Analysis and Technical Update to the Colorado Water Plan

Technical Memorandum

Prepared for:

Colorado Water Conservation Board

Subject:

Current and Projected Planning Scenario Municipal and Industrial Water Demands

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This document provides an overview of Municipal and Industrial (M&I) water demand projections that have been prepared for the analysis and technical update (Technical Update) to the Colorado Water Plan (CWP), formerly known as the Statewide Water Supply Initiative or SWSI.

Section 1: Description of Methodology

The Technical Update uses a scenario planning process, including five plausible future scenarios for the year 2050 that are described in the CWP and summarized in Figure 1-1 and Appendix A[1].

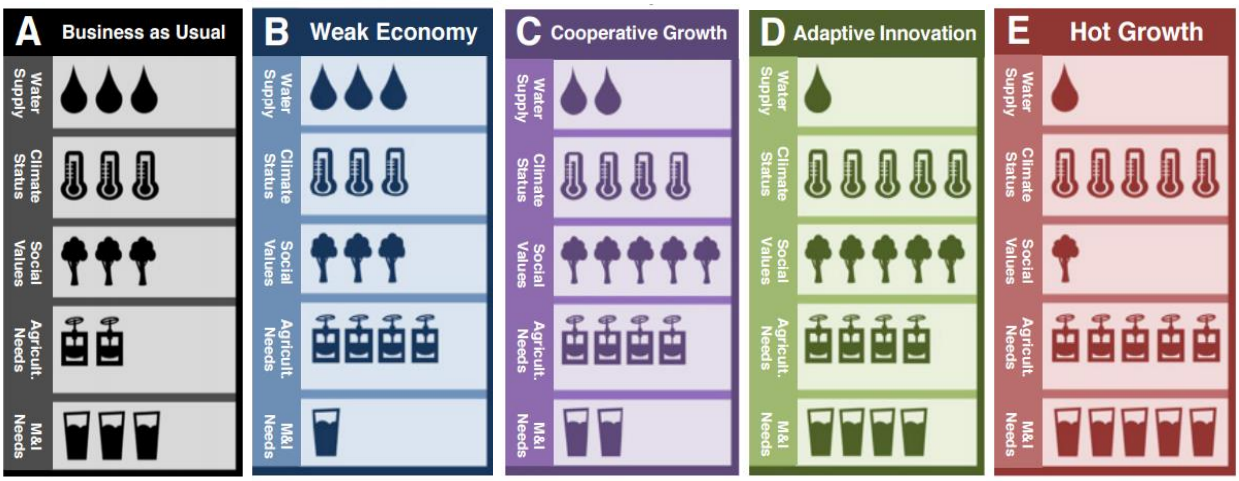

Figure 1-1: Planning Scenario Descriptions from the Colorado Water Plan.

Section 6.1 of the CWP provides the relative demand ranking, from low at a value of 1 to high at a value of 5, for the statewide M&I demand projections, as shown in Figure 1-1 and summarized in Table 1-3 and Table 1-10 below. These rankings were previously defined in the CWP and provide direction for how the combinations of demand drivers should affect the statewide future volumetric demands under each scenario, e.g. the Weak Economy scenario has the lowest volumetric demands and the Hot Growth scenario has the highest volumetric demands.

The methodologies used in SWSI 2010 were expanded upon to prepare 2050 demand projections for the five CWP planning scenarios. The following criteria were used in considering potential methodology enhancements:

- Sound, integrated, and widely accepted methods.
- Transparent, understandable, and reproducible.
- Based on data available statewide.
- Capable of producing demands representative of the five planning scenarios.

[1] Section 6.1 of the CWP provides a narrative framework for the five planning scenarios that were developed by the Interbasin Compact Committee (IBCC). (CWCB, 2015b).

This section provides an overview of the methodologies used in SWSI 2010 and the enhancements developed for the Technical Update, which were initially outlined in the Draft Municipal and Industrial Demand Methodologies Technical Memorandum prepared by ELEMENT Water Consulting for the Colorado Water Conservation Board, and the last draft was dated November 14, 2017 ("Methodologies TM"). The Methodologies TM was developed with input and review by a Technical Advisory Group ("TAG") comprised of individuals from municipal and industrial water providers throughout the state who were identified by the Colorado Water Conservation Board (CWCB) to provide representative input and information. The TAG recognized and supported that some adjustments to the methodologies may be necessary as they were applied to the updated population and water use data. Through the process of preparing the Technical Update demand projections, relatively few modifications were made to the approach outlined in the Methodologies TM, and these are reflected in the methodology overview provided below which thereby supersedes the Methodologies TM.

As with prior SWSI demand projections, the methods utilized in this Update are for the purpose of general statewide and basinwide planning and are not intended to replace demand projections prepared by local entities or for project-specific purposes. The M&I demand projections provide a snapshot of demands for the year 2050 for each scenario and do not contemplate how demands change at any point between now and then. This is primarily because the planning scenarios include a climate driver and the climate projections are only available for the year 2050. Some of the calculations and assumptions were made to maximize the use of available data and to apply a consistent methodology throughout the state, and different decisions may be made when looking at a subset of available information for a particular region or location within the state. The recommended methodologies are designed to be adaptable and used again in future Technical Updates or Basin Implementation Plan updates, as additional data become available, and potentially under new scenarios.

Note that throughout this report, the number of significant figures in tables and figures are generally used for continuity in reporting and do not mean to imply a level of accuracy. Occurrences of reporting percentages not adding to 100% or totals not equating to the sum of individually reported items are due to rounding that occurs when displaying model results in reporting tables and figures.

1.1 MUNICIPAL DEMANDS

1.1.1 SWSI 2010 METHODOLOGY

SWSI 2010 defined Municipal and Industrial (M&I) demands as the water uses typical of municipal systems including residential, commercial, light industrial, non-agricultural related irrigation, non-revenue water, and firefighting. Demands for self-supplied households not connected to a public water supply were also included in the municipal demand category. The M&I demand category from SWSI 2010 is equivalent to the municipal portion of the demands in the Technical Update. SWSI 2010 separately defined self-supplied industrial demands, as further described in Section 1.2.1 below, which are equivalent to the industrial demands in the Technical Update.

"Baseline future" M&I water demands were prepared as follows, using a driver multiplied by rate-of-use, where population was the primary driver:

- Population was projected with the process and models utilized by the Colorado State Demography Office (SDO), which include assumptions about economic conditions including availability of

future employment opportunities. Population projections were provided at a county level and were only available from the SDO through the year 2035 but were extended from 2035 to 2050 by adjusting the SDO models. Low, medium, and high population scenarios were developed to represent the uncertainty in projecting conditions in 2050.

- The then-current (circa 2008) rate of water use was represented by systemwide gallons per capita per day (gpcd) values, which were calculated at a water-provider level and then aggregated on a service area population-weighted basis to county and basin levels. Service area population and total water delivery[2] data were compiled from a variety of sources including water conservation plans, master plan reports, other independent reports, the 2007 Colorado Drought and Water Supply Update, and water provider interviews. A large portion of the data were reported for the year 2008, however some of the data represented demands prior to 2003 that had been compiled under prior SWSI planning. For data reported between the years of 2003 and 2010, the most recent year available was used. Where data were only available prior to 2003, water use information was averaged to account for the 2002 drought. While service area populations include only permanent residents, the systemwide gpcd values included water used by commercial, light industrial, tourism and other transient influences. For this and other reasons, gpcd values from one location were and are not directly comparable to values from another location with different characteristics. This remains the case for the Technical Update.

- Baseline future low, medium, and high demands were calculated for the year 2050, using the 2050 population projection and the baseline (circa 2008) rate of water use. Passive water conservation savings were subtracted to account for impacts from new construction and retrofitting housing stock and businesses with high-efficiency toilets, clothes washers, and dishwashers. A range of potential passive savings were estimated for each county and the upper end of the range was incorporated into the M&I demands to produce low, medium, and high demand projections for the year 2050 with passive conservation savings3. A summary of the SWSI 2010 baseline future demand values, in acre-feet per year (AFY), are provided in Table 1-1 (CWCB, 2010a).

[2] Based on review of the data, it appears that these data represent 'distributed water' as defined under 1051 reporting or 'water supplied' as defined in the AWWA Water Loss Control audit methodology, which is based on water production records and includes water loss.

[3] Future demand values that incorporated effects of passive conservation were also sometimes referred to as "baseline demands minus passive conservation."

Table 1-1: SWSI 2010 M&I Baseline Future Water Demands with Passive Conservation and No Active Conservation[4].

Table 1-1A.

Basin	No. Utilities in Database	No. Updated Since SWSI Phase I	SWSI Phase I gpcd	SWSI 2010 gpcd
Arkansas	65	40	214	185
Colorado	55	46	244	182
Gunnison	21	18	226	174
Metro	100	35	191	155
North Platte	1	1	267	310
Rio Grande	9	4	332	314
South Platte	60	53	220	188
Southwest	16	9	246	183
Yampa-White	10	8	230	230
Statewide	337	214	210	172

Table 1B.

Basin	SWSI 2010 Baseline Demand in 2008 (AFY)	SWSI 2010 Baseline Future Water Demands (AFY)				SWSI 2010 Future Water Demands with Passive Conservation (AFY)			
		2035	2050 Low	2050 Medium	2050 High	2035	2050 Low	2050 Medium	2050 High
Arkansas	196,000	299,000	327,000	349,000	380,000	273,000	298,000	320,000	352,000
Colorado	63,000	115,000	135,000	150,000	174,000	106,000	125,000	140,000	164,000
Gunnison	20,000	36,000	40,000	43,000	46,000	33,000	36,000	39,000	43,000
Metro	437,000	627,000	695,000	717,000	785,000	557,000	620,000	642,000	709,000
North Platte	500	600	700	800	900	600	700	700	800
Rio Grande	18,000	24,000	26,000	27,000	30,000	22,000	24,000	26,000	28,000
South Platte	206,000	338,000	377,000	397,000	430,000	311,000	347,000	367,000	401,000
Southwest	22,000	38,000	42,000	47,000	52,000	35,000	39,000	43,000	49,000
Yampa-White	12,000	21,000	25,000	31,000	41,000	20,000	23,000	30,000	40,000
Statewide	974,500	1,498,600	1,667,700	1,761,800	1,938,900	1,357,600	1,512,700	1,607,700	1,786,800

Three "water conservation strategies" – low, medium, and high – were developed with varying assumptions about effects of social values, urban land use patterns, regulations, and technology on the future rate of use, as follows:

- Data from over 40 municipal water conservation plans that had been approved by the CWCB as of July 2010 were used to estimate how water was distributed to each of the following water use sectors: Residential (Single Family and Multi-Family) Indoor, Non-Residential Indoor, Single Family Residential Outdoor, Multi-Family Residential Outdoor, Non-Residential Outdoor, and Utility Water Loss. The "baseline future" demands (with passive conservation) for the 2050 *medium* population were disaggregated into these categories at the basin scale.

[4] The Statewide M&I and SSI Gaps in 2050 reported in Table ES-6 of the SWSI 2010 Report appear to represent the demands in 2050 as if the then-current gpcd (circa 2008) continued, adjusted for passive conservation, with future population projections and do not include active conservation.

- Potential demand reductions were estimated for implementation of specific "active" conservation measures and programs, largely founded upon those identified in the Best Practices Guide for Municipal Water Conservation in Colorado (Colorado WaterWise and Aquacraft, 2010). Water demand reduction targets were based on an extensive review of the literature documenting impacts of conservation measures and programs, and engineering judgement was used to estimate implementation levels necessary to achieve the targets.

- Average annual demand projections were prepared for each basin using the 2050 *medium* population under future conditions that did not consider the potential impacts of climate change. The results are provided in Table 1-2 (CWCB, 2011a).

Table 1-2: SWSI 2010 M&I Statewide Savings Projections for Conservation Strategies with Medium Population[5].

Phase	Level	2030 Forecast Savings (AFY)	2050 Forecast Savings (AFY)
SWSI Phase 1	Level 1 (Passive)	101,900	NA
	Level 2 (active only)	68,633	
	Level 3 (active only)	170,952	
	Level 4 (active only)	341,485	
	Level 5 (active only)	597,283	
SWSI 2010	Passive	131,000	154,000
	Low (active only)	78,000	160,200
	Medium (active only)	133,000	331,200
	High (active only)	197,100	461,300

The active water savings projections were described as conditional in that they assumed the identified strategies would be implemented and did not account for water providers' management decisions, such as storing a portion of the savings for drought planning or using a portion to improve stream flows for environmental or recreational benefits. Some of the other topics that were not addressed in the savings methodology, but recommended for future consideration, included:

- The demand projections were prepared at a basin scale and did not address differences between individual water providers, such as one provider within the basin having an adequate water supply while another has an identified future need.

- Changes in density and impacts from new construction were not explicitly modeled.

- A representative average statewide split between indoor and outdoor demands of 46% and 54%, respectively, was estimated and applied to all demands. Impacts on return flows from the different conservation strategies were not analyzed.

The CWP utilized results from SWSI 2010 to describe total potential water savings by 2050, ranging from 160,000 to 461,000 AF. This range appears to have been based on demand projections using the medium population projection with low, active-only conservation savings and high, active-only savings, respectively. An additional 150,000 AF of passive savings was projected in addition to the active conservation

[5] SWSI 2010 Report Table ES-7.

savings under the medium population projection. Additionally, the CWCB adopted a 400,000 AF "aspirational savings goal" identified by the Interbasin Compact Committee (IBCC), which was between the SWSI 2010 medium and high levels of active conservation savings potential projected with a medium population growth.

1.1.2 TECHNICAL UPDATE METHODOLOGY ENHANCEMENTS

Similar to SWSI 2010, the Technical Update uses a driver multiplied by per-capita rate of use in preparing a range of possibilities that reflect the uncertainties in future municipal demands. This is a commonly applied methodology that accounts for driving changes in water demand (Billings and Jones, 2008; Donker et al., 2014) and is being used in other statewide planning, as demonstrated in California, Texas, and Georgia.

Unlike SWSI 2010, the Update provides projected 2050 demands for five future scenarios that each include a different level of conservation and demand management that is characteristic of the scenario as defined in the CWP. The potential impact from drivers of climate, urban land use, technology, regulations, and social values are incorporated into the municipal demand projections through an adjustment to the current gpcd rate of use. This is different from SWSI 2010 where there was a "baseline future" demand projection using then-current gpcd values with future population, upon which various levels of "active" conservation strategies were evaluated but only for the medium population projection. The differences in methodology between SWSI 2010 and the Technical Update make it challenging to directly compare the future demand projections. A comparison of the projected population is provided throughout this report, however the relationship between the projected municipal demands is generally limited to the statewide projections presented in Section 2 below.

Key words from the CWP narrative descriptions that influenced the municipal demand projections are provided in Table 1-3. These rankings provide direction for how the combinations of M&I drivers should affect the future volumetric demands under each scenario, and it should be noted that the CWP rankings were interpreted to apply to the average annual statewide volumetric demands rather than per capita demands. For example, the Adaptive Innovation scenario drivers have some of the lowest future per capita demand values paired with a high population, ranking it the second highest projected statewide volumetric municipal demand in accordance with the CWP rankings. These rankings heavily influenced, and in some cases constrained, the combinations of drivers and population utilized in each scenario.

Table 1-3: CWP Relative Demand Ranking and Narrative for Municipal Planning Scenarios.

A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Demand Rank 3	Demand Rank 1	Demand Rank 2	Demand Rank 4	Demand Rank 5
• Recent trends continue • Regular economic cycles • Slow increase in denser developments • Social values and regs remain the same • Water conservation efforts slowly increase • Climate is similar	• Economy struggles • Maintenance of infrastructure becomes difficult to fund • Little change in social values, levels of water conservation, urban land use patterns, and environmental regulations • Climate is similar	• Environmental stewardship • Integrated and efficiency planning/development • More development in urban centers and mountains • Embrace water and energy conservation • New water-saving technologies • Env. regs are more protective • Moderate warming of climate	• Much warmer climate causes major environmental problems • Social attitudes shift towards shared responsibility • Technological innovation and strong research investments • Warmer climate increases irrigation demand, but technology mitigates increases • Higher water efficiency helps maintain streamflows • Regulations are well defined and permitting is predictable and expedited • More compact urban development	• Vibrant economy fuels population growth • Regulations are relaxed • Hot and dry conditions • Families prefer low-density housing

The approach and results for the baseline and projected future demands are further described in the sections below.

1.1.2.1 POPULATION

County-level population data for the Technical Update were prepared by BBC Research & Consulting (BBC, 2017 and 2018). Baseline population data for the year 2015 are based on data from the SDO. A unique 2050 population projection was prepared for each growth scenario based on the November 2017 growth projections from the Colorado State Demography Office, as shown in Table 1-4. The CWP scenario narrative describes a low, medium, and high projection for each scenario. The medium population projection used for the Business as Usual scenario is the SDO projection. BBC prepared a low and high projection for the Weak Economy and Hot Growth scenarios, respectively, and "adjusted" medium and high projections for the Cooperative Growth and Adaptive Innovation scenarios, respectively. The adjusted scenarios reflect the movement to mountain resort and urban areas that is described in the CWP, partially addressing the urban land use and growth pattern driver influences. This resulted in a unique population growth for each county under each scenario. Within a given scenario, population may be increasing in some counties while it is decreasing in others.

Table 1-4: 2050 Population Projection for the Five Planning Scenarios.

A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Medium	Low	Medium, Adjusted	High, Adjusted	High

1.1.2.2 BASELINE WATER DEMANDS

Key Definitions:

Baseline Demands – Reported and estimated demands representing average conditions for the Technical Update baseline year of 2015. Municipal demands are represented by the per capita rate of use (gpcd) and on a volumetric basis, which is calculated from population and gpcd data.

Demand – Portion of *Distributed Water* attributable to uses typical of municipal systems including residential, commercial, light industrial, non-agricultural related irrigation, firefighting, and non-revenue water. Demands for self-supplied households not connected to a public water supply are also included in the municipal demand category.

Distributed Water – Volume of water entering the distribution system. Calculated as total water production from all sources minus water exported to another water provider.

Metered Water Use – Water that reaches the end use, including billed/unbilled and authorized/unauthorized uses.

Non-Revenue Water – The calculated difference between *Distributed Water* and authorized *Metered Water Use*, which is also the sum of real and apparent loss. Represents system water loss, or water produced but not billed. Includes transmission and distribution system losses in water systems as well as apparent losses from unauthorized uses and water that is unaccounted for due to metering inaccuracies and data handling errors.

Systemwide Demand – Equivalent to *Distributed Water* as defined by 1051 or *Water Supplied* as defined in the

Baseline municipal water demands were prepared by county, on a per-capita and volumetric basis. One of the key objectives for the Technical Update was to maximize the use of new data that were not available for SWSI 2010. The baseline (circa 2015) demands were prepared for each county using the following four data sources:

- Data Reported to the CWCB by Water Providers Pursuant to House Bill 2010-1051 ("1051")[6]
    - Annual water provider-reported water use data for 2013 through 2016 reported by 53 water providers.
    - A high-level review and data validation were conducted for this analysis.
- Municipal Water Efficiency Plans ("WEP")
    - A total of 68 out of 85 WEPs were used to supplement the 1051 report data (data provided in the other 17 WEPs were already represented in the 1051 reports).

[6] House Bill 2010-1051 requires that the CWCB implement a process for the reporting of water use and conservation data by covered entities. A "covered entity" is defined as each municipality, agency, utility, including any privately owned utility, or other publicly owned entity with a legal obligation to supply, distribute, or otherwise provide water at retail to domestic, commercial, industrial, or public facility customers, and that has a total demand for such customers of two thousand acre-feet or more, per Section 37-60-126(1)(b) of the Colorado Revised Statutes (C.R.S.). 1051 reporting data provided by CWCB for the Technical Update in February 2018.

- All WEPs utilized were on file with the CWCB as of February 2018.

- Targeted Water Provider Outreach ("Targeted Outreach")[7]
  - Conducted for select counties that had no 1051, WEP, or Basin Implementation Plan data.
  - Outreach was facilitated by CWCB.

- Basin Implementation Plans ("BIP")
  - Each BIP prepared in 2015 was reviewed for the availability of new water use data; however, only the Colorado and Rio Grande Basins had sufficient information to be relied upon for the Technical Update methodology.
  - The majority of data in the Rio Grande BIP was reported at a county level, rather than for individual water providers. All data in the Colorado BIP was available at the provider level.
  - Available data only included systemwide demands, rather than for individual customer categories, creating some limitations for utilization in baseline water demand calculations.

The availability of data for statewide planning is dramatically improving through the 1051 reporting process, which provides water use data at the customer category level and includes all distributed water supplies (i.e. potable treated, non-potable raw, and non-potable reuse[8]). WEPs also provide this type of data but are typically updated on a seven-year cycle, to meet the statutory obligation, whereas 1051 is an annual reporting process. There were 53 water providers with at least one year of 1051 data[9] and WEP data were available for an additional 68 water providers who were not represented by 1051 reporting, yielding detailed water use information for at least 121 providers and approximately 84% of the statewide population (see Figure 2-4).[10] These data were combined and used to represent demands in the year 2015. The WEP data were based on varying time periods; however, almost all data was from 2008 through 2016.

The data were reviewed and aside from parts of the state with incomplete data representation, the most significant data issues were identified by preparing a mass balance analysis at the water provider level. Engineering judgement was used where data issues resulted in negative or unreasonably high non-revenue values and to address other challenges such as data not being reported for individual demand categories. In comparing the updated volumetric and per capita demands to values from SWSI 2010, some differences were attributed to the inclusion of raw and reuse water supplies in the Technical Update, which may not have been included in some of the SWSI 2010 data reporting. All reported types of water supply (potable, non-potable raw, and non-potable reuse) were included in the Technical Update demand calculations to the extent that data were available. It was assumed that only potable supplies were used

[7] Facilitated and tabulated by CWCB.

[8] Statewide, the 1051 reported dataset was comprised of approximately 92% potable treated, 6% non-potable raw, and 2% non-potable reuse supplies.

[9] Based on 1051 reporting through 2016.

[10] BIPs also provide some water use data for additional providers.

for residential customers. Non-potable raw water supplies were largely classified as non-residential outdoor use with the exception of three providers where there was relatively extensive wintertime use. Non-potable reuse water supplies were classified entirely as non-residential outdoor use. Compared to potable water supplies, less information is available regarding how raw water and reuse supplies are coupled with demands. However, it was determined that the demands associated with raw water and reuse should be included in the Technical Update demand analysis, to reflect the potential impacts in the hydrologic modeling. It is recommended that additional information about these types of supplies and associated demands be collected to support future modeling efforts.

Baseline systemwide demands were calculated for each county. Reported water use data from the 1051, WEPs, outreach, and BIPs data sources were used to calculate an average per-capita demand, in gpcd, for the portion of the county population represented by the data sources. Demands were estimated for the remaining population within each county that was not represented by one of the data sources. If over 40% the county population was represented by any combination of the data sources, then the county average systemwide gpcd calculated from the available data was used to estimate the average gpcd for the entire county. For counties with less than 40% of the population represented by the data sources, the per-capita demands from neighboring counties were used to estimated demands for the population that was not represented by the data sources. Neighboring counties used to fill the missing data were selected based on a combination of geographic proximity and a comparison of the relative baseline demands from SWSI 2010.

Certain drivers, such as the climate driver, are expected to primarily affect outdoor demands whereas other drivers, such as technology, could affect both indoor and outdoor demands. Similar to SWSI 2010, systemwide municipal demands were disaggregated into the following water demand categories, prior to applying the per-capita drivers:

- Residential (Single Family & Multi-Family) Indoor[11]
- Non-Residential Indoor
- Residential (Single Family & Multi-Family) Outdoor[12]
- Non-Residential Outdoor
- Non-Revenue Water[13]

For water providers with adequate information, indoor and outdoor demands were estimated from total residential and total non-residential water use data, using a representative winter or other month(s) to estimate indoor, i.e. non-seasonal use, and assuming that the indoor use remains relatively constant throughout the year. The 1051 data provide an indication of which months(s) are typically representative of indoor use for a particular water provider. If not specifically identified by water providers, then the in-

[11] Sufficient information was not available to further disaggregate the residential indoor category into single and multi-family categories

[12] Sufficient information was not available to further disaggregate the outdoor residential category into single and multi-family categories.

[13] This category was referred to in SWSI 2010 as “water loss”.

door use was estimated from the average use for the months of December through February. This technique has potential for error because there may be some outdoor use included in the winter or other identified indoor-representative month(s) and indoor use may not remain constant throughout the year. However, this is a commonly used method for estimating indoor and outdoor uses from total water use data in locations that have limited outdoor use during winter months.

A demand category distribution, as a percentage of the systemwide use, was calculated for each county and as a basin-wide average. Similar to the gpcd calculations described above, the reported distributions were used for the portion of the county populations represented by the data sources. Distributions for the remaining population within each county that was not represented by one of the data sources were based on the basin average. The statewide average demand category distribution was applied to the Rio Grande and North Platte basins because there were insufficient data available to calculate unique distributions for these basins.

1.1.2.3 PER-CAPITA WATER DEMAND PROJECTIONS

Key Definitions:

Adoption Rate – Portion of existing (2015) population that will have water use consistent with the future gpcd value for a given scenario by the year 2050 (i.e. retrofit population). Water use for all new population is based on the future gpcd value for a given scenario. Adoption rate is applied to all demand drivers except non-revenue adjustments.

Projected Demands – Calculated future demands representing average conditions for Technical Update projection year 2050.

Projected future per capita rates of water demand in gpcd were calculated for each county by adjusting the baseline gpcd values by future demand drivers representing urban land use, technology, regulations, and social values. The following descriptions provide an overview of possible future effects and uncertainties associated with these drivers.

- Changes in urban land use primarily impact outdoor municipal water demand, due to impacts on the amount and type of irrigated landscape (Clarion, 2015), although low density can also be associated with higher leakage (EPA, 2006) and some high-density developments use water-intensive cooling towers (Clarion, 2015). For service areas with significant projected population increases that are already substantially built out, the additional population may cause an increase in the current density due to infill, e.g. from single-family detached residential housing products to a denser attached or multi-family type of housing. Alternatively, service areas may be expanded, adding acreage to the service area, in which case the density of the current and future population may not change significantly. With increased density, the amount of outdoor landscaped area per person generally decreases and, in some circumstances, the landscape characteristics also change from a higher water use category, such as lawn grass, to include more low water use plants and shrubs. The relationship between density and landscaping demands is further complicated because irrigation methods and management of irrigation systems have a significant effect on water use, in addition to the amount and type of landscape vegetation. A theoretical analysis completed by CWCB (2010b) indicated that a 20% increase in residential density, on average, could decrease total (indoor and outdoor) residential water demand by approximately 10%. Other studies have reported even greater water savings from increased density (Clarion, 2015); however, it is unclear whether savings can be exclusively attributed to increased density.

For certain planning scenarios, the Technical Update Agricultural Demand Methodology included a reduction in future agricultural demands, due to the removal of irrigated agricultural acres from municipal urbanization. Data from the population projections were utilized to inform the locations and extent to which future agricultural irrigated acres were reduced.

- Technology affects the level and extent to which water use can be managed without requiring significant behavioral changes. Substantial reductions in indoor water uses have occurred over the past two decades, primarily from improved indoor fixture and appliance technology. End use studies and metered water use data provide useful data-based methodologies for benchmarking water-efficient residential uses. While there has historically been a substantial behavioral component related to landscape irrigation, the equipment and technology is changing and becoming more user-friendly, which has the potential to reduce the behavioral influence in the future. Improved efficiencies in non-residential uses and landscape irrigation equipment have also started to be implemented relatively recently.

- Water rates, provider policies, and state/federal regulations (e.g., WaterSense, EnergyStar, Colorado Senate Bill 14-103) have the potential to affect all water demand categories. Often there is a relationship between technology and regulations, e.g. Colorado adopted WaterSense plumbing fixture legislation once efficient technology was reliable and affordable. Regulations also affect the prioritization of investment in water efficient technology, conservation programs, managing water loss control through replacement of aging infrastructure, etc. Recent regulations have primarily impacted indoor uses, but a shift toward focusing on outdoor uses and water loss control is beginning to occur. There is also some level of inelasticity related to indoor demands, and a limit in the extent to which rates will impact water demand. Affordability may increasingly become a social issue into the future as rates increase.

- Social values affect the level of support for higher municipal water efficiency efforts and preference for human water uses versus other concerns.

The potential future impact of these drivers on each of the five water demand categories was evaluated. The driver values were developed with input from the M&I TAG. The residential indoor demand category was adjusted to a fixed gpcd value, while a percentage adjustment to baseline values was applied to the other demand categories with positive values creating an increase and negative values a decrease in gpcd. The adjustment values are shown in Table 1-5 below. The adjusted future indoor and outdoor gpcd rates were used to represent all new population (associated with new construction) and a portion of the existing population reflected by the adoption rates[14] shown in Table 1-6 (associated with retrofits), with the remainder of the existing population continuing at the baseline gpcd rate. This methodology assumes that by 2050, all "new" population between the current and 2050 populations, and a portion of the current population, will use water at the future per-capita demand rate. Thereby, the future gpcd rates that were used in the demand modeling included the combined effects of active and passive conservation.

[14] The adoption rate was applied to all demand categories except for non-revenue water.

Table 1-5: Municipal Per Capita (gpcd) Rate Adjustments for 2050 Projections.

Demand Category	A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Residential Indoor	42.4	42.4	36.4	33.3	42.4
Non-Residential Indoor	0%	-5%	-10%	-10%	+5%
Outdoor	0%	-5%	-15%	-20%	+5%
Non-Revenue Water	0%	+5%	0%	-5%	0%

Table 1-6: Municipal Adoption Rates Applied to Indoor and Outdoor Demand Categories for 2050 Projections.

Scenario:	A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Adoption Rate	50%	40%	60%	70%	60%

The following information provides additional detail regarding the basis for these adjustments:

- Future Residential Indoor gpcd: Residential indoor demands have significantly decreased throughout much of the state in recent years, largely due to advancements in technology. In preparing the South Platte BIP, the Metro Basin concluded that 34 gpcd is a realistic goal for its future indoor demand and the South Platte Basin envisioned reducing its indoor demand to 40 gpcd. Similar targets were not specified in other BIPs. Therefore, it is recommended that the same future gpcd values be used for all basins, based on the best available literature at this time, and the individual basins can modify the values as part of future BIP updates. Based on data from end use studies of existing homes (including homes located in Colorado and throughout the nation) and water efficiency benchmarks summarized below, future gpcd values are expected to range between around 30 and 45 gpcd as follows (DeOreo et al., 2016):
    - 58.6 gpcd – 2016 average indoor daily water use from 737 existing study homes across 9 study sites.
    - 42.4 gpcd – 'current efficiency benchmark' based on 247 retrofit homes equipped with high efficiency fixtures and appliances which generally meet or exceed the WaterSense specifications; included both existing homes that were retrofit and new homes built with high efficiency devices.
    - 40.9 gpcd – efficiency benchmark achievable in coming years with high-efficiency fixtures and appliances widely installed.
    - 36.4 gpcd - benchmark for ultra-efficient average indoor water use in the future, as even more efficient devices are adopted.
    - 33.3 gpcd – achievable if household leakage can be reduced.

The M&I TAG recommended that 33.3 gpcd be used for either the Cooperative Growth or Adaptive Innovation scenario, assuming that advanced metering infrastructure, regulations, and rates could support this future demand rate.

- Non-Residential Indoor: Non-residential indoor demands have not decreased as significantly in recent years as the residential demands. Whereas residential demands are generally associated with new/retrofitted homes that are likely to utilize new technology, only a portion of the non-

residential demands are similarly influenced by new growth. Depending upon the nature of the non-residential use (e.g. type of business), some demands are not able to decrease as significantly while still providing the same product. Due to the breadth of the non-residential category, it is impractical to further disaggregate the category such that a future gpcd value can be selected. Although SWSI 2010 estimated future non-residential indoor demands by using comparable adjustment factors to the percent reduction represented in the residential indoor sector, resulting in a future reduction of up to 25%, the M&I TAG recommended against this method for the reasons described above. The percentages shown in Table 1-5 are based, in part, on the M&I TAG recommendation to show smaller changes relative to the residential indoor category. This factor is applied as a percentage change to the disaggregated non-residential indoor portion of the gpcd values calculated from the current available data.

- Outdoor: Advancement in landscape irrigation technology and associated regulations have the potential to significantly reduce future outdoor demands. Water savings over 50% have been reported from some outdoor efficiency programs (Mayer et al., 2015), and savings of between 20% and 30% are often reported from the types of programs currently being implemented and anticipated on a broader scale over the planning period. Some of these reported values may be influenced, at least in part, by increases in density. However, some of the estimates are based on retrofits and technology, which are not dependent upon changes in density. Future urbanization and land use changes will also impact outdoor uses and are generally expected to result in a reduction in gpcd. For the Technical Update, the statewide average total outdoor adjustment associated with the land use, technology, regulations, and social values was limited to a maximum of around 20%. Note that there is a relational effect between the outdoor adjustment and the climate adjustment. The adjustments shown in Table 1-5 are made prior to considering climate effects, which are described in Section 1.1.2.4 below.

- Non-Revenue Water: Transmission and distribution losses from potable water produced in the United States has been reported to average between 14% and 18% of all potable water produced (Water Research Foundation, 2017). As of 2009, reported utility water losses[15] in Colorado ranged from between 2% and 12% (Aquacraft, 2009). An 8% statewide average water loss was used for the SWSI 2010 baseline demands and the representative future gpcd rates prepared for the Conservation Strategies were assumed to achieve real losses of 6% to 7%, as a percentage of the water deliveries. The relevant data available through 1051 reporting is non-revenue water, which is the difference between Distributed Water and authorized Metered Water Use, as those terms are defined above, which is also the sum of real and apparent losses. Based on review of the 1051 data, there is a wide range of reported values in this category. The percentage adjustment values are intended to demonstrate that a lower factor would be used for the Adaptive Innovation scenario, and a higher factor would be used for Weak Economy scenario.

[15] The reported values were described as non-uniform across water providers but typically based on system input or production volume minus billed water data.

Some important considerations about this methodology include:

- The projected demands represent potential demands under conditions described in the CWP for each scenario, however they do not necessarily represent the full potential for demand management under each scenario, e.g. more aggressive active conservation programs.

- Erroneous or suspect reported non-revenue water loss values were adjusted to provide a reasonable range of planning values for several water providers. An emphasis should continue to be placed on improving this data and an understanding of the associated real and apparent losses.

- Aside from the climate driver described below, per capita drivers were not modified by basin or county. Drivers were applied using the same values and methodology for each county and are intended to prepare a scenario planning approach that can be further customized at the basin level.

- Planning scenarios do not include acute drought management planning (e.g. imposing restrictions), so comparing to other areas of the country (e.g. Southern California) is not appropriate if their current demands reflect not only aggressive active conservation, but also imposed restrictions.

- Demand projections were prepared using the same adoption rate for indoor and outdoor demands and for residential and non-residential demands. The adoption rate should be further investigated at a local level because it is highly influenced by new construction and active water conservation programs. The adoption rate also encompasses effects such as the persistence of demand reductions associated with indoor and outdoor uses, which should be considered. For example, unless repeated over time, demand reductions associated with certain outdoor demand management programs such as an irrigation audit may result in less permanent savings than changing indoor plumbing fixtures to lower water use models.

- The per capita gpcd metric is being used as a projection tool for this statewide planning project, even in areas with a significant influence from non-permanent residents such as mountain resort communities, and is not applicable as a comparison tool between communities. It is not appropriate to compare a gpcd value from areas that have a significant influence from tourism and non-permanent residents to areas that have a primarily year-round residential type of population. Specific characteristics about each community need to be understood when interpreting per-capita demand data.

- Urban land use changes have the potential to significantly affect future municipal, primarily outdoor, and agricultural demands. The range of impacts may not be fully reflected in the Technical Update municipal and agricultural demand projections, primarily due to a lack of information available for use in statewide planning projections. Future demand projections may be improved by collecting service area delineations (e.g. irrigated acreage) and density information regarding developed and irrigated landscaped areas under current conditions and anticipated for the future planning year, i.e. 2050.

- The climate factor adjustments described in Section 1.1.2.4 below represent the average annual change in 2050 for the climate represented in each scenario. Regardless of the climate status, there will be annual and monthly variability in outdoor demands. Figure 1-2 shows an illustrative

example of the historical annual variability in modeled irrigation water demands under a full water supply for bluegrass at representative climate stations throughout the state and presented as a relative change to the average demand over the historical period. A review of historical water provider-reported data shows that while some municipal systems experience this type of annual variability in outdoor water use, others do not, which may be an indication of water use management or that there is an issue with using the full irrigation water requirement of bluegrass as proxy for outdoor water demands. It was determined that applying this level of variability to all outdoor demands is unreasonable without having additional information regarding the irrigated landscaped areas represented in the reported data. Furthermore, the historical patterns may not be representative of likely future patterns under all five scenarios. Therefore, this type of annual variability is not included in the hydrological modeling for the Technical Update but should be considered and incorporated in future Technical Updates as additional information regarding irrigated landscaped areas and types of landscaping are known.

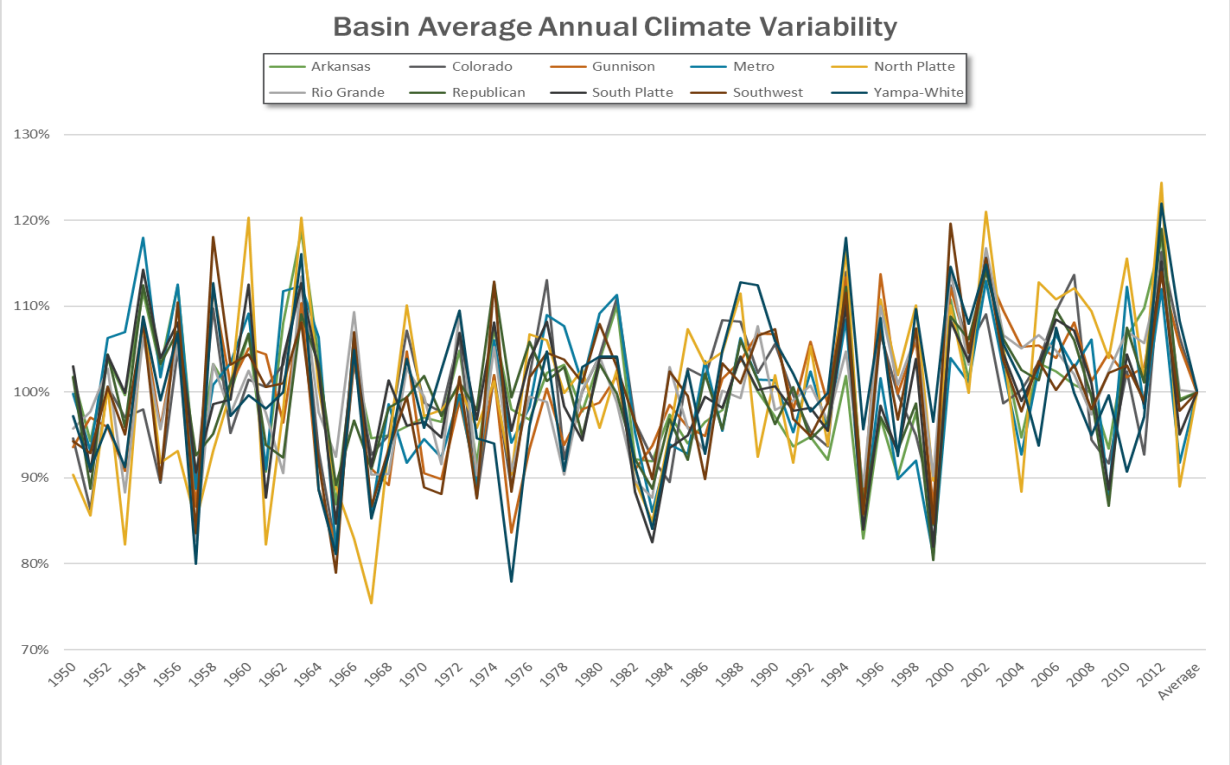

Figure 1-2: Basin Average Annual Variability in Bluegrass ET.

1.1.2.4 CLIMATE DRIVER

The Colorado Climate Plan, published by the State of Colorado, describes the most recent global climate projections (CMIP5) and recommends the integration of these results with the previous global climate projections (CMIP3) to provide a representative range of potential future climate and hydrological conditions. Using this information, three of the CWP scenarios have a climate different from what was observed during the 20th century (referred to as "Current"). Section 4 of the CWP describes uncertainties in future water supplies and the two future potential climate projections selected by the IBCC to represent "Hot and Dry" conditions and "between 20th century observed and hot and dry" conditions (referred to as

"In-Between"), in addition to Current climate conditions. Figure 1-3 below, which is Figure 4-9 on page 4-11 of the CWP, illustrates the runoff versus crop irrigation requirement relationship for these scenarios.

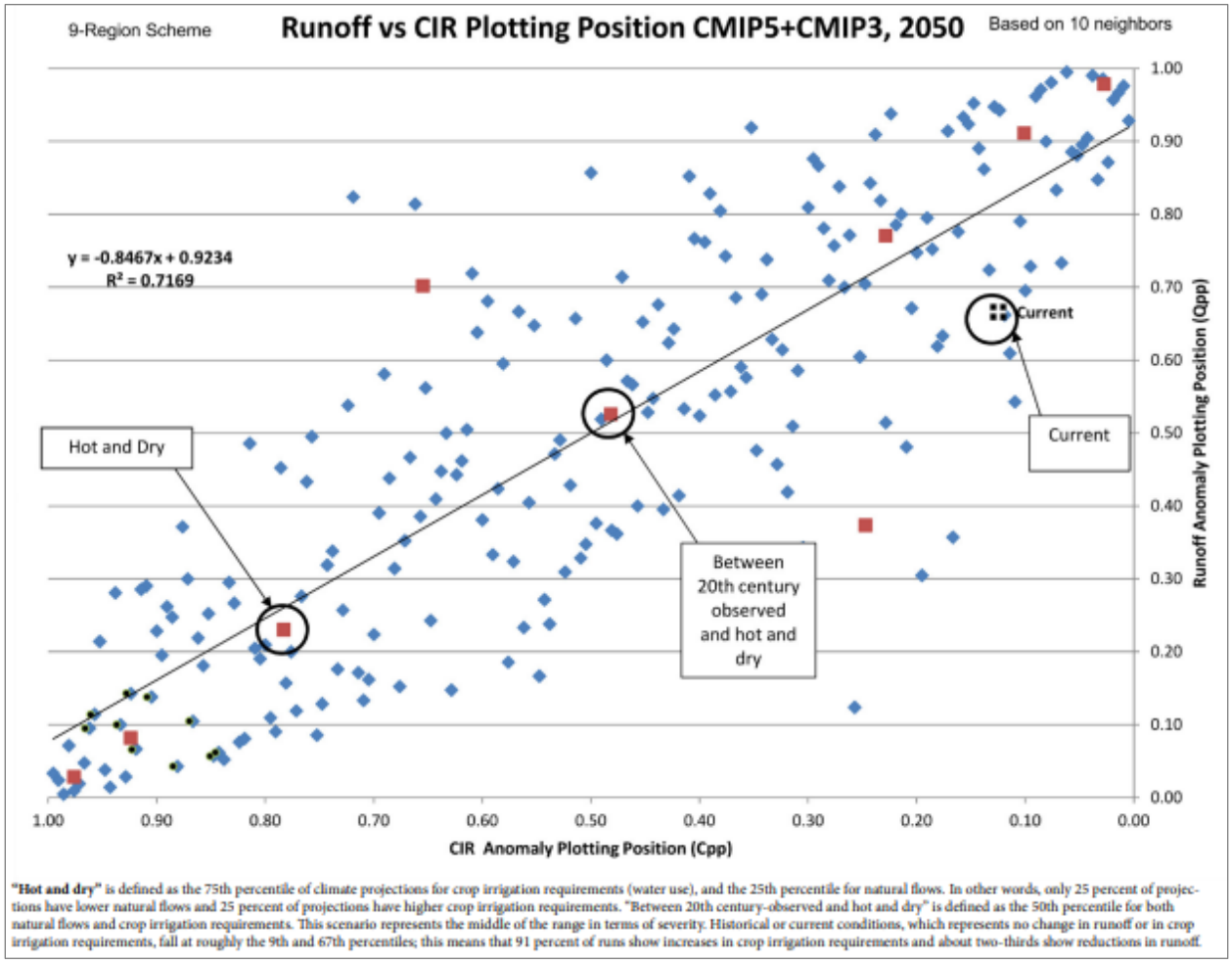

Figure 1-3: Runoff versus Crop Irrigation Requirement (from the CWP), Illustrating Climate Scenarios.

The CWP assigned a climate projection to each of the five scenarios, as shown in Table 1-7.

Table 1-7. Climate Status for Each Planning Scenario.

Scenario:	A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Climate:	Current	Current	In-Between	Hot and Dry	Hot and Dry

Changes in climate primarily influence outdoor aspects of municipal demands, due to impacts on landscape vegetation irrigation water needs (WWA, 2014). These impacts are typically associated with warmer temperatures that increase evapotranspiration ("ET") rates and lengths of growing seasons, which increase the landscape irrigation water demand and consumptive use. For the Technical Update, it was assumed that indoor demands and non-revenue water are not affected by climate changes.

Climate effects on outdoor demands can be quantified through an ET-based analysis. Where sufficient data are available, the irrigation water requirement ("IWR") under varying climates could be used to evaluate the range of effects on future municipal outdoor demands. This type of analysis would require data or assumptions about the mix of landscaping materials, e.g. low versus high water-demand plants and grasses and irrigated areas. Irrigation application efficiency data would also need to be available or assumed. Some water providers have begun reporting landscaped areas through the 1051 reporting, but sufficient information to apply this type of methodology on a statewide basis are not yet available. It is recommended that efforts continue to be made to collect this data. This will be challenging as permeable areas, landscaping materials, and application efficiencies change over time, however it is the type of information that will better inform future municipal outdoor demand projections. In the absence of the irrigated landscape area and other related data, IWR based on ET rates serves as a proxy for water use. The Technical Update utilizes the relative difference between ET rates under current conditions and the future climate status under a given scenario to develop a percentage adjustment to the outdoor portion of the future per capita demand values for the residential and non-residential outdoor demand categories.

ET change factors were developed under the Colorado River Water Availability Study Phase II (BOR, 2012), by processing projected climate data and downscaling the information for use at the water district level. This effort resulted in a time series of 64 years of annual change factors for each water district, reflecting the relative change in IWR under each climate projection. The factors were prepared for use with irrigated agriculture crops rather than municipal landscaping but are the best available information at this time. To estimate the impacts of changing climate on future outdoor demands for the Technical Update analysis, the water district factors were translated to county factors. In areas where multiple water districts cover a single county (mostly occurring in the west-slope basins), the current geographic population distribution was used to weight the water district factors based on the relative population distribution. These factors were applied to outdoor demands at a county level to represent the average annual change in outdoor demand in the year 2050 due to the climate status (Table 1-8).

Some important considerations about this methodology include:

- The analysis assumes that an adequate water supply is available in that the methodology adjusts the outdoor demand by the relative change in the demand that would occur with a full landscaping water supply to meet the IWR, which does not account for deficit irrigation under current or future conditions.

- The adjustments assume that amount and type of vegetative cover and the irrigation methods and management remain the same in the future as today. Other driver adjustments should be considered in the future modeling, to reflect potential changes in land use, including landscaping characteristics that may be influenced by climate changes (e.g. a shift toward vegetation that needs less water).

- The methodology assumes that the percentage reduction in outdoor use found from existing programs, i.e. 20% to 30%, remains possible and representative of the potential percentage reductions under future climate scenarios. However, the percentages are a net effect between the current and future conditions. Some communities are already struggling to support healthy landscapes in response to utility rate charge increases. It is anticipated that it will require active management and a concerted effort to maintain healthy landscapes under future climate scenarios or that landscapes will have to change.

Table 1-8: County Climate Adjustment Factors by Planning Scenario.

Scenario:	A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Climate:	Current	Current	In Between	Hot and Dry	Hot and Dry
Adams	1	1	1.09	1.15	1.15
Alamosa	1	1	1.15	1.18	1.18
Arapahoe	1	1	1.09	1.15	1.15
Archuleta	1	1	1.16	1.23	1.23
Baca	1	1	1.12	1.17	1.17
Bent	1	1	1.12	1.17	1.17
Boulder	1	1	1.08	1.14	1.14
Broomfield	1	1	1.09	1.15	1.15
Chaffee	1	1	1.12	1.17	1.17
Cheyenne	1	1	1.07	1.13	1.13
Clear Creek	1	1	1.08	1.14	1.14
Conejos	1	1	1.15	1.18	1.18
Costilla	1	1	1.15	1.18	1.18
Crowley	1	1	1.12	1.17	1.17
Custer	1	1	1.12	1.17	1.17
Delta	1	1	1.16	1.22	1.22
Denver	1	1	1.09	1.15	1.15
Dolores	1	1	1.16	1.23	1.23
Douglas	1	1	1.09	1.15	1.15
Eagle	1	1	1.13	1.21	1.21
El Paso	1	1	1.12	1.17	1.17
Elbert	1	1	1.10	1.15	1.15
Fremont	1	1	1.12	1.17	1.17
Garfield	1	1	1.13	1.21	1.21
Gilpin	1	1	1.08	1.14	1.14
Grand	1	1	1.13	1.21	1.21
Gunnison	1	1	1.16	1.22	1.22
Hinsdale	1	1	1.16	1.22	1.22
Huerfano	1	1	1.12	1.17	1.17
Jackson	1	1	1.16	1.26	1.26
Jefferson	1	1	1.09	1.15	1.15
Kiowa	1	1	1.12	1.17	1.17
Kit Carson	1	1	1.04	1.11	1.11
Lake	1	1	1.12	1.17	1.17
La Plata	1	1	1.16	1.23	1.23
Larimer	1	1	1.08	1.14	1.14
Las Animas	1	1	1.12	1.17	1.17
Lincoln	1	1	1.10	1.16	1.16
Logan	1	1	1.08	1.14	1.14
Mesa	1	1	1.13	1.21	1.21
Mineral	1	1	1.15	1.18	1.18
Moffat	1	1	1.20	1.35	1.35
Monte-zuma	1	1	1.16	1.23	1.23
Montrose	1	1	1.16	1.22	1.22
Morgan	1	1	1.08	1.14	1.14
Otero	1	1	1.12	1.17	1.17

Scenario:	A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Climate:	Current	Current	In Between	Hot and Dry	Hot and Dry
Ouray	1	1	1.16	1.22	1.22
Park	1	1	1.08	1.14	1.14
Phillips	1	1	1.04	1.11	1.11
Pitkin	1	1	1.13	1.21	1.21
Prowers	1	1	1.12	1.17	1.17
Pueblo	1	1	1.12	1.17	1.17
Rio Blanco	1	1	1.22	1.37	1.37
Rio Grande	1	1	1.15	1.18	1.18
Routt	1	1	1.20	1.35	1.35
Saguache	1	1	1.15	1.18	1.18
San Juan	1	1	1.16	1.23	1.23
San Miguel	1	1	1.16	1.23	1.23
Sedgwick	1	1	1.06	1.13	1.13
Summit	1	1	1.13	1.21	1.21
Teller	1	1	1.10	1.15	1.15
Washing-ton	1	1	1.05	1.11	1.11
Weld	1	1	1.08	1.14	1.14
Yuma	1	1	1.04	1.11	1.11

1.2 INDUSTRIAL DEMANDS

1.2.1 SWSI 2010 METHODOLOGY

SWSI 2010 defined self-supplied industrial (SSI) demands as large industrial water users that have their own water supplies or lease raw water from others. Domestic water demands that result from increases in population associated with SSI activities ("indirect demands") were represented in the municipal demands. The future demand projections were prepared on an average annual basis and potential impacts of climate change were not considered in any of the demand analyses. The SSI demand category from SWSI 2010 is equivalent to the industrial portion of the demands in the Technical Update.

SWSI 2010 included demands for the following four SSI sub-sectors:

- Large industry demand data were primarily collected during the prior SWSI Phase 1 study (CWCB, 2004). In SWSI 2010, three large industries in the South Platte Basin that receive their water supply from municipalities were added to the SSI category and removed from the municipal calculations, to avoid double counting in the M&I demands. SSI demands for Routt and Moffat Counties were increased through 2035 based on mining and golf course projections in the Yampa Valley Water Demand Study (BBC, 1998); demands were then held constant through 2050. SSI demands for all other counties were held constant between 2008 and 2050.

- Snowmaking demand projections were based on estimates of 2008 snowmaking acres for each resort, the amount of water used for snowmaking in 2008, and expected future snowmaking water demand based on regional studies. Demands for resorts without water use data were estimated using a "water use factor" (WUF) per acre of snowmaking for each basin. Water use was held constant for resorts with no known or reported future expansions.

- Thermoelectric power generation demand data for coal-fired and natural gas power facilities through 2035 were largely based on information provided by power producers for the SWSI Phase 1 study (CWCB, 2004). SWSI Phase 1 demands for the Colorado and Yampa-White basins were modified and extended through 2050 using specific study information. Data for all other counties relied on SWSI Phase 1 projections for 2035 and were extended through 2050 using 5%, 25%, and 50% increases for low, medium, and high demand scenarios, respectively.

