projected to increase relative to baseline in the three scenarios that are climate-impacted, because the available supply is forecast to be reduced.

M&I

The M&I gap for each scenario was estimated as the difference between the projected diversion demands and the current levels of municipal diversions and pumping. The diversion demand and gap results for M&I uses in the Rio Grande Basin are summarized in Table 4.7.10 and illustrated in Figure 4.7.12. Time series of M&I gaps were not developed in the Rio Grande Basin, because a CDSS water allocation model is not available at this time.

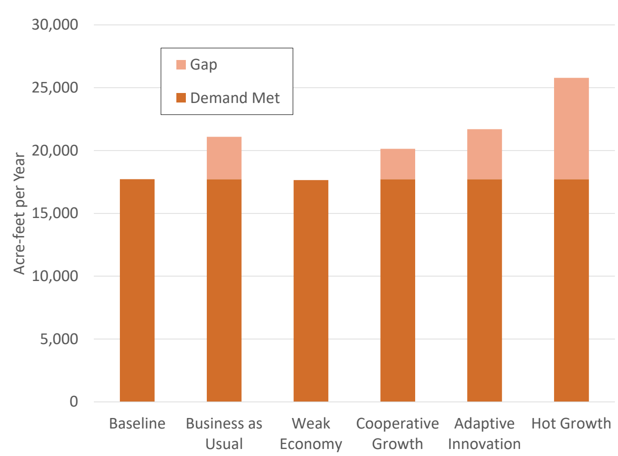
Table 4.7.10 Rio Grande Basin M&I Gap Results (AFY)

		Scenario					
		Scenario	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand	17,700	21,100	17,700	20,100	21,700	25,800
	Average Annual Gap	-	3,400	-	2,400	4,000	8,100
	Average Annual Percent Gap	-	16%	-	12%	18%	31%
Maximum	Demand in Maximum Gap Year	17,700	21,100	17,700	20,100	21,700	25,800
	Gap in Maximum Gap Year	-	3,400	-	2,400	4,000	8,100
	Percent Gap in Maximum Gap Year	-	16%	-	12%	18%	31%

The following are observations on the M&I diversion demands and gaps:

- Average annual M&I gap in the Rio Grande Basin ranges from 0 AF to more than 8,100 AF.
- Municipal diversion demand and SSI diversion demand contribute nearly evenly to total M&I diversion demand, with municipal accounting for just a little more than half. This is unique among Colorado's river basins.
- Population growth is the main driver for the modest increases in M&I demands in the planning scenarios, as per capita water use decreased for every scenario except *Hot Growth*.
- For *Hot Growth*, the M&I gap is much larger than other scenarios, at 31 percent of demand.

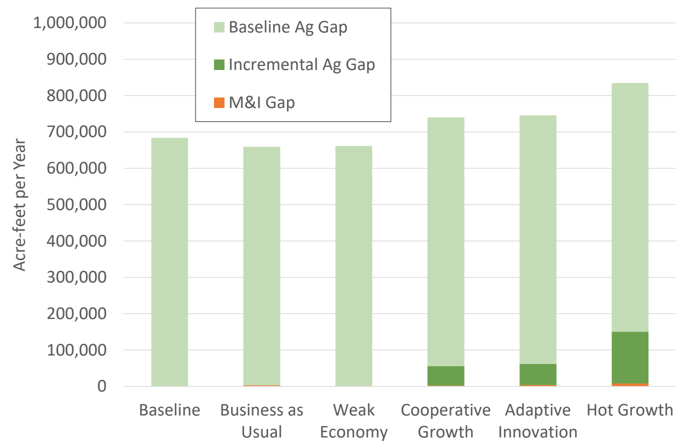
Figure 4.7.12 Projected Maximum Annual M&I Demand Met and Gaps in the Rio Grande Basin



Total Gap

Figure 4.7.13 illustrates the total combined agricultural and M&I diversion demand gap in the Rio Grande Basin. The figure combines the average annual baseline and incremental agricultural gap and the maximum M&I gap. In *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth*, gaps were driven by agricultural demands, which increase in the "Hot and Dry" climate conditions.

