Colorado's Water Supply Future

Colorado Water Conservation Board

State of Colorado 2050 Municipal & Industrial Water Use Projections

July 2010

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Study Objectives

The objectives of this study were to develop a reconnaissance-level water use forecast that employs consistency in data collection and forecast methodology across the state and maximizes available data. The methods utilized in this approach are for the purpose of general statewide and basinwide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes.

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Acronyms

AFY	acre-feet per year
CBEF	Center for Business and Economic Forecasting
CDM	Camp Dresser & McKee Inc.
CDWSU	Colorado Drought and Water Supply Update
CEC	California Energy Commission
CWCB	Colorado Water Conservation Board
EIS	Environmental Impact Statement
gpcd	gallons per capita per day
IBCC	Interbasin Compact Committee
ICP	*in situ* conversion process
IPPs	Identified Projects and Processes
M&I	municipal and industrial
SDO	State Demographer's Office
SFE	single-family equivalents
SSI	self-supplied industrial
state	State of Colorado
SWSI	Statewide Water Supply Initiative
WUF	water use factor

Executive Summary

In 2004, the Colorado Water Conservation Board (CWCB) completed the Statewide Water Supply Initiative (SWSI) Phase 1 Study. One of the key findings of the study was that while SWSI evaluated water needs and solutions through 2030, very few municipal and industrial (M&I) water providers have identified supplies beyond 2030. Beyond 2030, growing demands may require more aggressive solutions. Since the SWSI Phase 1 Study was completed, Colorado's legislature established the Water for the 21st Century Act. This act established an Interbasin Compact Process that provides a permanent forum for broad-based water discussions in the state. It creates two new structures: 1) the Interbasin Compact Committee (IBCC), and 2) the Basin Roundtables. There are nine Basin Roundtables based on Colorado's eight major river basins and the Denver metro area (Figure ES-1).

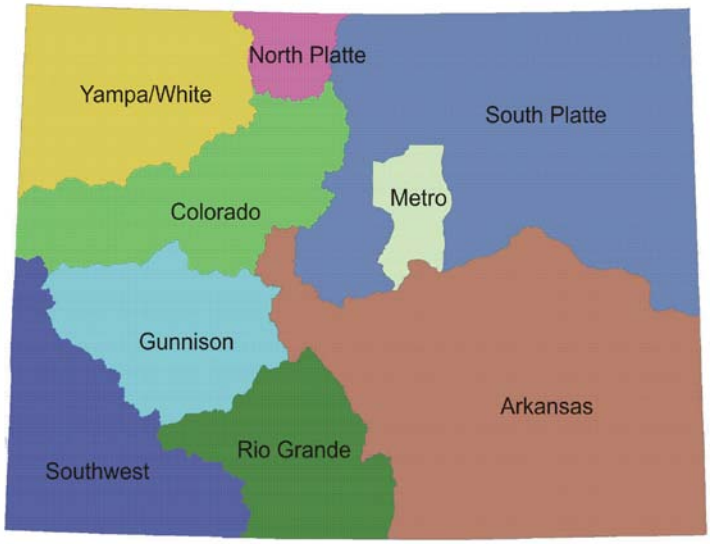

Figure ES-1. Colorado's Nine Basin Roundtables

This update of M&I water use projections will assist the Basin Roundtables in completing their consumptive needs assessments. The CWCB is currently in the process of updating the SWSI report based on efforts conducted by the Basin Roundtables and information from this report will be used as a common technical platform for the Basin Roundtable's M&I demands. The water demand forecast developed in this report provides a basis for discussing and addressing the state's future M&I water needs. The objectives of this current effort are to: 1) update population projections and extend them to 2050, 2) extend the SWSI Phase 1 projections to 2050, 3) update M&I per capita estimates including passive conservation, and 4) update the Self-Supplied Industrial (SSI) sector forecast.

This report uses a water use forecast horizon of 2050 for a number of reasons. West Slope Basin Roundtables suggested the 2050 timeframe for the demand projections so that potential growth rates on the West Slope could be better characterized. In addition, the CWCB determined that the forecast horizon for the water demand projections needed to be extended to the year 2050 to better represent the long-term water needs that the state will face. Infrastructure investments and commitment of water supplies require a longer term view into the future. In addition, several of the SWSI Identified Projects and Processes (IPPs) with Environmental Impact Statement (EIS) requirements have used a planning horizon of 2050.

Standard methods were adapted for use in updating future M&I water demands throughout Colorado. The objectives were to develop a reconnaissance-level water use forecast that employs consistency in data collection and forecast methodology across the state and maximizes available data. The methods utilized in this approach are for the purpose of general statewide and basinwide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes. The M&I water demands forecast takes on a driver multiplied by rate of use approach. This is a commonly accepted forecast methodology that accounts for driving changes in water demand. The driver for the M&I water demands forecast is population and the rate of use is gallons per capita per day, or gpcd. The population projections were estimated using the forecasting process and models utilized by the Colorado State Demographer's Office (SDO). Population projections were only available through the year 2035. Population projections from 2035 to 2050 were based on extending and adjusting the SDO forecasting models. Because of the uncertainty in projecting economic conditions and employment levels in 2050, low, medium, and high scenario population projections were developed.