- Energy development demand projections were primarily based on the Phase I and II Energy Development Water Needs Assessment Reports released by the Colorado and Yampa-White Roundtables (URS, 2008; AMEC, 2011). The local reports estimated direct demands needed to support extraction and production of natural gas, coal, uranium, and oil shale through 2050. Information in the local reports were interpreted to develop low, medium, and high scenarios for the energy industry in northwest Colorado. The Rio Grande Basin was also projected to include the development of a solar energy industry over a period of 40 to 50 years (i.e. thru 2050/2060).

Low, medium, and high demand projections were developed for the energy and thermoelectric power generation sub-sectors whereas a single 2050 demand value was prepared for the large industry and snowmaking subsectors as shown in Table 1-9. The potential for future conservation savings was not evaluated.

Table 1-9. SWSI 2010 Self-Supplied Industry Demands by Basin (AFY).[16]

Basin	Sub-Sector	2008	2035	2050 Low	2050 Med	2050 High
Arkansas	Energy Development	-	-	-	-	-
	Large Industry	49,400	49,400	49,400	49,400	49,400
	Snowmaking	-	-	-	-	-
	Thermoelectric	9,000	14,700	15,400	18,400	22,100
	Basin Total	58,400	64,100	64,800	67,800	71,500
Colorado	Energy Development	2,300	500	200	4,700	10,700
	Large Industry	-	-	-	-	-
	Snowmaking	3,180	4,740	4,740	4,740	4,740
	Thermoelectric	-	-	-	-	-
	Basin Total	5,480	5,240	4,940	9,440	15,440
Gunnison	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	260	650	650	650	650
	Thermoelectric	-	-	-	-	-
	Basin Total	260	650	650	650	650
Metro	Energy Development	-	-	-	-	-
	Large Industry	52,400	52,400	52,400	52,400	52,400
	Snowmaking	-	-	-	-	-
	Thermoelectric	12,000	12,000	12,600	15,000	17,900
	Basin Total	64,400	64,400	65,000	67,400	70,300
Rio Grande	Energy Development	-	600	1,200	1,500	2,000
	Large Industry	-	-	-	-	-
	Snowmaking	-	-	-	-	-
	Thermoelectric	-	-	-	-	-
	Basin Total	-	600	1,200	1,500	2,000
South Platte	Energy Development	-	-	-	-	-
	Large Industry	6,600	6,600	6,600	6,600	6,600
	Snowmaking	320	320	320	320	320
	Thermoelectric	21,400	35,400	37,200	44,400	53,100
	Basin Total	28,320	42,320	44,120	51,320	60,020
Southwest	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	410	410	410	410	410
	Thermoelectric	1,900	3,900	4,100	4,900	5,900
	Basin Total	2,310	4,310	4,510	5,310	6,310
Yampa-White	Energy Development	2,000	6,000	3,900	7,500	41,800
	Large Industry	6,100	9,500	9,500	9,500	9,500
	Snowmaking	290	570	570	570	570
	Thermoelectric	20,200	38,300	36,700	40,500	44,000
	Basin Total	28,590	54,370	50,670	58,070	95,870
Statewide Total		187,760	235,990	235,890	261,490	322,090

[16] Copied from Table 4-13 of CWCB, 2010a.

1.2.2 TECHNICAL UPDATE METHODOLOGY ENHANCEMENTS

The CWP provides some narrative guidance regarding effects on industrial demands under the five planning scenarios, as described in Table 1-10, although less specific than for the municipal demands.

Table 1-10: CWP Guidance on Industrial Demands for the Five Planning Scenarios.

A. Business as Usual	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
• Recent trends continue • Regular economic cycles • Social values and regulations remain the same • Oil-shale development continues to be researched	• Economy struggles • Greenhouse gas emissions do not grow as much	• Embrace water and energy conservation • Widespread water efficiency and increased environmental protection	• Renewable and clean energy become dominant	• Rapid business and population growth • Fossil fuel is the dominant energy source • Large production of oil shale, coal, natural gas, and oil

New and updated information related to current and projected future industrial demands is limited. SWSI 2010 values were updated where possible and appropriate as follows, based on published references and data collected through outreach with the M&I TAG. To the extent possible with the available information, 1051 data that were relied upon in preparing municipal demands were reviewed and adjusted to exclude water uses associated with industrial demands, to avoid double counting. The drivers in Table 1-11 were developed with input from the M&I TAG and as further summarized below.

- Large Industry: Baseline large industry demands for facilities represented in SWSI 2010 were updated using either: i) BIP data; ii) recent data from existing hydrologic models; or iii) interpolating between 2008 and 2035 values in SWSI 2010. A mining facility was also added in Grand County (Colorado Basin) because it is an explicitly-modeled location in an existing hydrologic model. Business as Usual demands were developed using BIP data and information provided by M&I TAG participants to the extent possible, while all remaining values were based on projections from SWSI 2010. All large industry demands were varied by scenario according to the factors in Table 1-11 except for those occurring in Jefferson County as further described under the South Platte Basin.

- Snowmaking: Baseline demands were updated based on current snowmaking acres for each resort[17] and WUFs from SWSI 2010. Baseline snowmaking demands are estimated to have increased by approximately 15% as compared to the 2008 values used in SWSI 2010, which is in line with the linear increase from 2008 to 2050 reported in SWSI 2010. Therefore, SWSI 2010 projections appear to provide a reasonable estimate of Business as Usual demands. SWSI 2010 projections represent the best-available information for Business as Usual demands in 2050. As with

[17] Source: https://www.onthesnow.com/colorado/skireport.html

SWSI 2010, snowmaking demands were not varied by scenario, in part, due to uncertainty regarding the effects of climate change.

- Thermoelectric Power Generation: Baseline and Business as Usual thermoelectric demands for 10 of the 13 facilities were updated using data provided by M&I TAG participants. Baseline and Business as Usual demands for one facility were based on information from the Yampa-Green-White BIP. SWSI 2010 values were used to define Baseline and Business as Usual demands for the remaining two facilities where no updated information was available. Thermoelectric demands for all facilities were varied by scenario according to the factors in Table 1-11.

- Energy Development: Baseline energy development demands were updated using either BIP data or interpolating between 2008 and 2035 values in SWSI 2010. 2050 demand projections in the Rio Grande Basin were based on information from the BIP and did not vary by scenario. 2050 demands in all other basins were based on low, medium, and high projections from SWSI 2010 as summarized in Table 1-11.

Table 1-11: Industrial Adjustments for 2050 Projections.

Industrial Category	A. Business as Usual [a]	B. Weak Economy	C. Cooperative Growth	D. Adaptive Innovation	E. Hot Growth
Large Industry [b]	-	-10%	0%	0%	10%
Snowmaking	-	0%	0%	0%	0%
Thermoelectric	-	-5%	10%	-5%	10%
Energy Development [c]	SWSI 2010 - Medium	SWSI 2010 - Medium	SWSI 2010 - Low	SWSI 2010 - Low	SWSI 2010 - High

a) The Business as Usual scenario is based on updated baseline demands. The percentage values shown for other scenarios are an adjustment to the baseline demands from the Business as Usual scenario.

b)Jefferson County large industry demands were not varied by scenario.

c) Rio Grande energy development demands were not varied by scenario.

In addition to the industrial demands described above, the hydrologic modeling for the Technical Update includes demands associated with hydroelectric power generation. Hydroelectric demands are non-consumptive and were not adjusted from the values that were included in the existing models, for the baseline or planning scenarios in the hydrologic modeling, because no new information was available for this demand category. As previously noted, limited new information about industrial demands was available for the Technical Update. It is recommended that targeted outreach for each sub-sector, including hydroelectric power, be completed as part of the BIP updates and/or well in advance of the next Technical update. For example, oil and gas demands are known to exist in the South Platte and North Platte Basins; however, no data were available to be relied upon at the time the analysis was completed.

1.3 PREPARING DEMANDS FOR HYDROLOGIC MODELING

As part of the Technical Update, the M&I demands are incorporated into a hydrologic modeling analysis that combines water demand and water supply projections on a spatial basis throughout the state of Col-

orado, using monthly basin-scale models. The M&I baseline and projected future demands were developed at a county scale however, the hydrologic models use water district boundaries.[18] The models include representative monthly municipal and industrial demand distributions and explicitly model most larger water users at a representative model demand location or "node." Demands not represented at explicit locations (generally smaller municipalities, unincorporated municipal areas including use from wells, and county-wide industrial uses) were aggregated at the water district scale. Explicitly modeled[19] demands are evaluated at their respective model node locations, with the remaining county demands translated to aggregated water district demands in the hydrologic modeling.

The M&I demands were prepared by ELEMENT for each county using the methodologies described above. The hydrologic modeling consultant, Wilson Water Group, provided a list of the explicitly-modeled M&I water demands and ELEMENT used the following methodology to separate the explicitly-modeled demands from the remainder of the county demands:

- Municipal – The per capita rate of water use and population for each county were calculated using the methodologies described above. For each explicitly modeled water provider with data reported under one of the available sources used in this analysis (1051, WEP, Outreach, or BIP), the reported population for that provider was applied to the county-representative gpcd to calculate the total demands for that provider. These calculated demands were used rather than actual provider-reported demands for the explicitly modeled demands based on input from the TAG and in order to provide a consistent statewide methodology. For explicitly modeled providers with no information available from the data sources used in this analysis, the modeled demands within the current WWG models were used. Where explicit providers' service areas cover multiple counties, ELEMENT created a population-weighted gpcd using the representative gpcd for each county served and the associated population within that county. County aggregate demands were calculated by subtracting the explicitly modeled demands within that county from the total county demand.

- Industrial – All snowmaking, thermoelectric, and hydropower demands, and the majority of large industry demands, are associated with specific industrial users (e.g. at a ski resort or power generating facility); however, some large industry and all energy development demands were calculated at the county-scale. To the extent a specific industrial user was represented in the hydrologic models, its baseline and projected demands were used to for the explicitly modeled demands. The remaining county-level demands were translated to aggregated water district demands in the hydrologic modeling.

ELEMENT reviewed the municipal and industrial monthly demand curves in the existing hydrologic models and found them to be generally representative for statewide modeling purposes.

[18] Water districts are administrative boundaries used by the Colorado State Engineer's Office, typically aligned with hydrologic boundaries. This is not a reference to a special district water provider.

[19] Specific water provider demands modeled as independent model nodes in the hydrologic modeling.

Section 2: Statewide M&I Results

The updated M&I demands presented below include baseline demands, estimated for the year 2015, and projected future demands for the year 2050 for multiple planning scenarios. It is important to note that these demand projections do not represent drought conditions or associated responses.

2.1 MUNICIPAL

Municipal demands were calculated for each county and then summarized by basin. Water demands for counties that are located in multiple basins were distributed between basins by using the portion of the county population located within each basin to prorate the water demands.

2.1.1 POPULATION

Similar to the SWSI 2010 baseline, approximately 88% of the state lives in one of three basins – the Arkansas, Metro, and South Platte. The Technical Update statewide baseline population, which is based on 2015 population data, is approximately 8% higher than the SWSI 2010 baseline, which used 2008 population as a baseline. However, the increase is less than the amount that SWSI 2010 had projected for the year 2015. While most basins have increased in population between 2008 and 2018, the Gunnison, North Platte, Rio Grande, and Yampa-White have decreased. A basin-level summary is provided in Table 2-1 and Figure 2-1, with more detailed data provided in Section 3 below.

Table 2-1: Current Baseline Population for SWSI 2010 and Technical Update.

(number of people unless otherwise indicated)

Basin	SWSI 2010 Baseline (2008)[a]	SWSI 2010 Projection for 2015[b]	Technical Update Baseline (2015)	
			People	% of Statewide Total
Arkansas	948,000	1,067,000	1,008,434	18.51%
Colorado	307,000	366,000	307,570	5.65%
Gunnison	105,000	125,000	103,121	1.89%
Metro	2,513,000	2,846,000	2,768,126	50.81%
North Platte	1,500	1,600	1,353	0.02%
Rio Grande	50,000	54,000	45,975	0.84%
Republican	see note c	see note c	31,616	0.58%
South Platte	977,000	1,118,000	1,030,138	18.91%
Southwest	105,000	123,000	107,999	1.98%
White	see note d	see note d	6,529	0.12%
Yampa	45,000	53,000	37,194	0.68%
Statewide	5,051,500	5,754,600	5,448,055	100.00%

a) SWSI 2010 Report Table 4-1 (CWCB, 2011a).

b) SWSI 2010 Appendix H, Exhibit 36 (CWCB, 2010a).

c) Republican included in the South Platte total for SWSI 2010 reporting.

d) Yampa and White combined for SWSI 2010 reporting and included here under the Yampa.

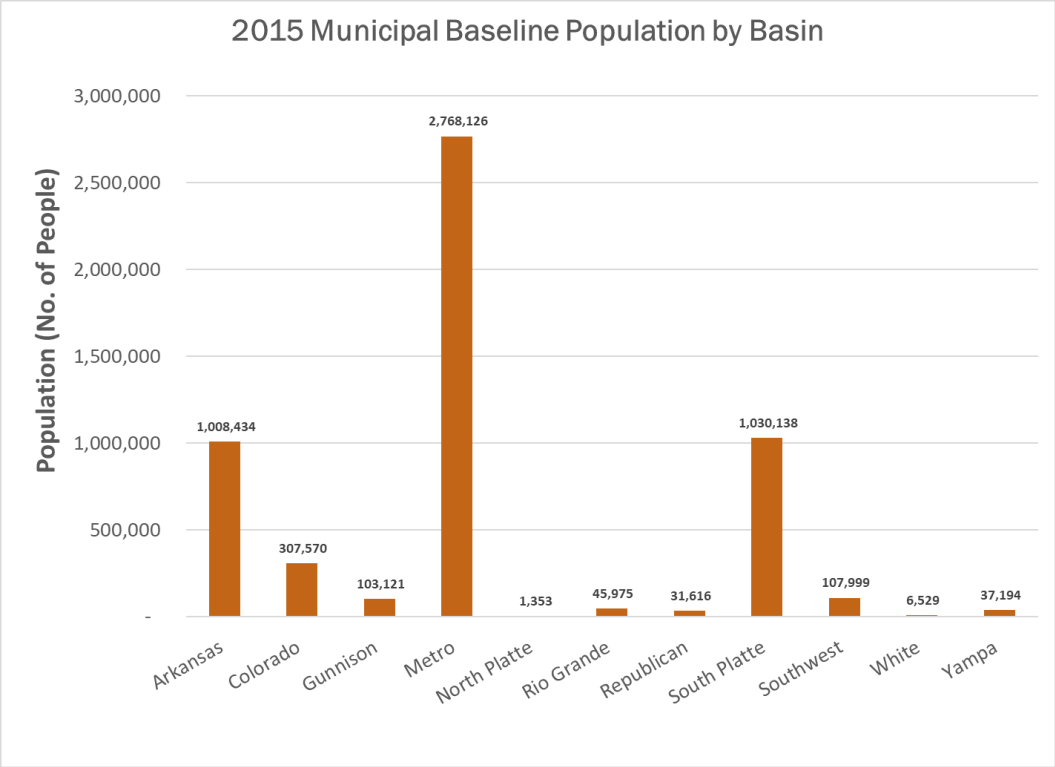

Figure 2-1: SWSI 2015 Municipal Baseline for each Basin.

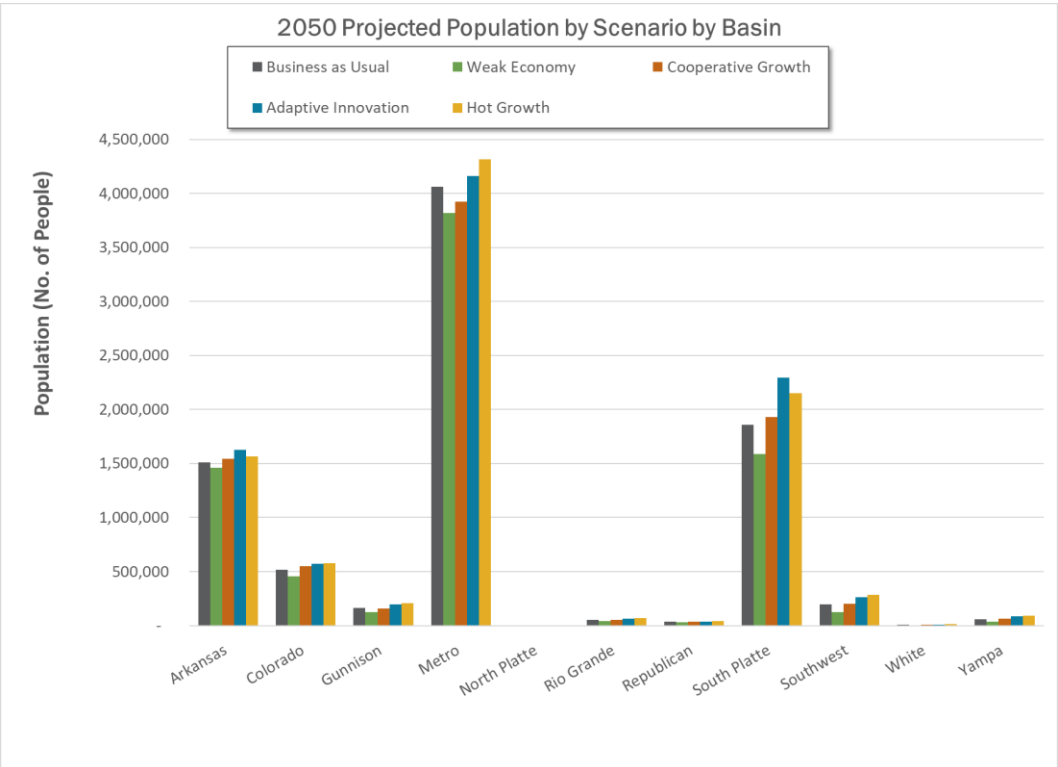

Figure 2-2: Projected Population Summarized by Basin for each Planning Scenario.

Figure 2-2 and Appendix B show the Technical Update population projections for 2050, summarized by basin. Between the years 2015 and 2050, the State of Colorado is projected to grow from approximately 5.5 million to between 7.7 million to 9.3 million in the low and high scenarios, respectively. Using the specific numbers, this is an increase in population of about 41% to 71%.

Figure 2-3 provides a comparison of the population baseline and projections between SWSI 2010 and the Technical Update. Although the Technical Update baseline population is higher than the SWSI 2010 baseline, it is lower than the SWSI 2010 projection for the Technical Update baseline year of 2015. All of the Technical Update planning scenario projections for 2050 anticipate lower population than the SWSI 2010 high population projection. The Technical Update medium growth projection that is used for the Business as Usual and Cooperative Growth scenarios is similar to, within about 2%, the SWSI 2010 Low population projection. The Technical Update high growth projection that is used for the Adaptive Innovation and Hot Growth scenarios is similar to, within about 2%, the SWSI 2010 Medium population projection.

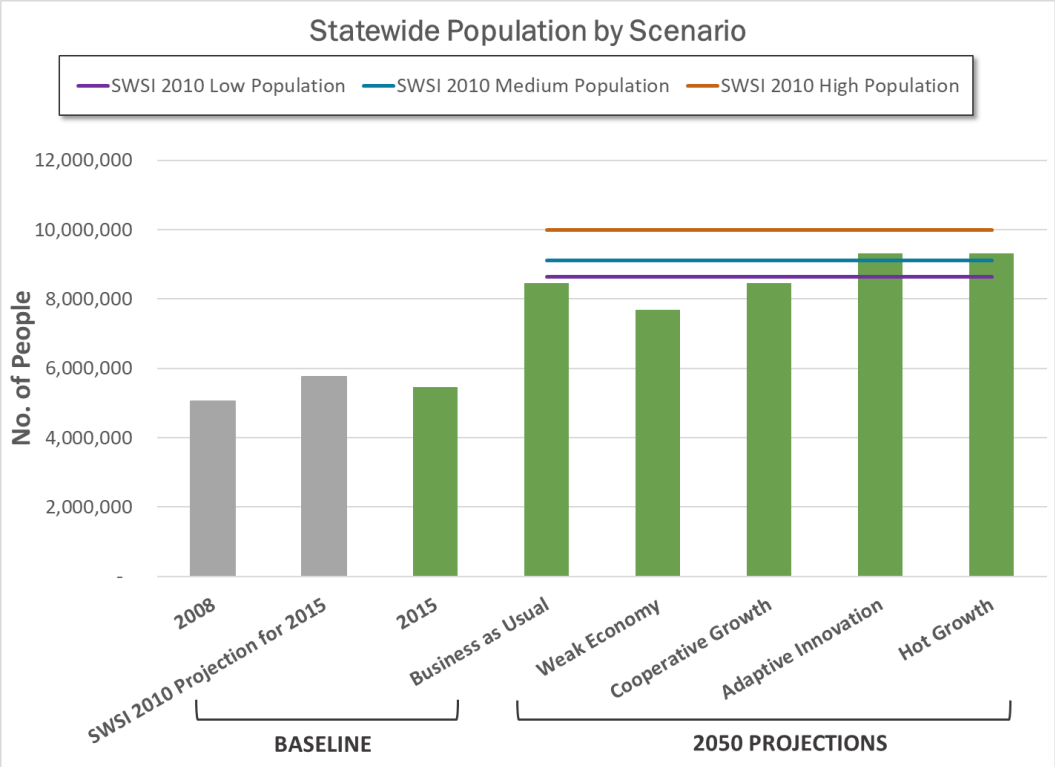

Figure 2-3: Statewide Baseline and Projected Population.

2.1.2 MUNICIPAL DEMANDS

The statewide baseline water demands were largely based on water provider-reported data, with approximately 70% of the baseline population demands represented by 1051 data, 11% from WEPs, 1% from water provider outreach, and 1% from BIP data. This resulted in demands for about 16% of the statewide population having to be estimated, as shown in Figure 2-4.

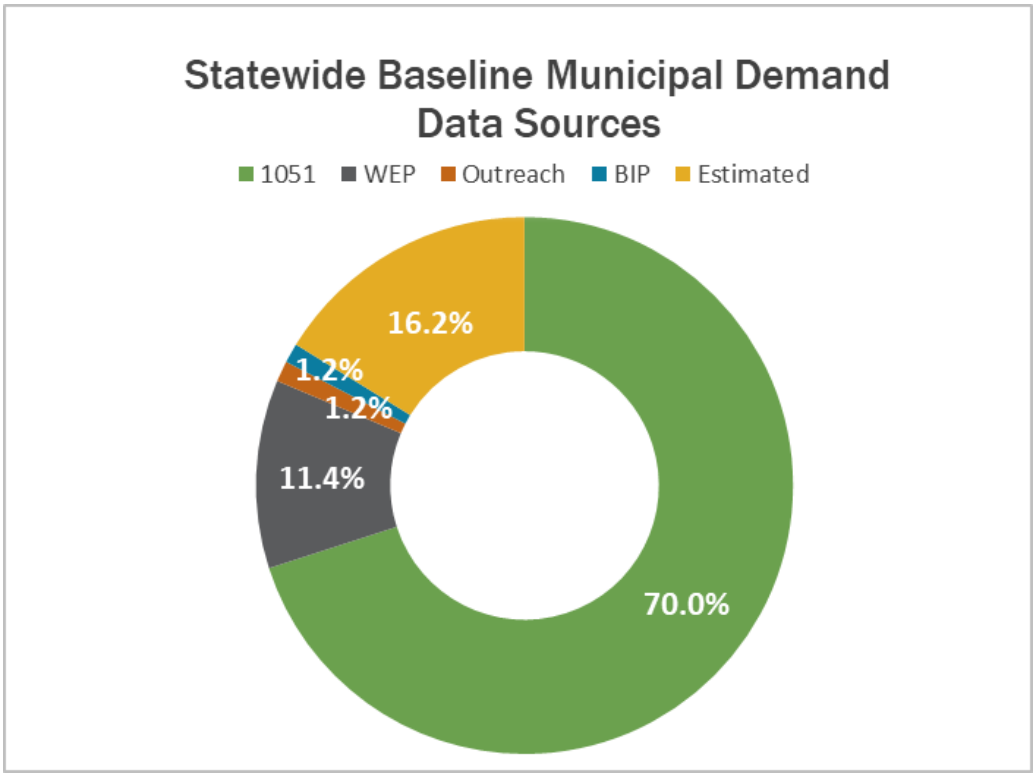

Figure 2-4: Statewide Baseline Municipal Demand Data Sources.

The statewide baseline per capita systemwide demand has decreased from 172 in SWSI 2010 to approximately 164 gpcd, which is nearly a 5% reduction in demands between 2008 and 2015. The reduction is associated with improved data availability, conservation efforts, and ongoing behavioral changes. There are more significant differences from SWSI 2010 at a basin level (Figure 2-5). The differences are largely attributable to updated data, with a significant portion of the state represented by 1051 reporting and updated WEPs.

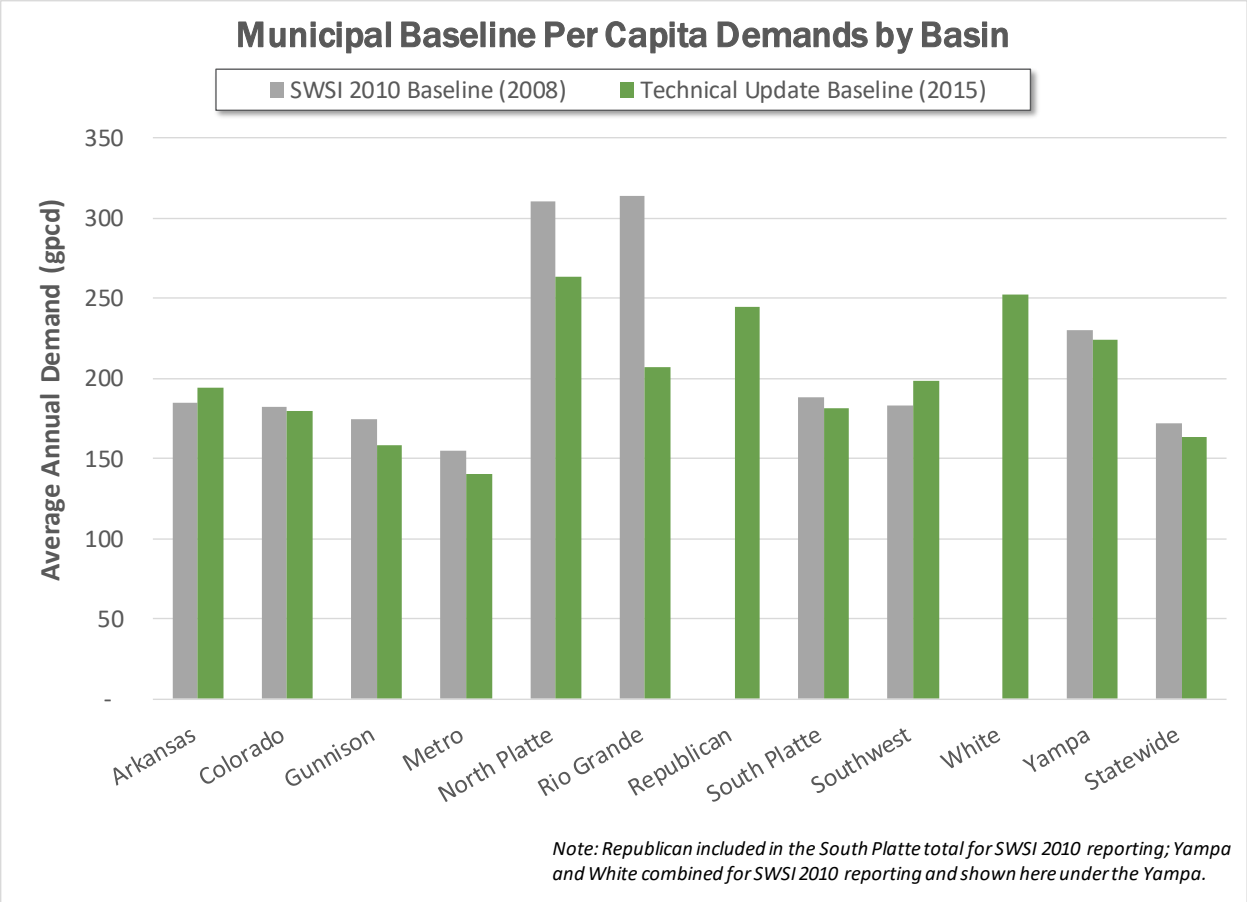

Figure 2-5. Municipal Baseline Per Capita Water Demands.

Table 2-2 below represents baseline and projected per capita demands for basins throughout the state. The Adaptive Innovation planning scenario has the lowest per capita demands and Hot Growth has the highest per capita demands, both statewide and within each basin. On an average statewide basis, all of the Technical Update planning scenario projections of per capita demands are higher than the SWSI 2010 low savings forecasts. Differences in the per-capita driver approaches, the adoption rate methodology, and the influence of climate change all contribute to the Technical Update projections being consistently higher than the SWSI 2010 values. Note that the statewide per capita demand projections do not match the CWP M&I volumetric demand scenario ranking, and they were not intended to do so. For example, the Adaptive Innovation planning scenario results in the lowest per capita demand but coupling this with the highest population projection results in the second highest overall demand volume across the scenarios, as further described below.

Table 2-2: Per Capita Demand Projections by Planning Scenario for Each Basin.

Basin	SWSI 2010 [a]				Technical Update					
	Base-line (2008)	Low Savings [b]	Medium Savings [b]	High Savings [b]	Baseline (2015)	Busi-ness as Usual	Weak Econ-omy	Cooper-ative Growth	Adaptive Innova-tion	Hot Growth
Arkansas	185	149	132	119	194	179	179	170	164	192
Colorado	182	148	131	117	179	153	156	145	136	165
Gunnison	174	138	124	113	158	146	149	140	133	160
Metro	155	135	118	106	141	138	135	130	126	148
North Platte	310	253	225	207	264	245	254	242	232	270
Rio Grande	314	254	228	209	207	194	198	188	177	209
Republican	see note "c"				245	236	236	221	214	251
South Platte	188	146	129	116	181	176	174	164	158	190
Southwest	183	124	110	98	198	181	186	173	166	199
White	see note "d"				252	240	254	240	231	269
Yampa	230	179	158	114	224	172	197	161	150	180
Statewide	172	142	126	113	164	157	155	148	143	169

a) SWSI 2010 per capita values from SWSI 2010 Appendix L, Tables 8, 14, 15, and 16 (CWCB, 2011b).

b) 2050 projected demands with passive and active conservation savings included.

c) The Republican Basin demands were included in the South Platte Basin demand reporting for SWSI 2010.

d) The White Basin demands were included with the Yampa Basin demand reporting for SWSI 2010.

Statewide baseline municipal water demands are comprised of approximately 51% indoor, 37% outdoor, and 12% non-revenue water uses, as shown in Figure 2-6. On a statewide average basis, residential indoor demands represent the greatest demand category at 32%, however this varies by basin and by county. Non-revenue water represents the smallest demand category statewide at 12% but varies between basins from approximately 5% to 18%. The 1051 and WEP data are the primary sources of water demand category distribution data.

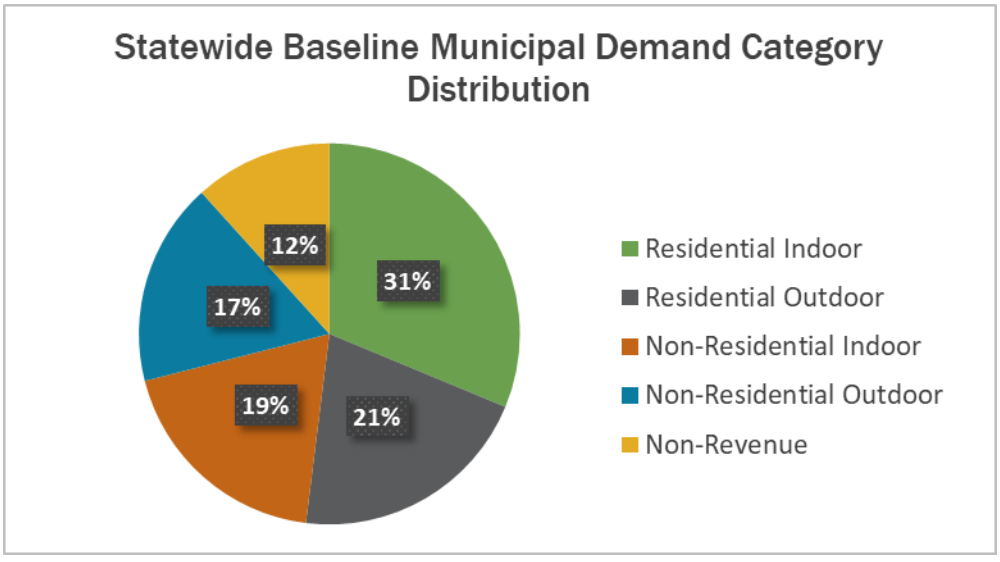

Figure 2-6: Statewide Baseline Municipal Demand Category Distribution.

For each planning scenario, residential indoor demands represent the largest category of water demand, starting at nearly 52 gpcd for the 2015 Baseline on a statewide level. The projected residential indoor demands vary greatly across planning scenarios, from 46 gpcd in the Weak Economy to 36.5 gpcd in the Adaptive Innovation scenario. Other demand categories show less variability across the scenarios, as represented in Figure 2-7. This is influenced by the following projection drivers/methodology:

- The residential indoor demands account for both the gpcd values shown in Table 1-5 and the adoption rate. In other words, the projected rates contemplate that some existing residences will not have adopted water saving technologies by 2050, and therefore the projected rate is slightly higher than the values shown in Table 1-5.

- The Technical Update indoor and outdoor demand driver adjustments, coupled with the adoption rate methodology, generally result in higher per-capita demand projections than the active conservation savings projected in SWSI 2010. **The Technical Update demand projections are not intended to capture the full range of future active conservation potential, as was the intent of SWSI 2010.** Additional future conservation may still be achieved under each planning scenario through identified projects and processes. To that end, basins may still continue to develop water conservation efforts as part of existing and future projects that could further reduce demands.

- The residential indoor driver was the only category that was assigned an absolute gpcd value. Drivers for all other categories were represented as a percent increase/reduction from the baseline.

- The outdoor driver reductions in the Cooperative Growth and Adaptive Innovation scenarios were offset by climate change adjustments.

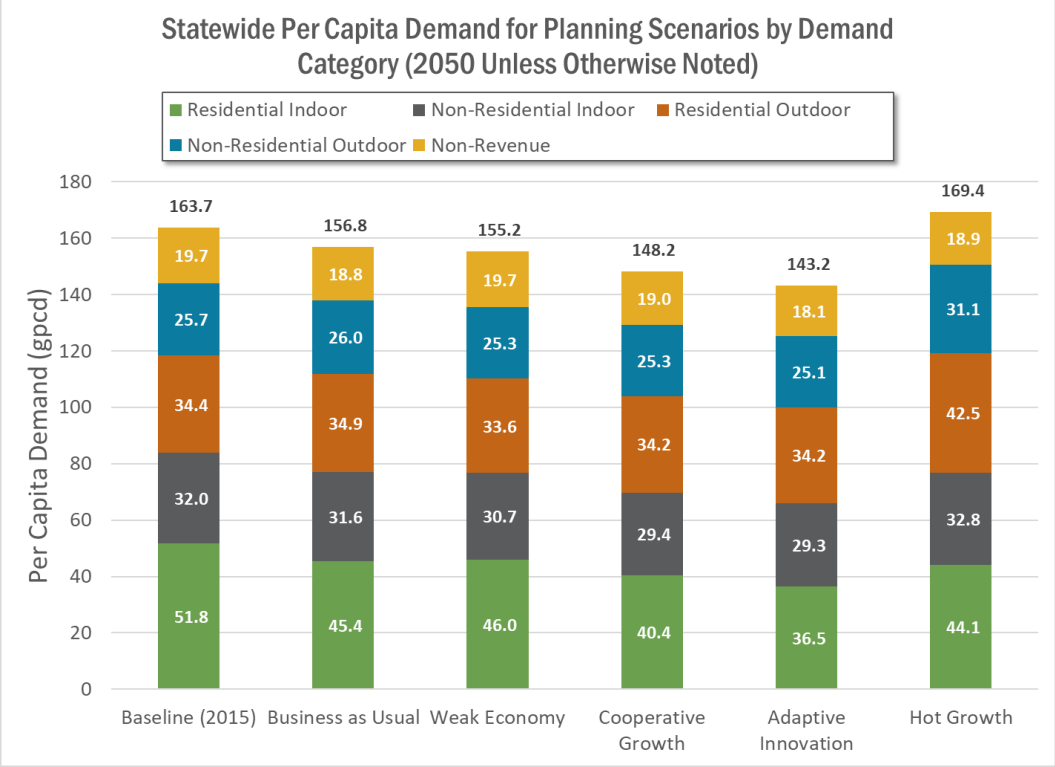

Figure 2-7: Statewide per Capita Demand for Planning Scenarios by Demand Category.

Figure 2-8 depicts the influence of the climate driver on per capita water demands, with outdoor demands increasing by 5 to 10 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 135 to 159 gpcd, which exceed the SWSI 2010 projection of 126 gpcd for medium active conservation[20]. On a county scale, the climate change factors increased the outdoor demands by 4% to 22% for the In-Between and 11% to 37% for Hot and Dry adjustments. Although it was impacted by the Hot and Dry climate change factors, Adaptive Innovation still resulted in the lowest per capita demands.

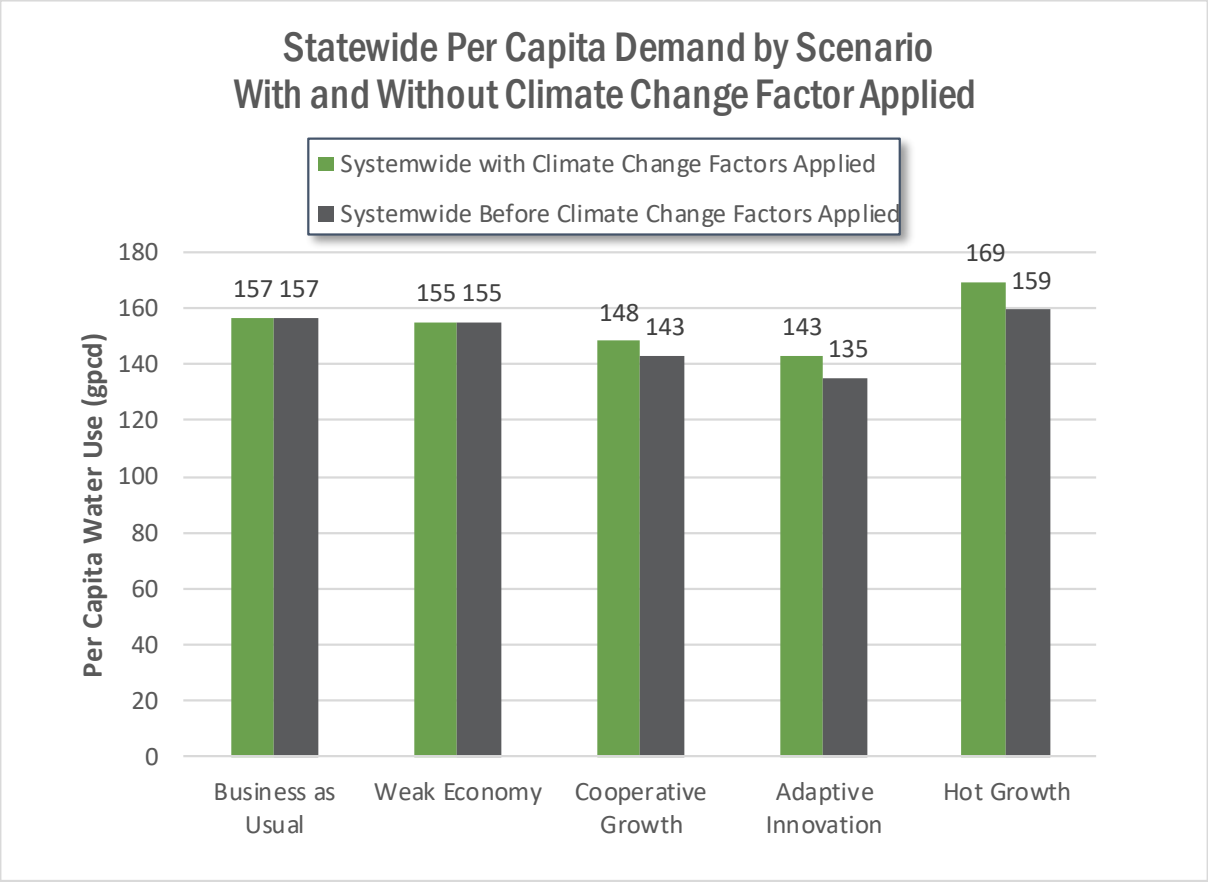

Figure 2-8: Effect of Climate Change Driver on the Statewide Average Per Capita Demand.

The projection scenarios, as described by the CWP, often paired high water demand savings drivers with high population growth or low demand reductions with low growth, resulting in a narrowing of the range in demand projections. There are no scenarios that represent high demand reductions with low growth or low demand reductions with high growth. Table 2-3 presents baseline and projected demands for basins throughout the state, showing the combined effect of population and per capita demands. The volumetric municipal demand projections match the CWP ranking listed in Table 1-3 on a statewide basis and are projected to grow from approximately 1.0 million AFY in 2015 to between 1.34 and 1.77 million AFY in

[20] SWSI 2010 projected per capita demands include savings from passive conservation.

2050. While total statewide demand projections for the five planning scenarios meet the CWP ranking, individual basin results do not.

As shown in Figure 2-9, the Business as Usual and Cooperative Growth scenarios both use the medium population projection on a statewide basis, with different distributions between counties. Similarly, the Adaptive Innovation and Hot Growth scenarios both use the high population projection on a statewide basis, with different distributions between counties. As previously noted, the CWP rankings limited the extent to which the per capita drivers could be adjusted to reflect future demand reductions. The influence of the population is so significant that the demand projections for all scenarios aside from the Hot Growth, which has the high population coupled with climate change, are relatively similar. For example, the Adaptive Innovation scenario has the greatest reductions in per capita demand but is paired with both the highest population and the Hot and Dry climate. Applying much additional reduction in the Adaptive Innovation per capita demand values would result in the Business as Usual scenario projections exceeding the Adaptive Innovation scenario. Similarly, much additional reduction in the Cooperative Growth per capita demands would result in the Weak Economy scenario projections exceeding the Cooperative Growth scenario. To some extent, the scenario rankings precluded evaluating the potential for future demand management activities, such as lower water demand landscapes, to further offset the effects of climate change. These types of activities should be further considered for local or basin-level planning.

Table 2-3. Statewide Municipal Baseline and Projected Volumetric Demands by Basin (AFY).

Basin	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Arkansas	219,208	303,352	293,842	294,540	298,095	337,222
Colorado	61,790	88,589	79,886	88,984	87,534	106,578
Gunnison	18,262	26,674	20,509	24,887	29,142	36,789
Metro	435,745	626,501	578,969	570,151	586,176	715,885
North Platte	400	351	301	328	355	441
Rio Grande	10,639	11,947	9,370	11,000	12,496	15,732
Republican	8,666	9,361	8,019	8,323	9,208	11,524
South Platte	208,842	365,716	309,615	354,319	404,554	457,803
Southwest	24,009	39,810	26,214	38,864	49,164	62,851
White	1,845	1,980	1,203	1,875	2,737	3,405
Yampa	9,324	11,552	7,580	11,418	14,471	18,511
Statewide	998,730	1,485,833	1,335,508	1,404,688	1,493,931	1,766,740

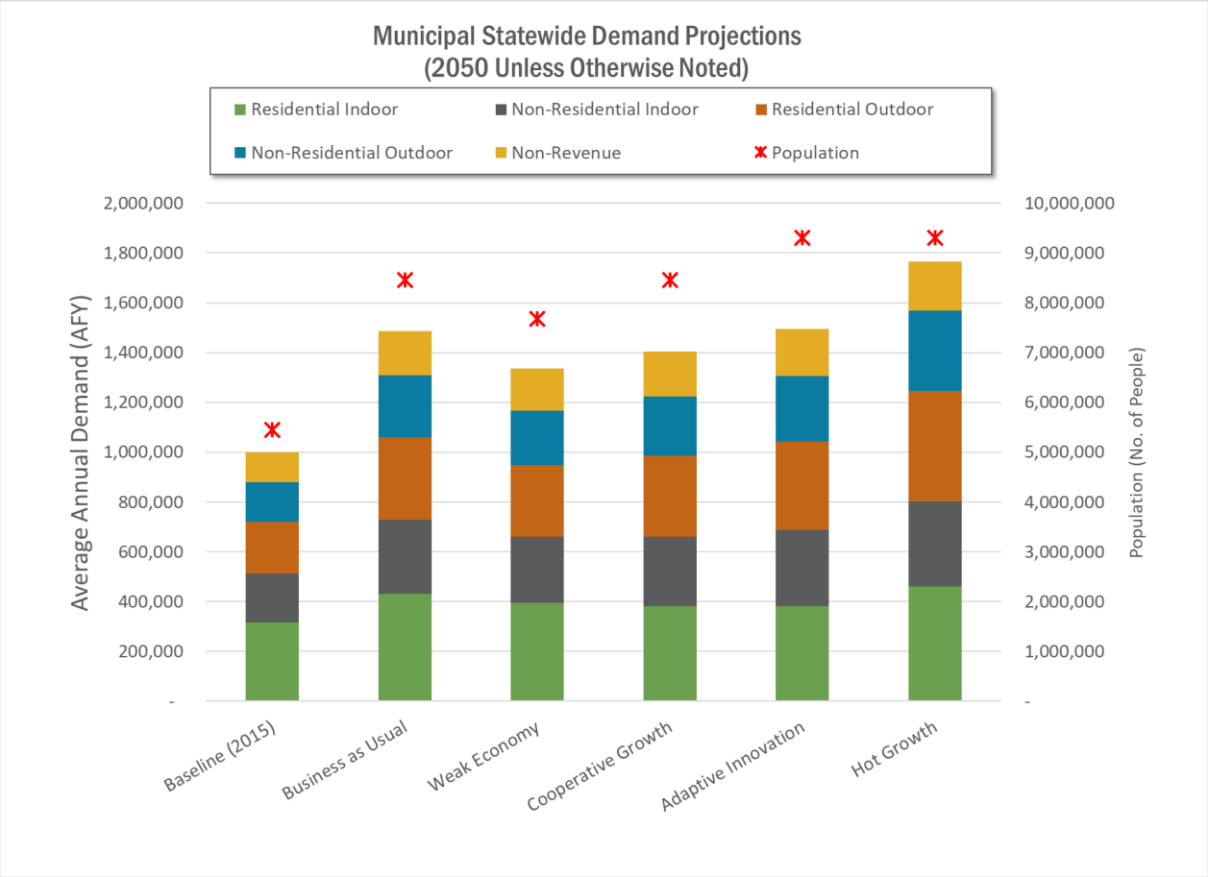

Figure 2-9. Statewide Baseline and Projected Population and Municipal Demands.

Figure 2-10 provides a comparison of the Technical Update results with the SWSI 2010 projected demands for 2050. As previously described, it is challenging to directly compare the municipal demand projections due to differences in the methodologies. The SWSI 2010 projections selected for Figure 2-10 are intended to show a range of the spread in the SWSI 2010 projections relative to the Technical Update projections. For SWSI 2010, the passive savings methodology that was included with low, medium, and high population projections was different from the Technical Update methodology that uses an adoption rate. Therefore, the SWSI 2010 low, medium, and high projections that incorporated passive savings are provided for comparison, along with the SWSI 2010 high projection that had no passive or active conservation savings as the highest demand projection from SWSI 2010. The low, medium, and high level of active conservation savings potential that was evaluated in SWSI 2010 was only prepared for the medium population projection. The SWSI 2010 medium active savings potential, which includes the passive savings, with the SWSI 2010 medium population projection is provided in Figure 2-10 as an example of the level of active savings that was considered. The Technical Update demand projections for all planning scenarios fall within the spread of the SWSI 2010 high population demands with passive conservation savings and the SWSI 2010 medium population growth with passive and high active conservation savings. This result was anticipated with the Technical Update methodology, considering that the updated projections represent potential demands under conditions described for each scenario and do not necessarily represent the full potential for demand management under each scenario.

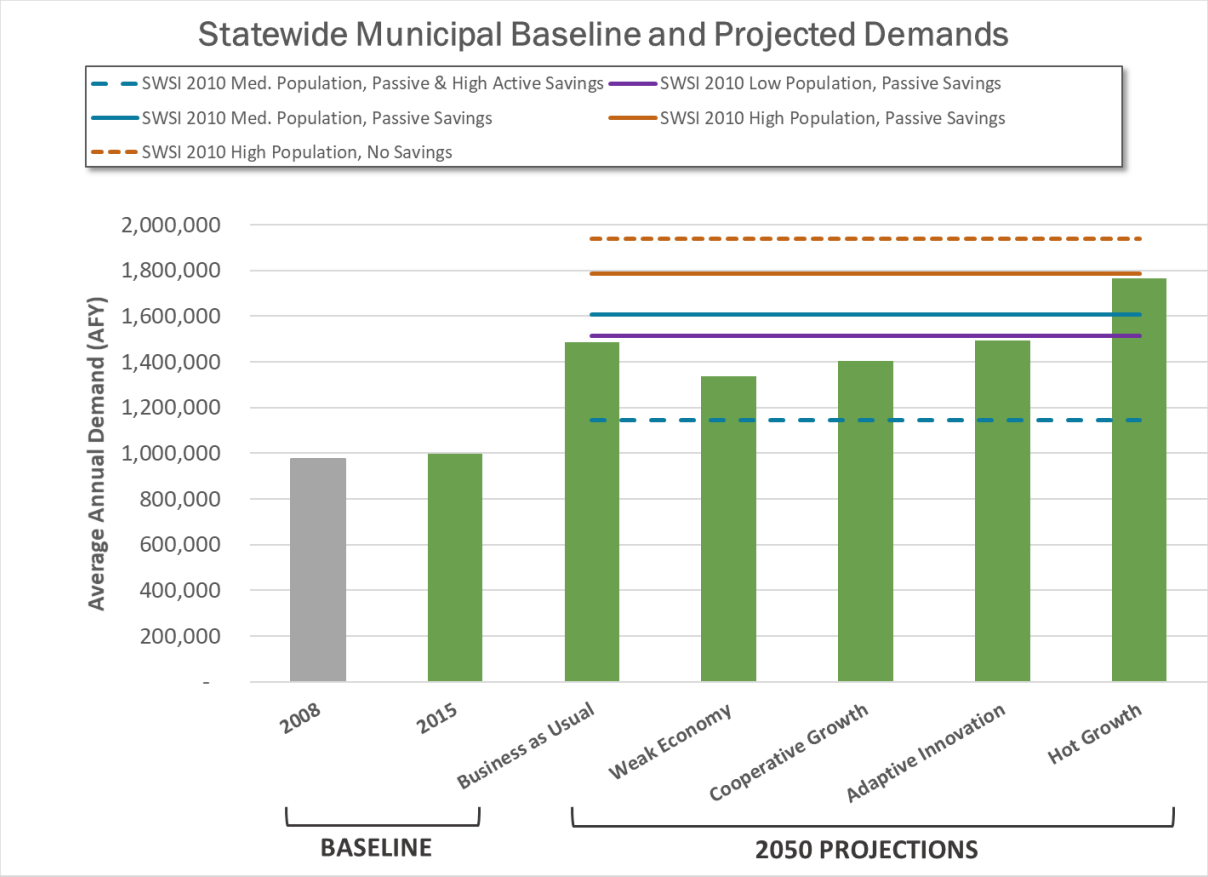

Figure 2-10: Statewide Municipal Baseline and Projected Volumetric Demands.

2.2 INDUSTRIAL

As with municipal, the updated industrial demands presented herein include both baseline demands (estimated as 2015 demands) and future demands for multiple planning scenarios (estimated as 2050 demands). These demand projections do not include drought conditions or associated responses. Industrial demands were calculated at the county level and then summarized by basin. No county-level industrial demands had to be distributed between multiple basins.

Statewide baseline industrial water demands are comprised of approximately 64% large industry, 3% snowmaking, 30% thermoelectric, and 3% energy development, as shown in Figure 2-11.

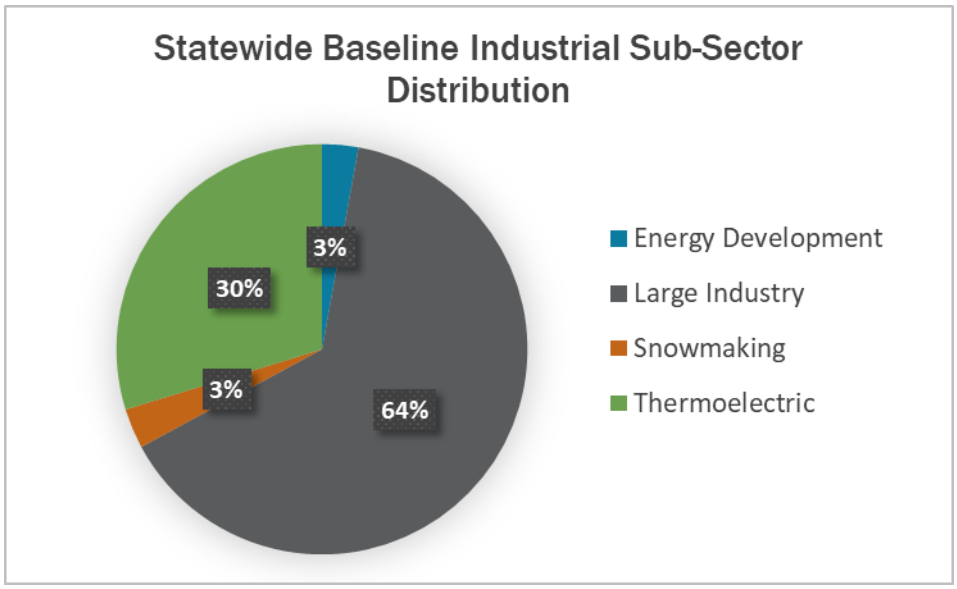

Figure 2-11: Statewide Baseline Industrial Sub-Sector Distribution.