Figure 4.7.13 Projected Average Annual Agricultural Gaps and Maximum M&I Diversion Demand Gaps in the Rio Grande Basin



Supplies from Urbanized Lands

By 2050, irrigated acreage in the Rio Grande Basin is projected to decrease by 4,000 acres due to urbanization. Irrigation supplies for these lands could potentially be used for M&I needs in the future (subject to a variety of unknowns such as seniority and type of water supply, willingness to change the use of water through water court, etc.). The average annual historical consumptive use associated with potentially urbanized acreage for each scenario is reflected in Table 4.7.11. The data in the table represent planning-level estimates of this potential supply and has not been applied to the M&I gaps.

Table 4.7.11 Estimated Consumptive Use from Lands Projected to be Urbanized by 2050 in the Rio Grande Basin

	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Urbanized Acreage (acres)	4,000	-	4,000	4,000	4,000
Estimated Consumptive Use (AFY)	5,300	-	5,400	4,600	5,100

4.7.7 Available Supply

For the purposes of the Technical Update, it was assumed that due to compact constraints, there are no available water supplies now or in the future that can meet new demands.

4.7.8 Environment and Recreation

A surface water allocation model is not currently available in the Rio Grande Basin. As a result, hydrologic datasets in the Flow Tool include only naturalized flows and naturalized flows as impacted by climate change. A total of four water allocation model nodes, all in the mountains and foothills west of the San Luis Valley, were selected for the Flow Tool within the Rio Grande Basin (see list below and Figure 4.7.14). Figure 4.7.14 also shows subwatersheds (at the 12-digit HUC level) and the relative number of E&R attributes located in each subwatershed.

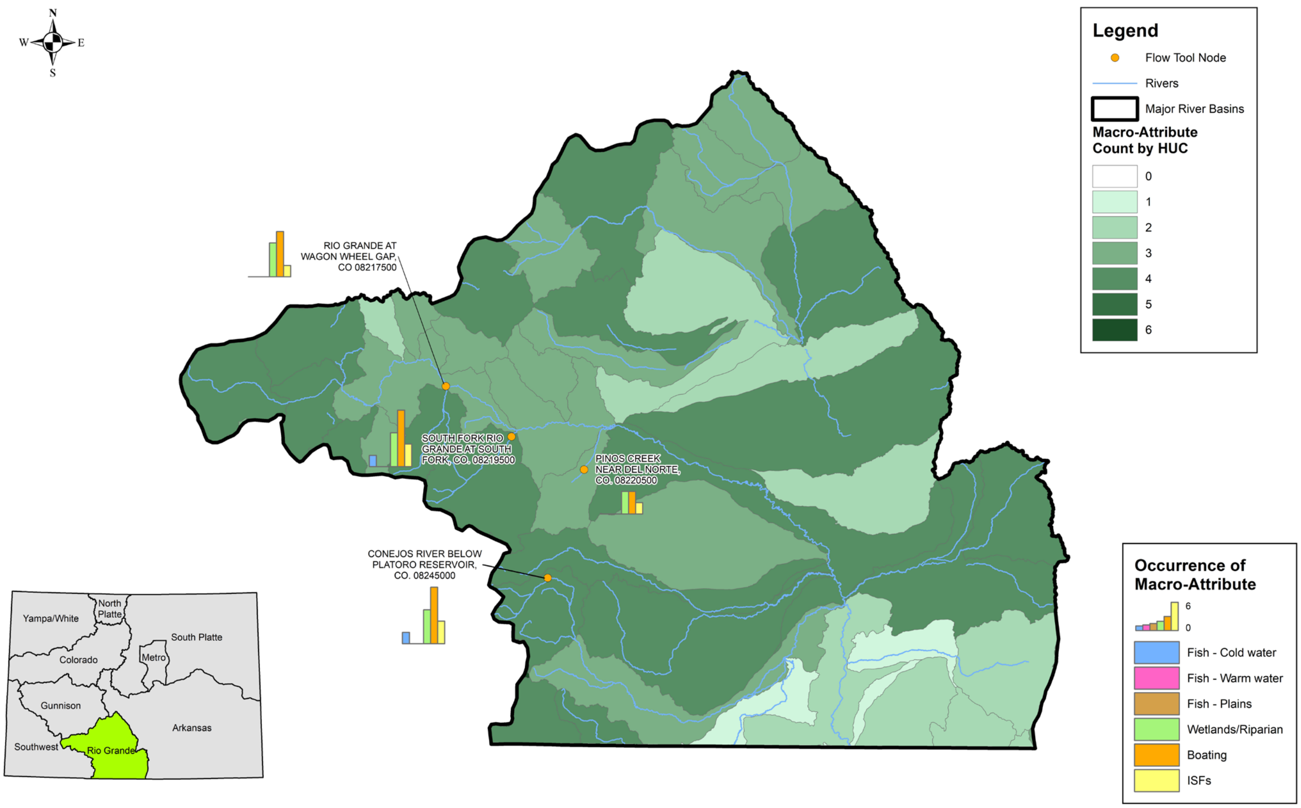
- Rio Grande at Wagon Wheel Gap, Colorado (08217500)
- South Fork Rio Grande at South Fork, Colorado (08219500)
- Pinos Creek near Del Norte, Colorado (08220500)
- Conejos River below Platoro Reservoir, Colorado (08245000)