The projected demands for all planning scenarios were compared with the SWSI 2010 projected demands for 2050. With the exception of the Hot Growth scenario, the updated demand projections for all planning scenarios were below the SWSI 2010 range, as shown on Figure 2-12. This is primarily related to changes in assumptions for thermoelectric demands. The thermoelectric baseline has decreased relative to SWSI 2010 largely due to regulations that require an increase in power generation from renewable sources, per M&I TAG participants. SWSI 2010 also assumed thermoelectric demands would increase by 5%, 25%, and 50% under Low/Medium/High scenarios, respectively; however, the TAG indicated that slightly varying demands by scenario up to +/- 10% would be more appropriate. Thermoelectric accounts for a large component of total industrial demand (Figure 2-11), therefore, the methodology changes had a relatively large effect on the results. Large industry, snowmaking, and energy development projections are generally comparable to the ranges projected in SWSI 2010.

The industrial demand projections do not match the CWP ranking listed in Table 1-3 on a statewide basis. The Business as Usual and Adaptive Innovation rankings were flipped as compared to the municipal projections. However, as with the municipal demand projections, there is little variation in the projections aside from the Hot Growth scenario.

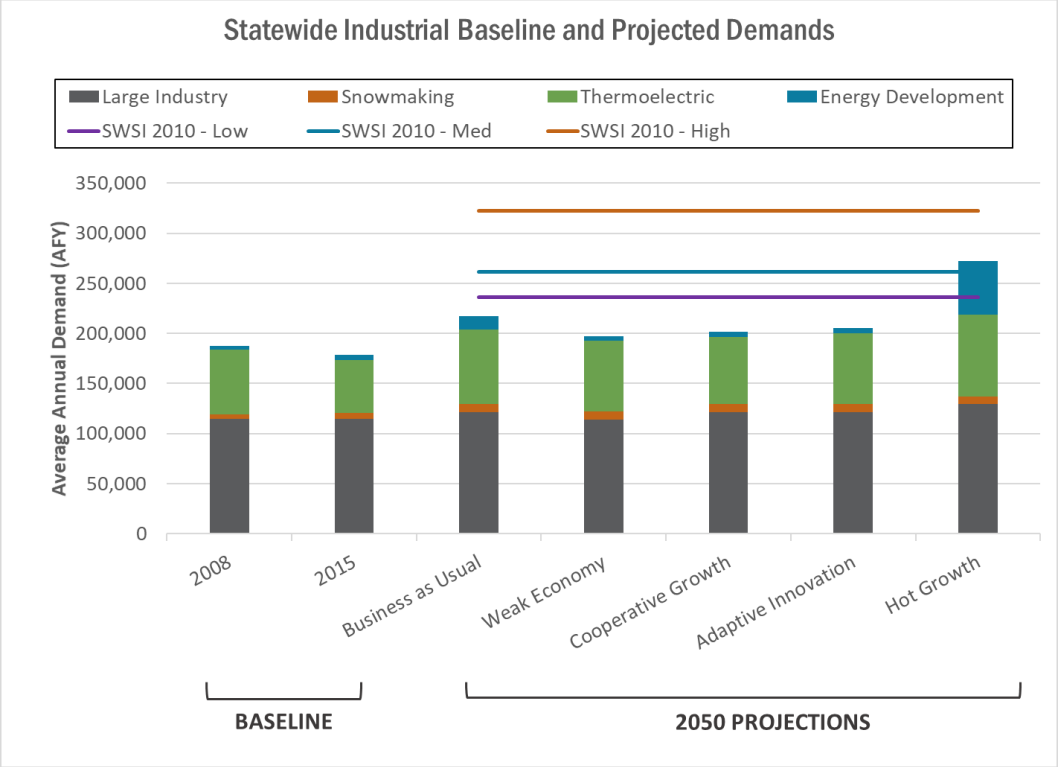

Figure 2-12: Industrial Statewide Baseline and Projected Demands.

2.3 TOTAL M&I DEMANDS

Total statewide M&I demands projected for 2050 range from approximately 1.5 million AFY (Weak Economy) to 2.0 million AFY (Hot Growth). The Hot Growth projected demands are just under the SWSI 2010 projected high demands of 2.1 million AFY, which included high growth with passive savings municipal demands combined with high industrial demand projections. The Weak Economy projected demands fall significantly under the SWSI 2010 projected low demands of 1.7 million AFY, which included low growth with passive savings municipal demands combined with low industrial demand projections[21].

Figure 2-13 Table 2-3 represent statewide municipal and industrial baseline 2015 and projected 2050 water demands for the planning scenarios. For all basins except for the Yampa, municipal demands exceed the industrial demands for every planning scenario. Statewide, industrial demands are around 15% to 18% of the municipal demands.

As discussed in Section 1.1.2, the CWP rankings were the guiding objective in the preparation of average annual statewide volumetric demands. Statewide municipal projections followed the CWP rankings; however, industrial and combined M&I demands deviated to a limited degree, with the Business as Usual demands exceeding the Adaptive Innovation demands. Preliminary municipal demands were prepared with an outdoor per capita reduction of 10%, which resulted in combined M&I demands for the Adaptive Inno-

[21] Table 4-9 Summary of M&I and SSI Demands for Each Basin and Statewide, SWSI 2010 (CWCB, 2011a).

vation scenario being ranked higher than Business as Usual and meeting the CWP ranking guideline. However, based on review of the initial results and peer review by members of the TAG, the outdoor savings factor was adjusted to -20% to better reflect the narrative guidance in the CWP and potential range of achievable future savings. The resulting statewide M&I demands for the Business as Usual and Adaptive Innovation scenarios vary by approximately 3,700 AFY (0.2%); therefore, were determined to be sufficiently representative of the CWP rankings.

These results show that the Business as Usual and Adaptive Innovation scenario futures may be similar, which indicates innovative demand management measures have the potential to significantly offset the higher population and much warmer climate in the Adaptive Innovation scenario. The potential effects of demand management are also demonstrated by comparing the Adaptive Innovation and Hot and Dry scenarios. Both use a high population, although distributed differently across counties, with Hot and Dry climate, yet the Adaptive Innovation scenario has approximately 300,000 AFY less demand.

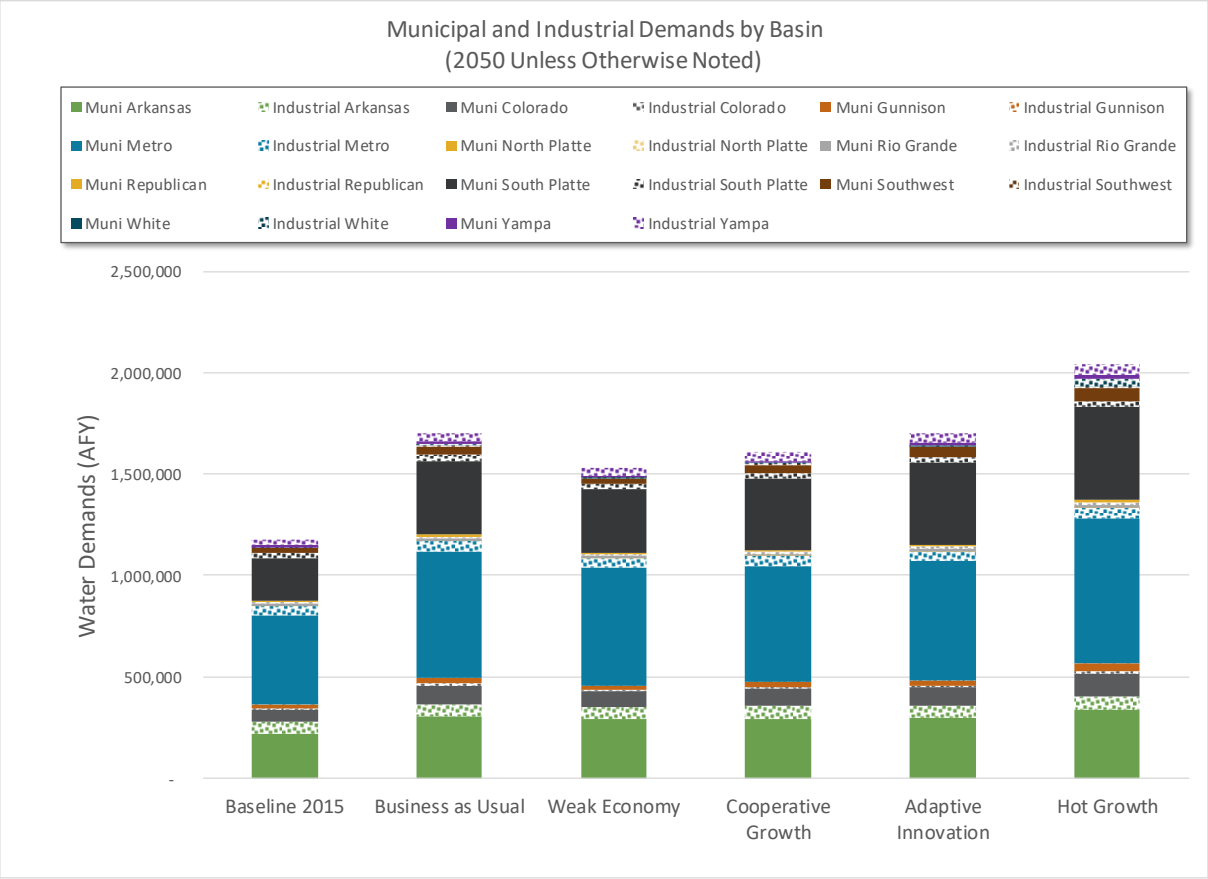

Figure 2-13. Municipal and Industrial Baseline and Projected M&I Demands by Basin.

Table 2-4: Summary of M&I Demands for Each Basin and Statewide (AFY)

Basin	Demand Type	Baseline 2015	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Arkansas	Municipal	219,208	303,352	293,842	294,540	298,095	337,222
	Industrial	58,720	61,720	56,160	60,490	61,100	67,890
	Total	277,928	365,072	350,002	355,030	359,195	405,112
Colorado	Municipal	61,790	88,589	79,886	88,984	87,534	106,578
	Industrial	7,840	12,290	7,620	7,790	7,790	18,460
	Total	69,630	100,879	87,506	96,774	95,324	125,038
Gunnison	Municipal	18,262	26,674	20,509	24,887	29,142	36,789
	Industrial	270	650	650	650	650	650
	Total	18,532	27,324	21,159	25,537	29,792	37,439
Metro	Municipal	435,745	626,501	578,969	570,151	586,176	715,885
	Industrial	48,670	48,670	48,520	48,370	48,520	48,980
	Total	484,415	675,171	627,489	618,521	634,696	764,865
North Platte	Municipal	400	351	301	328	355	441
	Industrial	-	-	-	-	-	-
	Total	400	351	301	328	355	441
Rio Grande	Municipal	10,639	11,947	9,370	11,000	12,496	15,732
	Industrial	7,860	9,860	8,960	9,860	9,860	10,760
	Total	18,499	21,807	18,330	20,860	22,356	26,492
Republi-can	Municipal	8,666	9,361	8,019	8,323	9,208	11,524
	Industrial	-	-	-	-	-	-
	Total	8,666	9,361	8,019	8,323	9,208	11,524
South Platte	Municipal	208,842	365,716	309,615	354,319	404,554	457,803
	Industrial	23,530	29,550	27,760	27,290	28,420	32,470
	Total	232,372	395,266	337,375	381,609	432,974	490,273
Southwest	Municipal	24,009	39,810	26,214	38,864	49,164	62,851
	Industrial	2,280	4,330	4,140	3,940	4,140	4,720
	Total	26,289	44,140	30,354	42,804	53,304	67,571
White	Municipal	1,845	1,980	1,203	1,875	2,737	3,405
	Industrial	1,600	5,800	3,000	3,000	3,000	37,900
	Total	1,845	7,780	4,203	4,875	5,737	41,305
Yampa	Municipal	9,324	11,552	7,580	11,418	14,471	18,511
	Industrial	28,040	44,010	40,650	39,990	41,600	50,380
	Total	38,964	55,562	48,230	51,408	56,071	68,891
Statewide	Municipal	998,730	1,485,833	1,335,508	1,404,688	1,493,931	1,766,740
	Industrial	178,810	216,880	197,460	201,380	205,080	272,210
	Total	1,177,540	1,702,713	1,532,968	1,606,068	1,699,011	2,038,950

Section 3: Basin M&I Results

The Technical Update M&I results in the following sections are summarized by river or planning (Southwest and Metro) basin. Figure 3-1 depicts the counties located within each basin. Note that some counties are located in multiple basins.

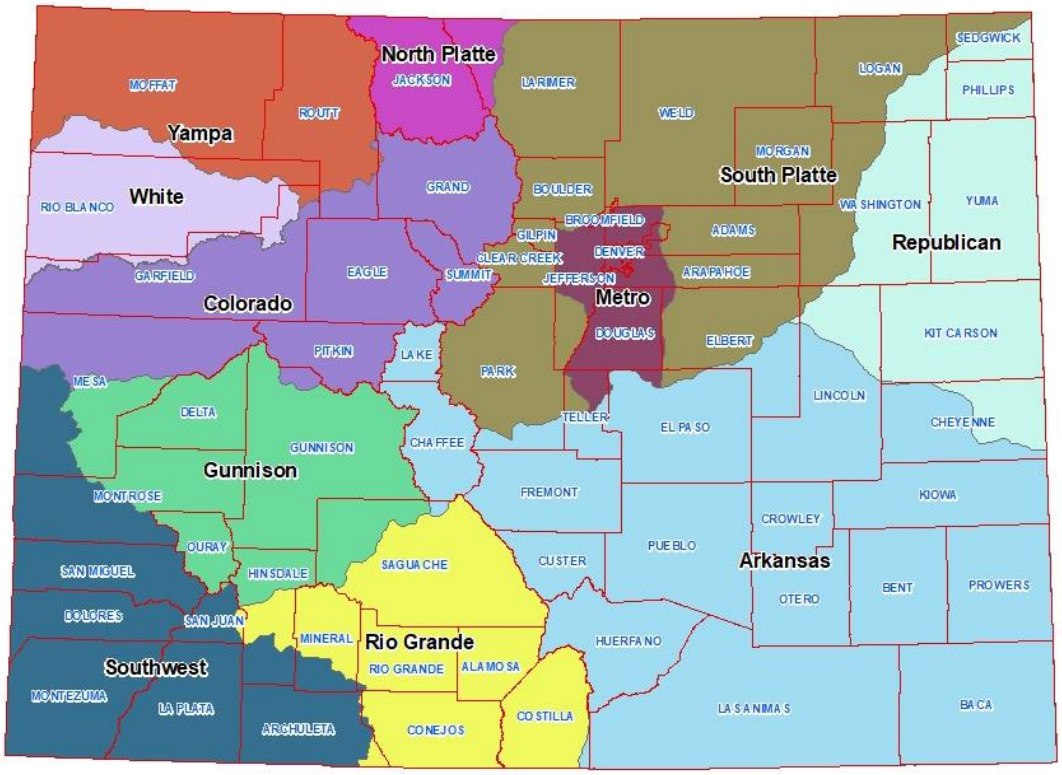

Figure 3-1: Colorado County and Basin Boundaries

3.1 ARKANSAS BASIN

3.1.1 MUNICIPAL

3.1.1.1 POPULATION

The Arkansas Basin currently includes about 19% of the statewide population. Between the years 2015 and 2050, it is projected to grow from approximately 1.0 million to between 1.46 million and 1.63 million people in the low and high growth scenarios, respectively. Using the specific numbers, this is an increase in population of 45% to 61%.

Table 3-1 shows how population growth is projected to vary across counties under each planning scenario. While the basin as a whole is projected to increase in population under all scenarios, 7 of the 18 counties are projected to decrease under all scenarios. The two most populous counties, El Paso County followed by Pueblo County, are projected to account for most of the growth and remain the largest popu-

lation centers in the basin. Elbert County, which currently has about 1% of the basin population, is projected to have the highest growth rate for an individual county, ranging from about 154% to 179% increase in the low and high growth scenarios, respectively. Even with this large percentage increase, Elbert County is still projected to account for only about 1% of the future total basin population. Note that Cheyenne, Elbert, Lincoln, and Teller Counties are split between multiple basins, with the county demands prorated between basins based on the population located within each basin. This approach is consistent with prior SWSI analyses.

Table 3-1: Arkansas Basin 2015 Baseline and 2050 Projected Populations by County.

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Baca	3,594	2,949	2,858	2,790	2,868	3,063
Bent	5,847	6,607	6,403	6,252	6,426	6,863
Chaffee	18,603	27,145	26,306	25,686	26,403	28,197
Cheyenne*	686	615	596	582	599	639
Crowley	5,569	7,754	7,514	7,337	7,542	8,055
Custer	4,457	5,934	5,751	5,615	5,772	6,164
El Paso	676,178	1,076,486	1,043,223	1,116,517	1,177,637	1,118,209
Elbert*	7,634	20,526	19,891	19,422	19,964	21,321
Fremont	46,659	56,406	54,663	53,373	54,864	58,592
Huerfano	6,456	5,983	5,798	5,661	5,819	6,215
Kiowa	1,396	1,193	1,156	1,129	1,160	1,239
Lake	7,502	9,868	9,563	9,337	9,598	10,250
Las Animas	14,061	13,249	12,840	12,537	12,887	13,763
Lincoln*	4,485	6,857	6,645	6,488	6,669	7,123
Otero	18,265	15,302	14,829	14,479	14,884	15,895
Prowers	11,905	11,441	11,087	10,826	11,128	11,884
Pueblo	163,196	224,184	217,257	230,283	245,249	232,873
Teller*	11,941	16,964	16,440	16,052	16,501	17,622
Basin Total	1,008,434	1,509,463	1,462,821	1,544,367	1,625,970	1,567,968

*Counties with population located in multiple basins. This table represents the portion of the county located in the Arkansas Basin.

The Arkansas Basin baseline for the Technical Update, which is based on 2015 population, is approximately 6% higher than the SWSI 2010 baseline, which used 2008 population. The SWSI 2010 medium growth population projection for 2050 exceeded the Technical Update population projections for all planning scenarios by between about 4% and 15%. High growth in the Technical Update Adaptive Innovation is the only population projected to exceed the SWSI 2010 low growth projection. A comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-2.

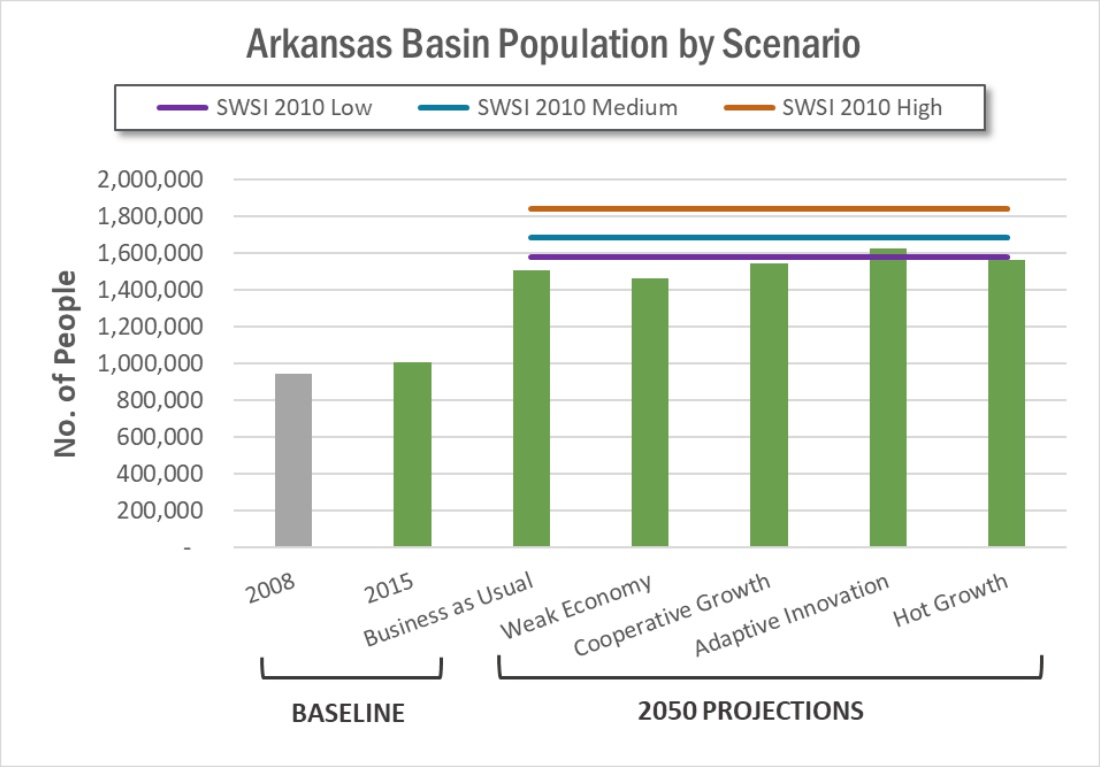

Figure 3-2: Arkansas Basin Baseline and Projected Population.

3.1.1.2 WATER DEMANDS

The Arkansas Basin baseline water demands were largely based on water provider-reported data, with approximately 67% of the baseline population demands represented by 1051 data, 8% from WEPs, and 4% from water provider outreach, requiring demands for about 21% of the basin's baseline population to be estimated, as shown in Figure 3-3.

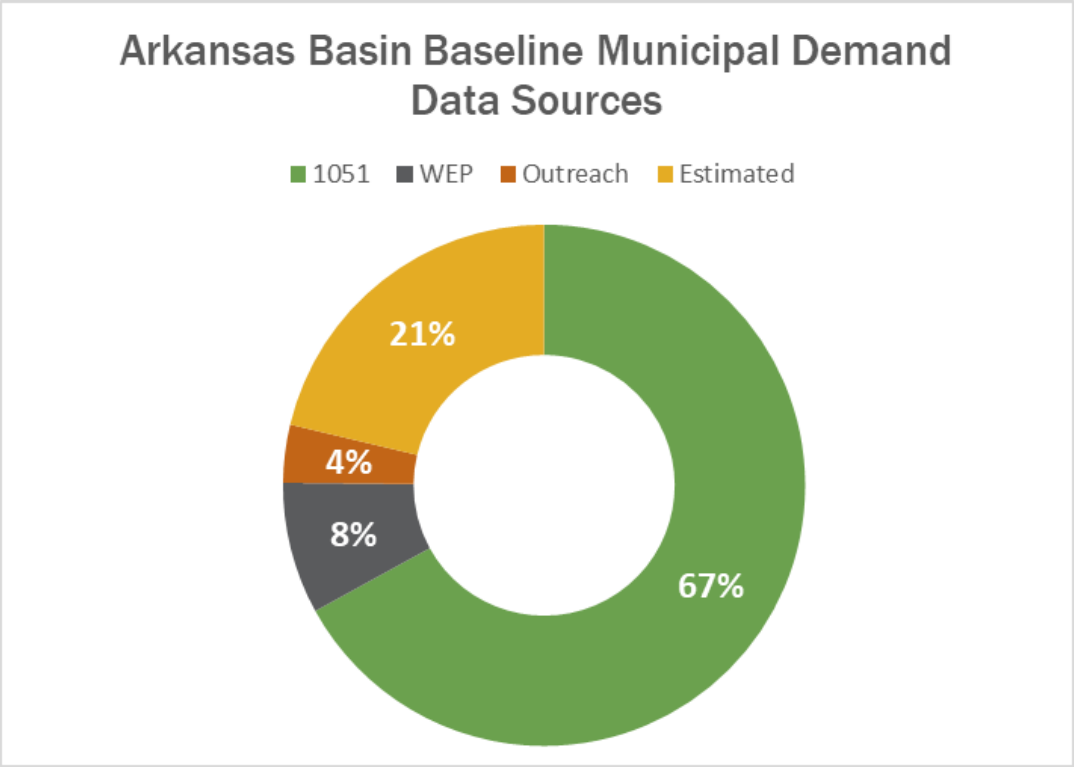

Figure 3-3: Arkansas Basin Baseline Municipal Water Demand Data Sources.

The Arkansas Basin average baseline per capita systemwide demand has increased from 185 gpcd in SWSI 2010 to approximately 194 gpcd. There are more significant differences from SWSI 2010 at a county level. The differences are largely attributable to updated data, with a significant portion of the basin represented by 1051 reporting and updated WEPs. Some counties include a significant amount of raw and reuse water supplies reported for the Technical Update, which may not have been quantified and included in the SWSI 2010 water use data. Table 3-2 represents baseline and projected per capita demands for counties within the basin.

Table 3-2: Arkansas Basin Municipal Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Technical Update Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Baca	329	296	279	286	272	259	294
Bent	113	198	189	190	183	175	202
Chaffee	297	167	163	162	156	150	175
Cheyenne*	183	222	216	218	207	199	229
Crowley	141	208	196	197	188	180	210
Custer	226	167	163	163	156	150	175
El Paso	172	147	138	137	129	124	148
Elbert*	111	137	138	135	128	124	149
Fremont	219	152	151	151	146	140	162
Huerfano	155	204	197	199	191	183	209
Kiowa	325	436	401	414	391	370	421
Lake	183	174	169	169	162	156	181
Las Animas	221	227	216	219	210	201	230
Lincoln*	254	238	222	222	211	203	238
Otero	185	216	208	211	203	194	220
Prowers	232	236	225	228	219	210	240
Pueblo	206	397	383	387	370	356	407
Teller*	173	163	159	159	152	146	171
Basin Total	185	194	179	179	170	164	192

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

**Counties with population located in multiple basins. Per capita demand is calculated at a county level.*

The Arkansas Basin baseline municipal water demands are comprised of approximately 51% indoor, 31% outdoor, and 18% non-revenue water uses, as shown in Figure 3-4. With nearly 80% of the population represented through 1051, WEPs, and water provider outreach, the basin average demand category distribution was well informed. Still, only 6 of the 18 counties had sufficient demand category data available to apply a county-specific distribution. The basin average demand category distribution was used for the remaining counties. On a basin scale, the residential outdoor demand as a percentage of the systemwide demands is one of the lowest reported throughout the state, at approximately 17%. Conversely, the baseline non-revenue water demand is one of the highest statewide, at approximately 18% of the systemwide demands.

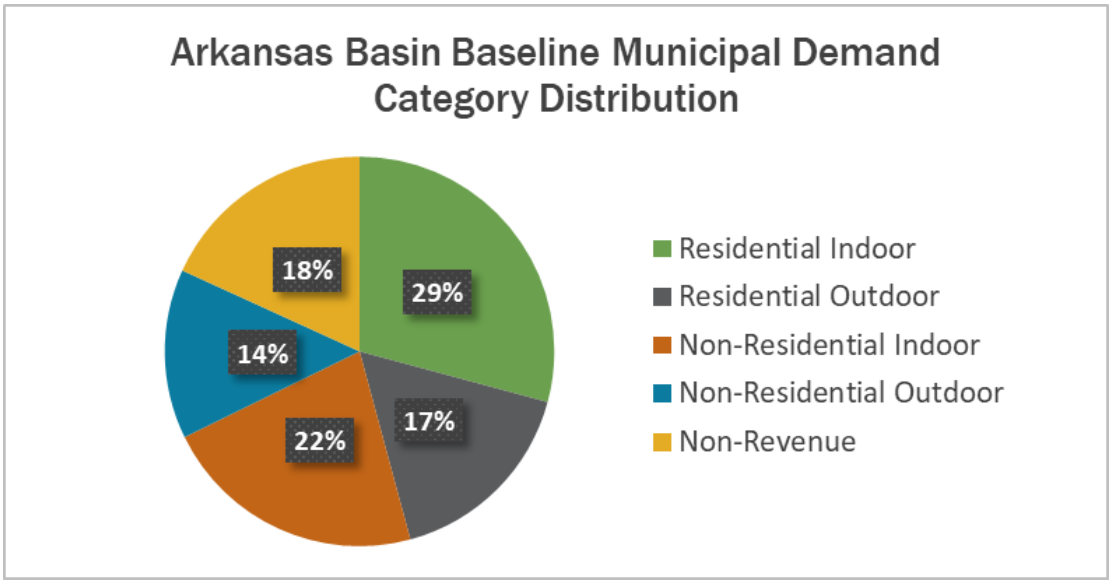

Figure 3-4: Arkansas Basin Baseline Municipal Demand Category Distribution.

Figure 3-5 provides a summary of per capita baseline and projected water demands for the Arkansas Basin. Systemwide, all of the projected per capita demands decrease relative to the baseline. The Hot Growth scenario is nearly as high as the baseline, with lower residential indoor but higher residential and non-residential outdoor demands that are significantly influenced by the climate driver. Consistently across all scenarios, residential indoor demand is the greatest individual demand category while non-residential outdoor is the lowest. Aside from the Hot Growth scenario, there is minimal variation in outdoor demands between scenarios. This is due to the scenario pairing of water demand reductions and climate drivers, particularly for the Adaptive Innovation scenario which has high outdoor reductions coupled with the "Hot and Dry" climate. Outdoor demands increased significantly for the Hot Growth scenario, largely due to the influence of the "Hot and Dry" climate.

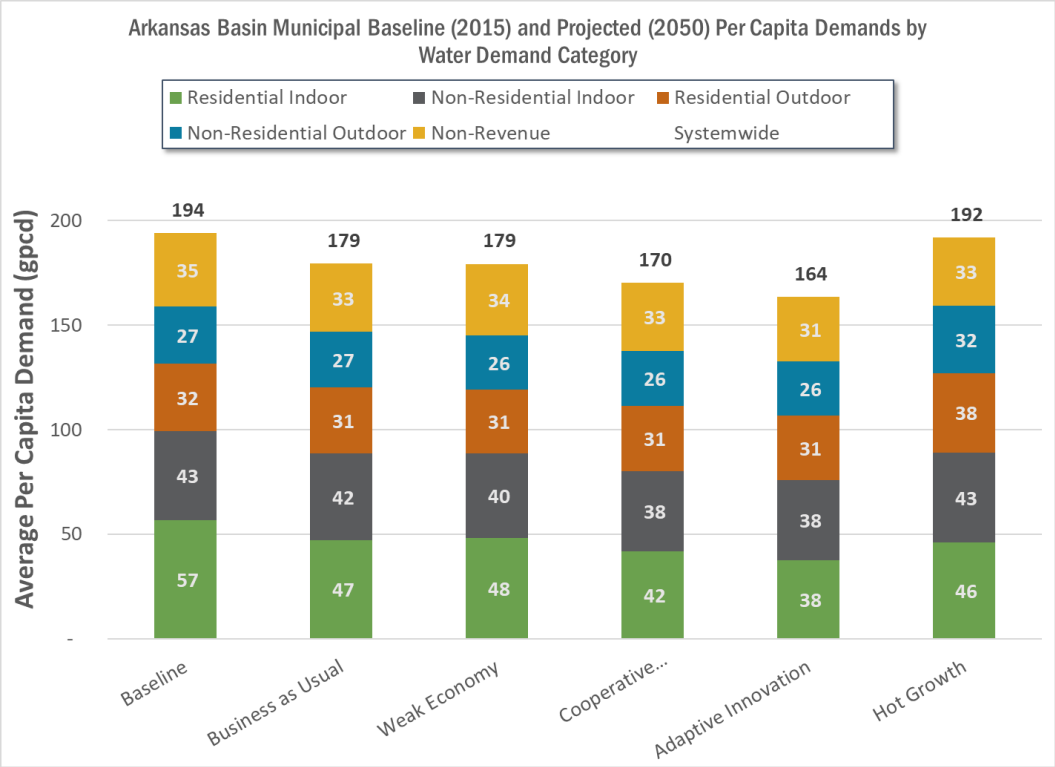

Figure 3-5: Arkansas Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-6 demonstrates the influence of the climate driver on per capita water demands, with outdoor demands increasing by 6 to 10 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 156 to 182 gpcd, which exceed the SWSI 2010 projection of 132 gpcd for medium population with active conservation[22]. This is partly due to the Technical Update baseline per capita demand exceeding the SWSI 2010 baseline.

[22] SWSI 2010 projected per capita demands include savings from passive conservation.

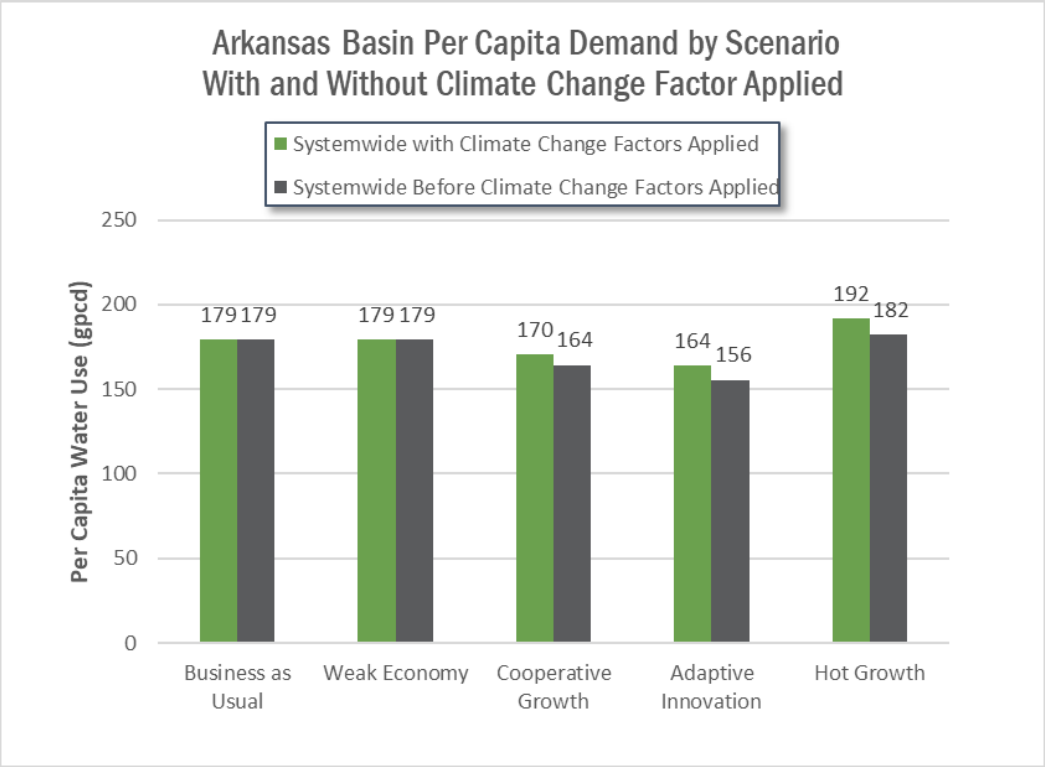

Figure 3-6: Effect of Climate Change Driver on the Arkansas Basin Average Per Capita Demand.

The Arkansas Basin municipal baseline and projected volumetric demands are provided in Table 3-3, showing the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 219,000 AFY in 2015 to between 294,000 and 337,000 AFY in 2050. El Paso County accounts for around half of the baseline demand followed by Pueblo County at about one-third of the basin demand.

Table 3-3: Arkansas Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Baca	1,192	921	916	852	831	1,008
Bent	1,295	1,400	1,365	1,280	1,262	1,556
Chaffee	3,473	4,945	4,778	4,476	4,425	5,525
Cheyenne*	171	149	135	135	143	176
Crowley	1,296	1,703	1,654	1,546	1,525	1,899
Custer	832	1,082	1,047	983	971	1,208
El Paso	111,144	166,041	159,910	161,662	163,337	185,392
Elbert*	1,176	3,172	2,945	2,790	2,815	3,627
Fremont	7,962	9,553	9,236	8,705	8,614	10,662
Huerfano	1,478	1,317	1,291	1,214	1,194	1,456
Kiowa	682	536	536	494	481	584
Lake	1,461	1,865	1,807	1,695	1,674	2,081
Las Animas	3,578	3,206	3,151	2,951	2,898	3,539
Lincoln*	1,197	1,704	1,614	1,533	1,548	1,942
Otero	4,421	3,562	3,509	3,297	3,237	3,924
Prowers	3,151	2,888	2,833	2,660	2,616	3,198
Pueblo	72,522	96,277	94,074	95,539	97,912	106,171
Teller*	2,177	3,029	2,758	2,730	2,849	3,573
Basin Total	219,208	303,352	293,842	294,540	298,095	337,222

**Counties with population located in multiple basins. This table represents systemwide demands for the portion of the county located in the Arkansas Basin.*

The baseline and projected demands shown in Table 3-4 and Figure 3-7 also illustrate how the population varies between the scenarios. All of the projection scenarios result in an increase relative to the baseline. Except for Hot Growth, the systemwide demand projections are similar, demonstrating how the pairing of drivers and population can offset each other and even out the results.

Table 3-4: Arkansas Basin Municipal Baseline and Projected Volumetric Demands by Demand Category (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	System-wide
Baseline (2015)	63,980	48,134	36,404	30,847	39,843	219,208
Business as Usual	79,733	70,173	53,107	45,040	55,298	303,352
Weak Economy	79,065	65,995	49,933	42,343	56,224	293,560
Cooperative Growth	72,114	66,542	53,898	45,641	56,344	294,540
Adaptive Innovation	68,613	69,676	56,004	47,382	56,658	298,333
Hot Growth	80,964	75,634	66,791	56,648	57,484	337,522

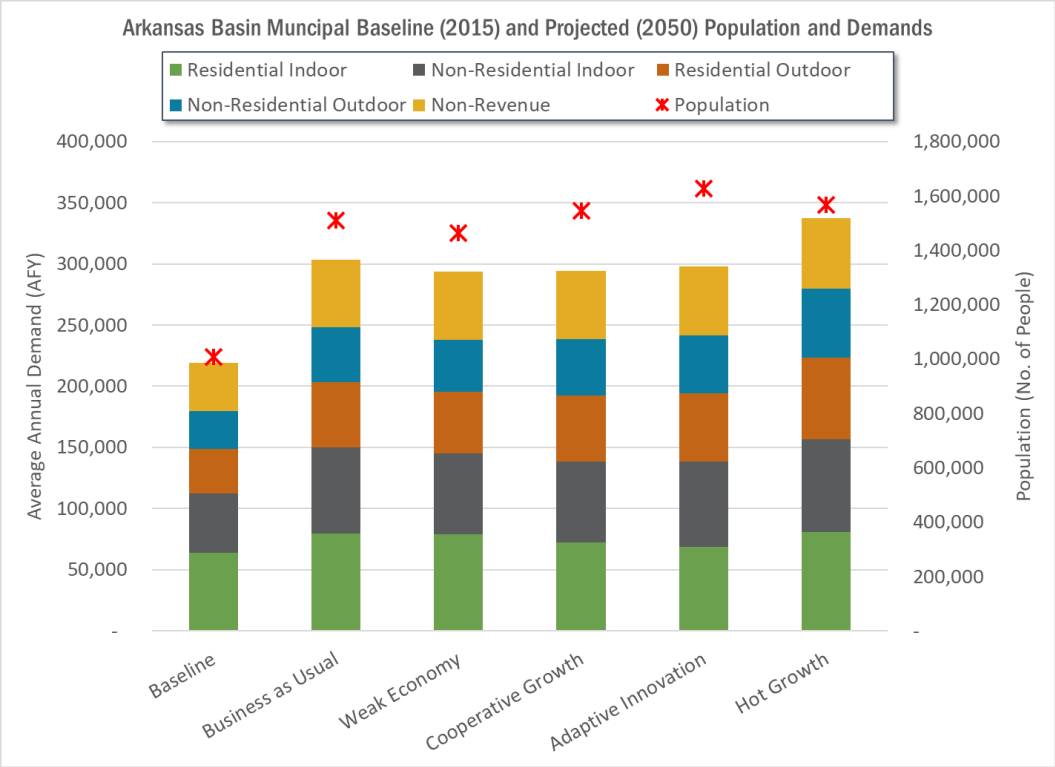

Figure 3-7: Arkansas Basin Baseline and Projected Population and Municipal Demands.

3.1.2 INDUSTRIAL

The Arkansas Basin currently includes about 33% of the statewide industrial demand. Industrial demands in this basin are associated with the Large Industry and Thermoelectric sub-sectors, with no demands projected for Snowmaking or Energy Development sub-sectors. Basin-scale industrial demands are shown on Figure 3-8 and county-scale industrial demands are summarized in Table 3-5.

Large Industry demands are related to steel manufacturing in Pueblo County and were based on the data provided in the BIP. The baseline demand has decreased from 49,400 AFY in SWSI 2010 to 46,400 AFY. Projected 2050 Large Industry demands range from 44,460 AFY to 54,340 AFY.

Thermoelectric demands are related to one facility located in Pueblo County and were based on information from Xcel Energy. The baseline demand has increased from 9,000 AFY in SWSI 2010 to 12,320 AFY. Projected 2050 Thermoelectric demands range from 11,090 AFY to 13,550 AFY.

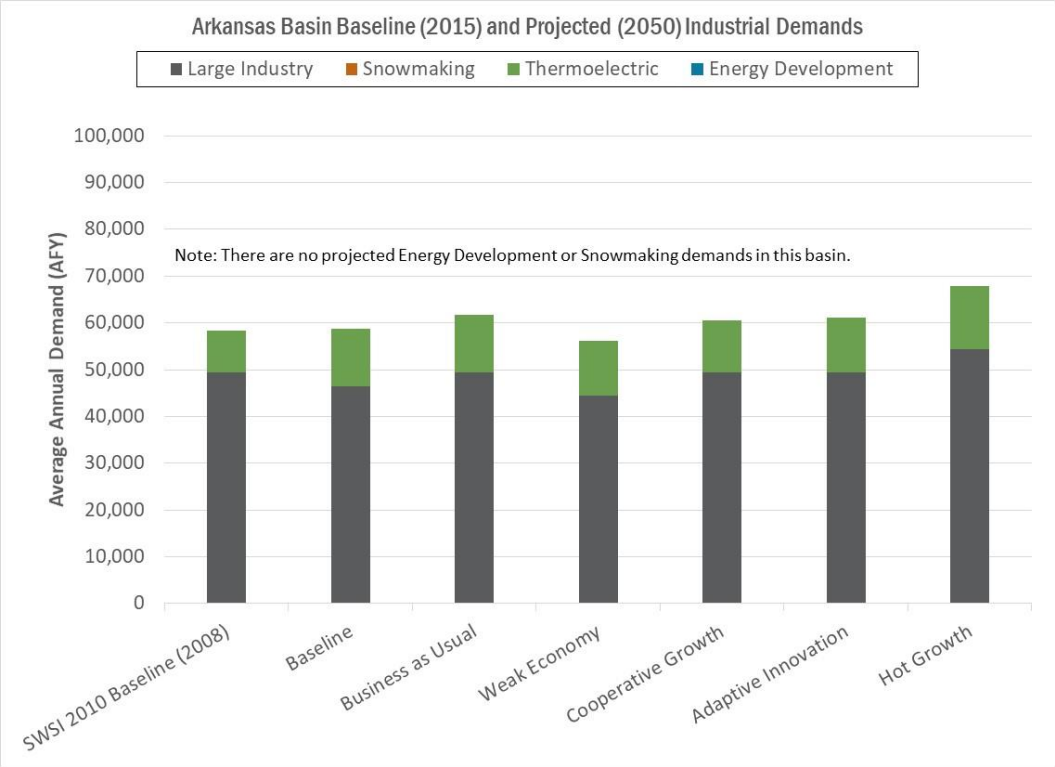

Figure 3-8: Arkansas Basin Industrial Baseline and Projected Demands.

Table 3-5: Arkansas Basin Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Pueblo	Large Industry	46,400	49,400	44,460	49,400	49,400	54,340
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	12,320	12,320	11,700	11,090	11,700	13,550
	Energy Development	-	-	-	-	-	-
Basin Total		58,720	61,720	56,160	60,490	61,100	67,890

3.1.3 TOTAL

Arkansas Basin combined M&I demand projections for 2050 range from approximately 350,000 AFY in the Weak Economy scenario to 405,000 AFY in the Hot Growth scenario, as shown in Figure 3-9. Industrial demands account for 16% to 17% of the projected M&I demands. On a basin scale, the total M&I demand projections do not follow the statewide sequence of the scenario rankings described in the CWP, with the Adaptive Innovation scenario falling out of sequence.

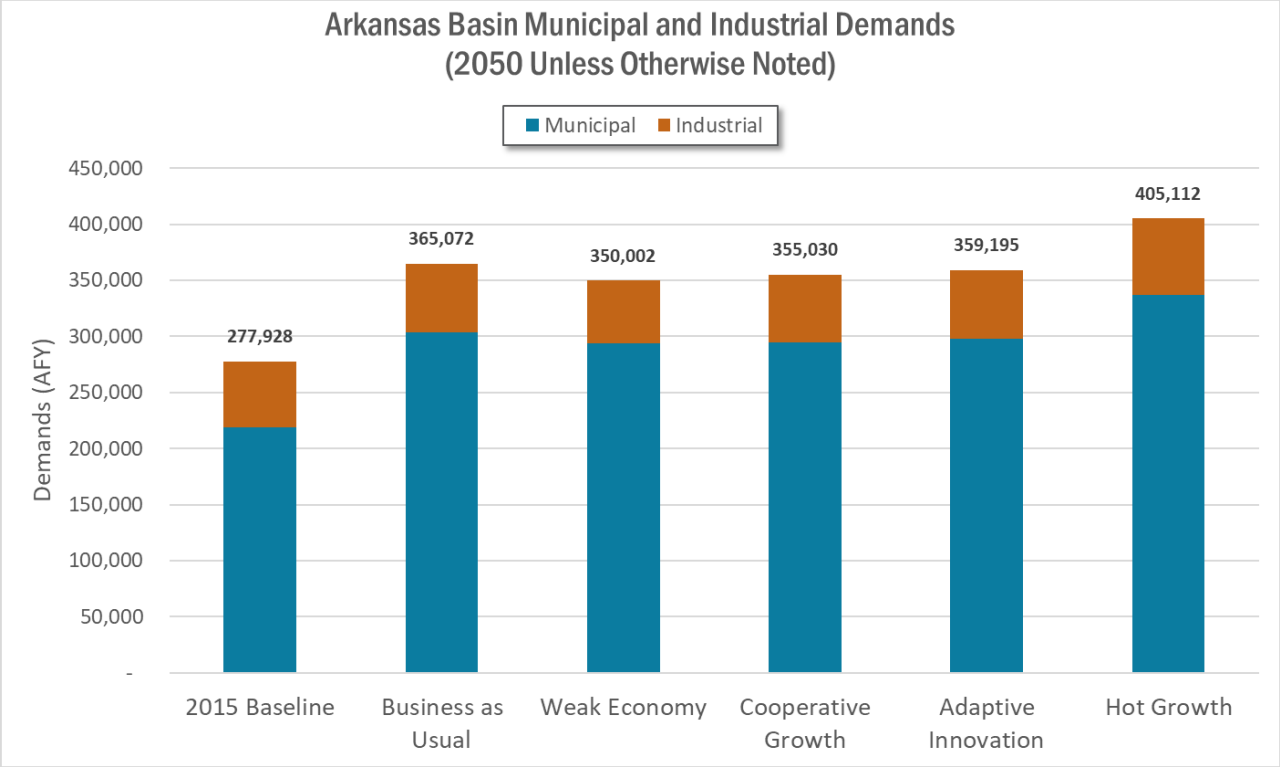

Figure 3-9: Arkansas Basin Baseline and Projected M&I Demands.

3.2 COLORADO BASIN

3.2.1 MUNICIPAL

3.2.1.1 POPULATION

The Colorado Basin currently includes about 6% of the statewide population. Between the years 2015 and 2050, it is projected to grow from approximately 310,000 to between 460,000 and 580,000 people in the low and high growth scenarios, respectively. Using the specific numbers, this is an increase in population of 48% to 88%.

Table 3-6 shows how population growth is projected to vary across counties under each planning scenario. All counties are projected to increase in population under all scenarios. Mesa County is the most populous and is projected to account for a substantial portion of the basin growth, followed by Garfield and Eagle Counties. Grand County is projected to have the highest growth rate for an individual county, ranging from about 66% to 110% increase in the low and high growth scenarios, respectively. Pitkin County has the lowest growth projection, estimated at 46% in the high growth scenario. Note that Mesa County is split between multiple basins, with the county demands pro-rated between basins based on the population located within each basin. This approach is consistent with prior SWSI analyses.

Table 3-6: Colorado Basin 2015 Baseline and 2050 Projected Populations by County.

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Eagle	53,320	94,459	83,620	102,687	99,147	105,885
Garfield	57,779	105,711	93,581	115,297	110,957	118,498
Grand	14,602	27,406	24,261	29,967	28,766	30,721
Mesa*	134,096	212,859	188,433	220,735	255,228	238,608
Pitkin	17,845	23,209	20,546	24,282	24,361	26,017
Summit	29,928	51,828	45,881	56,208	54,400	58,097
Basin Total	307,570	515,472	456,321	549,176	572,860	577,827

**Counties with population located in multiple basins. This table represents the portion of the county located in the Colorado Basin.*

The Colorado Basin baseline for the Technical Update, which is based on 2015 population, is approximately the same as the SWSI 2010 baseline, which used 2008 population. All SWSI 2010 projections for 2050 exceeded the Technical Update population projections for all planning scenarios by at least 14%. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-10.

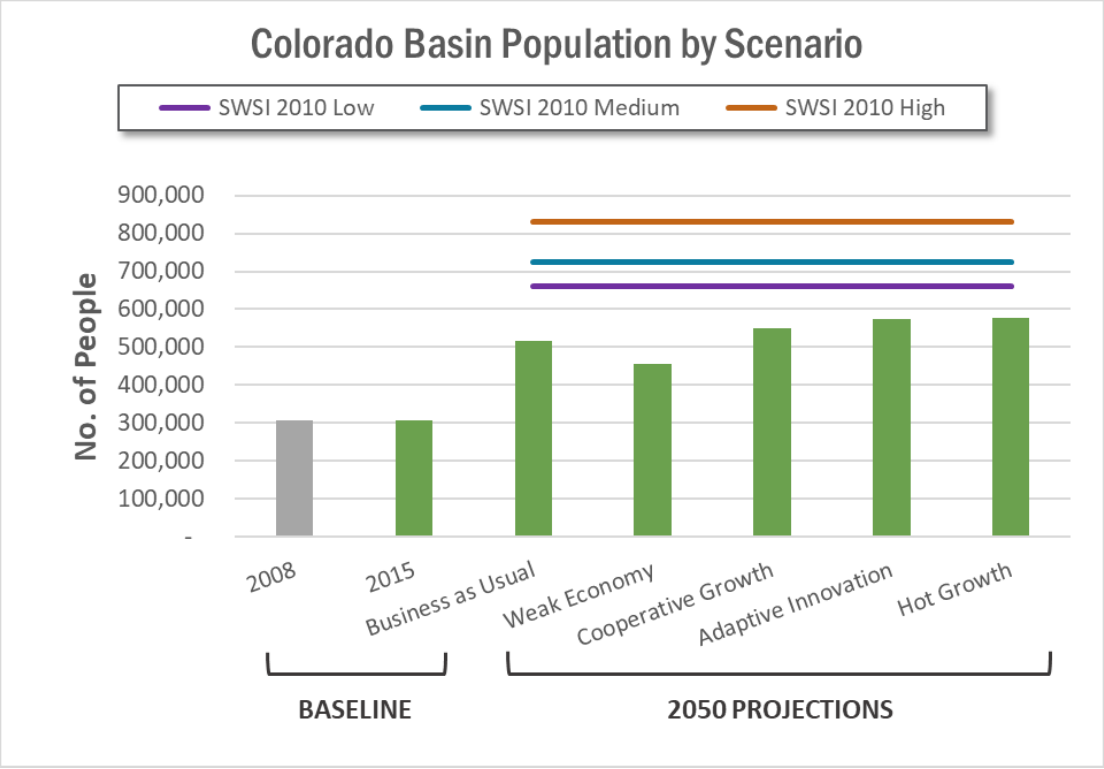

Figure 3-10: Colorado Basin Baseline and Projected Population.

3.2.1.2 WATER DEMANDS

The Colorado Basin baseline water demands were largely based on water provider-reported data, with approximately 43% of the baseline population demands represented by WEPs, 25% from 1051 data, and

9% from BIPs, requiring demands for about 23% of the basin's baseline population demands to be estimated, as shown in Figure 3-11.