These sites were selected because they are above major supply and demand drivers where future flow changes would likely be associated with only climate change factors. Management drivers impact river flows in areas downstream of mountainous areas in the Rio Grande and Conejos basins. Because a water allocation model that incorporates management is not available, the Flow Tool results for the Rio Grande Basin include only naturalized conditions and naturalized conditions as impacted by climate drivers ("In-Between" and "Hot and Dry" climate change projections) to illustrate a representative potential change in flow due to climate. These data do not represent changes in flow due to irrigation, transmountain imports, and/or storage.

NATURALIZED FLOW

Naturalized flows reflect conditions that would occur in the absence of human activities. Baseline flows reflect current conditions as influenced by existing infrastructure and river operations. While observations regarding naturalized flows may be informative, baseline flows reflect actual conditions and the diverse operations of a river's many users.

Figure 4.7.14 Flow Tool Nodes Selected in the Rio Grande Basin



Results and observations from Flow Tool analyses using flow data developed in the water supply and gap analyses for baseline conditions and the planning scenarios are described below in Table 4.7.11.

Table 4.7.12 Summary of Flow Tool Results in the Rio Grande Basin

Category	Observation
Projected Flows	For the selected locations, overall peak flow magnitude is not projected to change substantially under climate change projections; however, the timing of peak flow may shift to earlier in the year, with April and May flow magnitudes rising and June flows decreasing under the "In-Between" and "Hot and Dry" climate change projections.
	Mid- and late-summer flow may be reduced in all locations under the "In-Between" and "Hot and Dry" climate change projections, with July streamflow decreasing by roughly half on the Rio Grande and tributaries and even more on the Conejos River.
Ecological Risk	Peak flow related risk for riparian/wetland and fish habitat is projected to remain low or moderate in most cases, although there are some indications that risk could increase in smaller streams.
	Risk to trout due to decreasing mid- and late-summer streamflow may remain moderate in most years but could be higher in July and/or during dry years.
E&R Attributes	Because future flows under the five scenarios have not been modeled in the Rio Grande Basin, projected changes to flow and associated changes in risk to E&R attributes within the Flow Tool are attributable only to projected changes in climate. These climate-induced changes—earlier peak flow and reduced mid- and late-summer flows—are similar to the general pattern seen in many parts of Colorado.