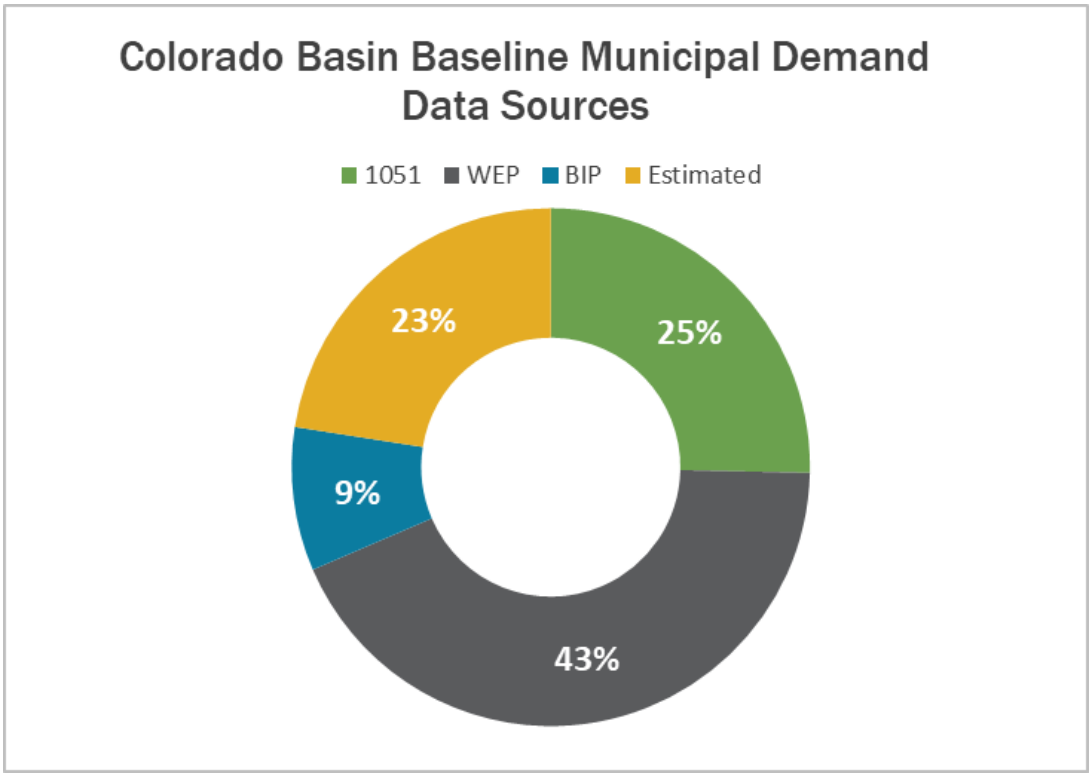

Figure 3-11: Colorado Basin Baseline Municipal Water Demand Data Sources.

The Colorado Basin average baseline per capita systemwide demand has decreased slightly from 182 gpcd in SWSI 2010 to approximately 179 gpcd. While the basin average per capita demand changed very little, there are more significant differences from SWSI 2010 at a county level. Demands associated with tourism and non-permanent population are significant for some areas of the basin, which must be considered when using per capita water demand data. Table 3-7 represents baseline and projected per capita demands for counties within the basin.

Table 3-7: Colorado Basin Municipal Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Technical Update Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Eagle	209	175	150	153	140	135	158
Garfield	198	218	182	186	171	164	194
Grand	250	300	228	237	213	204	241
Mesa*	127	115	112	111	106	102	124
Pitkin	284	392	337	348	322	311	364
Summit	246	215	152	160	138	130	154
Basin Total	182	179	153	156	145	136	165

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

**Counties with population located in multiple basins. Per capita demand is calculated at a county level.*

The Colorado Basin baseline municipal water demands are comprised of approximately 57% indoor, 29% outdoor, and 14% non-revenue water uses, as shown in Figure 3-12. The basin average demand category distribution was used for Grand County, due to insufficient demand category data, and all other counties had sufficient demand category data available to apply a county-specific distribution. On a basin scale, the residential indoor demand as a percentage of the systemwide demands is the highest reported throughout the state, at approximately 44% of the systemwide demands. Conversely, the baseline outdoor demands are the lowest percentages statewide.

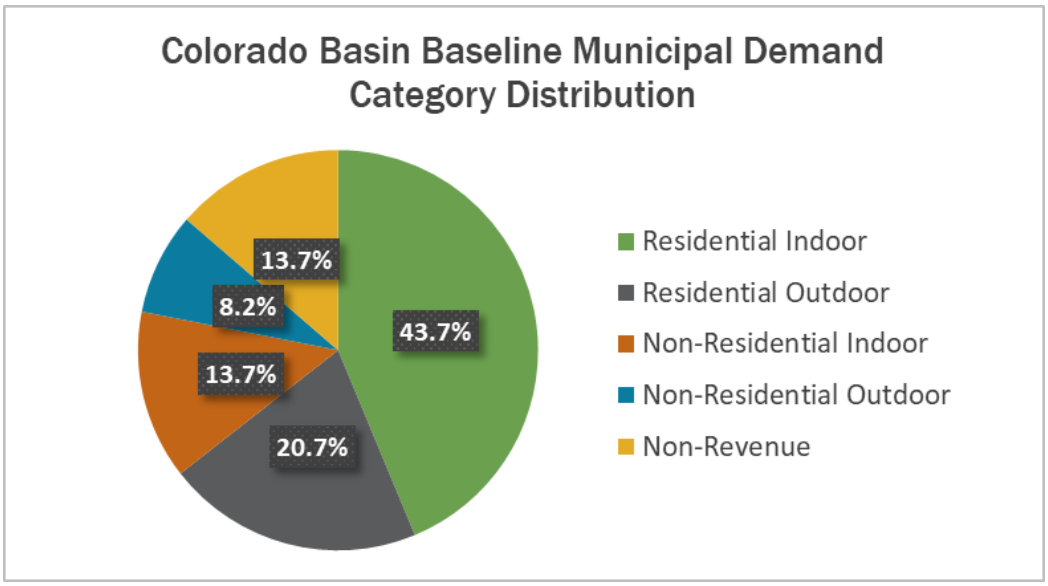

Figure 3-12: Colorado Basin Baseline Municipal Demand Category Distribution.

Figure 3-13 provides a summary of per capita baseline and projected water demands for the Colorado Basin. Systemwide, all of the projected per capita demands decrease relative to the baseline. Consistently across all scenarios, residential indoor demand is the greatest individual demand category while non-residential outdoor is the lowest. Aside from the Hot Growth scenario, there is minimal variation in outdoor demands between scenarios. This is due to the scenario pairing of water demand reductions and climate drivers, particularly for the Adaptive Innovation scenario which has high outdoor reductions coupled with

the “Hot and Dry” climate. Outdoor demands increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the “Hot and Dry” climate.

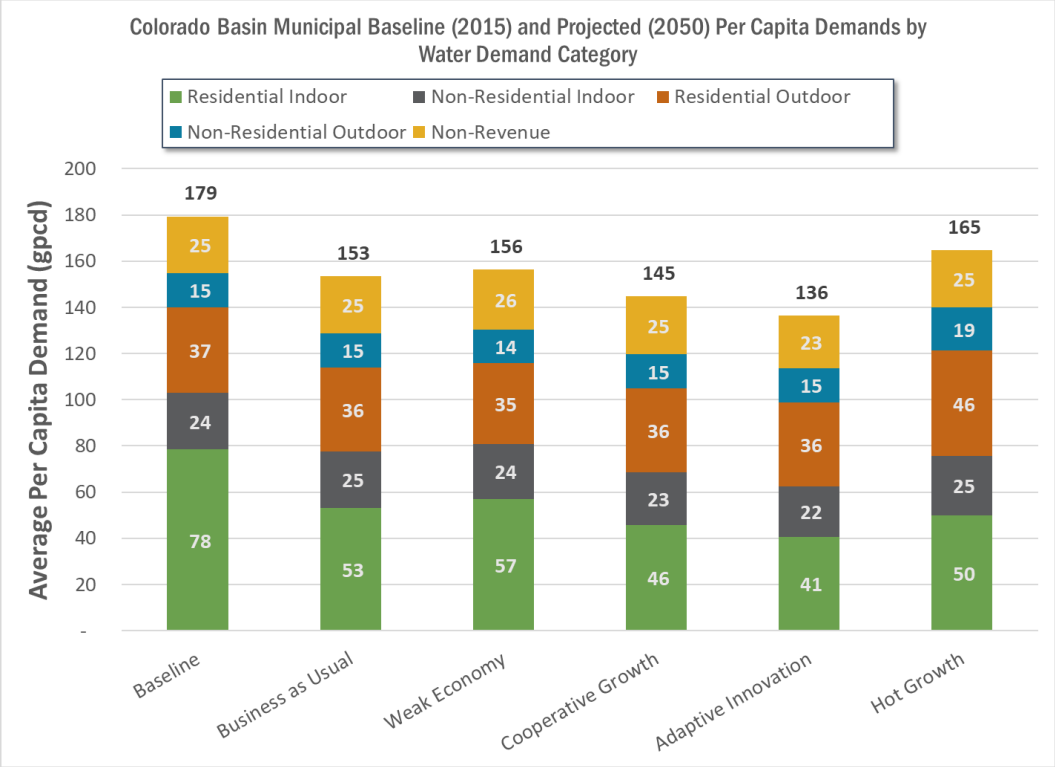

Figure 3-13: Colorado Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-14 demonstrates the influence of the climate driver on per capita water demands, with outdoor demands increasing by 6 to 12 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 127 to 156 gpcd, as compared to the SWSI 2010 projection of 131 gpcd for medium population with active conservation[23].

[23] SWSI 2010 projected per capita demands include savings from passive conservation.

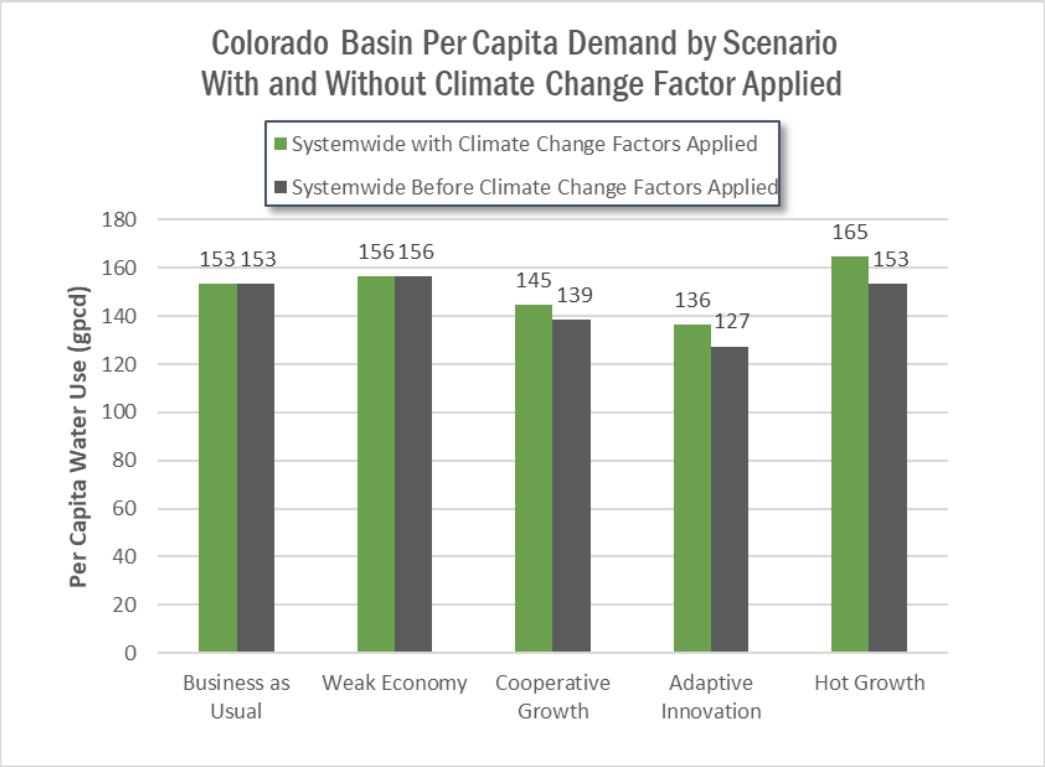

Figure 3-14: Effect of Climate Change Driver on the Colorado Basin Average Per Capita Demand.

The Colorado Basin municipal baseline and projected volumetric demands are provided in Table 3-8, showing the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 62,000 AFY in 2015 to between 80,000 and 107,000 AFY in 2050. Mesa County accounts for about 28% of the baseline demand followed by Garfield County at about 23% of the basin demand.

Table 3-8: Colorado Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Eagle	10,449	15,846	14,327	16,147	14,953	18,799
Garfield	14,141	21,530	19,476	22,036	20,417	25,779
Grand	4,915	7,006	6,430	7,144	6,572	8,280
Mesa*	17,242	26,641	23,436	26,230	29,207	33,070
Pitkin	7,829	8,761	8,006	8,761	8,474	10,606
Summit	7,215	8,806	8,212	8,665	7,912	10,044
Basin Total	61,790	88,589	79,886	88,984	87,534	106,578

**Counties with population located in multiple basins. This table represents systemwide demands for the portion of the county located in the Colorado Basin.*

The baseline and projected demand distributions are shown in Table 3-9 and Figure 3-15 also shows how the population varies between the scenarios. All of the projection scenarios result in an increase relative to the baseline. Except for Hot Growth, the systemwide demand projections for all of the Colorado Basin

scenarios are similar, demonstrating how the pairing of drivers and population can offset each other and even out the results.

Table 3-9: Colorado Basin Municipal Baseline and Projected Volumetric Demands by Demand Category (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	System wide
Baseline (2015)	27,021	8,439	12,796	5,090	8,445	61,790
Business as Usual	30,688	14,151	20,907	8,553	14,290	88,589
Weak Economy	29,134	12,155	17,968	7,347	13,283	79,886
Cooperative Growth	28,184	13,992	22,290	9,137	15,382	88,984
Adaptive Innovation	26,025	14,064	23,358	9,543	14,545	87,534
Hot Growth	32,405	16,487	29,567	12,099	16,018	106,578

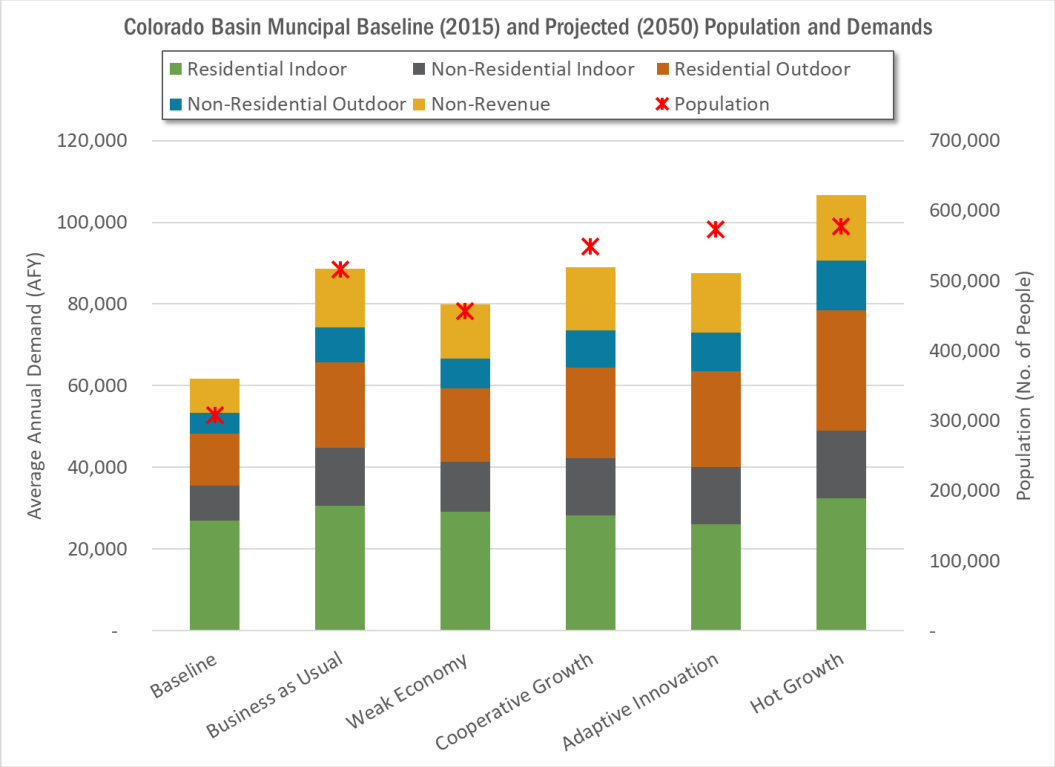

Figure 3-15: Colorado Basin Baseline and Projected Population and Municipal Demands.

3.2.2 INDUSTRIAL

The Colorado Basin currently includes about 4% of the statewide industrial demand. Industrial demands in this basin are associated with the Large Industry, Snowmaking, and Energy Development sub-sectors, with no demands projected for the Thermoelectric sub-sector. Basin-scale industrial demands are shown on Figure 3-16 and county-scale industrial demands are summarized in Table 3-10.

Large Industry demands are related to a mining facility in Grand County. This facility was not represented in SWSI 2010 and was added to the Technical Update because it is an explicitly-modeled location in an existing hydrologic model. The baseline demand of 1,700 AFY was based on data from the hydrologic model. Projected Large Industry demands range from 1,530 AFY to 1,870 AFY.

The baseline Snowmaking demand is 4,340 AFY as compared to 3,180 AFY in SWSI 2010. Snowmaking occurs in the following counties: Eagle, Garfield, Grand, Mesa, Pitkin, and Summit. Projected demands increase to 5,890 under all scenarios.

Energy Development demands are located in Garfield and Mesa counties. The baseline Energy Development demand in the Colorado Basin is 1,800 AFY as compared to 2,300 AFY in SWSI 2010. SWSI 2010 indicated that demands related to natural gas generation were shifted from Garfield County to Rio Blanco County (White Basin), which caused 2050 demands in the Colorado Basin to be less than in 2008. SWSI 2010 also showed no Energy Development demands in Mesa County in 2035 or under the "low" projection for 2050. Projected demands range from 200 AFY to 10,700 AFY.

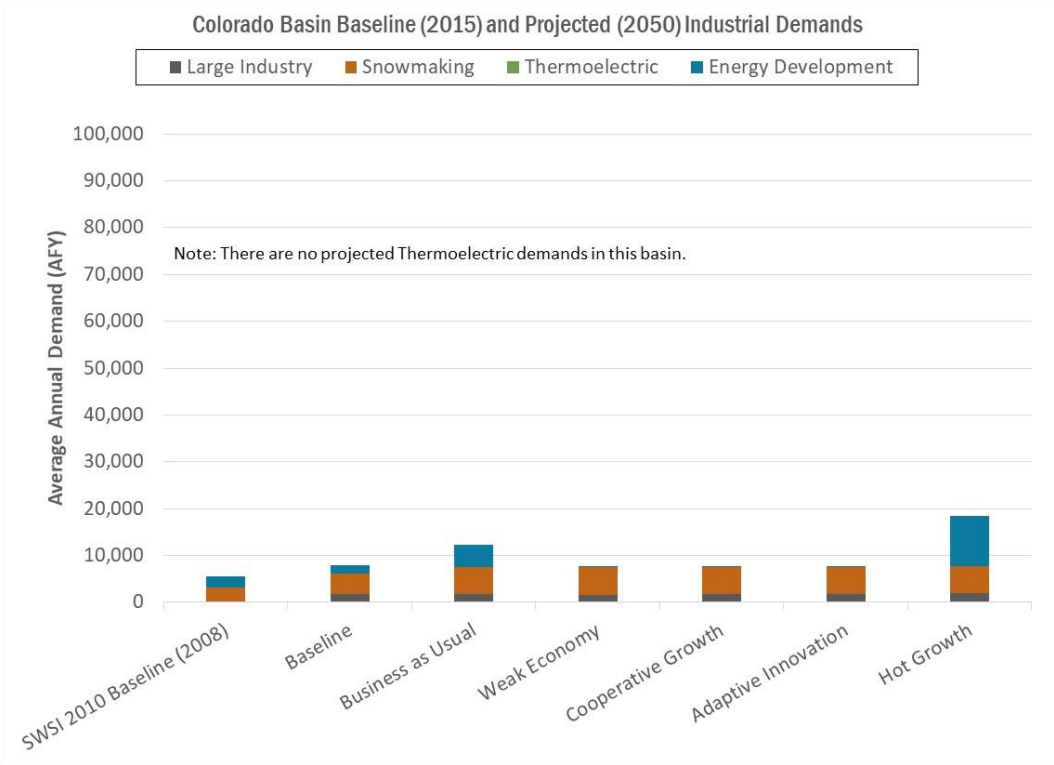

Figure 3-16: Colorado Basin Baseline and Projected Industrial Demands.

Table 3-10: Colorado Basin Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Eagle	Large Industry	-	-	-	-	-	-
	Snowmaking	1,310	1,310	1,310	1,310	1,310	1,310
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Garfield	Large Industry	-	-	-	-	-	-
	Snowmaking	20	20	20	20	20	20
	Thermoelectric	-	-	-	-	-	-
	Energy Development	1,600	3,300	200	200	200	6,900
Grand	Large Industry	1,700	1,700	1,530	1,700	1,700	1,870
	Snowmaking	360	630	630	630	630	630
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Mesa	Large Industry	-	-	-	-	-	-
	Snowmaking	40	50	50	50	50	50
	Thermoelectric	-	-	-	-	-	-
	Energy Development	200	1,400	0	0	0	3,800
Pitkin	Large Industry	-	-	-	-	-	-
	Snowmaking	1,000	1,000	1,000	1,000	1,000	1,000
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Summit	Large Industry	-	-	-	-	-	-
	Snowmaking	1,610	2,880	2,880	2,880	2,880	2,880
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Basin Total		7,840	12,290	7,620	7,790	7,790	18,460

3.2.3 TOTAL

Colorado Basin combined M&I demand projections for 2050 range from approximately 88,000 AFY in the Weak Economy scenario to 125,000 AFY in the Hot Growth scenario, as shown in Figure 3-17. Industrial demands account for between 8% and 15% of the M&I demands. On a basin scale, the demand projections do not follow the statewide sequence of the volumetric demand scenario rankings described in the CWP, with the Adaptive Innovation scenario falling out of sequence.

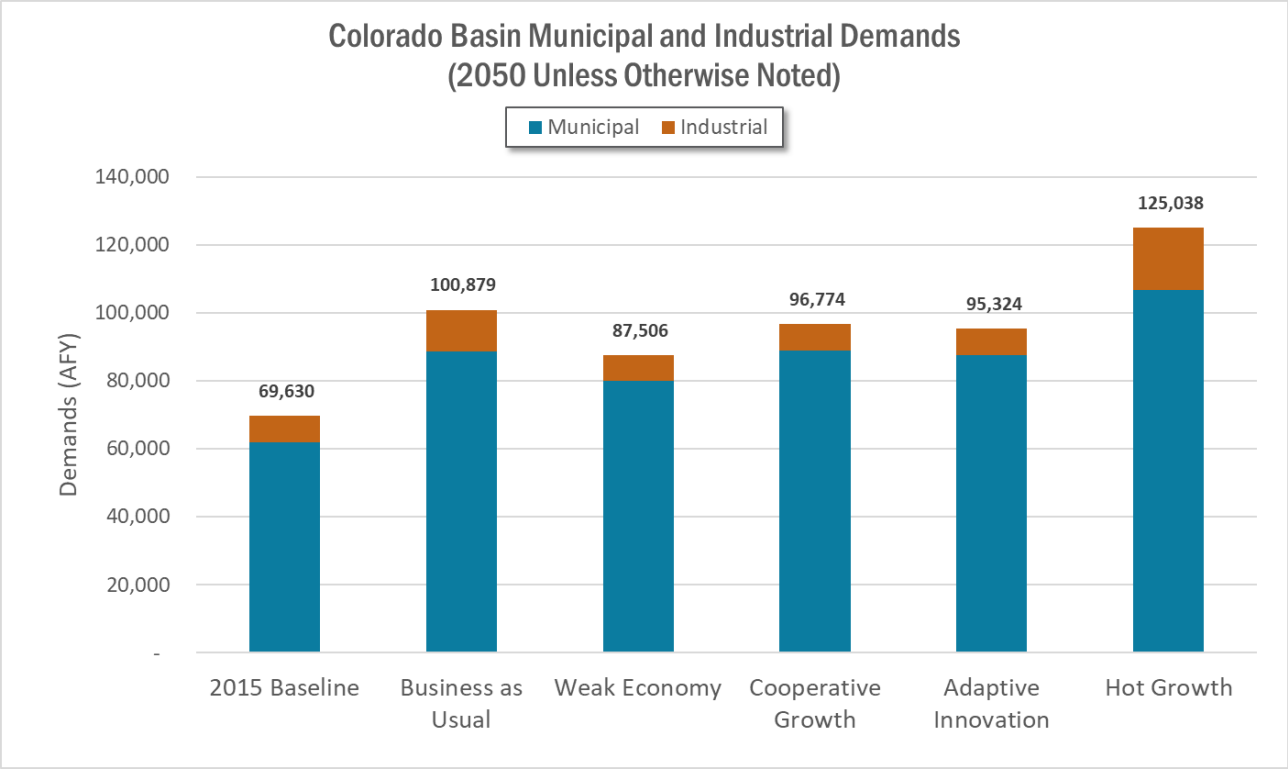

Figure 3-17: Colorado Basin Baseline and Projected M&I Demands.

3.3 GUNNISON BASIN

3.3.1 MUNICIPAL

3.3.1.1 POPULATION

The Gunnison Basin currently includes about 2% of the statewide population. Between the years 2015 and 2050, it is projected to grow from approximately 100,000 to between 120,000 and 200,000 people in the low and high growth scenarios, respectively. Using the specific numbers, this is an increase in population of 19% to 99%.

Table 3-11 shows how population growth is projected to vary across counties under each planning scenario. With the exception of Ouray County, all counties are projected to increase in population for all scenarios. Ouray County is projected to decrease by approximately 9% in the low growth scenario and increase by up to 51% in the high growth scenario. Montrose County is the most populous and is projected to account for a substantial portion of the basin growth. Hinsdale County is projected to have the highest growth rate for an individual county, ranging from about 55% to 160% increase in the low and high

growth scenarios, respectively. While it is projected to have the largest percent increase, Hinsdale County is still projected to account for only about 1% of the future total basin population. Note that Mesa and Montrose Counties are split between multiple basins, with the county demands pro-rated between basins based on the population located within each basin. This approach is consistent with prior SWSI analyses.

Table 3-11: Gunnison Basin Baseline and Projected Populations by County.

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Delta	29,973	42,126	31,878	39,861	49,704	53,082
Gunnison	16,097	22,728	17,199	24,054	26,817	28,639
Hinsdale	767	1,573	1,190	1,488	1,856	1,982
Mesa*	14,927	23,695	17,931	24,572	32,067	29,858
Montrose*	36,710	66,942	50,658	63,343	78,985	84,353
Ouray	4,647	5,568	4,214	5,269	6,570	7,016
Basin Total	103,121	162,632	123,070	158,587	195,998	204,931

**Counties with population located in multiple basins. This table represents the portion of the county located in the Gunnison Basin.*

The Gunnison Basin baseline for the Technical Update, which is based on 2015 population, is approximately 2% lower than the SWSI 2010 baseline, which used 2008 population. All SWSI 2010 projections for 2050 exceeded the Technical Update population projections for all planning scenarios. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-18.

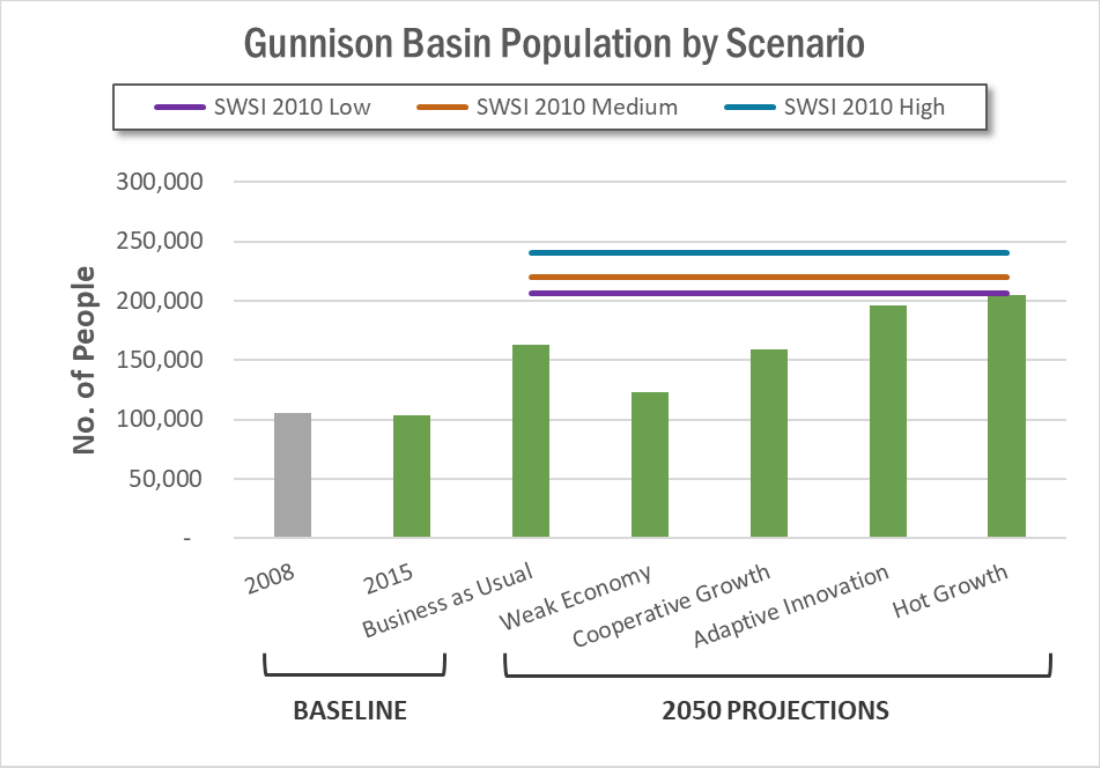

Figure 3-18: Gunnison Basin Baseline and Projected Population.

3.3.1.2 WATER DEMANDS

The Gunnison Basin baseline water demands were based on a mix of data sources, with approximately 36% of the baseline population demands represented by 1051 data, 11% from WEPs, and 3% from water provider outreach, requiring demands for about 50% of the basin's baseline population demands to be estimated, as shown in Figure 3-19.

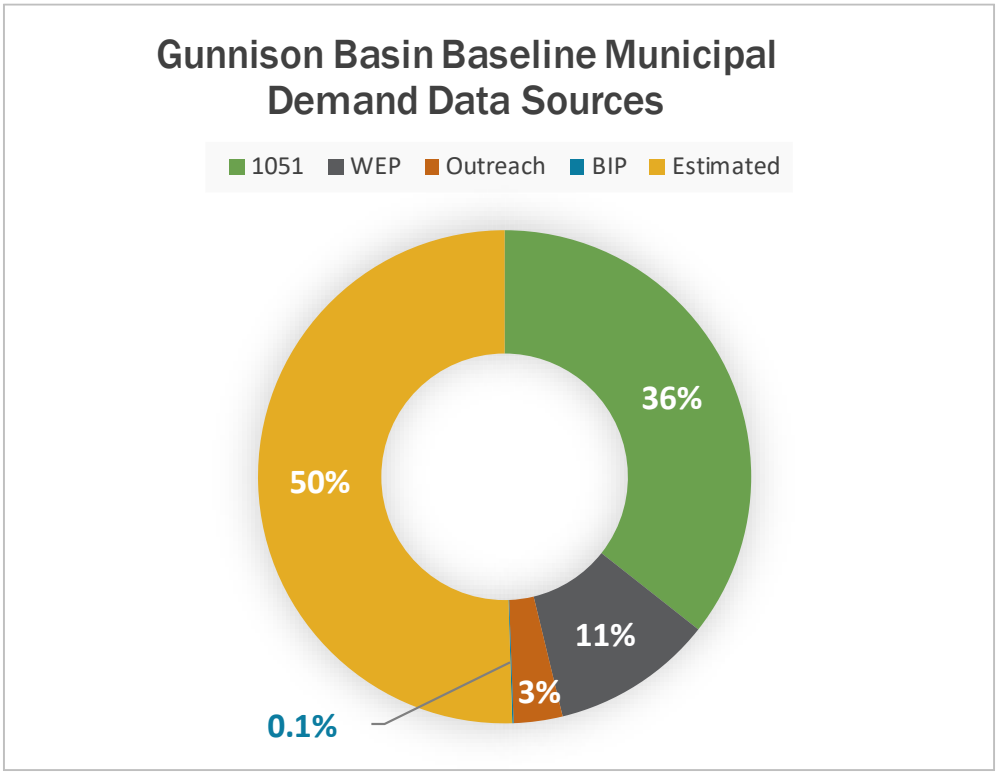

Figure 3-19: Gunnison Basin Baseline Municipal Water Demand Data Sources.

The Gunnison Basin average baseline per capita systemwide demand has decreased from 174 gpcd in SWSI 2010 to approximately 158 gpcd. County-level baseline per capita demands are either comparable or have also decreased from SWSI 2010. Table 3-12 represents baseline and projected per capita demands for counties within the basin.

Table 3-12: Gunnison Basin Municipal Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Technical Update Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Delta	165	132	122	124	117	110	131
Gunnison	197	176	161	164	154	147	176
Hinsdale	375	169	153	154	146	139	169
Mesa*	127	115	112	111	106	102	124
Montrose*	187	192	171	174	164	156	188
Ouray	157	135	127	130	123	116	138
Basin Total	174	158	146	149	140	133	160

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

**Counties with population located in multiple basins. Per capita demand is calculated at a county level.*

The Gunnison Basin baseline municipal water demands are comprised of approximately 57% indoor, 35% outdoor, and 9% non-revenue water, as shown in Figure 3-20. Three of the six counties had sufficient demand category distribution data available to apply a county-specific distribution. The basin average demand category distribution was used for the remaining counties. On a basin scale, the residential indoor demand as a percentage of the systemwide demands are relatively high, at approximately 40% of the systemwide demands.

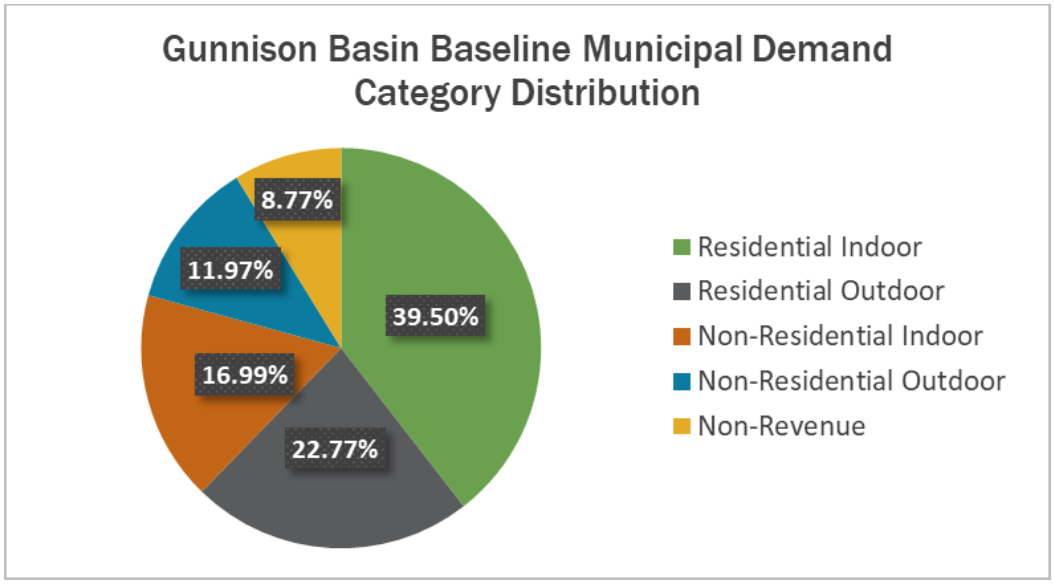

Figure 3-20: Gunnison Basin Baseline Municipal Demand Category Distribution.

Figure 3-21 provides a summary of per capita baseline and projected water demands for the Gunnison Basin. Systemwide, the projected per capita demands decrease relative to the baseline except for the Hot Growth Scenario. The residential indoor demand is the greatest demand category in the baseline and each projection except for Hot Growth where the residential outdoor demand is slightly higher. Outdoor demands increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the "Hot and Dry" climate.

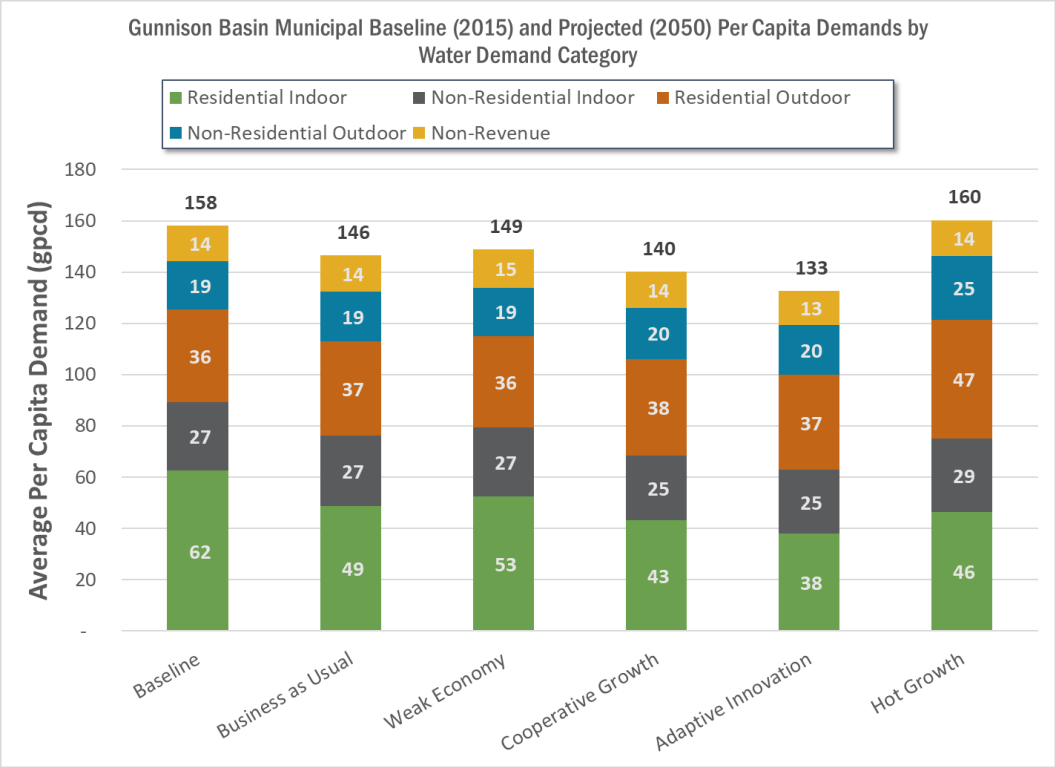

Figure 3-21: Gunnison Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-22 demonstrates the influence of the climate driver on per capita water demands, with outdoor demands increasing by 8 to 13 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 123 to 149 gpcd, as compared to the SWSI 2010 projection of 124 gpcd for medium population with active conservation[24].

[24] SWSI 2010 projected per capita demands include savings from passive conservation.

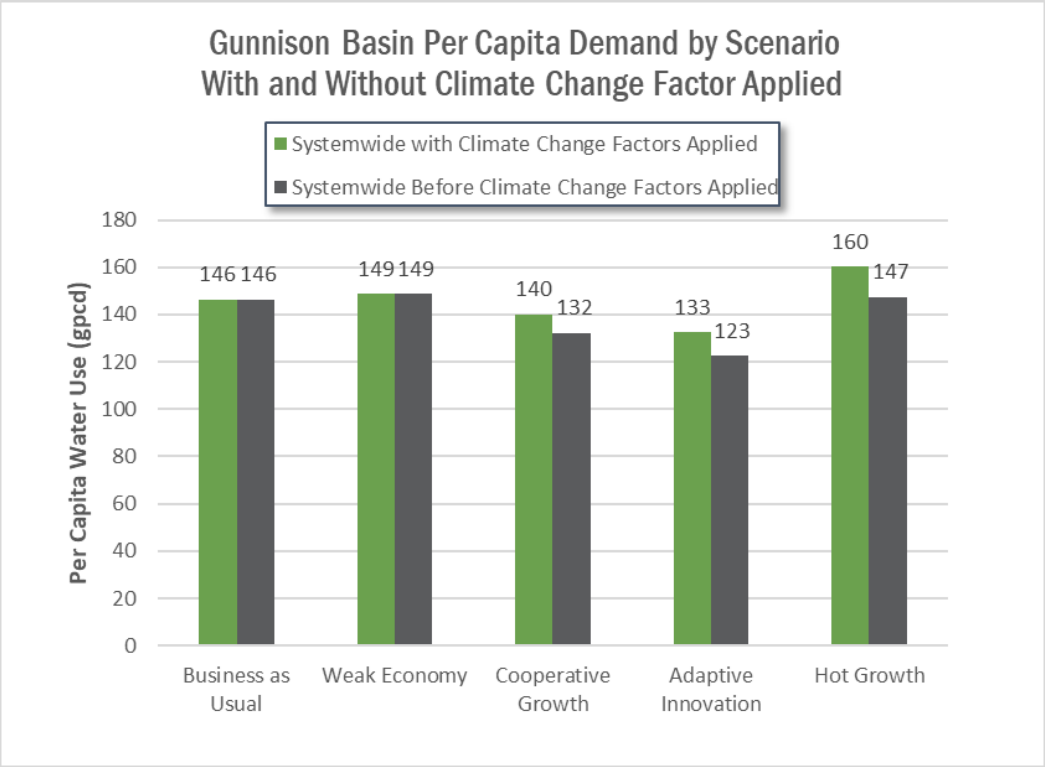

Figure 3-22: Effect of Climate Change Driver on the Gunnison Basin Average Per Capita Demand.

The Gunnison Basin municipal baseline and projected volumetric demands are provided in Table 3-13, showing the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 18,000 AFY in 2015 to between 21,000 and 37,000 AFY in 2050. Montrose County accounts for almost one-half of the baseline demand followed by Delta County at about one-fifth of the basin demand.

Table 3-13: Gunnison Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Delta	4,440	5,751	4,446	5,213	6,125	7,804
Gunnison	3,171	4,088	3,163	4,145	4,413	5,635
Hinsdale	145	269	205	244	290	375
Mesa*	1,919	2,966	2,230	2,920	3,670	4,138
Montrose*	7,881	12,807	9,851	11,638	13,789	17,749
Ouray	705	793	614	728	856	1,088
Basin Total	18,262	26,674	20,509	24,887	29,142	36,789

**Counties with population located in multiple basins. This table represents the systemwide demands for the portion of the county located in the Gunnison Basin.*

The baseline and projected demand distributions are shown in Table 3-14 and Figure 3-23 also shows how the population varies between the scenarios. All of the projection scenarios result in an increase relative to the baseline.

Table 3-14: Gunnison Basin Municipal Baseline and Projected Volumetric Demands by Demand Category (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	System wide
Baseline (2015)	7,214	3,103	4,158	2,185	1,602	18,262
Business as Usual	8,882	4,999	6,681	3,537	2,575	26,674
Weak Economy	7,241	3,687	4,926	2,608	2,046	20,509
Cooperative Growth	7,670	4,493	6,686	3,539	2,500	24,887
Adaptive Innovation	8,322	5,459	8,143	4,293	2,924	29,142
Hot Growth	10,656	6,552	10,680	5,656	3,245	36,789

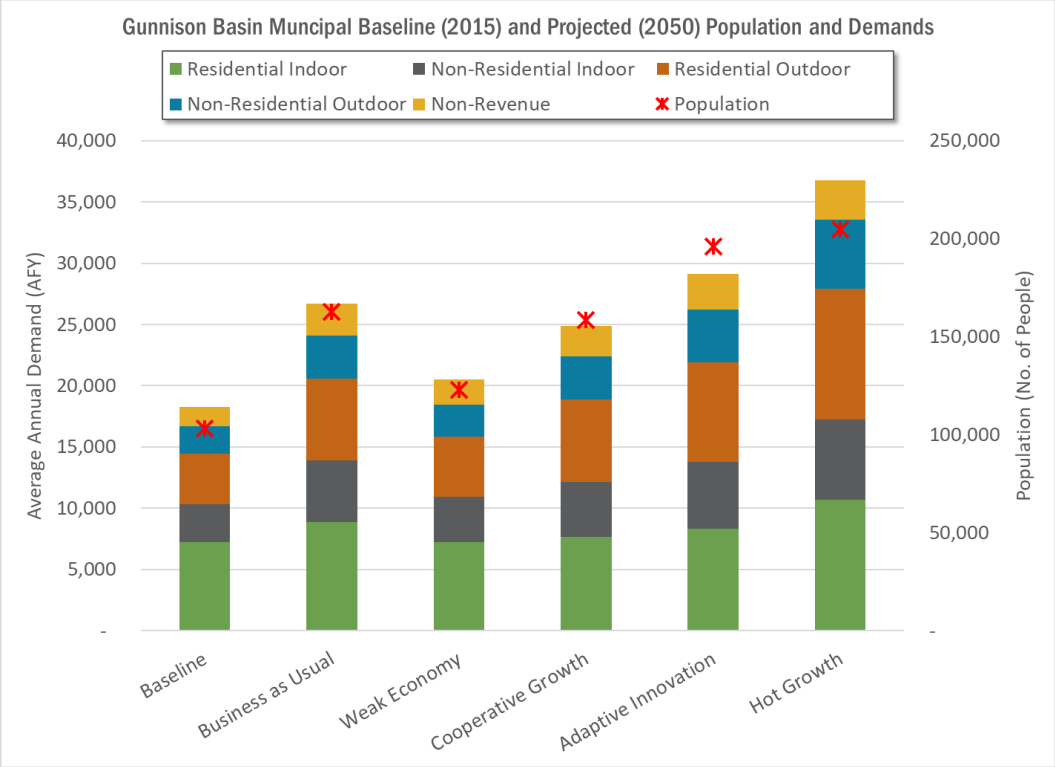

Figure 3-23: Gunnison Basin Baseline and Projected Population and Municipal Demands.

3.3.2 INDUSTRIAL

The Gunnison Basin currently includes less than one percent of the statewide industrial demand. Industrial demands in this basin are associated exclusively with the Snowmaking sub-sector. There are no demands projected for the Large Industry, Thermoelectric, and Energy Development sub-sectors. Basin-scale industrial demands are shown on Figure 3-24 and county-scale industrial demands are summarized in Table 3-15.

The baseline Snowmaking demand is 270 AFY as compared to 260 AFY in SWSI 2010. All snowmaking occurs in Gunnison County. Projected demands increase to 650 AFY under all scenarios.

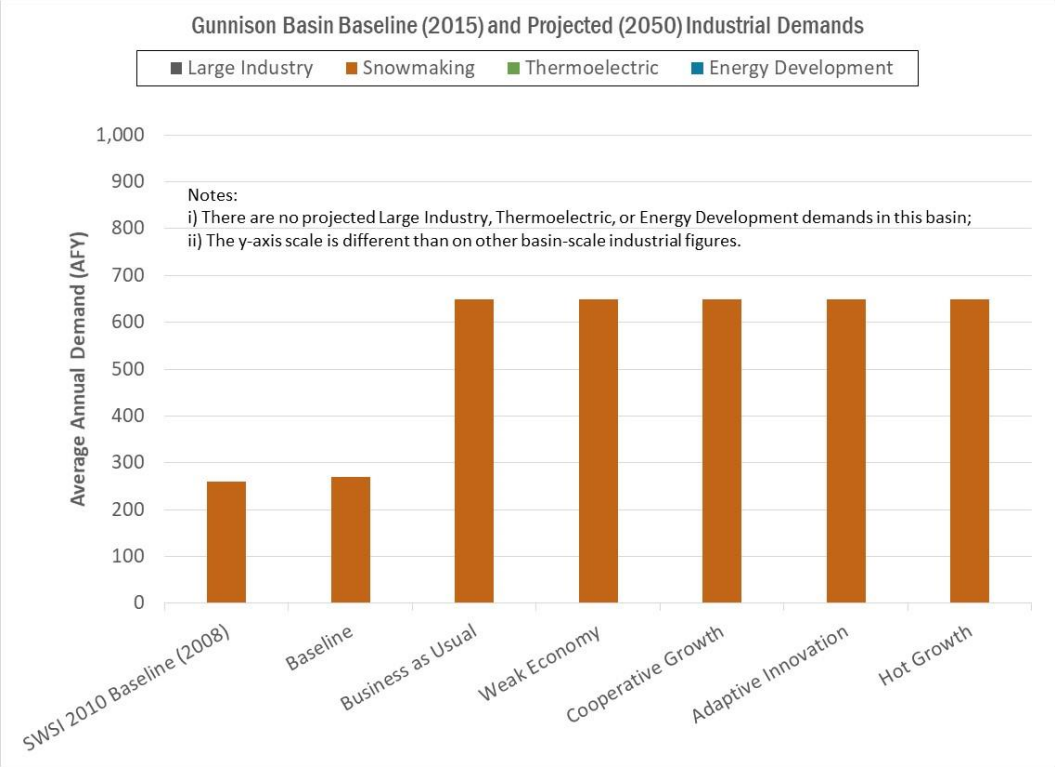

Figure 3-24: Gunnison Basin Industrial Baseline and Projected Demands.

Table 3-15: Gunnison Basin Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Gunnison	Large Industry	-	-	-	-	-	-
	Snowmaking	270	650	650	650	650	650
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Basin Total		270	650	650	650	650	650

3.3.3 TOTAL

Gunnison Basin combined M&I demand projections for 2050 range from approximately 21,000 AFY in the Weak Economy scenario to 37,000 AFY in the Hot Growth scenario, as shown in Figure 3-25. Industrial demands account for up to about 3% of the M&I demands. On a basin scale, the demand projections follow the statewide sequence of the volumetric demand scenario rankings described in the CWP.

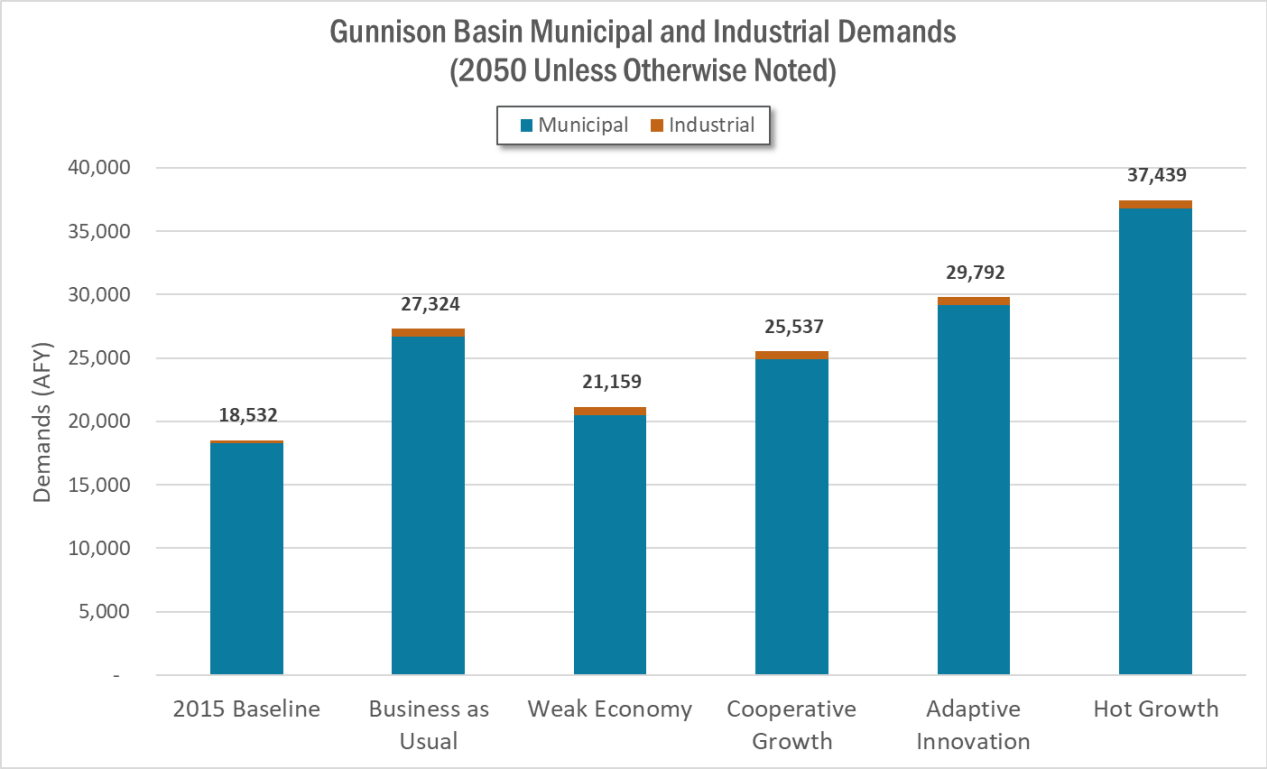

Figure 3-25: Gunnison Basin Baseline and Projected M&I Demands.

3.4 NORTH PLATTE BASIN

3.4.1 MUNICIPAL

3.4.1.1 POPULATION

The North Platte Basin currently includes about 0.02% of the statewide population. Between the years 2015 and 2050, it is projected to change from approximately 1,400 to between 1,100 and 1,500 people in the low and high growth scenarios, respectively. Using the specific numbers, this ranges from a 22% decrease in population to an increase of 8%. On a basin scale, the North Platte Basin represents the lowest baseline population and the lowest basin-wide growth amongst all basins in the state. Table 3-16 shows how population growth is projected to vary for Jackson County, which is the only county in the North Platte Basin, under each planning scenario.

Table 3-16: North Platte Basin Baseline and Projected Populations by County.

County	2015 Population	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Jackson	1,353	1,279	1,055	1,210	1,364	1,457
Basin Total	1,353	1,279	1,055	1,210	1,364	1,457

The North Platte Basin baseline for the Technical Update, which is based on 2015 population, has decreased by approximately 10% from the SWSI 2010 baseline, which used 2008 population. All SWSI 2010 population projections for 2050 exceeded all Technical Update population projections for all planning scenarios by at least 37%. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-26.

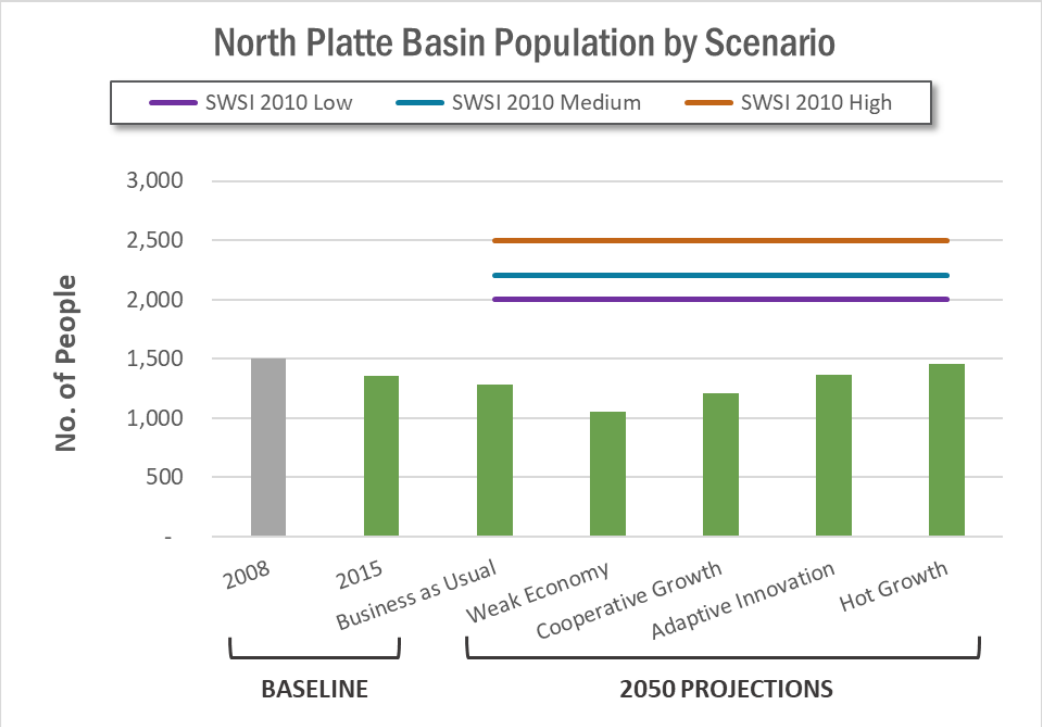

Figure 3-26: North Platte Basin Baseline and Projected Population.

3.4.1.2 WATER DEMANDS

The North Platte Basin baseline demands relied entirely on estimated data from neighboring counties. No municipal data were available for utilities within Jackson County, which is the only county in the North Platte Basin. The North Platte Basin average baseline per capita systemwide demand has decreased from 310 gpcd in SWSI 2010 to approximately 264 gpcd. Table 3-17 represents baseline and projected per capita demands for counties within the basin.

Table 3-17: North Platte Basin Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Technical Update Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Jackson	310	264	245	254	242	232	270
Basin Total	310	264	245	254	242	232	270

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

Because there was no water provider-reported data available for Jackson County, the statewide weighted average demand category distribution was used for the North Platte Basin, as shown in Figure 3-27.

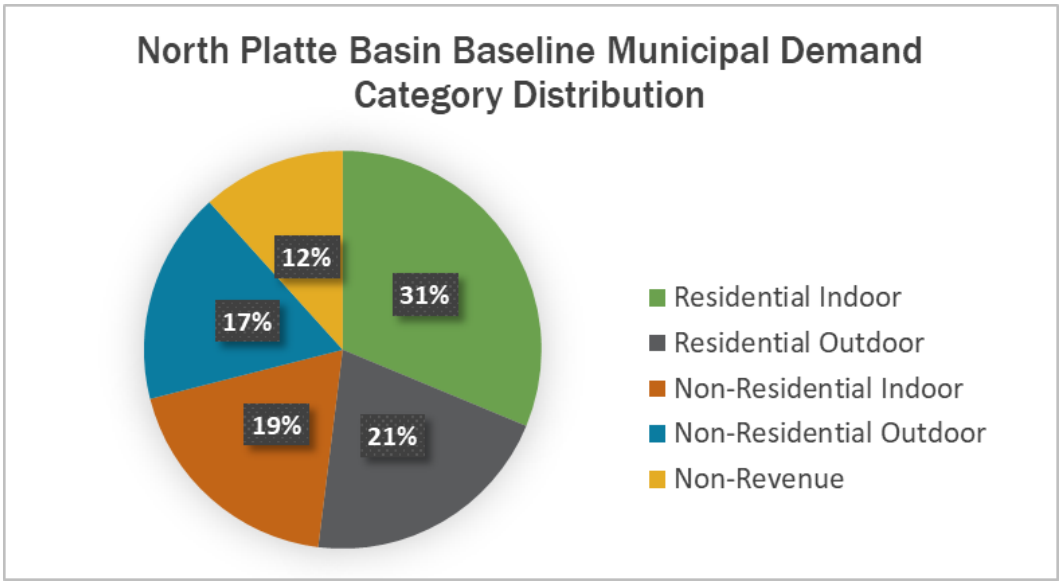

Figure 3-27: North Platte Basin Baseline Municipal Demand Category Distribution.

Figure 3-28 provides a summary of per capita baseline and projected water demands for the North Platte Basin. Systemwide, the projected per capita demands decrease relative to the baseline except for the Hot Growth scenario. The residential indoor demand is the greatest demand category in the baseline, but the residential outdoor demand exceeds the residential indoor demand in the Cooperative Growth, Adaptive Innovation, and Hot Growth scenarios. Outdoor demands increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the "Hot and Dry" climate.

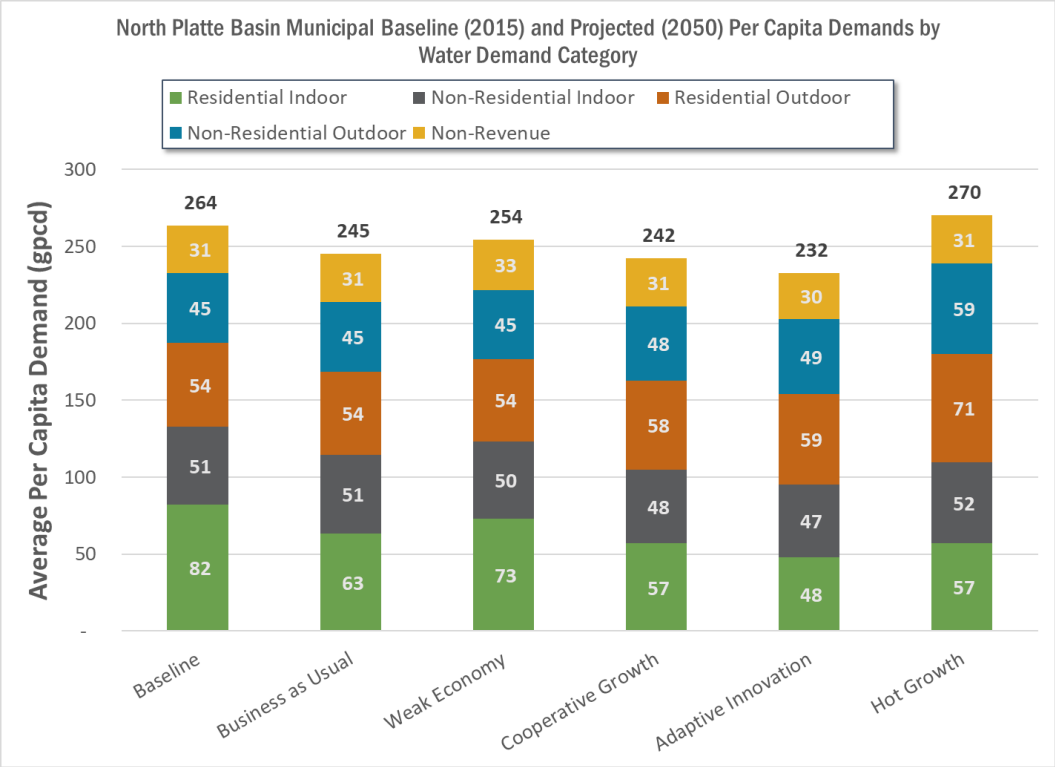

Figure 3-28: North Platte Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-29 demonstrates the influence of the climate driver on per capita water demands, with outdoor demands increasing by 15 to 27 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 210 to 254 gpcd, as compared to the SWSI 2010 projection of 225 gpcd for medium population with active conservation[25].

[25] SWSI 2010 projected per capita demands include savings from passive conservation.

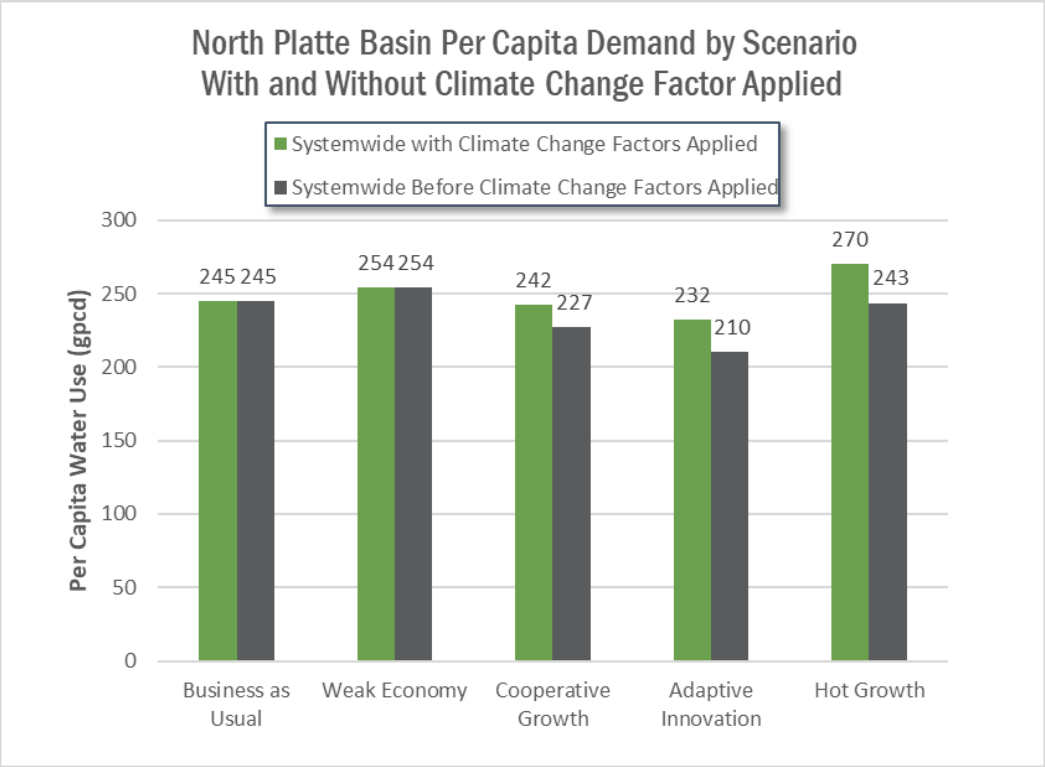

Figure 3-29: Effect of Climate Change Driver on the North Platte Basin Average Per Capita Demand.

The North Platte Basin municipal baseline and projected volumetric demands are provided in Table 3-18, showing the combined effect of population and per capita demands. Municipal demands are projected to change from approximately 400 AFY in 2015 to between 300 and 440 AFY in 2050.

Table 3-18: North Platte Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Jackson	400	351	301	328	355	441
Basin Total	400	351	301	328	355	441

The baseline and projected demand distributions are shown in Table 3-19 and Figure 3-30 also shows how the population varies between the scenarios. Hot Growth is the only planning scenario in which the projected demands increase from the baseline; all other planning scenarios show an overall decrease in demands by 2050.

Table 3-19: North Platte Basin Municipal Baseline and Projected Demand by Demand Category (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	System wide
Baseline (2015)	124	77	82	69	47	400
Business as Usual	91	73	78	65	45	351
Weak Economy	86	59	63	53	39	301
Cooperative Growth	77	65	79	66	42	328
Adaptive Innovation	73	72	90	75	45	355
Hot Growth	93	86	115	96	51	441

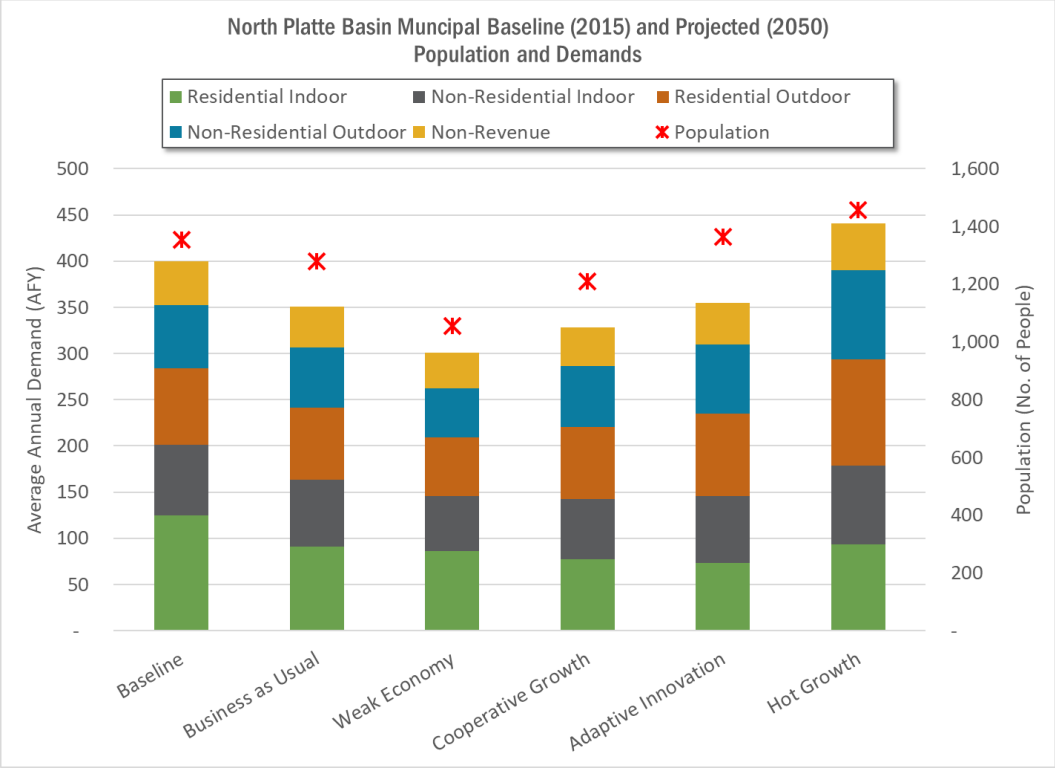

Figure 3-30: North Platte Basin Baseline and Projected Population and Municipal Demands.

3.4.2 INDUSTRIAL

There are no baseline or projected industrial demands in the North Platte Basin.

3.4.3 TOTAL

North Platte Basin combined M&I demand projections for 2050 range from approximately 300 AFY under Weak Economy to 440 AFY in the Hot Growth scenario, as shown in Figure 3-31. There are no current or projected industrial demands. On a basin scale, the demand projections follow the statewide sequence of the scenario rankings described in the CWP.

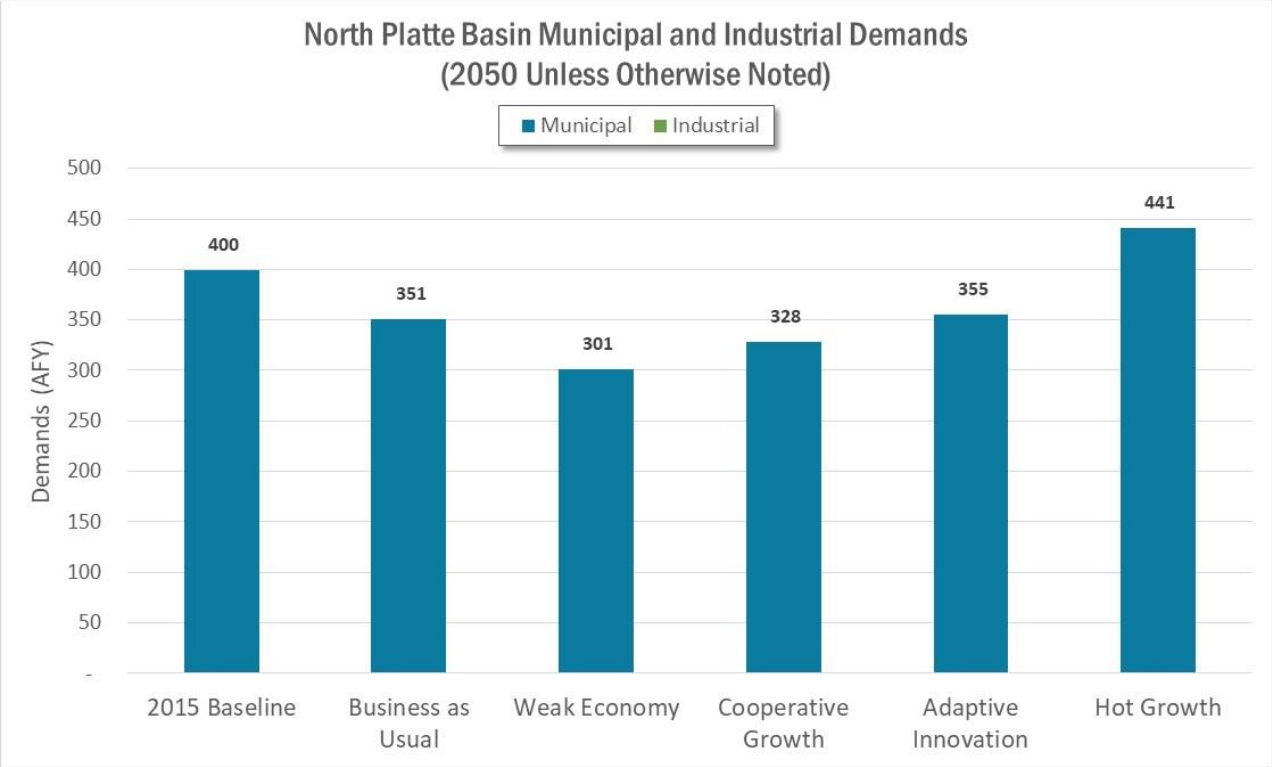

Figure 3-31: North Platte Basin Baseline and Projected M&I Demands.

3.5 RIO GRANDE BASIN

3.5.1 MUNICIPAL

3.5.1.1 POPULATION

The Rio Grande Basin currently includes less than 1% 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 scenarios, respectively. Using the specific numbers, this ranges from an 8% decrease in population to an increase of 46%.

Table 3-20 shows how population growth is projected to vary across counties under each planning scenario. Four of the six counties are projected to decrease in population for the low growth scenario. All counties are expected to grow by about 24% to 75% in the high growth scenario. The most populous county, Alamosa County, is projected to increase under all scenarios and account for most of the growth.

Table 3-20: Rio Grande Basin Baseline and Projected Populations by County

County	2015 Population	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Alamosa	15,968	22,934	17,593	21,701	26,209	27,990
Conejos	8,074	8,997	6,902	8,513	10,282	10,980
Costilla	3,572	3,934	3,018	3,722	4,496	4,801
Mineral	729	959	736	907	1,096	1,170
Rio Grande	11,413	11,612	8,907	10,988	13,270	14,172
Saguache	6,219	6,668	5,115	6,309	7,620	8,138
Basin Total	45,975	55,104	42,270	52,141	62,972	67,252

The Rio Grande Basin baseline for the Technical Update, which is based on 2015 population, is approximately 8% lower than the SWSI 2010 baseline, which used 2008 population. All SWSI 2010 projections for 2050 exceeded the Technical Update population projections for all planning scenarios by at least 10%. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-32.

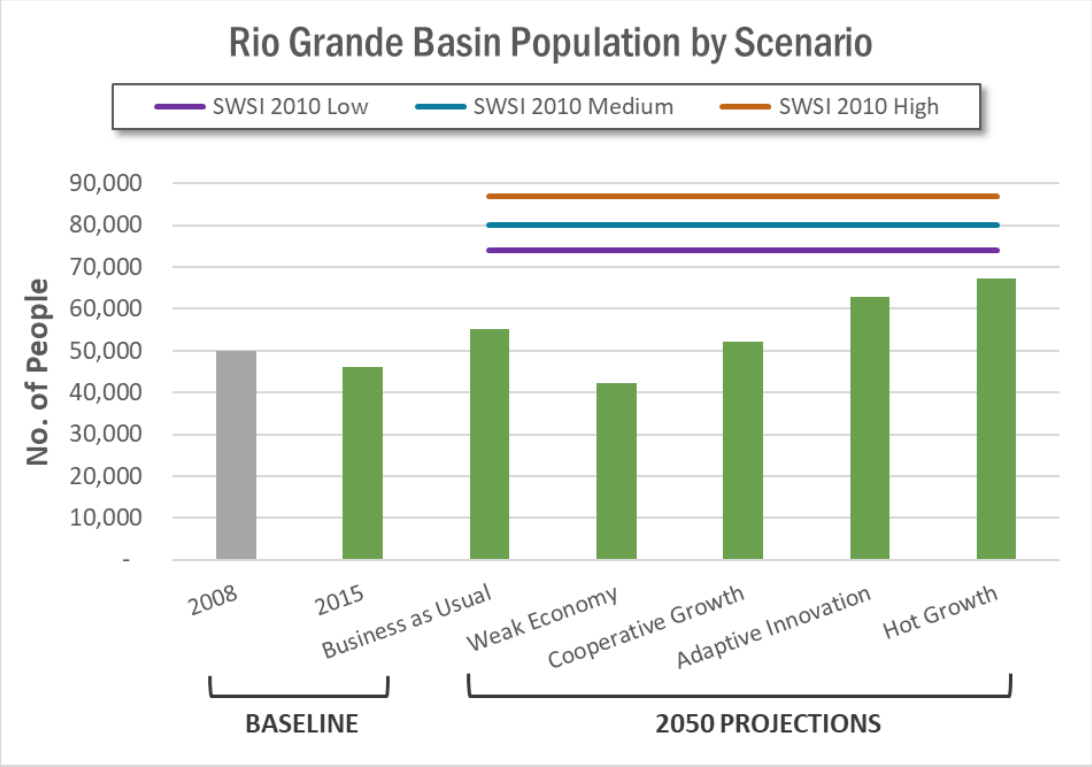

Figure 3-32: Rio Grande Basin Baseline and Projected Population.

3.5.1.2 WATER DEMANDS

The Rio Grande Basin baseline water demands were primarily based on BIP data, with approximately 79% of the baseline population demands represented by those reports. This is the highest representation of BIP data for any basin in the state. Data from WEPs represent demands for another 9% of the population,

requiring about 12% of the basin's baseline population demands to be estimated, as shown in Figure 3-33.

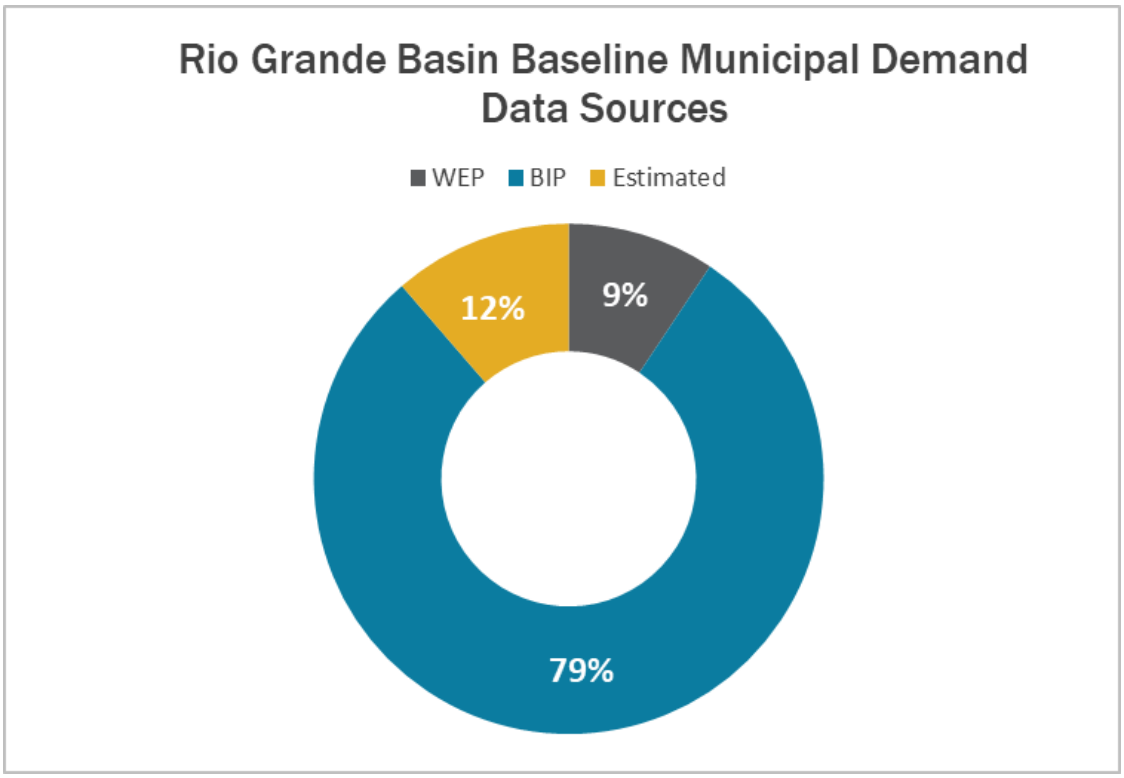

Figure 3-33: Rio Grande Basin Baseline Municipal Demand Data Sources.

The Rio Grande Basin average baseline per capita systemwide demand has decreased significantly from 314 gpcd in SWSI 2010 to approximately 207 gpcd. Baseline demands have also decreased for every county.

Table 3-21 represents baseline and projected per capita demands for counties within the basin.

Table 3-21: Rio Grande Basin Municipal Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Technical Update Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Alamosa	258	201	188	190	181	171	204
Conejos	521	279	255	265	249	232	273
Costilla	193	157	153	155	150	142	166
Mineral	296	154	151	151	146	139	164
Rio Grande	306	203	193	198	189	177	207
Saguache	274	168	162	165	159	150	176
Basin Total	314	207	194	198	188	177	209

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

The Rio Grande Basin had very high water demand data representation, primarily from the BIP. However, 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 in Figure 3-34.

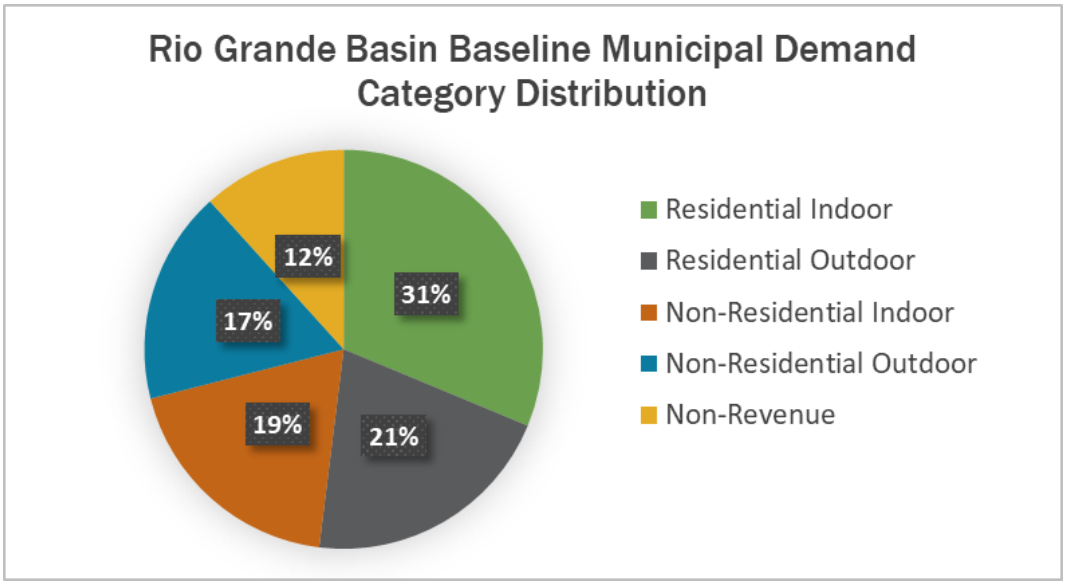

Figure 3-34: Rio Grande Basin Baseline Municipal Demand Category Distribution.

Figure 3-35 provides a summary of per capita baseline and projected water demands for the Rio Grande Basin. Systemwide, the projected per capita demands decrease relative to the baseline except for the Hot Growth scenario. The residential indoor demand is the greatest demand category in all scenarios except Adaptive Innovation and Hot Growth where the residential outdoor demand is higher. Aside from the Hot Growth scenario, there is minimal variation in outdoor demands between scenarios. This is due to the scenario pairing of water demand reductions and climate drivers, particularly for the Adaptive Innovation scenario which has high outdoor reductions coupled with the "Hot and Dry" climate. Outdoor demands

increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the "Hot and Dry" climate.

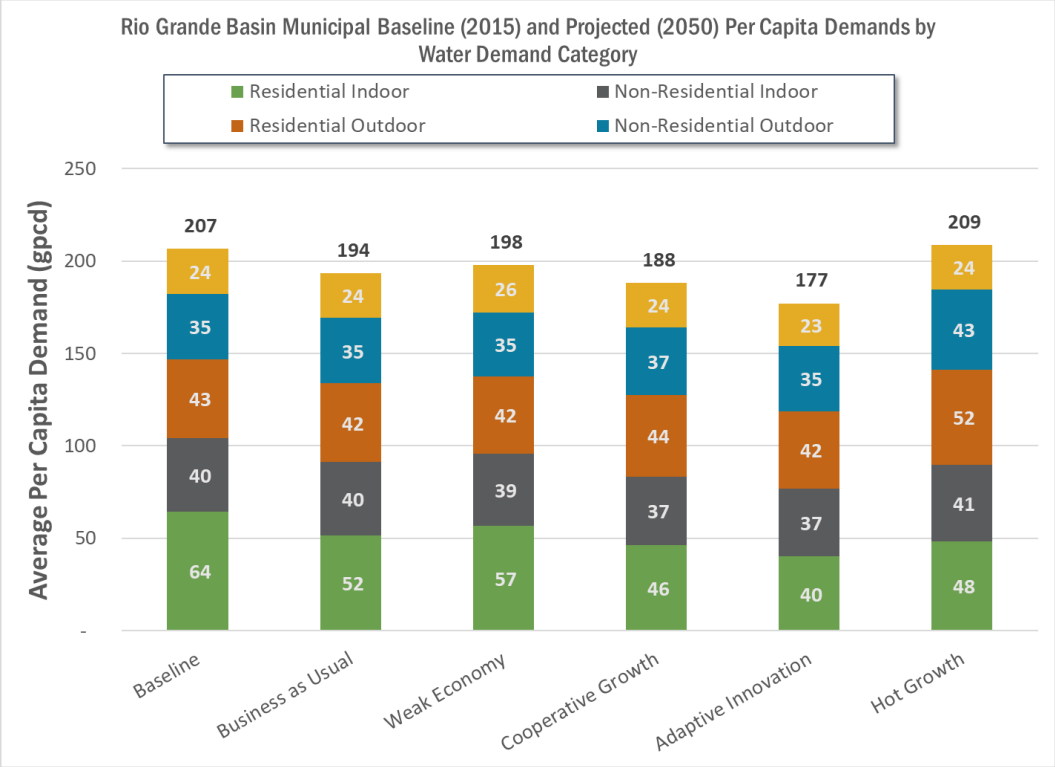

Figure 3-35: Rio Grande Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-36 demonstrates the influence of the climate driver on per capita water demands, with outdoor demands increasing by 10 to 14 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 166 to 198 gpcd, which are all lower than the SWSI 2010 projection of 228 gpcd for medium population with active conservation[26]. This is partly due to the Technical Update baseline being lower than the SWSI 2010 baseline.

[26] SWSI 2010 projected per capita demands include savings from passive conservation.

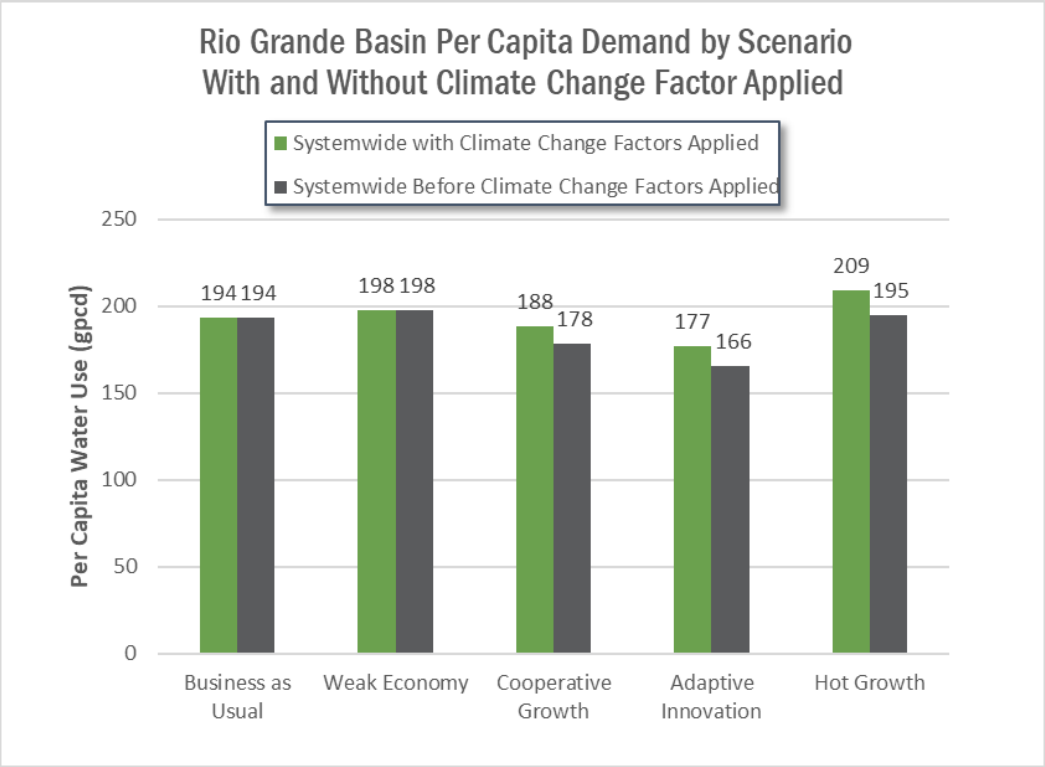

Figure 3-36: Effect of Climate Change Driver on the Rio Grande Basin Average Per Capita Demand.

The Rio Grande Basin municipal baseline and projected volumetric demands are provided in Table 3-22, showing the combined effect of population and per capita demands. Municipal demands are projected to grow 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.

Table 3-22: Rio Grande Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

County	Baseline	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Alamosa	3,592	4,822	3,749	4,411	5,030	6,382
Conejos	2,525	2,567	2,050	2,371	2,672	3,353
Costilla	627	676	523	624	713	894
Mineral	126	162	125	148	170	215
Rio Grande	2,601	2,507	1,980	2,324	2,633	3,288
Saguache	1,168	1,213	943	1,122	1,279	1,601
Basin Total	10,639	11,947	9,370	11,000	12,496	15,732

The baseline and projected demand distributions are shown in Table 3-23 and Figure 3-37 also shows how the population varies between the scenarios. The projected demands increase from the baseline under all scenarios except for Weak Economy.

Table 3-23: Rio Grande Basin Municipal Baseline and Projected Volumetric Demands by Demand Category (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	System wide
Baseline (2015)	3,312	2,052	2,191	1,828	1,256	10,639
Business as Usual	3,181	2,455	2,621	2,187	1,503	11,947
Weak Economy	2,685	1,851	1,976	1,648	1,210	9,370
Cooperative Growth	2,701	2,173	2,564	2,140	1,422	11,000
Adaptive Innovation	2,828	2,587	2,971	2,479	1,631	12,496
Hot Growth	3,646	3,105	3,897	3,251	1,834	15,732

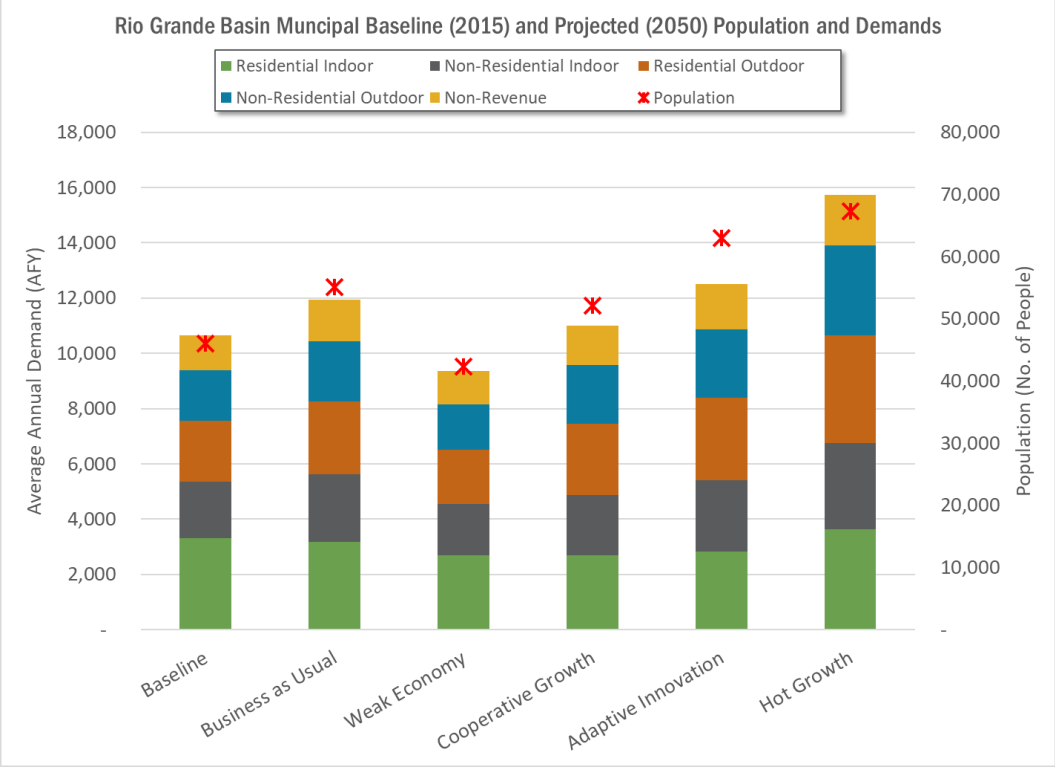

Figure 3-37: Rio Grande Basin Baseline and Projected Population and Municipal Demands.

3.5.2 INDUSTRIAL

The Rio Grande Basin currently includes about 4% of the statewide industrial demand. Modeled industrial demands in this basin are associated with the Large Industry and Energy Development sub-sectors. While there are approximately 5 acres of snowmaking in the Rio Grande Basin, the estimated demand of less than 5 AFY was not represented in the projections because it is relatively insignificant as compared to other industrial demands in the basin. with no demands projected for the Snowmaking and Thermoelectric sub-sectors. Basin-scale industrial demands are shown on Figure 3-38 and county-scale industrial demands are summarized in Table 3-24.

There were no Large Industry demands in the Rio Grande Basin in SWSI 2010. Large Industry demands were added based on information in the BIP, which described the following categories water uses: i) fisheries and aquaculture; ii) agricultural product processing; and iii) other, including manufacturing. The baseline Large Industry demand is 7,660 AFY and projected demands range from 7,960 AFY to 9,760 AFY.

Energy Development demands were also updated based on information in the BIP. The total baseline Energy Development demand is 200 AFY and is associated with solar power generation. Solar power generation demands are projected to increase to 800 AFY and oil and gas development demands are projected to be 200 AFY, totaling 1,000 AFY. Demand projections were not varied by scenario as directed by BIP representatives.

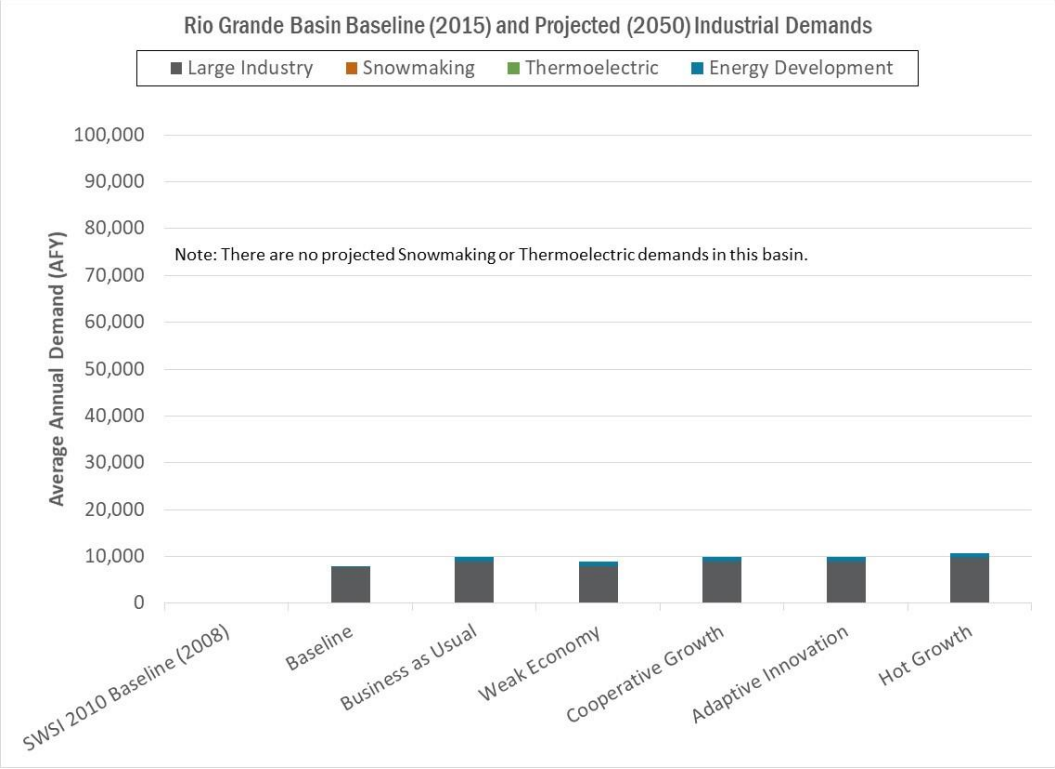

Figure 3-38: Rio Grande Basin Industrial Baseline and Projected Demands.

Table 3-24: Rio Grande Basin Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Alamosa	Large Industry	2,830	3,190	2,870	3,190	3,190	3,510
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	-	-	-	-	-	-
	Energy Development	160	640	640	640	640	640
Conejos	Large Industry	100	160	140	160	160	180
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	-	-	-	-	-	-
	Energy Development	20	80	80	80	80	80
Costilla	Large Industry	160	280	250	280	280	310
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Rio Grande	Large Industry	2,340	2,670	2,400	2,670	2,670	2,940
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	-	-	-	-	-	-
	Energy Development	20	280	280	280	280	280
Saguache	Large Industry	2,230	2,560	2,300	2,560	2,560	2,820
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Basin Total		7,860	9,860	8,960	9,860	9,860	10,760

3.5.3 TOTAL

Rio Grande Basin combined M&I demand projections for 2050 range from approximately 18,000 AFY in the Weak Economy scenario to 26,000 AFY in the Hot Growth scenario, as shown in Figure 3-39. Industrial demands account for about 40% to 50% of the M&I demands. On a basin scale, the demand projections follow the statewide volumetric demand sequence of the scenario rankings described in the CWP.

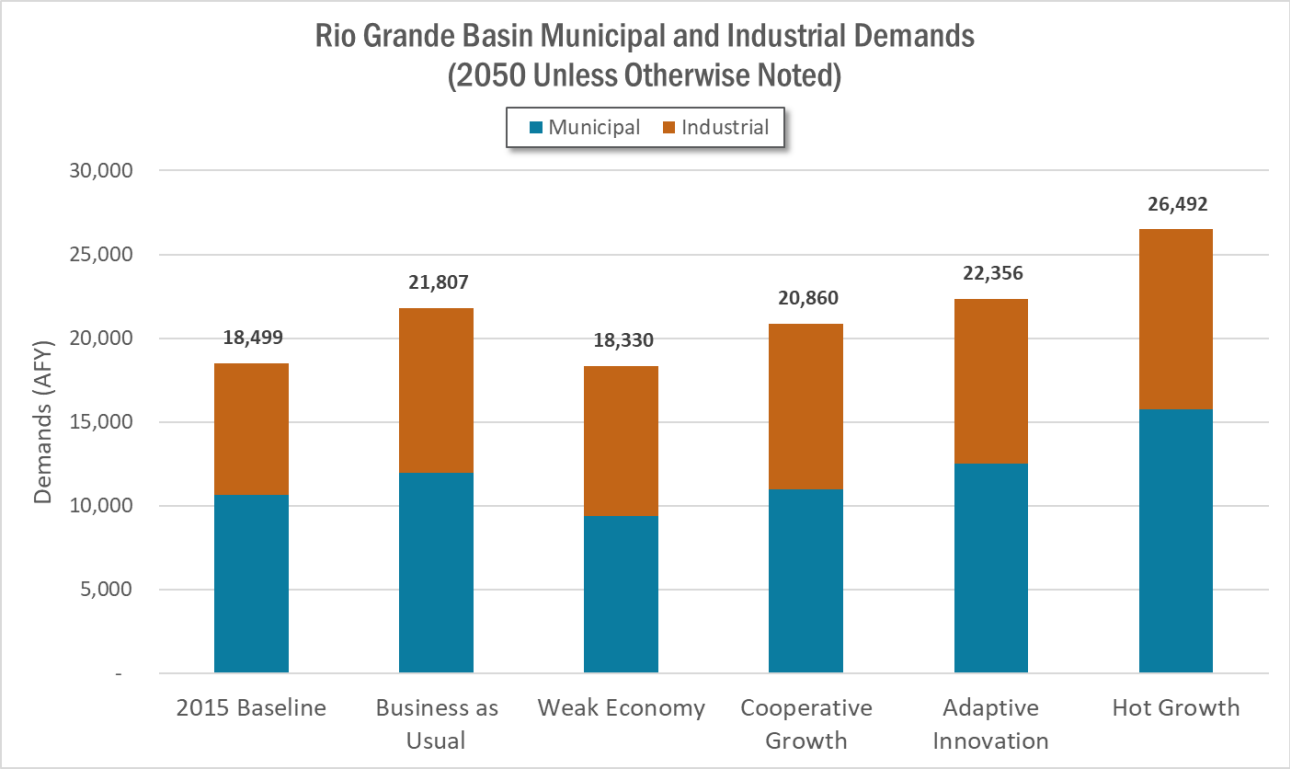

Figure 3-39: Rio Grande Basin Baseline and Projected M&I Demands.

3.6 SOUTH PLATTE BASIN

3.6.1 MUNICIPAL

For purposes of the Technical Update M&I demand reporting, the South Platte Basin includes three sub-basins (as shown in Figure 3-1): the Metro Region as defined by the basin roundtables, the Republican Basin, and the South Platte Without Metro or Republican Sub-Basin.[27] SWSI 2010 included the Republican Basin M&I demands in the reporting of the South Platte Basin demands, but separately reported demands for the Metro Region. The three sub-basins are each summarized in the following sections, along with the combined South Platte Basin.

[27] The hydrologic modelling for the Technical Update includes one model for the Republican Basin and a separate model for the South Platte Basin that includes the Metro Region.

3.6.1.1 POPULATION

Combined South Platte Basin

The South Platte Basin (including the three sub-basins described below) is currently the most populous basin and includes about 70% of the statewide population. Between the years 2015 and 2050, the South Platte Basin is projected to grow from approximately 3.8 million people to between 5.4 million and 6.5 million people in the low and high growth scenarios, respectively. Using the specific numbers, this is an increase in population of 42% to 70%. Table 3-25 shows how population growth is projected to vary across counties under each planning scenario and is summarized by sub-basin.

Metro Region Sub-Basin

The Metro Region currently includes about 51% of the statewide population. Between the years 2015 and 2050, it is projected to grow from approximately 2.8 million to between 3.8 million and 4.3 million people in the low and high growth scenarios, respectively. Using the specific numbers, this is an increase in population of 38% to 56%.

All counties are projected to increase in population under all scenarios, ranging from about 16% to 186% increases. Denver County is currently the most populous county at about 680,000 people and is projected to remain the largest under all scenarios, ranging from about 896,000 to 1.07 million people by 2050. However, under some scenarios, Arapahoe and Adams Counties increase by more people. Elbert County, which currently has about 1% of the sub-basin population, is projected to have the highest growth rate for an individual county, with increases of about 153% to 185% in the low and high growth scenarios, respectively. Even with this large percentage increase, Elbert County is still projected to account for only about 1% of the future total sub-basin population.

Republican Sub-Basin

The Republican Sub-Basin currently includes less than 1% of the statewide population. Between the years 2015 and 2050, it is projected to change from approximately 32,000 to between 30,000 and 41,000 people in the low and high growth scenarios, respectively. Using the specific numbers, this ranges from a decrease in population of 4% to an increase of 30%.

All counties are projected to increase in population for the high growth scenario, but only Lincoln and Logan Counties are projected to increase in the low growth scenario. The two most populous counties, Yuma County followed by Kit Carson County, are projected to account for most of the growth and remain the largest population centers in the basin. Lincoln County, which currently has about 3% of the sub-basin population, is projected to have the highest growth rate for an individual county, with increases of about 31% to 77% in the low and high growth scenarios, respectively. Even with this large percentage increase, Lincoln County is still projected to account for only about 5% of the future total sub-basin population.

South Platte Without Metro Region or Republican Sub-Basin

The portion of the South Platte Basin that is not included in the Metro Region or the Republican Sub-Basins currently includes about 19% of the statewide population. Between the years 2015 and 2050, it is projected to grow from approximately 1.0 million to between 1.6 million and 2.3 million people in the low and high growth scenarios, respectively. Using the specific numbers, this is an increase in population of 54% to 123%.

All counties are projected to increase in population for the high growth scenario, but three of the eleven counties are projected to decrease in the low growth scenario. Larimer County is currently the most populous county, followed by Boulder and Weld Counties. Weld County has the largest projected growth rate and becomes t`he most populous county in the sub-basin under low and high scenarios, followed by Larimer and Boulder Counties.

Table 3-25: South Platte Basin and Sub-Basin Baseline and Projected Populations by County

County	2015 Population	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
METRO REGION SUB-BASIN						
Adams	489,923	890,148	836,501	842,289	886,001	946,216
Arapahoe	629,066	899,738	845,513	851,363	895,546	956,410
Broomfield	64,656	95,566	89,806	90,428	95,121	101,585
Denver	680,658	952,955	895,523	980,185	1,067,123	1,012,979
Douglas	322,198	482,824	453,725	456,865	480,575	513,236
Jefferson	564,619	694,943	653,061	657,579	691,705	738,716
Elbert*	17,006	45,725	42,970	43,267	45,512	48,606
Sub-Basin Total	2,768,126	4,061,899	3,817,099	3,921,976	4,161,584	4,317,749
REPUBLICAN SUB-BASIN						
Cheyenne*	1,144	1,026	876	970	1,111	1,187
Kit Carson	8,219	9,595	8,194	9,079	10,397	11,104
Lincoln*	1,064	1,627	1,390	1,540	1,763	1,883
Logan*	2,032	2,711	2,315	2,565	2,938	3,137
Phillips	4,307	4,372	3,734	4,137	4,737	5,059
Sedgwick*	1,008	984	840	931	1,066	1,139
Washington*	3,790	3,763	3,214	3,561	4,078	4,355
Yuma	10,052	11,398	9,734	10,785	12,351	13,190
Sub-Basin Total	31,616	35,476	30,297	33,569	38,441	41,054
SOUTH PLATTE WITHOUT METRO OR REPUBLICAN SUB-BASIN						
Boulder	318,570	447,843	382,458	460,770	558,020	518,258
Clear Creek	9,392	12,448	10,631	11,779	13,488	14,405
Gilpin	5,824	6,626	5,659	6,270	7,180	7,668
Larimer	332,830	543,588	464,224	564,664	677,320	629,057
Logan*	20,090	26,805	22,891	25,364	29,045	31,019
Morgan	28,230	42,734	36,495	40,436	46,306	49,453
Park	16,716	23,797	20,323	22,518	25,786	27,539
Sedgwick*	1,381	1,348	1,151	1,275	1,461	1,560
Teller*	11,490	16,323	13,939	15,445	17,687	18,889
Washington*	1,044	1,037	885	981	1,123	1,200
Weld	284,571	734,343	627,129	779,320	915,004	849,804
Sub-Basin Total	1,030,138	1,856,891	1,585,784	1,928,822	2,292,420	2,148,852
TOTAL SOUTH PLATTE BASIN						
Basin Total	3,829,880	5,954,267	5,433,180	5,884,366	6,492,445	6,507,655

**Counties with population located in multiple basins. This table represents the portion of the county located in each sub-basin.*

The Metro Region baseline for the Technical Update, which is based on 2015 population, is approximately 10% higher than the SWSI 2010 baseline, which used 2008 population. The SWSI 2010 medium growth population projection for 2050 exceeded the low and medium projections in the Technical Update for the Business as Usual, Weak Economy, and Cooperative Growth scenarios by up to about 9% and the SWSI 2010 high growth projection also exceeded the Technical Update high growth projections for the Adaptive Innovation and Hot Growth scenarios by up to about 9%. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-40.

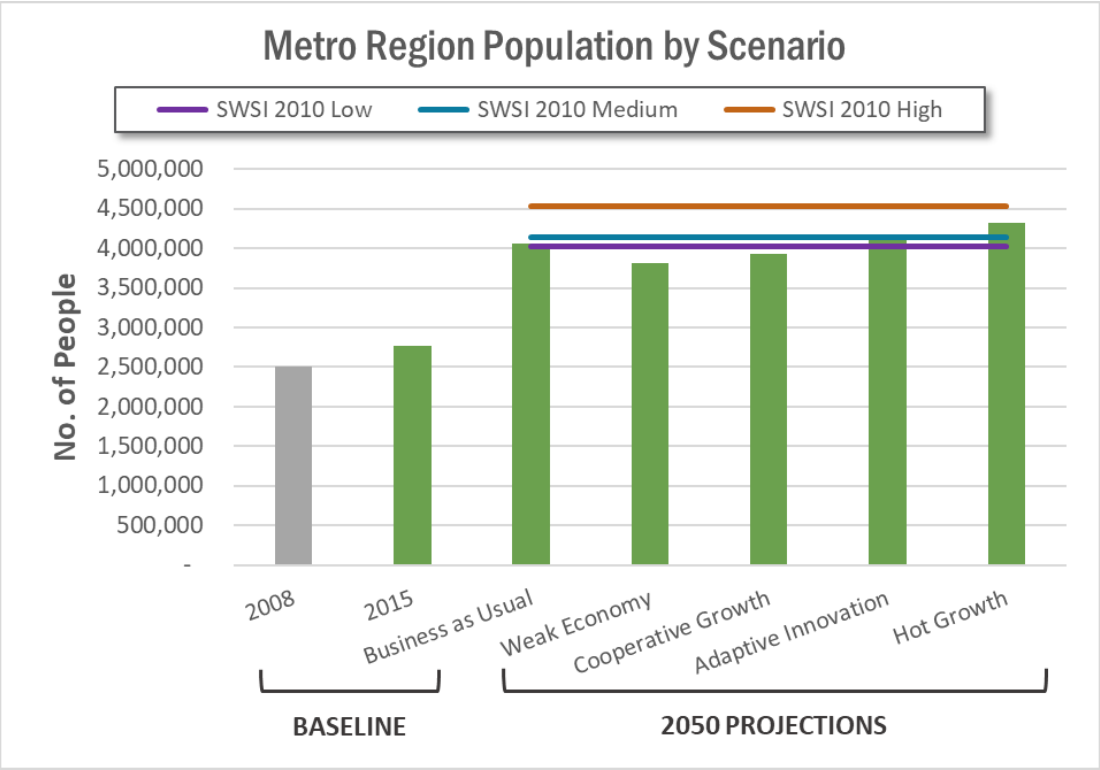

Figure 3-40: Metro Region Baseline and Projected Population.

The South Platte Basin including the Republican Sub-Basin but without the Metro Region Sub-Basin baseline for the Technical Update, which is based on 2015 population, is approximately 9% higher than the SWSI 2010 baseline, which used 2008 population. The SWSI 2010 low growth projection for 2050 exceeded the Technical Update projection for the Weak Economy scenario by about 12%. The SWSI 2010 medium growth population projection exceeded the Technical Update projection for Business as Usual but was slightly lower than the Cooperative Growth projection. The SWSI 2010 high growth population projection exceeded Technical Update projections by at least 12%. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-41.

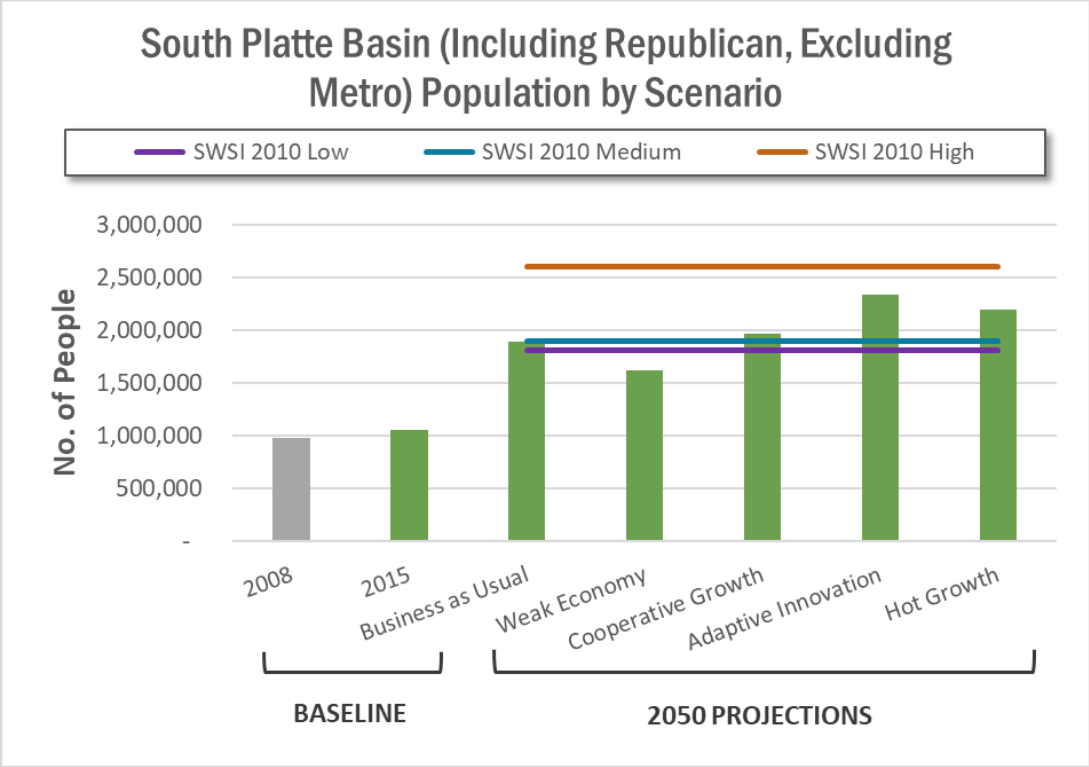

Figure 3-41: South Platte Basin Including Republican, Excluding Metro Region, Baseline and Projected Population.

3.6.1.2 WATER DEMANDS

The Metro Region baseline water demands were largely based on water provider-reported data, with approximately 86% of the baseline population demands represented by 1051 data, and 4% form WEPs, requiring 10% of the basin's baseline population demands to be estimated, as shown in Figure 3-42. This is the highest representation of 1051 data for any basin in the state.

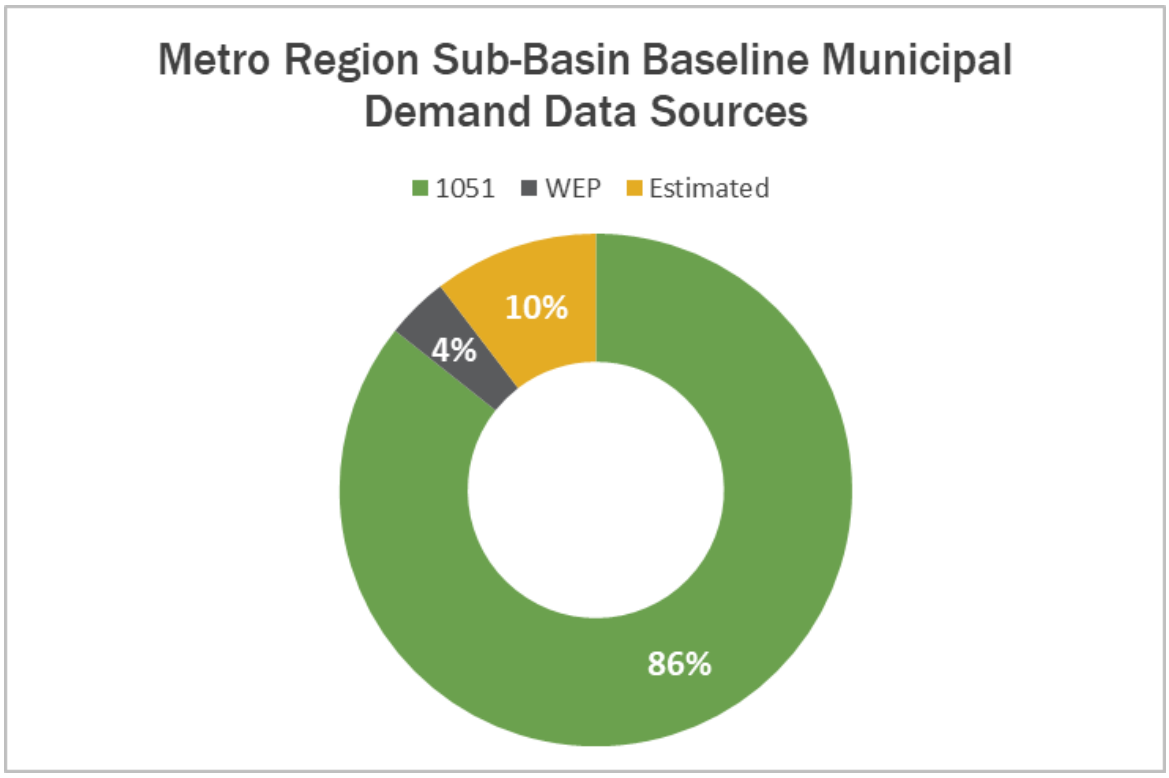

Figure 3-42: Metro Region Sub-Basin Baseline Municipal Water Demand Data Sources.

The Republican Sub-Basin baseline water demands were largely estimated. Approximately 13% of the baseline population demands were represented by water provider outreach and 4% from WEPs, requiring demands for about 83% of the basin's baseline population demands to be estimated, as shown in Figure 3-43. This is the second highest percentage of estimated demands for a basin in the state.

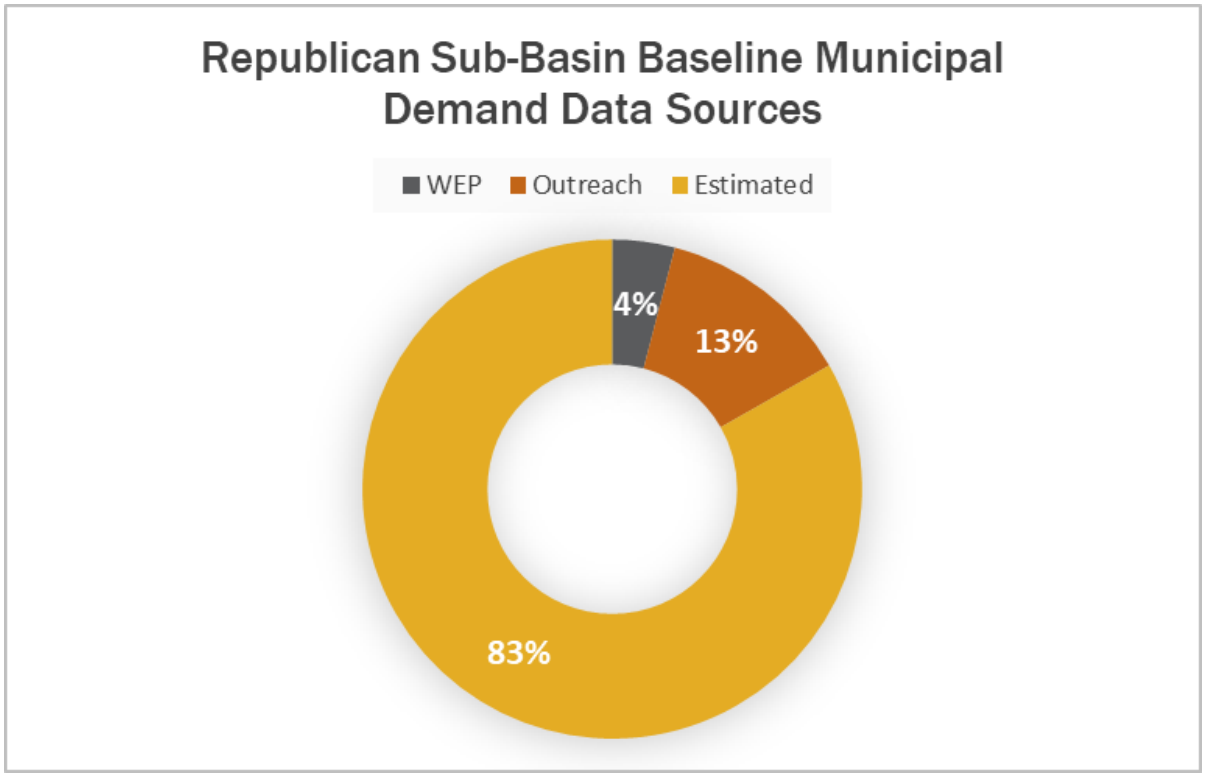

Figure 3-43: Republican Basin Baseline Municipal Water Demand Data Sources.

The baseline demands for the South Platte Without Metro or Republican Sub-Basin were also largely based on water provider-reported data, with approximately 60% of the baseline population demands represented by 1051 data, 27% from WEPs, and 0.1% from water provider outreach, requiring 13% of the basin's population demands to be estimated, as shown in Figure 3-44.

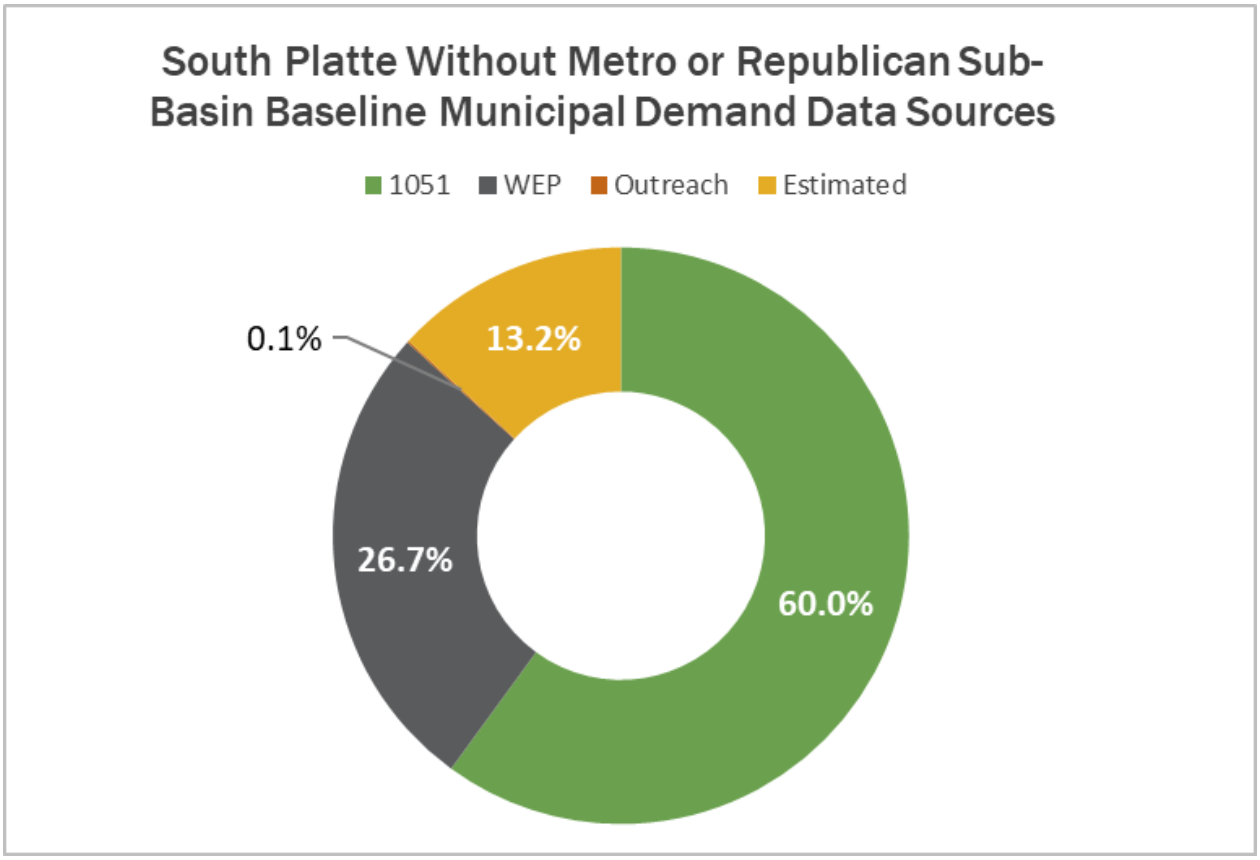

Figure 3-44: South Platte Without Metro or Republican Sub-Basin Baseline Municipal Demand Data Sources.

The combined South Platte Basin, including the Metro Region and the Republican Basin, average baseline per capita systemwide demand is approximately 152 gpcd. The Metro Region baseline has decreased from 155 gpcd in SWSI 2010 to approximately 141 gpcd and demands for most of the counties within this basin have also decreased. The average for the portion of the South Platte Without Metro or Republican Sub-Basin cannot be directly compared to SWSI 2010 because of differences in reporting. While baseline demands for counties outside of the Metro Region are generally higher, many decreased as compared to SWSI 2010. Some of the higher per capita values in the more rural areas are non-residential demands associated with businesses such as dairies, which are included in the municipal rather than industrial demand category. Table 3-26 represents baseline and projected per capita demands for counties within the basin.

Table 3-26: South Platte Basin Municipal Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Technical Update Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
METRO REGION SUB-BASIN							
Adams	142	135	129	128	121	118	141
Arapahoe	164	127	123	122	116	112	133
Broomfield	177	175	167	165	157	152	181
Denver	163	141	144	138	135	132	152
Douglas	146	130	126	125	118	114	137
Elbert*	111	137	138	135	128	124	149
Jefferson	152	163	162	162	155	150	174
Sub-Basin Total	155	141	138	135	130	126	148
REPUBLICAN SUB-BASIN							
Cheyenne*	183	222	216	218	207	199	229
Kit Carson	334	210	206	204	192	187	220
Lincoln*	254	238	222	222	211	203	238
Logan*	319	341	306	312	290	276	325
Phillips	390	252	244	245	229	221	258
Sedgwick*	322	284	272	277	260	249	288
Washington*	320	215	210	211	198	192	223
Yuma	281	261	250	250	234	226	266
Sub-Basin Total	NA	245	236	236	221	214	251
SOUTH PLATTE BASIN WITHOUT METRO OR REPUBLICAN SUB-BASIN							
Boulder	176	143	140	139	131	126	151
Clear Creek	224	265	243	247	230	220	259
Gilpin	75	216	204	207	195	186	218
Larimer	178	191	179	180	168	161	190
Logan*	319	341	306	312	290	276	325
Morgan	241	387	355	356	335	322	381
Park	110	147	145	145	137	132	156
Sedgwick*	322	284	272	277	260	249	288
Teller*	173	163	159	159	152	146	171
Washington*	320	215	210	211	198	192	223
Weld	186	179	180	175	167	162	198
Sub-Basin Total	NA	181	176	174	164	158	190
TOTAL SOUTH PLATTE BASIN							
Basin Total	NA	152	150	147	142	137	163

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

**Counties with population located in multiple basins. Per capita demand is calculated at a county level.*

The demand category distributions were individually evaluated for each sub-basin and the sub-basin average was used for counties within the respective sub-basin that had insufficient data to prepare a county-specific distribution. A summary of each sub-basin is provided below.

The Metro Region sub-basin baseline municipal water demands are comprised of approximately 53% indoor, 39% outdoor, and 8% non-revenue water uses, as shown in Figure 3-45. On a basin scale, the non-revenue water demand as a percentage of the systemwide demands is one of the lowest throughout the state. With a significant portion of the state population located in the Metro sub-basin, this relatively low non-revenue water demand percentage has a significant impact on the statewide average non-revenue water percentage.

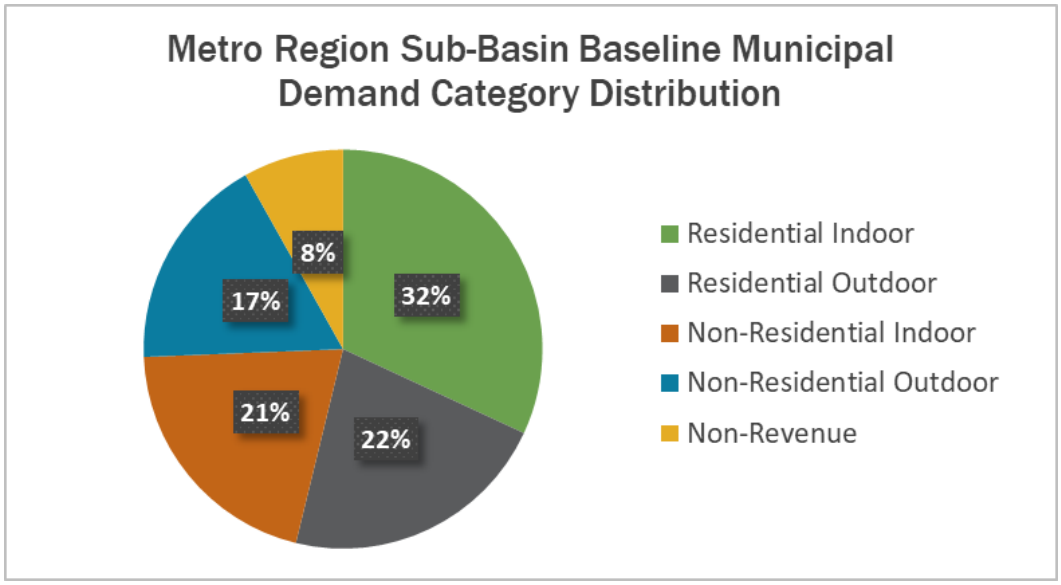

Figure 3-45: Metro Region Sub-Basin Baseline Municipal Demand Category Distribution.

The Republican sub-basin baseline municipal water demands are comprised of approximately 54% indoor, 40% outdoor, and 6% non-revenue water uses, as shown in Figure 3-46. The Republican sub-basin demands were mostly based on estimated demand data and the demand category distribution was based on outreach from one water provider. Two of the eighteen counties had sufficient demand category data available to apply a county-specific distribution. The basin average demand category distribution was used for the remaining counties. On a basin and sub-basin scale, the non-revenue water demand as a percentage of the systemwide demands is the lowest throughout the state.

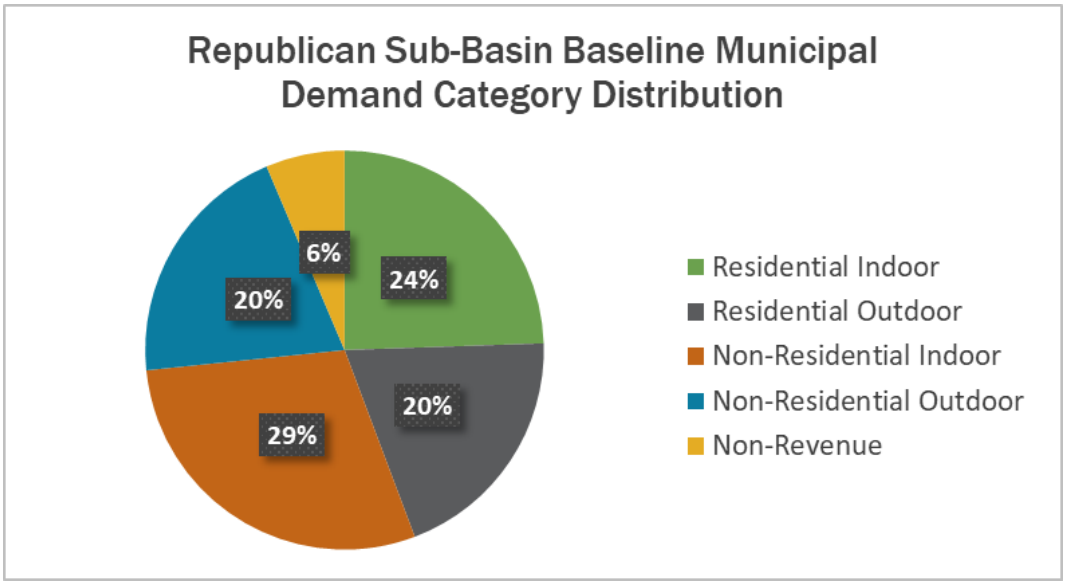

Figure 3-46: Republican Sub-Basin Baseline Municipal Demand Category Distribution.

The baseline municipal water demands for the South Platte Without Metro or Republican Sub-Basin are comprised of approximately 45% indoor use, 41% outdoor, and 14% non-revenue water, as shown in Figure 3-47. The South Platte Without Metro or Republican Sub-Basin had sufficient demand category data represented in seven of the eleven counties located in the basin. The basin average demand category distribution was used for the remaining counties. With the second largest population of all basins and sub-basins in the state, and a lower indoor demand percentage and higher non-revenue demand percentage than the Metro Region Sub-Basin, the influence of the South Platte Without Metro or Republican Sub-Basin on the statewide average partially offsets the Metro Region influence in these categories.

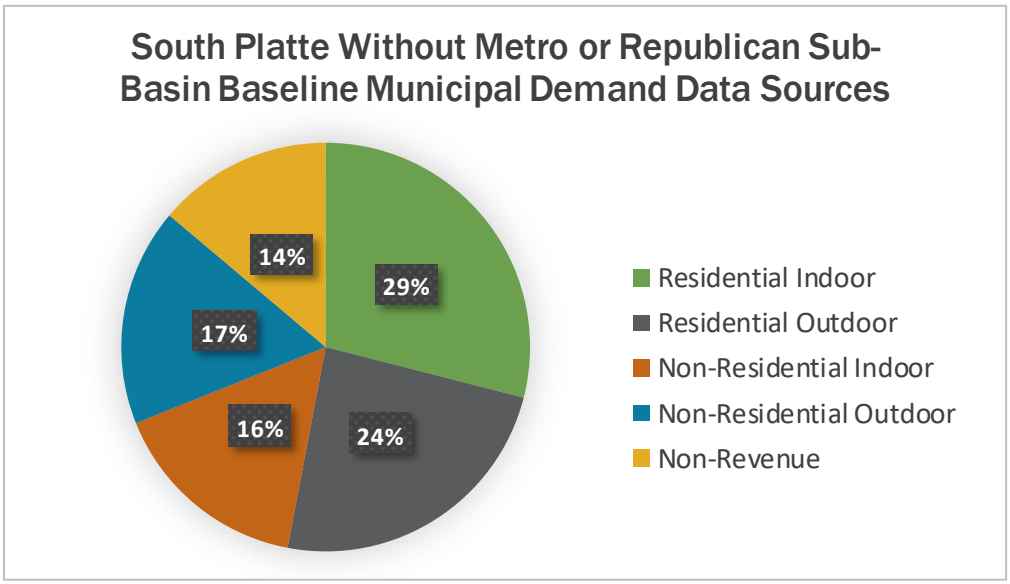

Figure 3-47: South Platte Without Metro or Republican Sub-Basin Baseline Municipal Demand Category Distribution.

Figure 3-48 provides a summary of per capita baseline and projected water demands for the Metro Region. Systemwide, the projected per capita demands decrease relative to the baseline except for the Hot Growth scenario. Consistently across all scenarios, residential indoor demand is the greatest individual demand category while non-revenue water is the lowest. Outdoor demands increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the "Hot and Dry" climate.

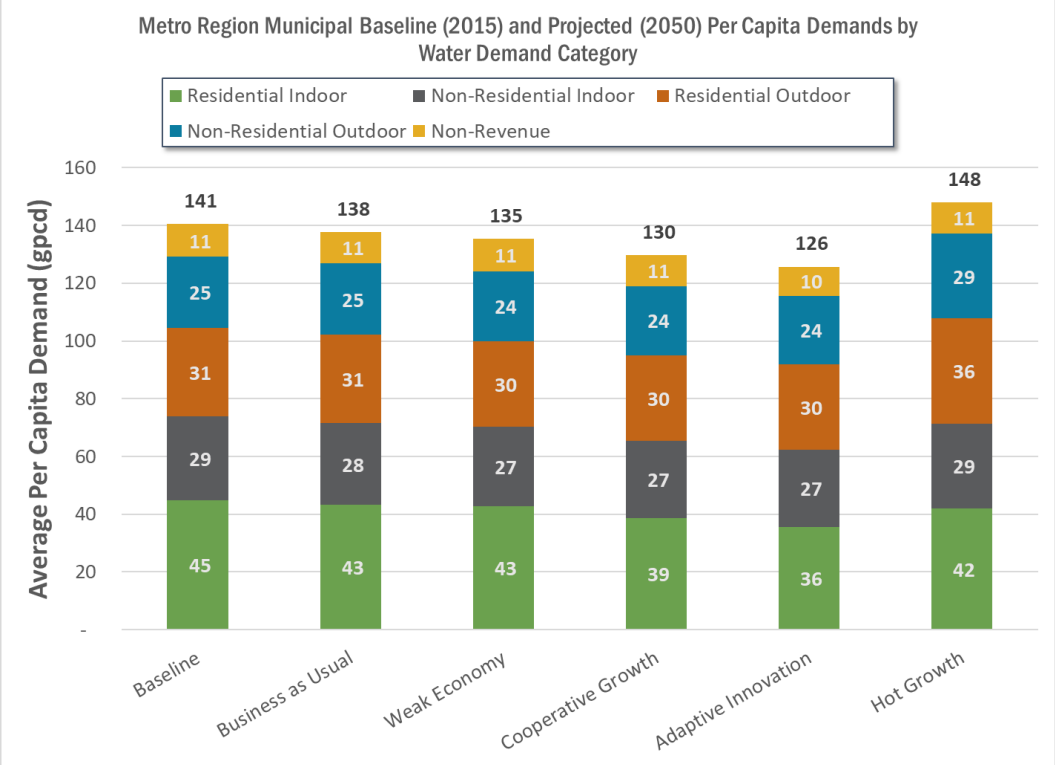

Figure 3-48: Metro Region Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-49 provides a summary of per capita baseline and projected water demands for the Republican Sub-Basin. Systemwide, the projected per capita demands decrease relative to the baseline except for the Hot Growth scenario. Consistently across all scenarios, non-residential indoor demand is the greatest individual demand category while non-revenue water is the lowest. Outdoor demands increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the "Hot and Dry" climate.

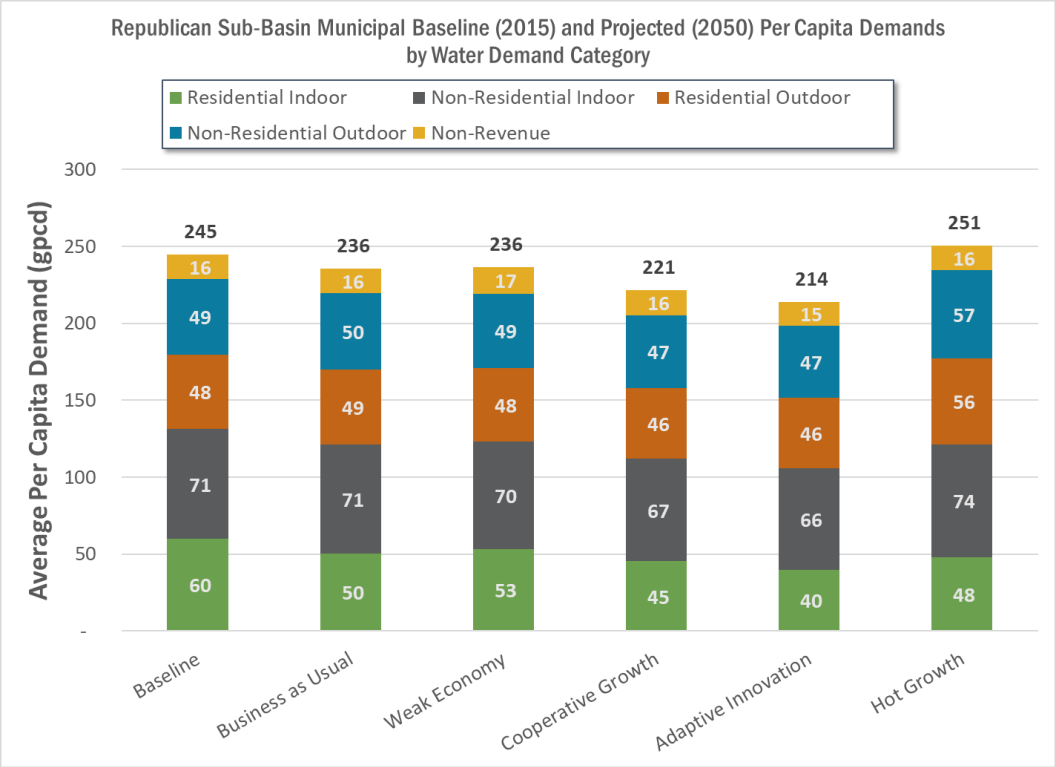

Figure 3-49: Republican Sub-Basin Municipal. Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-50 provides a summary of per capita baseline and projected water demands for the South Platte Without Metro or Republican Sub-Basin. Systemwide, the projected per capita demands decrease relative to the baseline except for the Hot Growth scenario. The residential indoor demand is the greatest demand category in the baseline, but the residential outdoor demand exceeds the residential indoor demand in the Cooperative Growth, Adaptive Innovation, and Hot Growth scenarios. Outdoor demands increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the "Hot and Dry" climate.

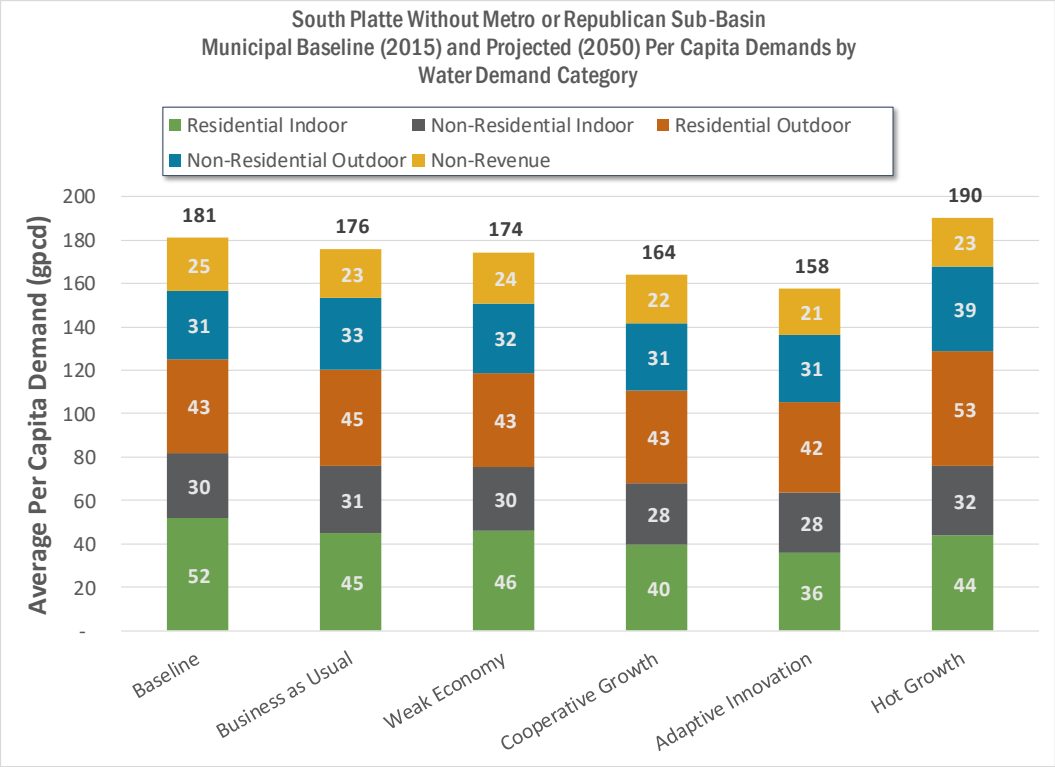

Figure 3-50: South Platte Without Metro or Republican Sub-Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-51 demonstrates the influence of the climate driver on per capita water demands in the Metro Region, with outdoor demands increasing by 5 to 8 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 119 to 140 gpcd, which exceed the SWSI 2010 projection of 118 gpcd for medium population with active conservation[28].

[28] SWSI 2010 projected per capita demands include savings from passive conservation.

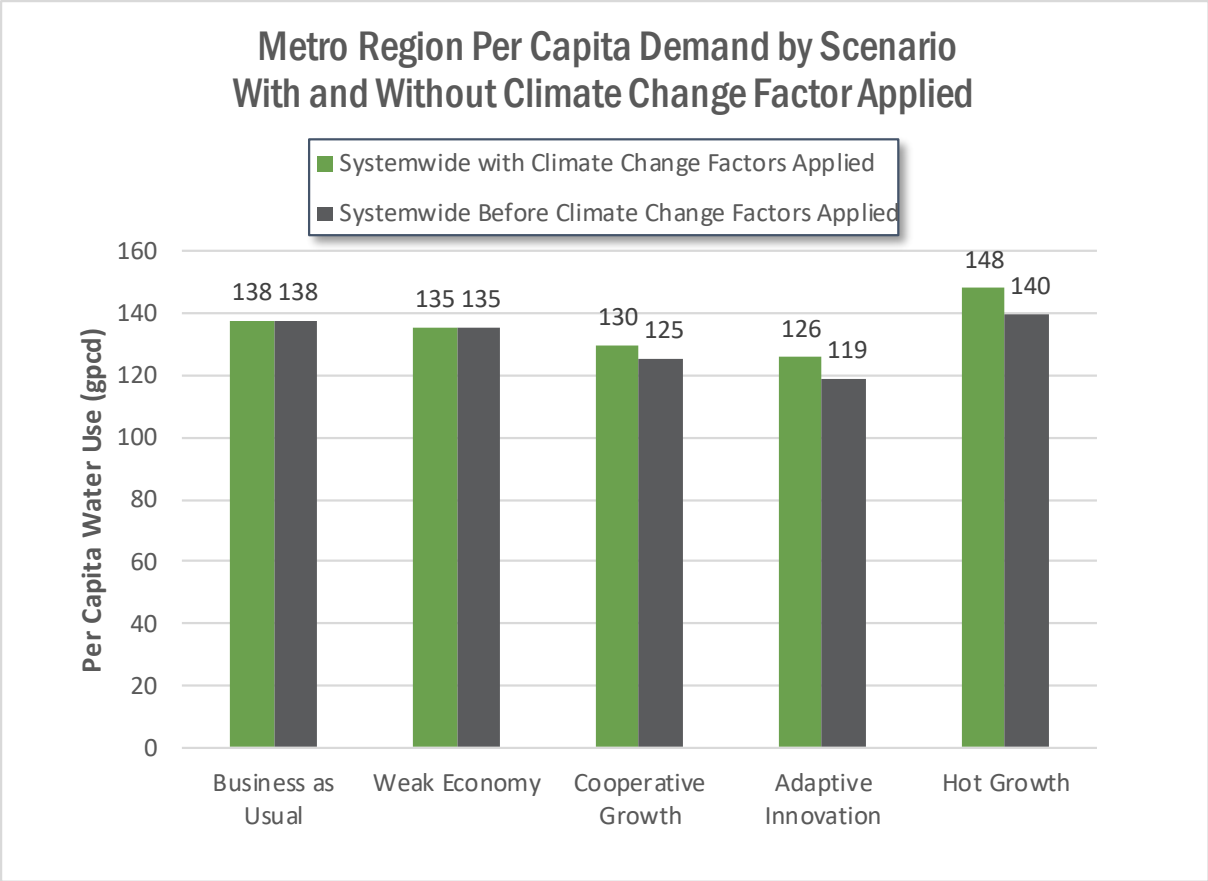

Figure 3-51: Effect of Climate Change Driver on the Metro Region Average Per Capita Demand.

Figure 3-52 demonstrates the influence of the climate driver on per capita water demands in the Republican Sub-Basin, with outdoor demands increasing by 4 to 12 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 204 to 239 gpcd. SWSI 2010 did not explicitly evaluate the Republican Sub-Basin. For the South Platte Basin, including the Republican Sub-Basin but excluding the Metro Region, SWSI 2010 projected a per capita demand of 129 gpcd for medium population with active conservation[29].

[29] SWSI 2010 projected per capita demands include savings from passive conservation.

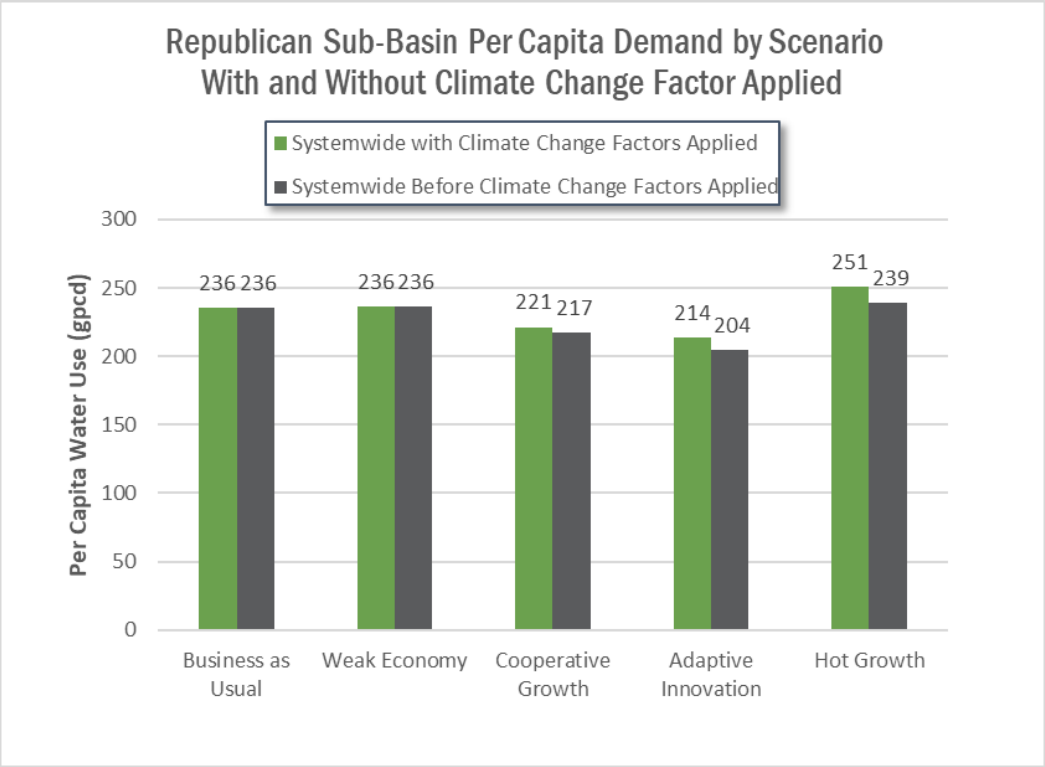

Figure 3-52: Effect of Climate Change Driver on the Republican Sub-Basin Average Per Capita Demand.

Figure 3-53 demonstrates the influence of the climate driver on per capita water demands in the South Platte Without Metro or Republican Sub-Basin, with outdoor demands increasing by 6 to 11 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 149 to 179 gpcd. As previously described, SWSI 2010 did not explicitly evaluate the South Platte Without Metro or Republican Sub-Basin. For the South Platte Basin, including the Republican Sub-Basin but excluding the Metro Region, the SWSI 2010 projected per capita demand was 129 gpcd for medium population with active conservation[30].

[30] SWSI 2010 projected per capita demands include savings from passive conservation.

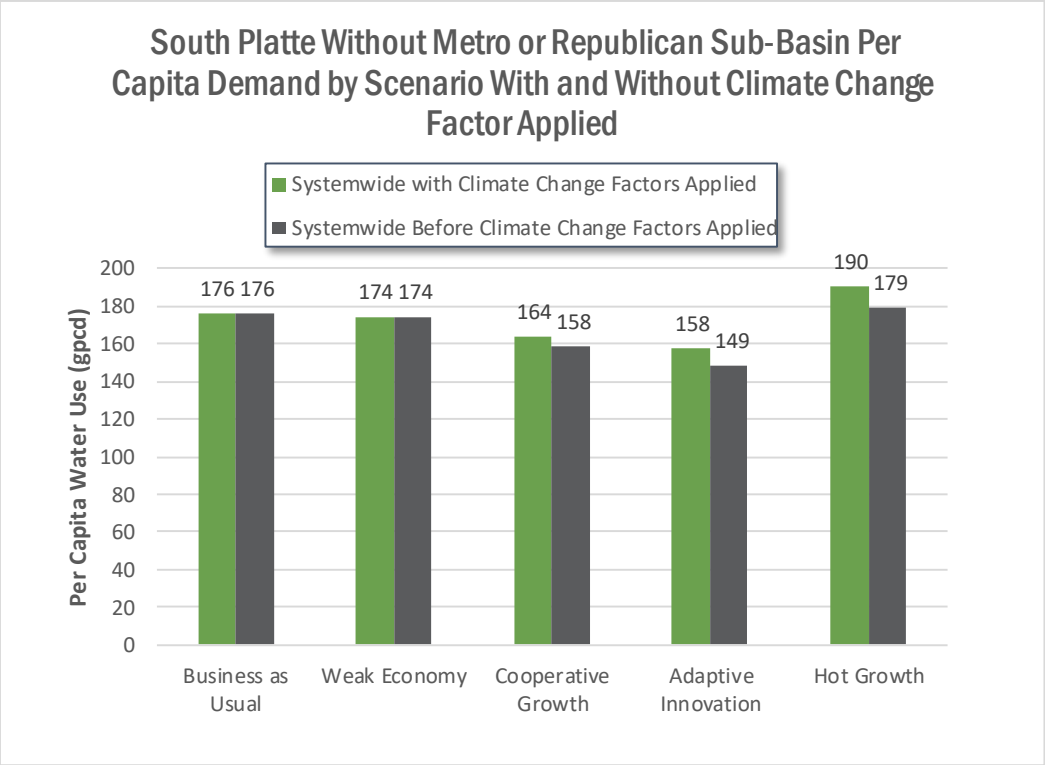

Figure 3-53: Effect of Climate Change Driver on the South Platte Without Metro or Republican Sub-Basin Average Per Capita Demand.

The total South Platte Basin municipal baseline and projected volumetric demands are provided in Table 3-27 and Table 3-28, showing the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 653,000 AFY in 2015 to between 900,000 and 1,200,000 AFY in 2050. The projected demands increase under all of the planning scenarios. The Metro Region accounts for about 67% of the baseline demand but slightly decreases as a percentage of the total basin demand under all of the planning scenarios.

Table 3-27: South Platte Basin Baseline and Projected Demands by County (AFY)

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
METRO REGION SUB-BASIN						
Adams	73,865	128,982	119,888	114,098	116,998	149,049
Arapahoe	89,320	124,348	115,718	110,521	111,948	142,660
Broomfield	12,701	17,851	16,632	15,902	16,153	20,560
Denver	107,129	153,810	138,561	148,680	157,418	172,789
Douglas	47,090	68,206	63,425	60,612	61,411	78,861
Jefferson	103,021	126,239	118,247	114,122	115,932	143,829
Elbert*	2,619	7,066	6,498	6,214	6,317	8,137
Sub-Basin Total	435,745	626,501	578,969	570,151	586,176	715,885
REPUBLICAN SUB-BASIN						
Cheyenne*	285	248	214	225	248	304
Kit Carson	1,932	2,211	1,876	1,954	2,174	2,731
Lincoln*	284	404	345	364	401	502
Logan*	775	928	809	833	908	1,142
Phillips	1,218	1,193	1,024	1,061	1,175	1,464
Sedgwick*	321	299	261	272	297	367
Washington*	914	884	758	791	875	1,088
Yuma	2,936	3,192	2,731	2,823	3,130	3,925
Sub-Basin Total	8,666	9,361	8,019	8,323	9,208	11,524
SOUTH PLATTE BASIN WITHOUT METRO OR REPUBLICAN BASINS						
Boulder	51,028	70,079	59,666	67,765	78,616	87,389
Clear Creek	2,784	3,382	2,936	3,040	3,320	4,172
Gilpin	1,407	1,518	1,315	1,371	1,499	1,870
Larimer	71,037	108,813	93,801	106,439	121,795	133,966
Logan*	7,666	9,178	8,002	8,232	8,981	11,293
Morgan	12,246	16,987	14,567	15,158	16,720	21,099
Park	2,743	3,874	3,294	3,467	3,818	4,819
Sedgwick*	440	410	358	372	407	503
Teller*	2,095	2,915	2,483	2,627	2,892	3,627
Washington*	252	244	209	218	241	300
Weld	57,145	148,317	122,984	145,630	166,264	188,765
Sub-Basin Total	208,842	365,716	309,615	354,319	404,554	457,803
TOTAL SOUTH PLATTE BASIN						
Basin Total	653,253	1,001,578	896,603	932,792	999,938	1,185,213

**Counties with population located in multiple basins. This represents the systemwide demands associated with the Arkansas Basin only.*

Table 3-28: Total South Platte Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	System wide
Baseline (2015)	201,179	126,911	146,739	114,162	64,261	653,253
Business as Usual	292,434	195,475	234,077	182,843	96,750	1,001,578
Weak Economy	265,948	172,871	205,653	160,940	91,192	896,603
Cooperative Growth	257,934	180,055	224,300	174,513	95,990	932,792
Adaptive Innovation	259,675	198,900	247,167	191,604	102,592	999,938
Hot Growth	311,080	222,253	305,972	238,591	107,317	1,185,213

Figure 3-54 shows how the projected demand and population vary between the scenarios for the Metro Region. All of the projection scenarios result in an increase relative to the baseline. Projected demand for Weak Economy, Cooperative Growth, and Adaptive Innovation are all within 3% of each other, even though each scenario has a different population projection – low, medium, and high, respectively.

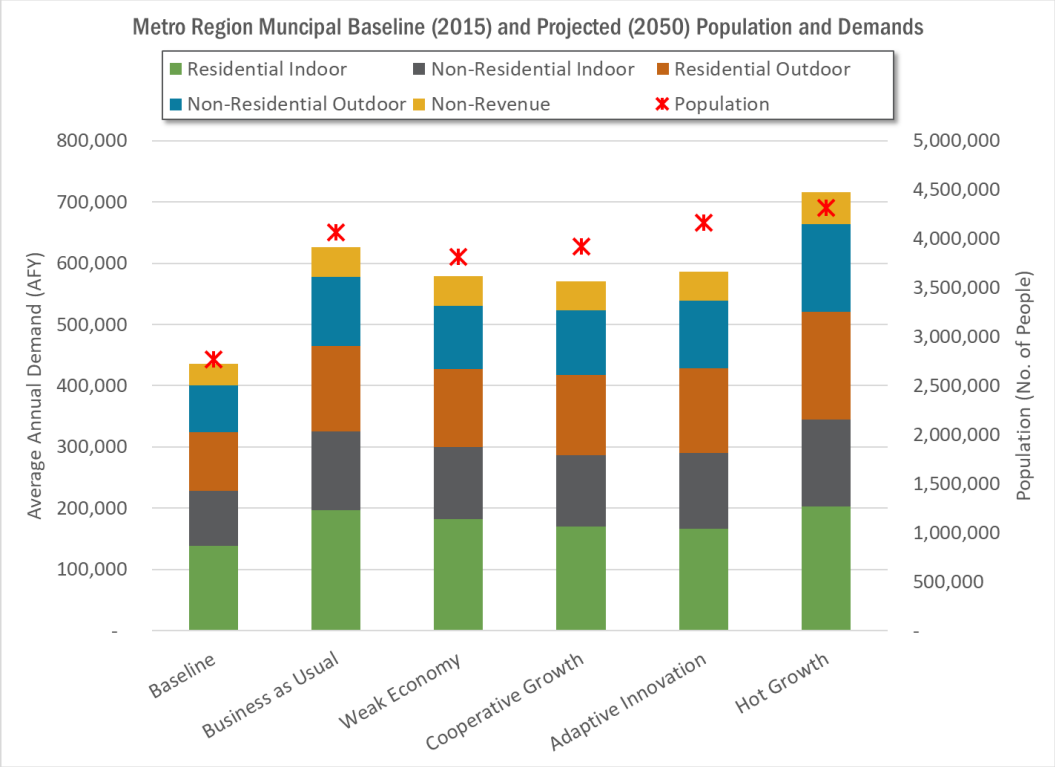

Figure 3-54: Metro Region Baseline and Projected Population and Municipal Demands.

Figure 3-55 shows how projected demand and population vary between the scenarios for the Republican Sub-Basin. Demands are projected to decrease relative to the baseline in the Weak Economy and Cooperative Growth scenarios.

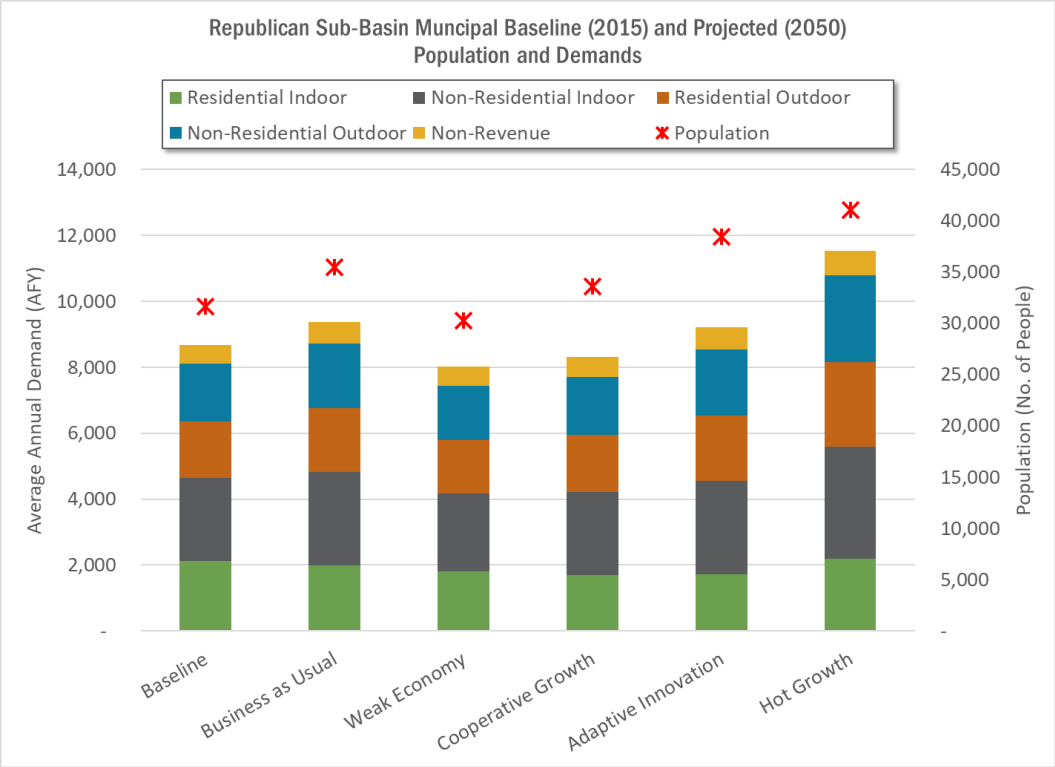

Figure 3-55: Republican Basin Baseline and Projected Population and Municipal Demands.

Figure 3-56 shows how the projected demand and population vary between the scenarios for the South Platte Without Metro or Republican Sub-Basin. All of the projection scenarios result in an increase relative to the baseline. Projected demands tend to follow population trends. This is not the case, however, for the Adaptive Innovation scenario in which the population exceeds the Hot Growth scenario population but the systemwide demand projection is lower. This shows the influence of projected per capita demands for this basin.

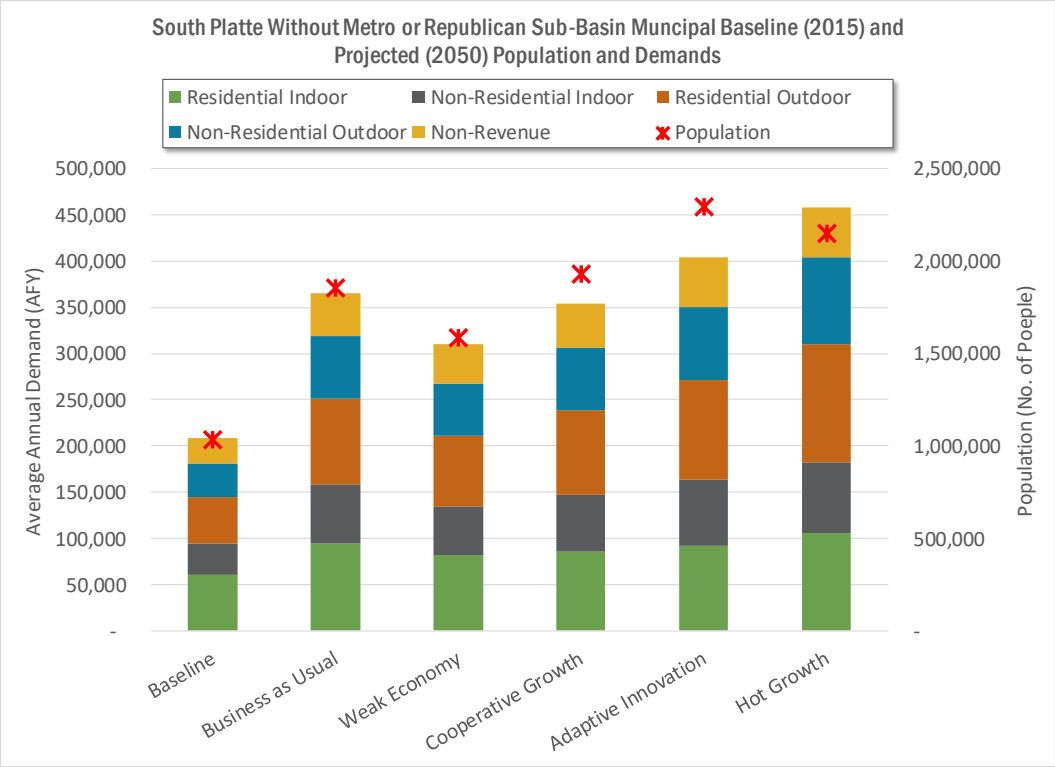

Figure 3-56: South Platte Without Metro or Republican Sub-Basin Baseline and Projected Population and Municipal Demands.

Figure 3-57 shows how projected demand and population vary between the scenarios for the entire South Platte Basin, including the three sub-basins. All of the projection scenarios result in an increase relative to the baseline. Projected demands in the Business as Usual and Adaptive Innovation scenarios are similar, although population projected for the Adaptive Innovation scenario is about 10% higher.

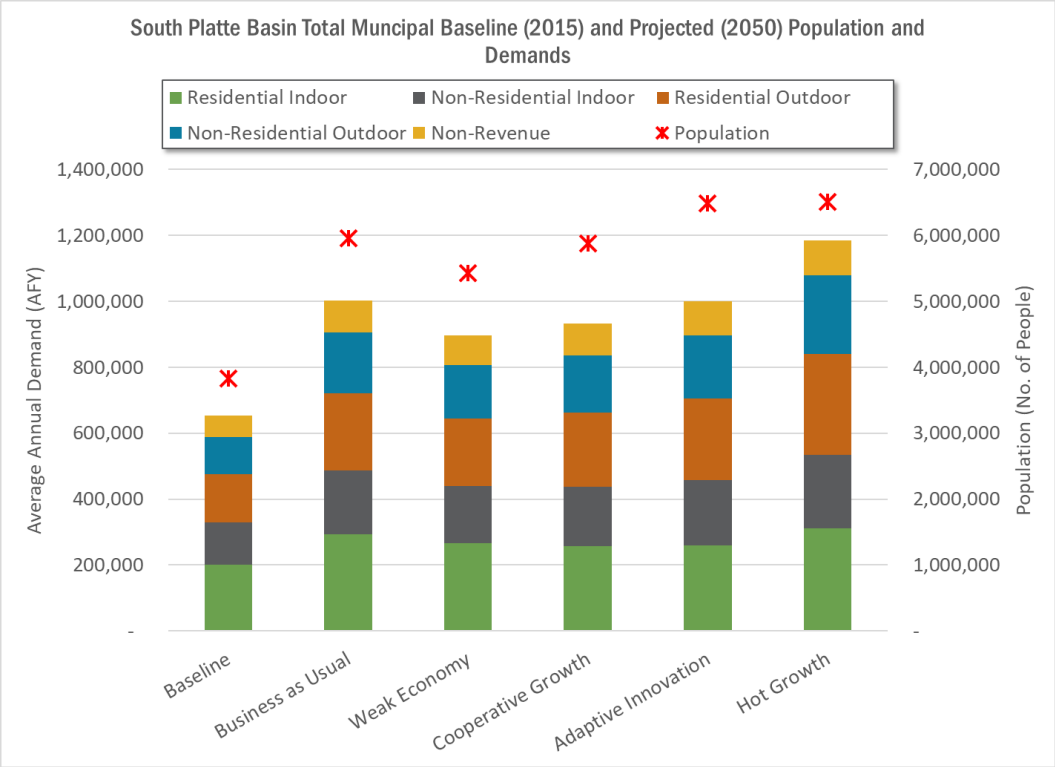

Figure 3-57: Total South Platte Basin Baseline and Projected Population and Municipal Demands.

3.6.2 INDUSTRIAL

The South Platte Basin currently includes about 40% of the statewide industrial demand. Approximately 67% of the baseline industrial demands are in the Metro Region and 33% are in the South Platte Without Metro or Republican Sub-Basin. There are no industrial demands in the Republican Basin. Industrial demands in the South Platte Basin are associated with the Large Industry, Snowmaking, and Thermoelectric sub-sectors. No demands were projected for the Energy Development sub-sector because data were not publicly available for the Technical Update. While water demands for energy development are generally small compared to other demands represented in the Technical Update, demands for this category could be represented in the future if additional data become available. Basin-scale industrial demands are shown on Figure 3-58 and county-scale industrial demands are summarized in Table 3-29 through Table 3-31.

Large Industry demands in this basin are located in three counties. Baseline demands in Jefferson County were based on data from an existing hydrologic model, and projected demands were not varied by scenario at the direction of the water user. Large Industry demands in Morgan and Weld counties were based on data from SWSI 2010. The baseline demand has decreased from 59,000 AFY in SWSI 2010 to 52,230 AFY in the Technical Update analysis, due to a decrease in Jefferson County. Projected 2050 Large Industry demands range from 51,570 AFY to 52,890 AFY.

The baseline Snowmaking demand is 300 AFY as compared to 320 AFY in SWSI 2010. The reduction in demand is due to a decrease in snowmaking acres in Clear Creek County. Projected demands are 320 AFY and were not varied by scenario.

Thermoelectric demands are related to eight facilities in seven counties. Baseline demands for seven of the facilities were updated based on information from Xcel and the eighth facility was based on data from SWSI 2010. This basin had a ninth facility in Denver County that was previously represented in SWSI 2010, but it has since been decommissioned. The total baseline demand has decreased from 33,400 AFY in SWSI 2010 to 19,670 AFY in the Technical Update analysis. Projected 2050 Thermoelectric demands range from 23,110 AFY to 28,240 AFY.

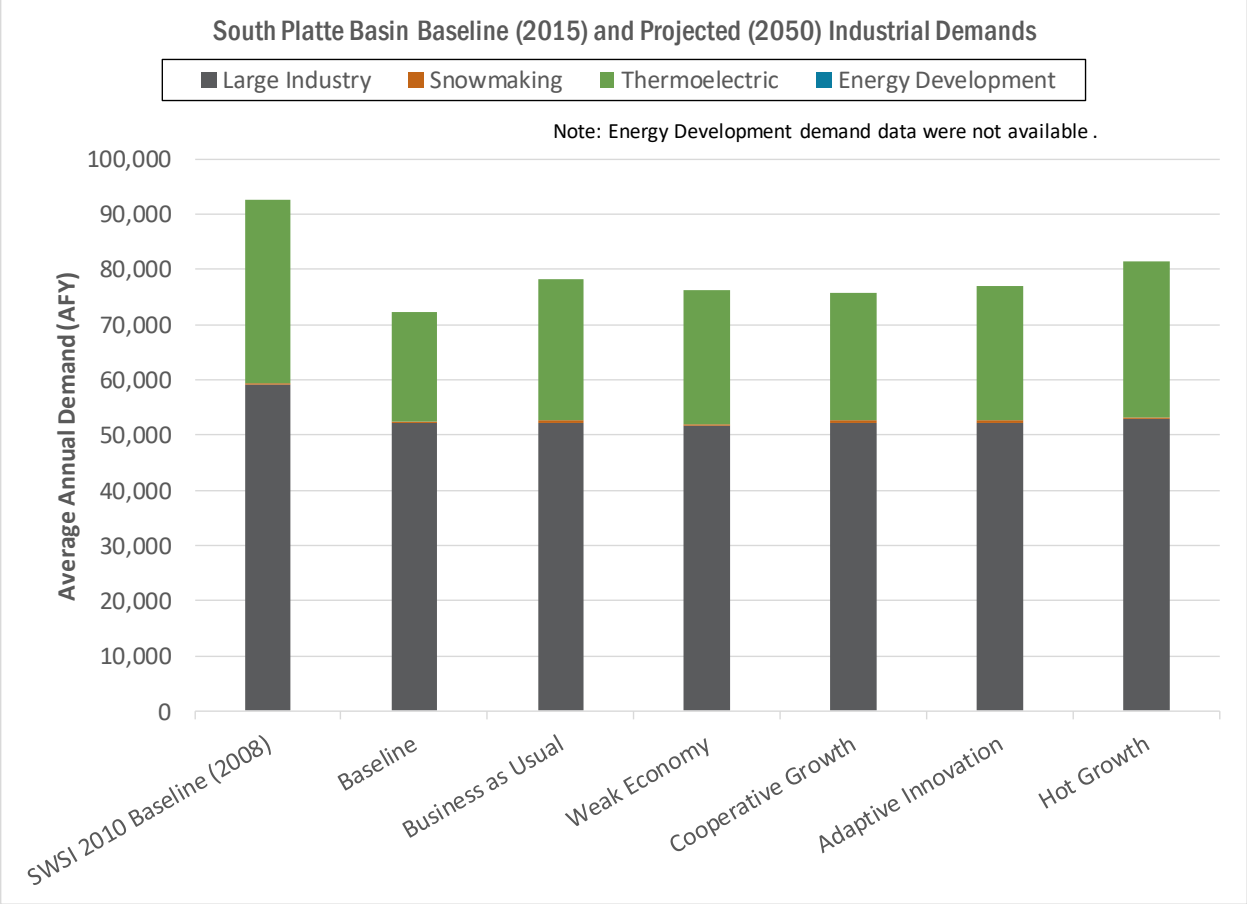

Figure 3-58: Total South Platte Basin Industrial Baseline and Projected Demands.

Table 3-29: Metro Region Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Econ-omy	Cooperative Growth	Adaptive Innovation	Hot Growth
Adams	Large Industry	-	-	-	-	-	-
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	2,990	2,990	2,840	2,690	2,840	3,290
	Energy Development	-	-	-	-	-	-
Arapahoe	Large Industry	-	-	-	-	-	-
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	50	50	50	50	50	60
	Energy Development	-	-	-	-	-	-
Denver	Large Industry	-	-	-	-	-	-
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	0	0	0	0	0	0
	Energy Development	-	-	-	-	-	-
Jefferson	Large Industry	45,630	45,630	45,630	45,630	45,630	45,630
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Sub-Basin Total		48,670	48,670	48,520	48,370	48,520	48,980

Table 3-30: South Platte Without Metro or Republican Sub-Basin Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Boulder	Large Industry	-	-	-	-	-	-
	Snowmaking	230	230	230	230	230	230
	Thermoelectric	1,890	1,890	1,800	1,700	1,800	2,080
	Energy Development	-	-	-	-	-	-
Clear Creek	Large Industry	-	-	-	-	-	-
	Snowmaking	70	90	90	90	90	90
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Larimer	Large Industry	-	-	-	-	-	-
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	5,200	11,200	10,640	10,080	10,640	12,320
	Energy Development	-	-	-	-	-	-
Morgan	Large Industry	2,100	2,100	1,890	2,100	2,100	2,310
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	4,830	4,830	4,590	4,350	4,590	5,310
	Energy Development	-	-	-	-	-	-
Weld	Large Industry	4,500	4,500	4,050	4,500	4,500	4,950
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	4,710	4,710	4,470	4,240	4,470	5,180
	Energy Development	-	-	-	-	-	-
Sub-Basin Total		23,530	29,550	27,760	27,290	28,420	32,470

Table 3-31: Total South Platte Basin Industrial Baseline and Projected Demands (AFY).

Basin	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Metro Sub-Region	Large Industry	45,630	45,630	45,630	45,630	45,630	45,630
	Snowmaking	0	0	0	0	0	0
	Thermoelectric	3,040	3,040	2,890	2,740	2,890	3,350
	Energy Development	0	0	0	0	0	0
South Platte Without Metro or Republican Sub-Basin	Large Industry	6,600	6,600	5,940	6,600	6,600	7,260
	Snowmaking	300	320	320	320	320	320
	Thermoelectric	16,630	22,630	21,500	20,370	21,500	24,890
	Energy Development	0	0	0	0	0	0
Basin Total		72,200	78,220	76,280	75,660	76,940	81,450

3.6.3 TOTAL

South Platte Basin combined M&I demand projections for 2050 range from approximately 970,000 AFY in the Weak Economy scenario to 1.27 million AFY in the Hot Growth scenario, as shown in Figure 3-59. Industrial demands account for 6% - 10% of the total M&I demands. On a basin scale, the demand projections do not follow the statewide sequence of the volumetric demand scenario rankings described in the CWP, with the Adaptive Innovation scenario falling out of sequence.

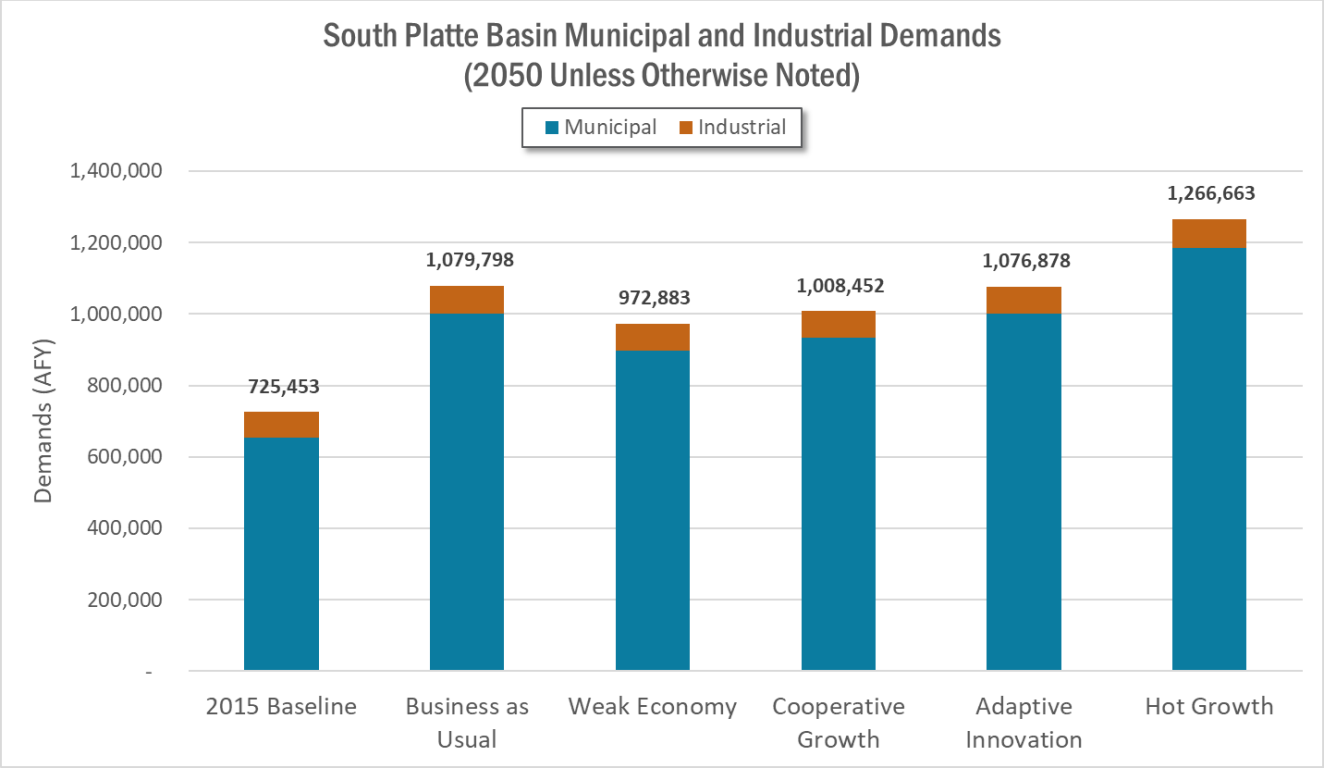

Figure 3-59: Total South Platte Basin Baseline and Projected M&I Demands.

3.7 SOUTHWEST REGION

3.7.1 MUNICIPAL

3.7.1.1 POPULATION

The Southwest Region currently includes about 2% of the statewide population. Between the years 2015 and 2050, it is projected to grow from approximately 110,000 to between 130,000 and 280,000 people in the low and high growth scenarios, respectively. Using the specific numbers, this is an increase in population of 16% to 161%,. On a percentage basis, the Southwest Region has the largest projected increase of all basins throughout the state. Yet, even with the 161% population increase under the high growth scenarios, the Southwest Region would include only about 3% of the future statewide population.

Table 3-32 shows how population growth is projected to vary across counties under each planning scenario. All counties are projected to increase in population for the high growth scenario, ranging from about 59% to 218%. Dolores and San Juan Counties are projected to decrease in population for the low growth scenario, with all other counties projected to increase. The most populous county, La Plata County, is projected to increase under all scenarios and account for most of the growth. San Miguel County is projected to have the highest growth rate for an individual county, ranging from about 42% to 218%. Note that Montrose County is split between multiple basins, with the county demands pro-rated between basins based on the population located within each basin. This approach is consistent with prior SWSI analyses.

Table 3-32: Southwest Region Baseline and Projected Populations by County

County	2015 Population	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Archuleta	12,417	26,571	17,070	25,142	35,845	38,281
Dolores	1,972	2,597	1,668	2,457	3,503	3,742
La Plata	54,857	94,002	60,391	101,831	126,811	135,430
Montezuma	26,129	47,158	30,296	44,623	63,617	67,941
Montrose*	4,085	7,449	4,785	7,048	10,048	10,731
San Juan	696	767	493	726	1,035	1,105
San Miguel	7,843	17,293	11,110	19,183	23,329	24,914
Basin Total	107,999	195,837	125,814	201,010	264,189	282,144

**Counties with population located in multiple basins. This table represents the portion of the county located in the Southwest Region.*

The Southwest Region baseline for the Technical Update, which is based on 2015 population, is approximately 3% higher than the SWSI 2010 baseline, which used 2008 population. The SWSI 2010 medium growth population projection for 2050 exceeded the Technical Update population projections for the Business as Usual, Weak Economy, and Cooperative Growth scenarios by at least 11%. However, the Technical Update projections for the Adaptive Innovation and Hot Growth scenarios exceed the SWSI 2010 high growth projection. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-60.

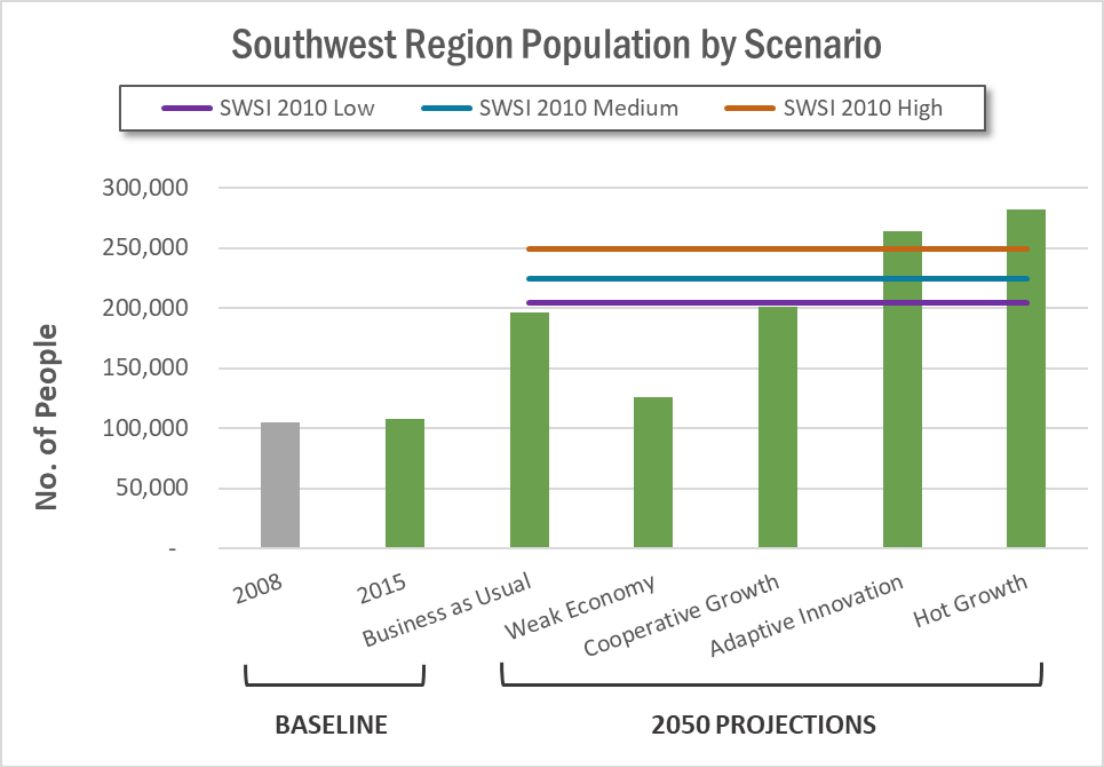

Figure 3-60: Southwest Region Baseline and Projected Population.

3.7.1.2 WATER DEMANDS

The Southwest Region baseline water demands were based on a mix of data sources, with approximately 27% of the baseline population demands represented by 1051 data, 18% from water provider outreach, and 3% from WEPs, requiring demands for about 52% of the basin's baseline population demands to be estimated, as shown in Figure 3-61.

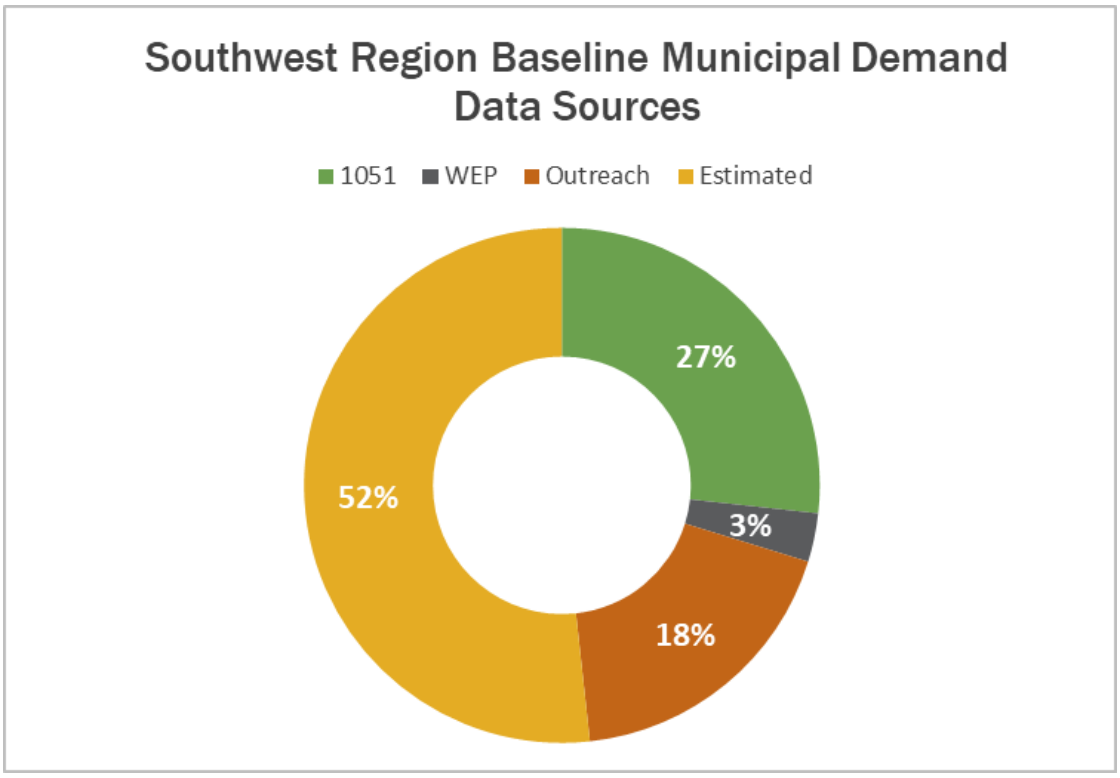

Figure 3-61: Southwest Region Baseline Municipal Water Demand Data Sources.

The Southwest Region average baseline per capita systemwide demand has increased from 183 gpcd in SWSI 2010 to approximately 198 gpcd. Table 3-33 represents baseline and projected per capita demands for counties within the Southwest Region. While demands for over half of the basin population were estimated, more water provider-reported data were available for the Technical Update as compared to SWSI 2010.

Table 3-33: Southwest Region Municipal Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Technical Update Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Archuleta	182	220	197	201	189	180	216
Dolores	242	108	112	108	108	104	119
La Plata	169	184	171	175	163	157	187
Montezuma	172	244	217	225	209	198	237
Montrose*	187	192	171	174	164	156	188
San Juan	182	199	173	193	166	151	175
San Miguel	289	137	135	134	128	123	149
Basin Total	183	198	181	186	173	166	199

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

**Counties with population located in multiple basins. While this represents the per capita demand associated with the Southwest Region only, per capita use does not change within a given county by basin.*

The Southwest Region baseline municipal water demands are comprised of approximately 51% indoor, 34% outdoor, and 15% non-revenue water uses, as shown in Figure 3-62. Only one of seven counties had

sufficient demand category data available to apply a county-specific distribution. The basin average demand category distribution was used for the remaining counties. On a basin scale, the non-residential outdoor demand as a percentage of the systemwide demand is one of the lowest reported throughout the state, at approximately 9%. Conversely, the baseline non-revenue water demand is one of the highest statewide, at approximately 15% of the systemwide demands.

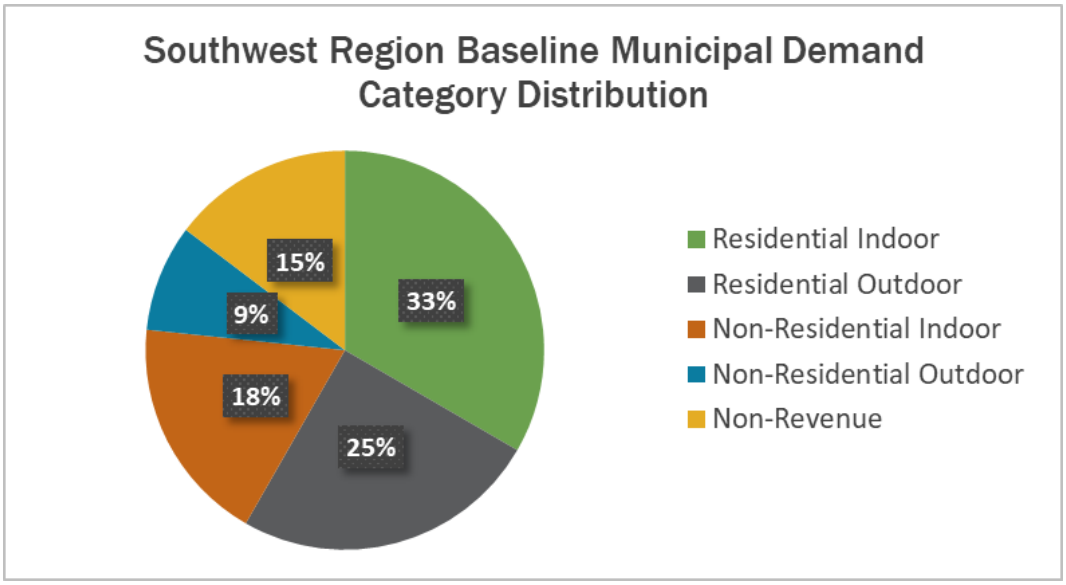

Figure 3-62: Southwest Region Baseline Municipal Demand Category Distribution.

Figure 3-63 provides a summary of per capita baseline and projected water demands for the Southwest Region. Systemwide, the projected per capita demands decrease relative to the baseline except for the Hot Growth scenario which has a similar systemwide per capita demand as the baseline, but the demand category distributions are different. The residential indoor demand is the greatest demand category in the baseline, but the residential outdoor demand exceeds the residential indoor demand in the all of the projections except for the Weak Economy scenario. Outdoor demands increased significantly for the Hot Growth scenario, due to an increase in outdoor demands coupled with the “Hot and Dry” climate.

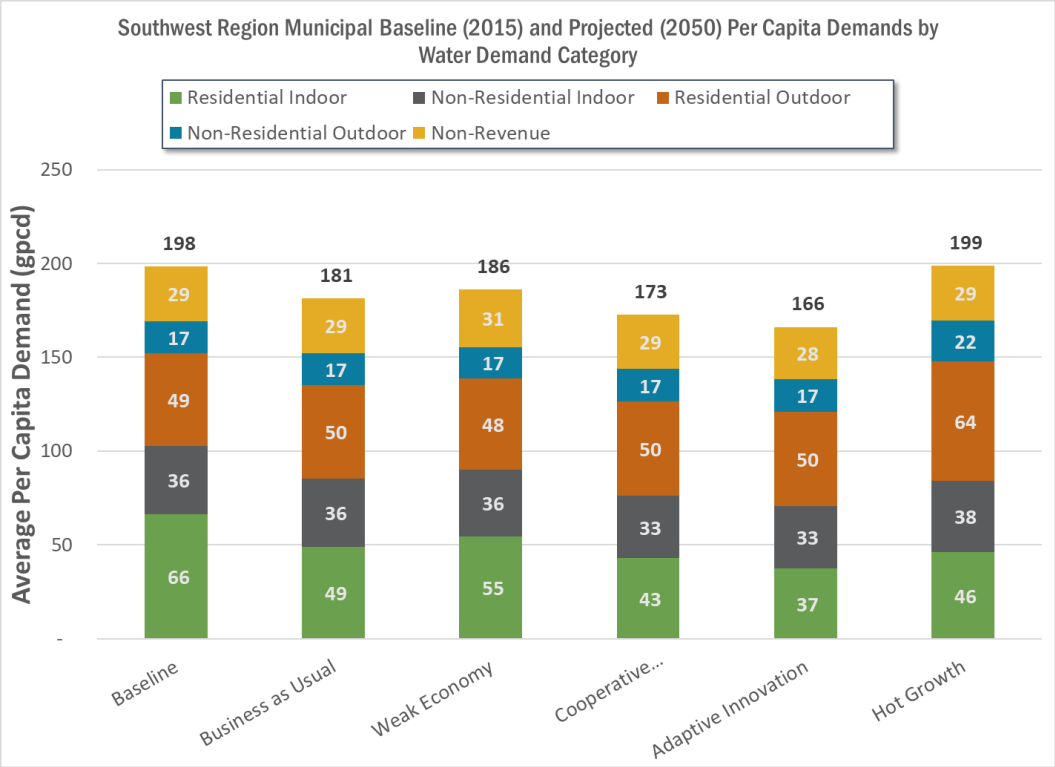

Figure 3-63: Southwest Region Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-64 demonstrates the influence of the climate driver on per capita water demands, with outdoor demands increasing by 9 to 16 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 153 to 186 gpcd, which exceed the SWSI 2010 projection of 110 gpcd for medium population with active conservation[31]. This is partly due to the Technical Update baseline exceeding the SWSI 2010 baseline. The Southwest Region per capita demand reported in SWSI 2010 was the lowest throughout the entire state.

[31] SWSI 2010 projected per capita demands include savings from passive conservation.

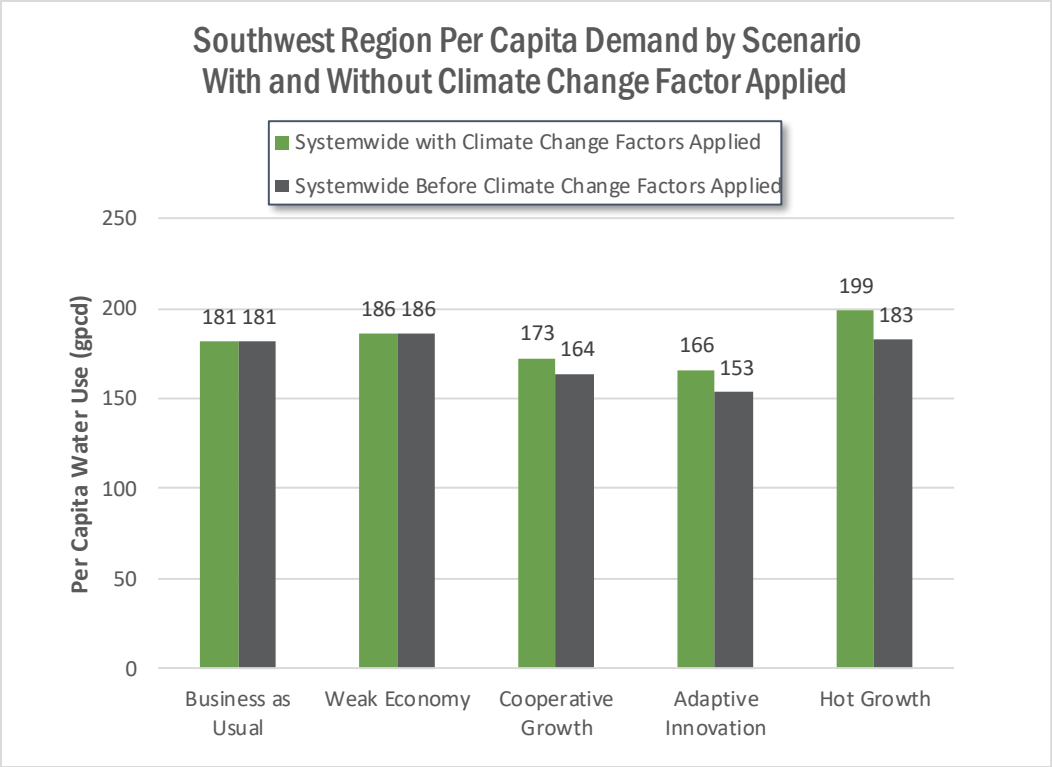

Figure 3-64: Effect of Climate Change Driver on the Southwest Region Average Per Capita Demand.

The Southwest Region municipal baseline and projected volumetric demands are provided in Table 3-34, showing the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 24,000 AFY in 2015 to between 26,000 and 63,000 AFY in 2050. La Plata County accounts for nearly half of the baseline demand followed by Montezuma County at just under one-third of the basin demand.

Table 3-34: Southwest Region Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Archuleta	3,060	5,853	3,848	5,314	7,226	9,270
Dolores	239	326	202	297	410	499
La Plata	11,322	18,011	11,837	18,645	22,269	28,441
Montezuma	7,152	11,436	7,620	10,430	14,109	18,021
Montrose*	877	1,425	931	1,295	1,754	2,258
San Juan	155	149	107	135	175	217
San Miguel	1,204	2,609	1,671	2,747	3,221	4,146
Basin Total	24,009	39,810	26,214	38,864	49,164	62,851

**Counties with population located in multiple basins. This table represents systemwide demands for the portion of the county located in the Southwest Region.*

The baseline and projected demand distributions are shown in Table 3-35 and Figure 3-65 and are reflective of population variations among the scenarios. All of the projection scenarios result in an increase relative to the baseline.

Table 3-35: Southwest Region Municipal Baseline and Projected Volumetric Demands by Demand Category (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	Systemwide
Baseline (2015)	8,006	4,409	5,986	2,079	3,528	24,009
Business as Usual	10,740	8,006	10,879	3,784	6,401	39,810
Weak Economy	7,689	5,018	6,819	2,371	4,318	26,214
Cooperative Growth	9,636	7,506	11,285	3,920	6,516	38,864
Adaptive Innovation	11,054	9,854	14,878	5,174	8,203	49,164
Hot Growth	14,536	12,023	20,085	6,985	9,221	62,851

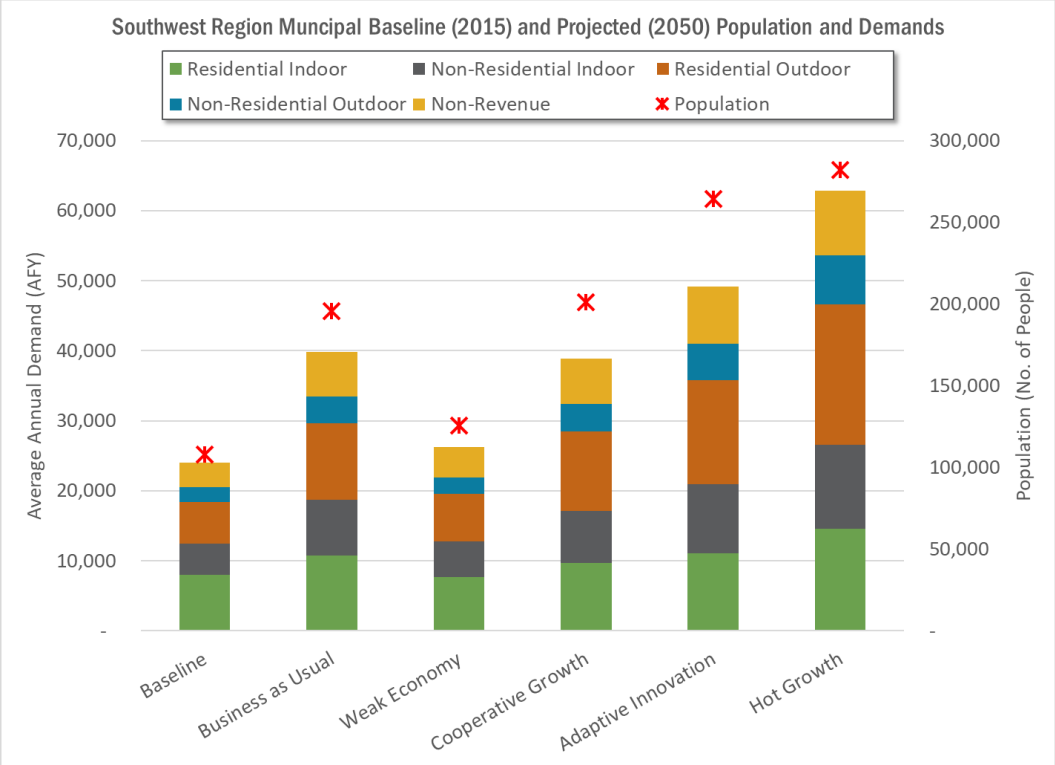

Figure 3-65: Southwest Region Baseline and Projected Population and Municipal Demands.

3.7.2 INDUSTRIAL

The Southwest Region currently includes about 1% of the statewide industrial demand. Industrial demands in this basin are associated with the Snowmaking and Thermoelectric sub-sectors, with no demands projected for Large Industry or Energy Development sub-sectors. Southwest region total industrial demands are shown on Figure 3-66 and county-scale industrial demands are summarized in Table 3-36.

The baseline Snowmaking demand is 430 AFY as compared to 410 AFY in SWSI 2010. Projected demands remain at 430 AFY because there is no planned expansion of snowmaking acreage. Projected demands were not varied by scenario.

Thermoelectric demands are related to one facility located in Montrose County and were based on information in SWSI 2010. The baseline demand remains 1,850 AFY as represented in SWSI 2010. Projected Thermoelectric demands range from 3,510 AFY to 4,290 AFY.

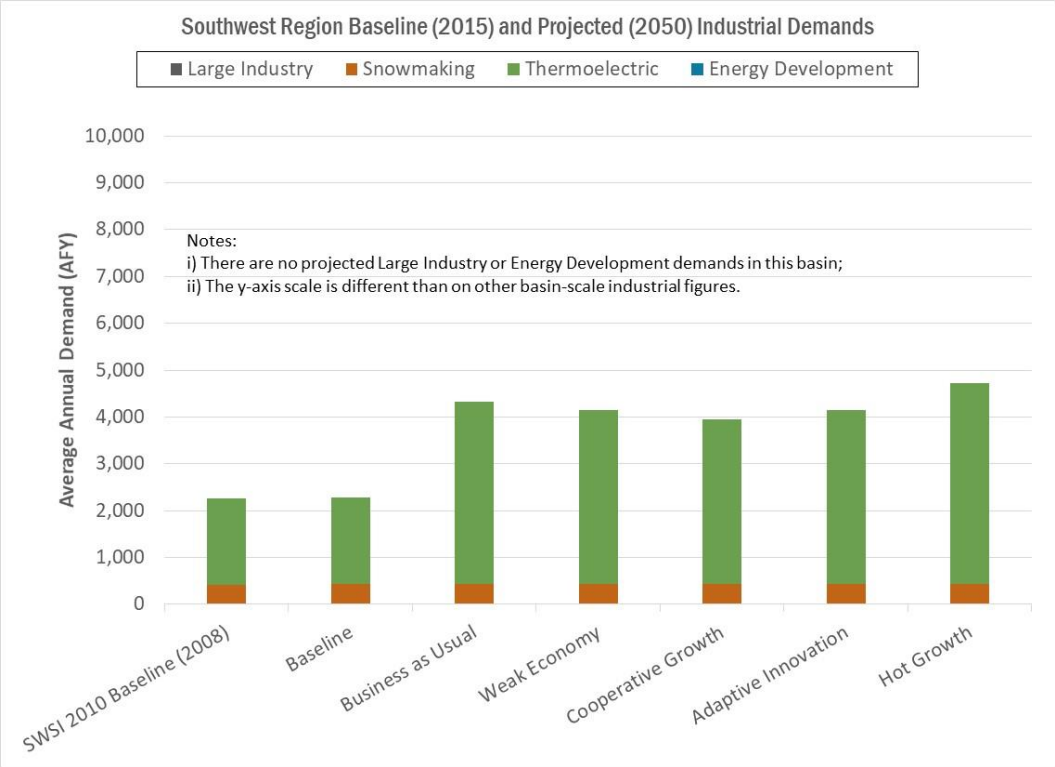

Figure 3-66: Southwest Region Industrial Baseline and Projected Demands.

Table 3-36: Southwest Region Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
La Plata	Large Industry	-	-	-	-	-	-
	Snowmaking	230	230	230	230	230	230
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Montrose	Large Industry	-	-	-	-	-	-
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	1,850	3,900	3,710	3,510	3,710	4,290
	Energy Development	-	-	-	-	-	-
San Miguel	Large Industry	-	-	-	-	-	-
	Snowmaking	200	200	200	200	200	200
	Thermoelectric	-	-	-	-	-	-
	Energy Development	-	-	-	-	-	-
Basin Total		2,280	4,330	4,140	3,940	4,140	4,720

3.7.3 TOTAL

Southwest Region combined M&I demand projections for 2050 range from approximately 30,000 AFY in the Weak Economy scenario to 68,000 AFY in the Hot Growth scenario, as shown in Figure 3-67. Industrial demands account for around 7% - 14% of the M&I demands in the Southwest Region. On a basin scale, the demand projections follow the statewide sequence of the volumetric demand scenario rankings described in the CWP.

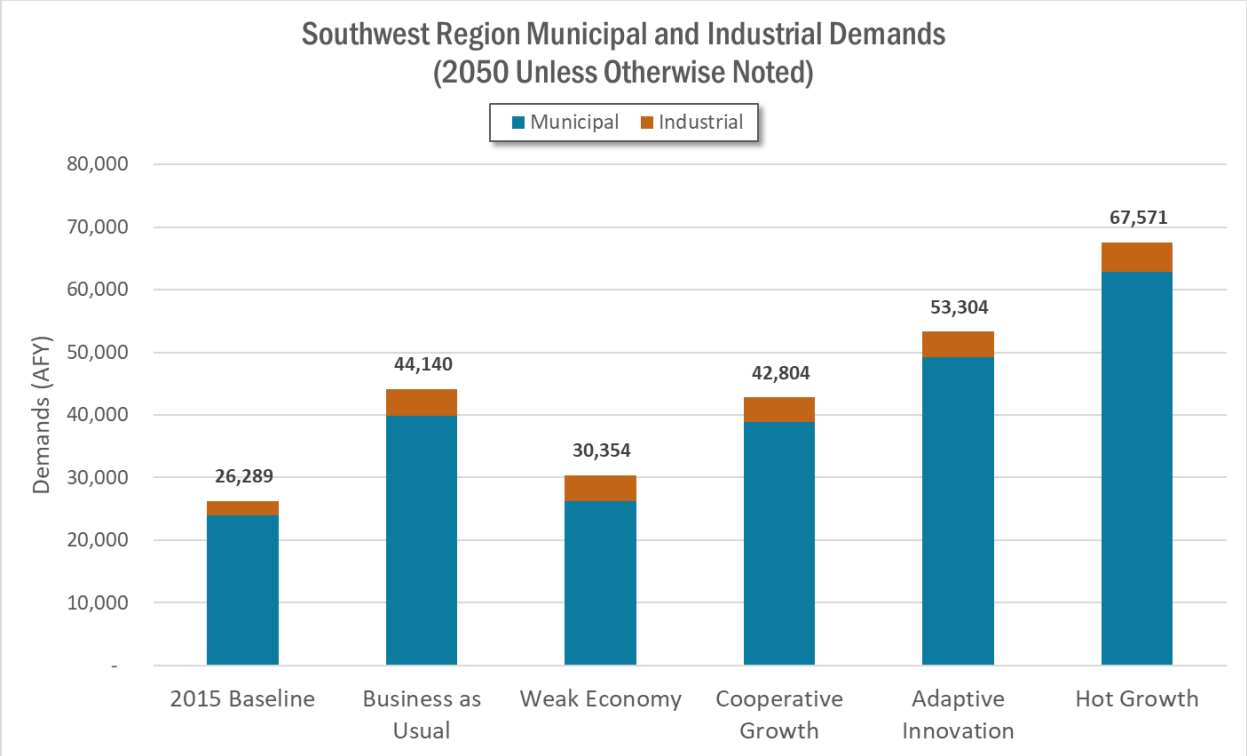

Figure 3-67: Southwest Region Baseline and Projected M&I Demands.

3.8 YAMPA-WHITE BASIN

3.8.1 MUNICIPAL

The Yampa-White Basin information summarized below includes municipal demands from the Yampa, Green, and White River sub-basins. For consistency and integration with the hydrologic modelling, the population and municipal demand data were separated into the Yampa and White Basins, with the population and demands from the Green included within the Yampa sub-basin.

3.8.1.1 POPULATION

Combined Yampa-White Basin

The combined Yampa-White Basin currently includes less than 1% of the statewide population. Between the years 2015 and 2050, it is projected to change from approximately 44,000 to between 39,000 and 103,000 people in the low and high growth scenarios, respectively. Using the specific numbers, this ranges from a decrease in population of 12% to an increase of 136%. Table 3-37 shows how population growth is projected to vary across counties under each planning scenario and is summarized by sub-basin.

White Sub-Basin

Between the years 2015 and 2050, the White Basin is projected to change from approximately 6,500 to between 4,200 and 11,300 people in the low and high growth scenarios, respectively. Using the specific numbers, this ranges from a decrease in population of 35% to an increase of 73%. Rio Blanco County is the only county in the White Basin.

Yampa Sub-Basin

Between the years 2015 and 2050, the Yampa Basin is projected to change from approximately 37,000 to between 34,000 and 92,000 people in the low and high growth scenarios, respectively. Using the specific numbers, this ranges from a decrease in population of 8% to an increase of 147%.

Routt County is currently the most populous county in the sub-basin at about 24,000 people and is projected to remain the largest in all scenarios, ranging from about 26,000 to 71,000 people by 2050. Moffat County population is projected to decrease by approximately 38% in the low growth scenario and to increase by 65% in the high growth scenario.

Table 3-37: Yampa-White Basin and Sub-Basin Baseline and Projected Populations by County

County	2015 Population	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
WHITE BASIN						
Rio Blanco	6,529	7,376	4,237	6,979	10,599	11,319
Sub-Basin Total	6,529	7,376	4,237	6,979	10,599	11,319
YAMPA BASIN						
Moffat	12,884	13,868	7,966	13,122	19,927	21,281
Routt	24,310	45,998	26,420	50,336	66,095	70,587
Sub-Basin Total	37,194	59,866	34,386	63,458	86,022	91,869
TOTAL YAMPA-WHITE BASIN						
Basin Total	43,723	67,242	38,623	70,437	96,621	103,188

The combined Yampa-White Basin baseline for the Technical Update, which is based on 2015 population, is about 3% lower than the SWSI 2010 baseline, which used 2008 population. The SWSI 2010 medium growth population projection for 2050 exceeded the Technical Update population projections for all planning scenarios by between about 13% and 203%. Comparison of the baseline and projected populations for the Technical Update and SWSI 2010 are shown in Figure 3-68.

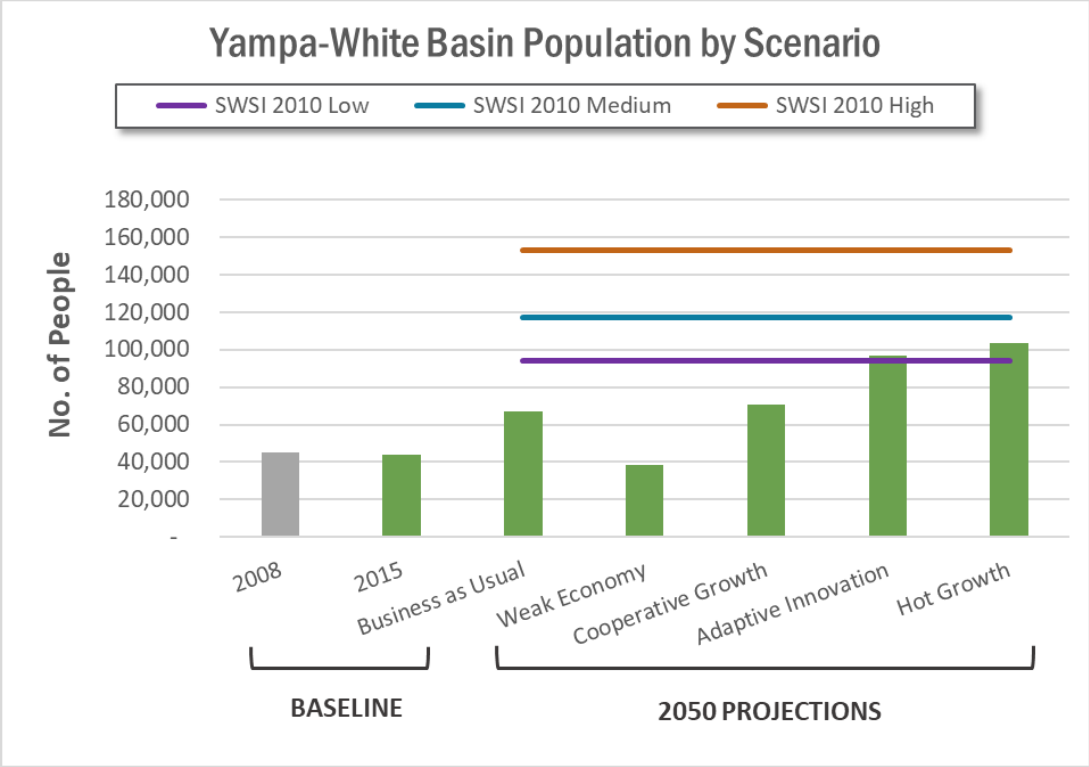

Figure 3-68: Yampa-White Basin Baseline and Projected Population.

3.8.1.2 WATER DEMANDS

The Yampa-White baseline water demands were largely estimated. Approximately 12% of the baseline population demand were represented by 1051 data and 8% from water provider outreach, requiring demands for about 80% of the basin's baseline population demands to be estimated, as shown in Figure 3-69. The data filling analyses were completed at the county level, resulting in different gpcd rate of use values for the Yampa and White sub-basins. In the Yampa sub-basin, some data were available from 1051 reporting, water efficiency plans, and targeted outreach, but much of the data still needed to be filled by using results from the other available sources. In the White sub-basin, some data were available from targeted outreach but most of the data were filled based on the outreach information. It is recommended that the Basin Roundtable work to acquire better data during the BIP update process.

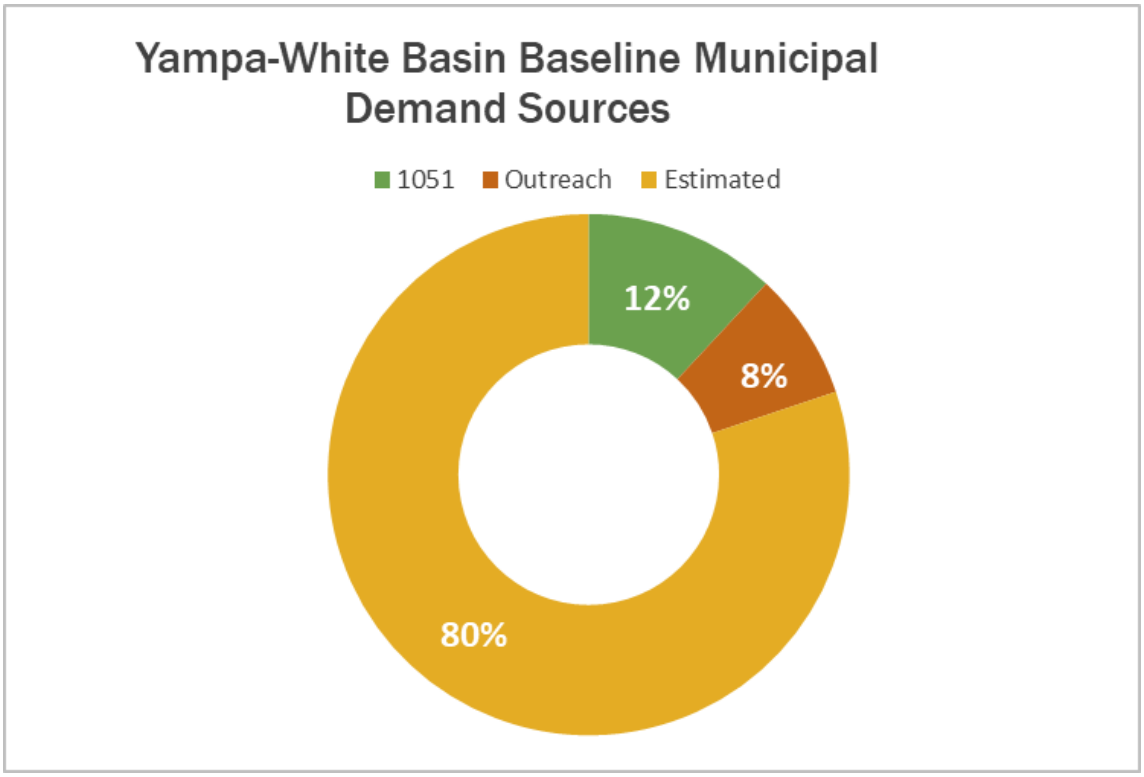

Figure 3-69: Yampa-White Basin Baseline Municipal Water Demand Data Sources.

The Yampa-White Basin average baseline per capita systemwide demand has decreased slightly from 230 gpcd in SWSI 2010 to approximately 228 gpcd. While the basin average per capita demand changed very little, there are more significant differences from SWSI 2010 at a county level. Table 3-38 below represents baseline and projected per capita demands for counties within the basin.

Table 3-38: Yampa-White Total Basin Municipal Baseline and Projected Per Capita Demands by County (gpcd).

County	SWSI 2010 Baseline [a]	Update Baseline	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
WHITE BASIN							
Rio Blanco	262	252	240	254	240	231	269
YAMPA BASIN							
Moffat	194	216	179	214	171	153	181
Routt	243	228	170	192	158	149	180
TOTAL YAMPA-WHITE BASIN							
Basin Total	230	228	180	203	168	159	190

a) SWSI 2010 per capita values from SWSI 2010 Appendix H, Table 3-1 (CWCB, 2010a).

The demand category distributions were individually evaluated for each sub-basin and the sub-basin average was used for counties within the respective sub-basin that had insufficient data to prepare a county-specific distribution. A summary of each sub-basin is provided below.

The White Sub-Basin baseline municipal water demands are comprised of approximately 42% indoor, 30% outdoor, and 27% non-revenue water uses, as shown in Figure 3-70. Rio Blanco County had sufficient demand category data available to apply a county-specific distribution.

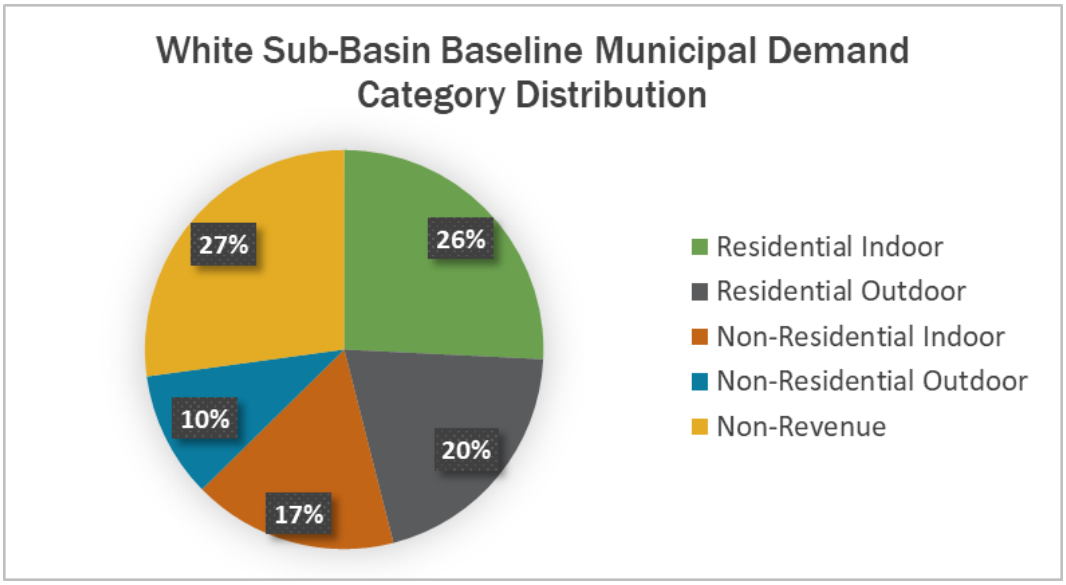

Figure 3-70: White Sub-Basin Baseline Municipal Demand Category Distribution.

The Yampa Sub-Basin baseline municipal water demands are comprised of approximately 75% indoor, 18% outdoor, and 6% non-revenue water uses, as shown in Figure 3-71. Routt County had sufficient demand category data available to apply a county-specific distribution. Moffat County was based on the basin distribution. On a basin scale, the residential indoor demand as a percentage of the systemwide demands is the highest reported throughout the state, at over 50%. Conversely, the baseline residential outdoor water demand is the lowest statewide, at approximately 18% of the systemwide demands.

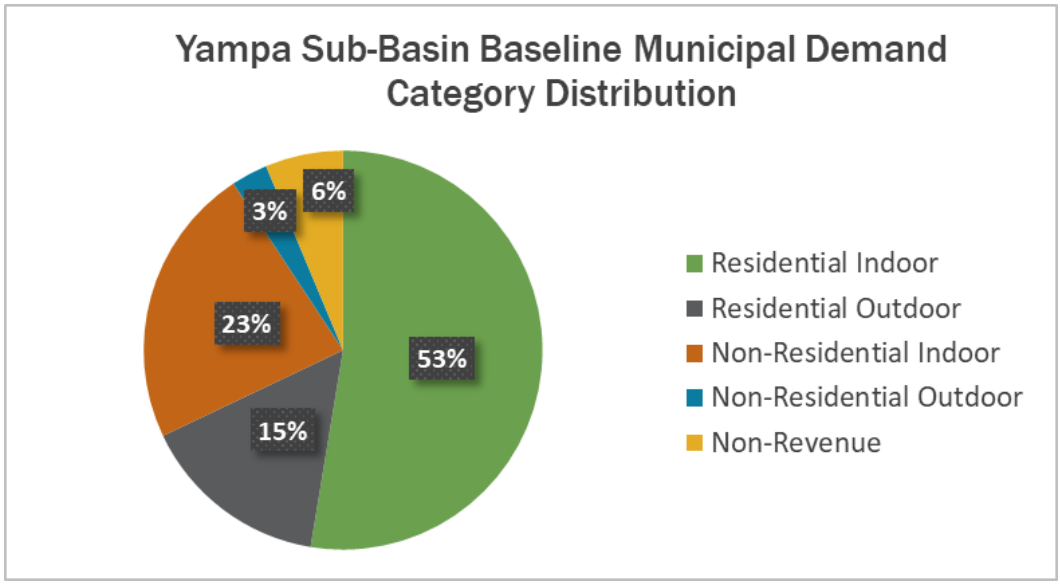

Figure 3-71: Yampa Sub-Basin Baseline Municipal Demand Category Distribution.

Figure 3-72 provides a summary of per capita baseline and projected water demands for the White Sub-Basin. Systemwide, the projected per capita demands decrease relative to the baseline except in the Weak Economy and Hot Growth scenarios. Consistently across all scenarios, the non-revenue water is the greatest demand category.

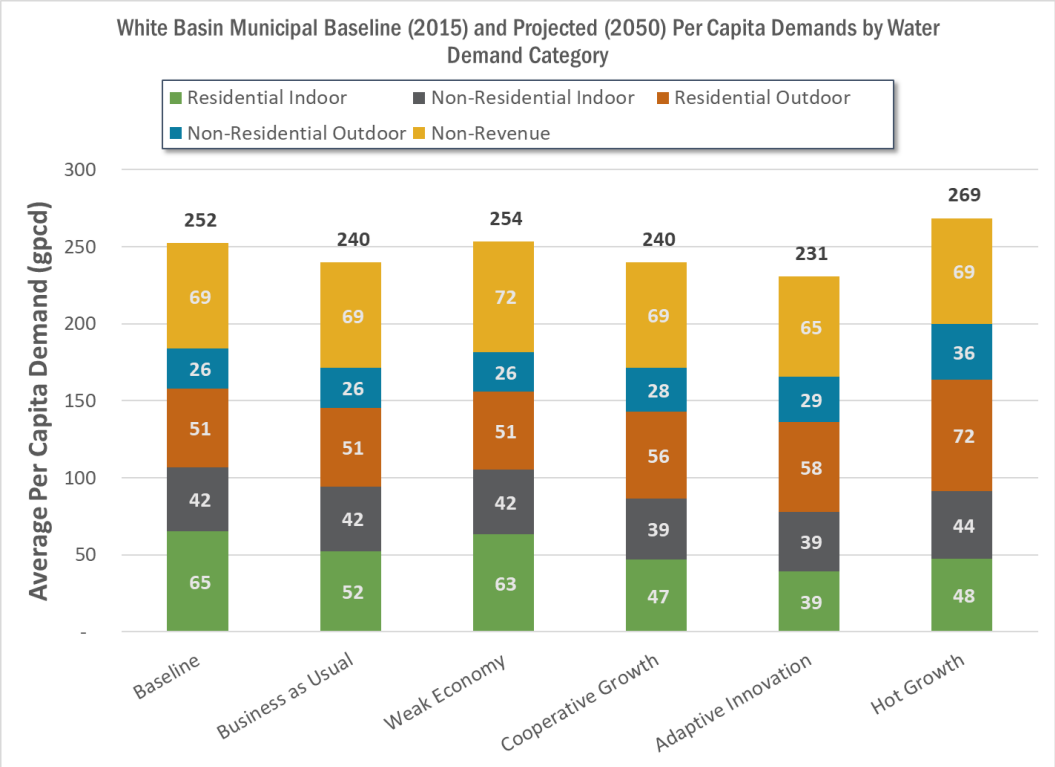

Figure 3-72: White Sub-Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-73 provides a summary of per capita baseline and projected water demands for the Yampa Sub-Basin. Systemwide, the projected per capita demands decrease relative to the baseline under all scenarios.

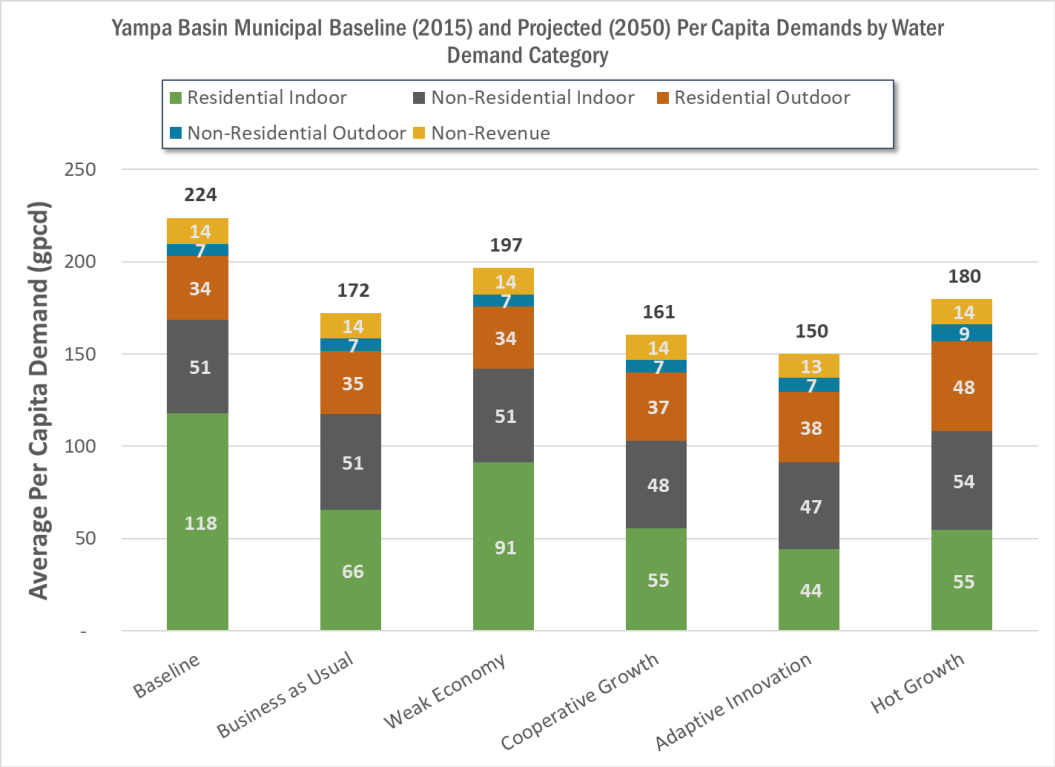

Figure 3-73: Yampa Municipal Baseline and Projected Per Capita Demands by Water Demand Category.

Figure 3-74 demonstrates the influence of the climate driver on the White Sub-Basin per capita water demands, with outdoor demands increasing by 15 to 30 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 207 to 254 gpcd. Figure 3-75 demonstrates the influence of the climate driver on the Yampa Sub-Basin per capita water demands, with outdoor demands increasing by 8 to 15 gpcd with the climate change factors applied. Without the climate change factors, the per capita demand projections range from 138 to 197 gpcd. The Yampa and White Sub-Basins were not evaluated separately for the SWSI 2010 evaluation. For the combined Yampa-White Basin, SWSI 2010 projected a per capita demand of 158 gpcd for medium population with active conservation[32].

[32] SWSI 2010 projected per capita demands include savings from passive conservation.

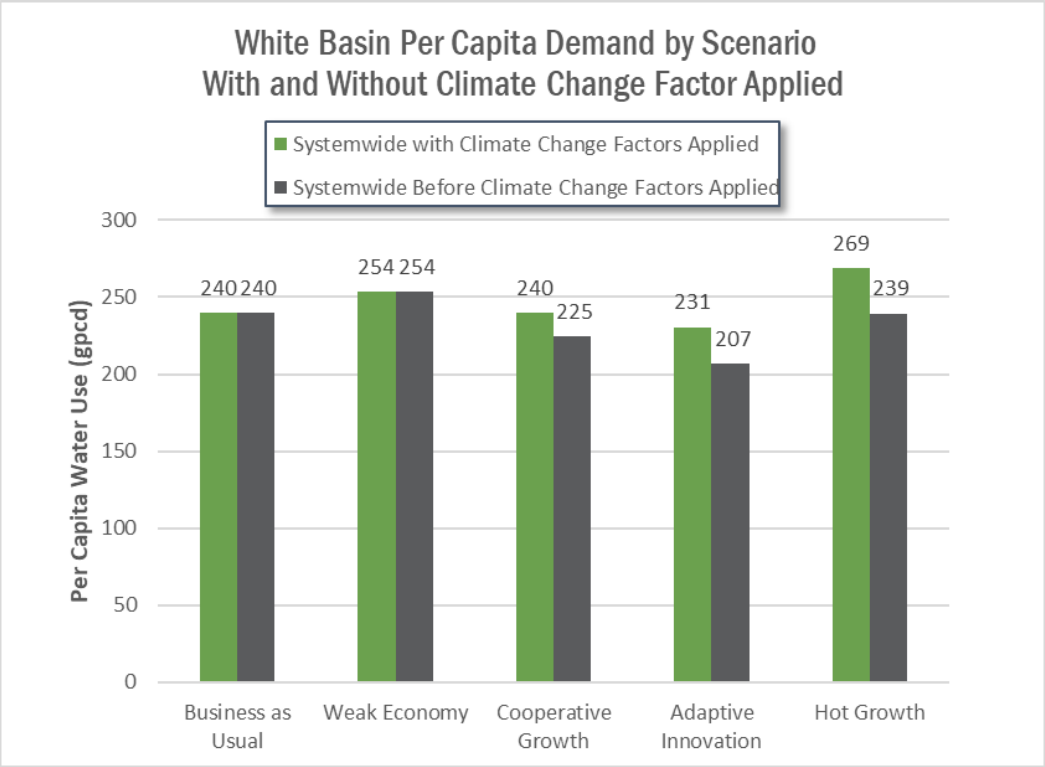

Figure 3-74: Effect of Climate Change Driver on the White Sub-Basin Average Per Capita Demand.

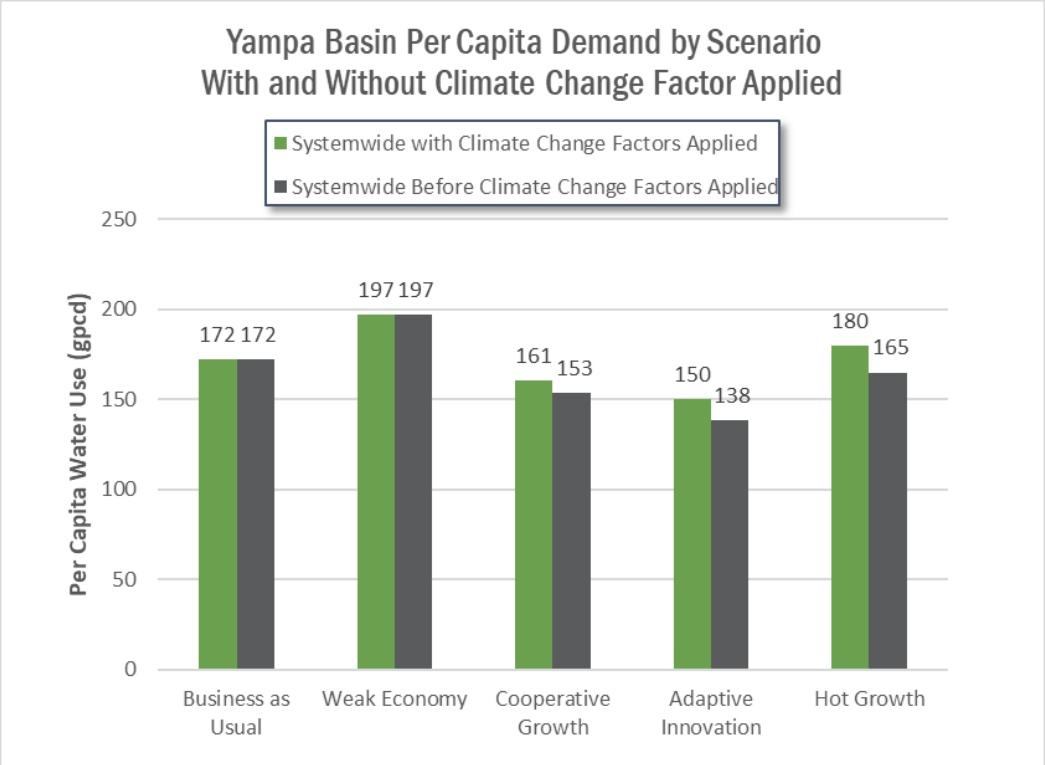

Figure 3-75: Effect of Climate Change Driver on the Yampa Sub-Basin Average Per Capita Demand.

The Yampa-White Basin municipal baseline and projected volumetric demands are provided in Table 3-39, showing the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 11,000 AFY in 2015 to between 9,000 and 22,000 AFY in 2050. Routt County accounts for over half of the basin demands.

Table 3-39: Yampa-White Basin Municipal Baseline and Projected Volumetric Demands by County (AFY).

County	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
WHITE SUB-BASIN						
Rio Blanco	1,845	1,980	1,203	1,875	2,737	3,405
Sub-Basin Total	1,845	1,980	1,203	1,875	2,737	3,405
YAMPA SUB-BASIN						
Moffat	3,113	2,773	1,913	2,507	3,412	4,306
Routt	6,211	8,779	5,667	8,911	11,060	14,204
Sub-Basin Total	9,324	11,552	7,580	11,418	14,471	18,511
TOTAL YAMPA-WHITE BASINS						
Basin Total	11,169	13,532	8,783	13,293	17,208	21,916

The baseline and projected demand distributions are shown in Table 3-40. Projected demands in the Business as Usual and Cooperative Growth scenarios are nearly identical, and all of the projection scenarios except for the Weak Economy scenario result in an increase relative to the baseline.

Table 3-40: Yampa-White Basin Municipal Baseline and Projected Volumetric Demands by Demand Category (AFY).

Scenario	Residential Indoor	Non-Residential Indoor	Residential Outdoor	Non-Residential Outdoor	Non-Revenue	System wide
Baseline (2015)	5,380	2,431	1,804	465	1,089	11,169
Business as Usual	4,845	3,800	2,736	663	1,488	13,532
Weak Economy	3,817	2,146	1,547	376	897	8,783
Cooperative Growth	4,311	3,694	3,051	730	1,507	13,293
Adaptive Innovation	4,729	4,987	4,393	1,069	2,031	17,208
Hot Growth	6,222	6,074	5,904	1,432	2,283	21,916

Figure 3-76 through Figure 3-78 shows how population differs between the scenarios for the White Sub-Basin, the Yampa Sub-Basin, and the entire Yampa-White Basin, respectively. For each, demands and population are projected to decrease by 2050 from current baseline conditions in the Weak Economy scenario.

Demands generally follow the population patterns, which shows the influence that population has within this basin. Projected demands and populations in the Business as Usual and Cooperative Growth scenarios are similar, with a slightly more noticeable distinction with the White Sub-Basin.

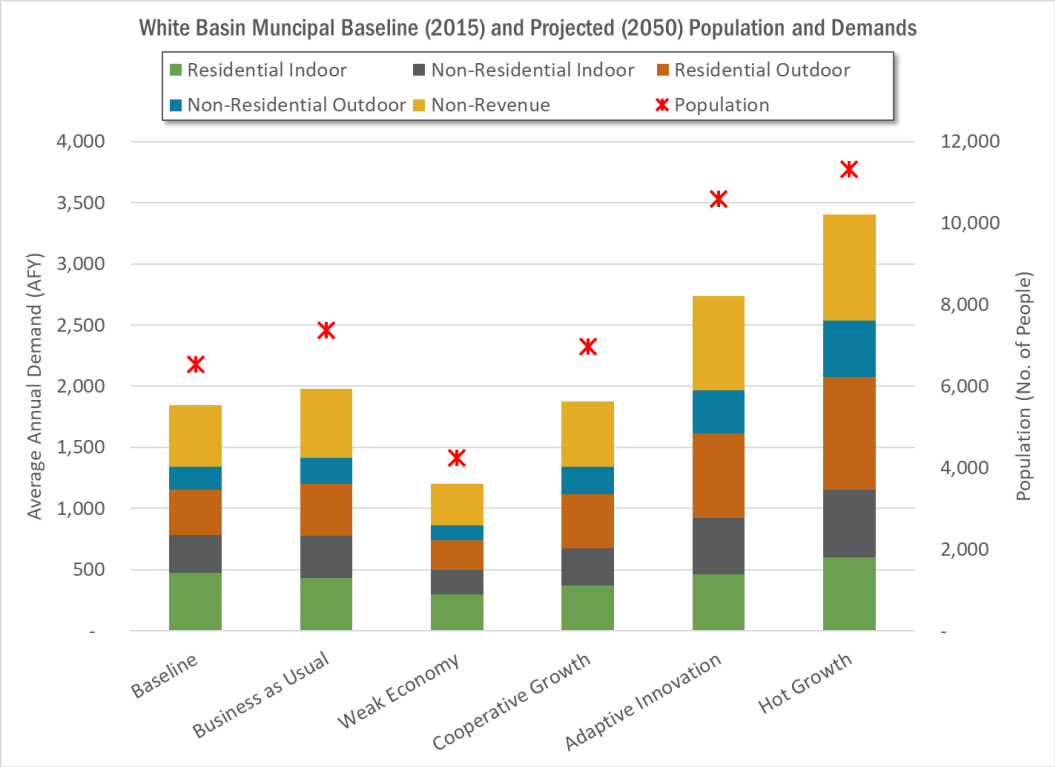

Figure 3-76: White Sub-Basin Baseline and Projected Population and Municipal Demands.

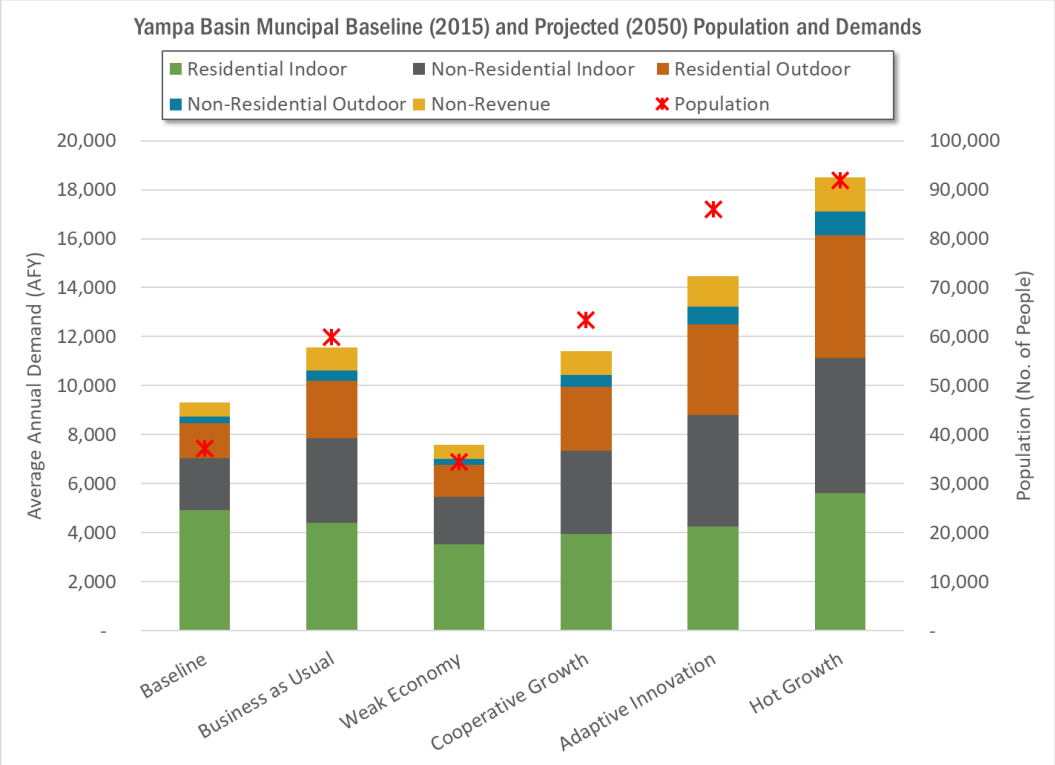

Figure 3-77: Yampa Sub-Basin Baseline and Projected Population and Municipal Demands.

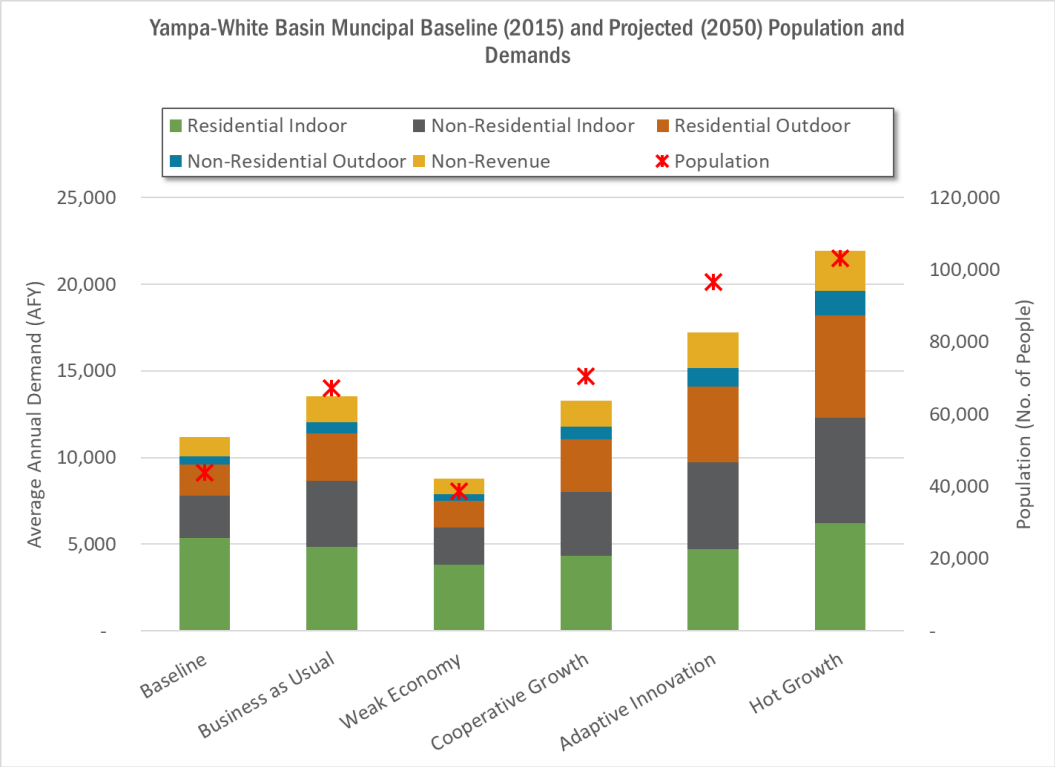

Figure 3-78: Yampa-White Basin Baseline and Projected Population and Municipal Demands.

3.8.2 INDUSTRIAL

The Yampa-White Basin currently includes about 17% of the statewide industrial demand. Approximately 93% of the baseline industrial demands are in the Yampa Sub-Basin and 7% are in the White Sub-Basin. Industrial demands in the Yampa-White Basin are associated with all four sub-sectors. Basin-scale industrial demands are shown on Figure 3-79 and county-scale industrial demands are summarized in Table 3-41.

Large Industry demands in this basin are located in Moffat and Routt counties. All baseline demands were based on data from SWSI 2010 and are related to mining in Moffat County and mining and golf courses in Routt County. The baseline demand has increased from 6,100 AFY in SWSI 2010 to 6,900 AFY in the Technical Update analysis. Projected Large Industry demands range from 8,550 AFY to 10,450 AFY.

The baseline Snowmaking demand is 290 AFY, which is the same as in SWSI 2010 because there has been no increase in snowmaking acreage. Projected demands are 570 AFY and were not varied by scenario.

Thermoelectric demands are related to two facilities. Baseline demands for the facility on Routt County were updated based on information from Xcel. Baseline demands for the facility in Moffat County were updated based on the BIP. The total baseline demand has decreased from 20,200 AFY in SWSI 2010 to 19,350 AFY. Projected Thermoelectric demands range from 29,020 AFY to 35,460 AFY.

Energy Development demands are located in Moffat, Rio Blanco, and Routt counties. The baseline Energy Development demand in the Yampa-White Basin is 3,100 AFY as compared to 2,000 AFY in SWSI 2010. Projected demands range from 3,900 AFY to 41,800 AFY.

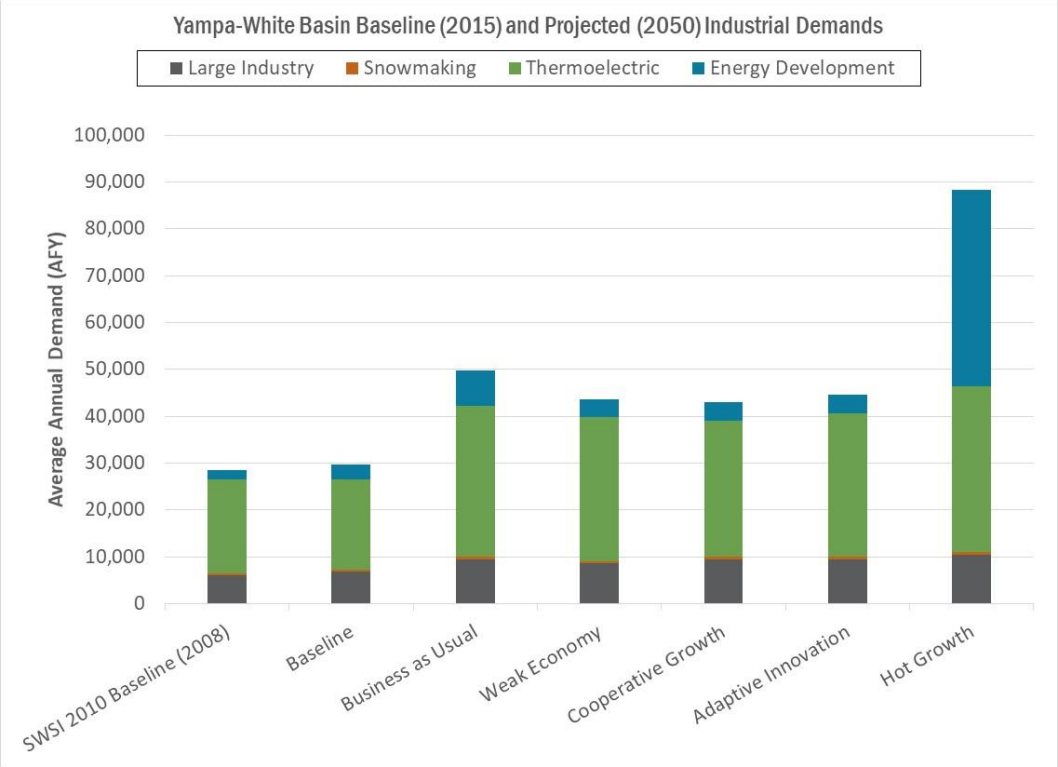

Figure 3-79: Total Yampa-White Basin Industrial Baseline and Projected Demands.

Table 3-41: Yampa-White Industrial Baseline and Projected Demands by County (AFY).

County	Sub-Sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
YAMPA SUB-BASIN							
Moffat	Large Industry	2,900	3,900	3,510	3,900	3,900	4,290
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	14,010	26,900	25,560	24,210	25,560	29,590
	Energy Development	1,000	1,200	400	400	400	2,300
Routt	Large Industry	4,000	5,600	5,040	5,600	5,600	6,160
	Snowmaking	290	570	570	570	570	570
	Thermoelectric	5,340	5,340	5,070	4,810	5,070	5,870
	Energy Development	500	500	500	500	500	1,600
Sub-Basin Total		28,040	44,010	40,650	39,990	41,600	50,380
WHITE SUB-BASIN							
Rio Blanco	Large Industry	-	-	-	-	-	-
	Snowmaking	-	-	-	-	-	-
	Thermoelectric	-	-	-	-	-	-
	Energy Development	1,600	5,800	3,000	3,000	3,000	37,900
Sub-Basin Total		1,600	5,800	3,000	3,000	3,000	37,900
TOTAL YAMPA-WHITE BASINS							
Basin Total		29,640	49,810	43,650	42,990	44,600	88,280

3.8.3 TOTAL

Yampa-White Basin combined M&I demand projections for 2050 range from approximately 52,000 AFY in the Weak Economy scenario to 110,000 AFY in the Hot Growth scenario, as shown in Figure 3-80. Under every planning scenario, industrial demands exceed the municipal demands. This is influenced by industrial use in the Yampa Sub-Basin and is the only basin in the state in which industrial demands exceed municipal. Industrial demands make up approximately 70% to 80% of the total M&I demands in the Yampa-White Basin, depending on planning scenario. On a basin scale, the demand projections do not follow the statewide sequence of the volumetric demand scenario rankings described in the CWP, with the Adaptive Innovation scenario falling out of sequence.

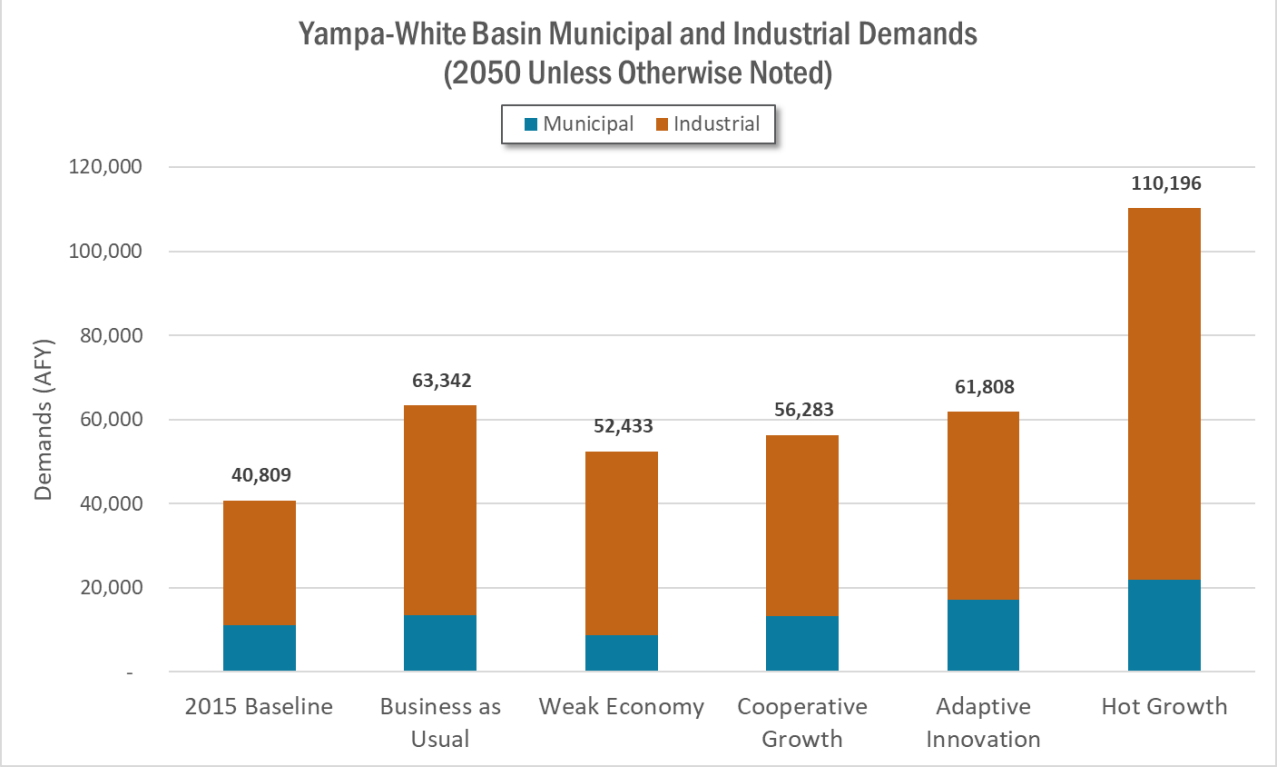

Figure 3-80: Yampa-White Basin Baseline and Projected M&I Demands.

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Appendix A: CWP PLANNING SCENARIO DESCRIPTIONS

Scenario:	Narrative Description
A: Business as Usual	Recent trends continue into the future. Few unanticipated events occur. The economy goes through regular economic cycles but grows over time. By 2050, Colorado's population is close to 9 million people. Single family homes dominate, but there is a slow increase of denser developments in large urban areas. Social values and regulations remain the same, but streamflows and water supplies show increased stress. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation of new water development slowly increases. Municipal water conservation efforts slowly increase. Oil-shale development continues to be researched as an option. Large portions of agricultural land around cities are developed by 2050. Transfer of water from agriculture to urban uses continues. Efforts to mitigate the effects of the transfers slowly increase. Agricultural economics continue to be viable, but agricultural water use continues to decline. The climate is similar to the observed conditions of the 20th century.
B: Weak Economy	The world's economy struggles, and the state's economy is slow to improve. Population growth is lower than currently projected, slowing the conversion of agricultural land to housing. The maintenance of infrastructure, including water facilities, becomes difficult to fund. Many sectors of the state's economy, including most water users and water dependent businesses, begin to struggle financially. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation decreases due to economic concerns. Greenhouse gas emissions do not grow as much as currently projected and the climate is similar to the observed conditions of the 20th century.
C: Cooperative Growth	Environmental stewardship becomes the norm. Broad alliances form to provide for more integrated and efficient planning and development. Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and in mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development. Coloradans embrace water and energy conservation. New water-saving technologies emerge. Eco-tourism thrives. Water-development controls are more restrictive and require both high water-use efficiency and environmental and recreation benefits. Environmental regulations are more protective, and include efforts to re-operate water supply projects to reduce effects. Demand for more water-efficient foods reduces water use. There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting streamflows and supplies. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.
D: Adaptive Innovation	A much warmer climate causes major environmental problems globally and locally. Social attitudes shift to a shared responsibility to address problems. Technological innovation becomes the dominant solution. Strong investments in research lead to breakthrough efficiencies in the use of natural resources, including water. Renewable and clean energy become dominant. Colorado is a research hub and has a strong economy. The relatively cooler

Scenario:	Narrative Description
	weather in Colorado (due to its higher elevation) and the high-tech job market cause population to grow faster than currently projected. The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand. The warmer climate reduces global food production increasing the market for local agriculture and food imports to Colorado. More food is bought locally, increasing local food prices and reducing the loss of agricultural land to urban development. Higher water efficiency helps maintain streamflows, even as water supplies decline. The regulations are well defined and permitting outcomes are predictable and expedited. The environment declines and shifts to becoming habitat for warmer-weather species. Droughts and floods become more extreme. More compact urban development occurs through innovations in mass transit.
E: Hot Growth	A vibrant economy fuels population growth and development throughout the state. Regulations are relaxed in favor of flexibility to promote and pursue business development. A much warmer global climate brings more people to Colorado with its relatively cooler climate. Families prefer low-density housing and many seek rural properties, ranchettes, and mountain living. Agricultural and other open lands are rapidly developed. A hotter climate decreases global food production. Worldwide demand for agricultural products rises, greatly increasing food prices. Hot and dry conditions lead to a decline in streamflows and water supplies. The environment degrades and shifts to becoming habitat for species adapted to warmer waters and climate. Droughts and floods become more extreme. Communities struggle unilaterally to provide services needed to accommodate the rapid business and population growth. Fossil fuel is the dominant energy source, and there is large production of oil shale, coal, natural gas, and oil in the state.

Source: CWCB, Colorado's Water Plan, Section 6.1, "Scenario Planning and Developing an Adaptive Water Strategy" and Section 4, "Water Supply". 2010.

Appendix B: BASELINE (2015) POPULATION AND 2050 POPULATION PROJECTIONS

Basin Forecasts	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Arkansas	1,008,434	1,509,463	1,462,821	1,544,367	1,625,970	1,567,968
Colorado	307,570	515,472	456,321	549,176	572,860	577,827
Gunnison	103,121	162,632	123,070	158,587	195,998	204,931
Metro	2,768,126	4,061,899	3,817,099	3,921,976	4,161,584	4,317,749
North Platte	1,353	1,279	1,055	1,210	1,364	1,457
Rio Grande	45,975	55,104	42,270	52,141	62,972	67,252
South Platte	1,061,754	1,892,367	1,616,081	1,962,391	2,330,861	2,189,906
Southwest	107,999	195,837	125,814	201,010	264,189	282,144
Yampa	43,723	67,242	38,623	70,437	96,621	103,188
Basin Totals	**5,448,055**	**8,461,296**	**7,683,154**	**8,461,296**	**9,312,421**	**9,312,421**

Forecasts by County		Baseline (2015)	Business as (2015)	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Arkansas							
Baca		3,594	2,949	2,858	2,790	2,868	3,063
Bent		5,847	6,607	6,403	6,252	6,426	6,863
Chaffee		18,603	27,145	26,306	25,686	26,403	28,197
Cheyenne	*part*	686	615	596	582	599	639
Crowley		5,569	7,754	7,514	7,337	7,542	8,055
Custer		4,457	5,934	5,751	5,615	5,772	6,164
El Paso		676,178	1,076,486	1,043,223	1,116,517	1,177,637	1,118,209
Elbert	*part*	7,634	20,526	19,891	19,422	19,964	21,321
Fremont		46,659	56,406	54,663	53,373	54,864	58,592
Huerfano		6,456	5,983	5,798	5,661	5,819	6,215
Kiowa		1,396	1,193	1,156	1,129	1,160	1,239
Lake		7,502	9,868	9,563	9,337	9,598	10,250
Las Animas		14,061	13,249	12,840	12,537	12,887	13,763
Lincoln	*part*	4,485	6,857	6,645	6,488	6,669	7,123
Otero		18,265	15,302	14,829	14,479	14,884	15,895

Prowers		11,905	11,441	11,087	10,826	11,128	11,884
Pueblo		163,196	224,184	217,257	230,283	245,249	232,873
Teller	*part*	11,941	16,964	16,440	16,052	16,501	17,622
Colorado							
Eagle		53,320	94,459	83,620	102,687	99,147	105,885
Garfield		57,779	105,711	93,581	115,297	110,957	118,498
Grand		14,602	27,406	24,261	29,967	28,766	30,721
Mesa	*part*	134,096	212,859	188,433	220,735	255,228	238,608
Pitkin		17,845	23,209	20,546	24,282	24,361	26,017
Summit		29,928	51,828	45,881	56,208	54,400	58,097
Gunnison							
Delta		29,973	42,126	31,878	39,861	49,704	53,082
Gunnison		16,097	22,728	17,199	24,054	26,817	28,639
Hinsdale		767	1,573	1,190	1,488	1,856	1,982
Mesa	*part*	14,927	23,695	17,931	24,572	32,067	29,858
Montrose	*part*	36,710	66,942	50,658	63,343	78,985	84,353
Ouray		4,647	5,568	4,214	5,269	6,570	7,016
Metro							
Adams		489,923	890,148	836,501	842,289	886,001	946,216
Arapahoe		629,066	899,738	845,513	851,363	895,546	956,410
Broomfield		64,656	95,566	89,806	90,428	95,121	101,585
Denver		680,658	952,955	895,523	980,185	1,067,123	1,012,979
Douglas		322,198	482,824	453,725	456,865	480,575	513,236
Jefferson		564,619	694,943	653,061	657,579	691,705	738,716
Elbert	*part*	17,006	45,725	42,970	43,267	45,512	48,606
North Platte							
Jackson		1,353	1,279	1,055	1,210	1,364	1,457
Rio Grande							
Alamosa		15,968	22,934	17,593	21,701	26,209	27,990
Conejos		8,074	8,997	6,902	8,513	10,282	10,980
Costilla		3,572	3,934	3,018	3,722	4,496	4,801
Mineral		729	959	736	907	1,096	1,170
Rio Grande		11,413	11,612	8,907	10,988	13,270	14,172

Saguache		6,219	6,668	5,115	6,309	7,620	8,138
South Platte							
Boulder		318,570	447,843	382,458	460,770	558,020	518,258
Cheyenne	*part*	1,144	1,026	876	970	1,111	1,187
Clear Creek		9,392	12,448	10,631	11,779	13,488	14,405
Gilpin		5,824	6,626	5,659	6,270	7,180	7,668
Kit Carson		8,219	9,595	8,194	9,079	10,397	11,104
Larimer		332,830	543,588	464,224	564,664	677,320	629,057
Lincoln	*part*	1,064	1,627	1,390	1,540	1,763	1,883
Logan		22,122	29,516	25,207	27,929	31,983	34,157
Morgan		28,230	42,734	36,495	40,436	46,306	49,453
Park		16,716	23,797	20,323	22,518	25,786	27,539
Phillips		4,307	4,372	3,734	4,137	4,737	5,059
Sedgwick		2,389	2,332	1,992	2,207	2,527	2,699
Teller	*part*	11,490	16,323	13,939	15,445	17,687	18,889
Washington		4,834	4,800	4,099	4,542	5,201	5,555
Weld		284,571	734,343	627,129	779,320	915,004	849,804
Yuma		10,052	11,398	9,734	10,785	12,351	13,190
Southwest							
Archuleta		12,417	26,571	17,070	25,142	35,845	38,281
Dolores		1,972	2,597	1,668	2,457	3,503	3,742
La Plata		54,857	94,002	60,391	101,831	126,811	135,430
Montezuma		26,129	47,158	30,296	44,623	63,617	67,941
Montrose	*part*	4,085	7,449	4,785	7,048	10,048	10,731
San Juan		696	767	493	726	1,035	1,105
San Miguel		7,843	17,293	11,110	19,183	23,329	24,914
Yampa							
Moffat		12,884	13,868	7,966	13,122	19,927	21,281
Rio Blanco		6,529	7,376	4,237	6,979	10,599	11,319
Routt		24,310	45,998	26,420	50,336	66,095	70,587

Forecasts by County	**Baseline (2015)**	**Business as Usual**	**Weak Economy**	**Cooperative Growth**	**Adaptive Innovation**	**Hot Growth**

Multi-basin Counties (complete totals by county)

Cheyenne	1,830	1,641	1,472	1,553	1,710	1,826
Elbert	24,640	66,251	62,861	62,689	65,477	69,927
Lincoln	5,549	8,484	8,035	8,028	8,432	9,006
Mesa	149,023	236,554	206,364	245,307	287,295	268,465
Montrose	40,795	74,391	55,443	70,391	89,034	95,084
Teller	23,431	33,287	30,380	31,497	34,187	36,511