The population estimates developed for this update and the gpcd values determined through data collection are multiplied to estimate county demands. The population estimates represent permanent populations of each county, thus the water use rates are based on total water use divided by the permanent population. As part of this report effort, updated per capita estimates were collected for 214 water providers covering 87 percent of the population in Colorado. The resulting gpcd water use rates incorporate water used by tourists, students, and other transient populations in that the water used by the transient population is indexed to the permanent population along with the water use of the permanent population. For statewide planning purposes, this is a consistent approach to account for water use by transient populations.

Forecasts include future baseline water demands as well as future water demands with passive conservation subtracted from baseline demands. While the 1992 National Energy Policy Act was considered in the passive conservation savings estimates, recent legislation enacted in California was considered due to the size and power of California's economy. The calculations used to estimate future demand reductions from passive conservation were developed for minimum and maximum scenarios based on the assumptions related to the retrofit of existing housing and commercial construction with high-efficiency toilets, clothes washers, and dishwashers.

2050 Population Projection Results

From 2008 to 2050, Colorado's population is projected to nearly double. The 2008 statewide population was approximately 5.1 million and in 2050, the state's population is projected to be between 8.6 and 10.5 million people. Figure ES-2 shows the relative populations in each of Colorado's major river basins. This figure shows that the majority of the state's population in 2035 and 2050 will live in the Arkansas, Metro, and South Platte Basins. West Slope basins will see the highest rate of population growth.

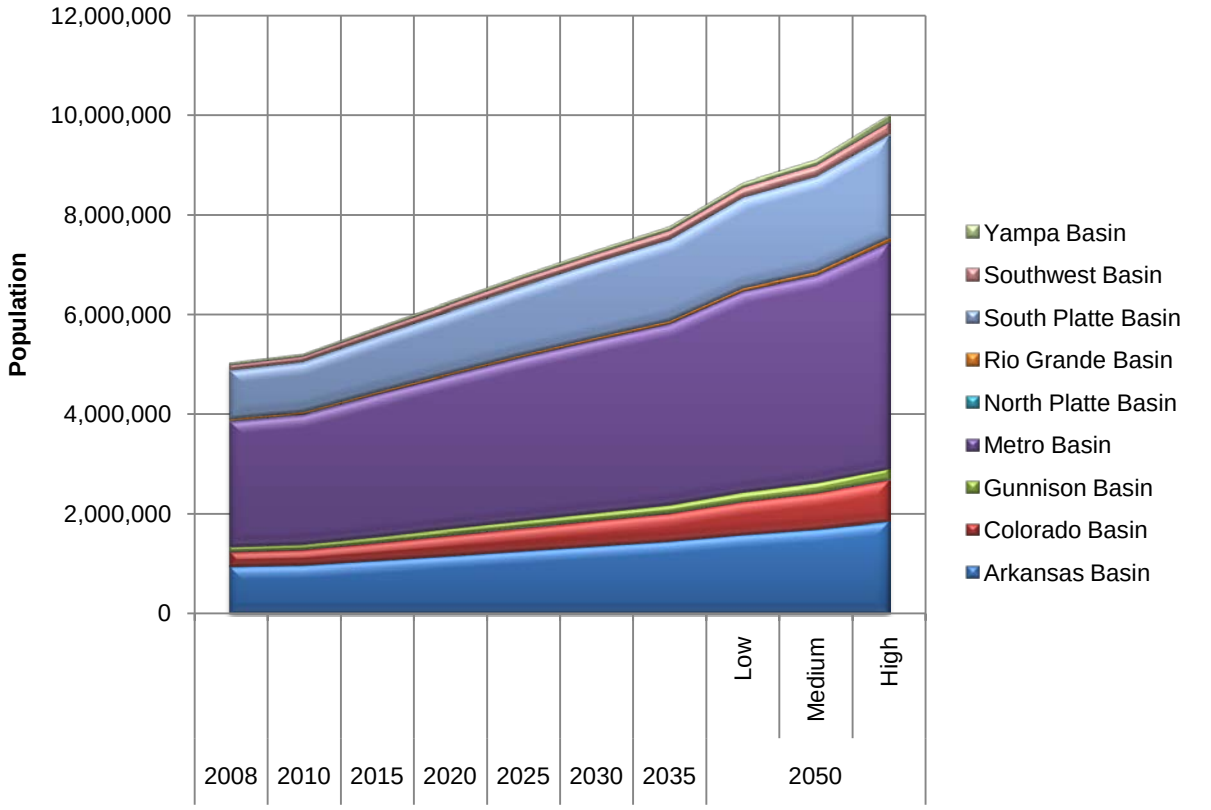

Figure ES-2. Relative Population Projections for Colorado's River Basins

2050 Water Use Projections Summary

Colorado's population is projected to nearly double by the year 2050. Figure ES-3 shows results for the M&I projected water use for the major river basins for 2008, 2035, and the 2050 low, medium, and high projection scenarios. Because the major driver for water use is population growth, M&I water usage is also expected to nearly double, even with savings from passive conservation. The majority of M&I water usage will be in the Arkansas, Colorado, Metro, and South Platte Basin Roundtables. The M&I water demand projections presented below include passive conservation savings.

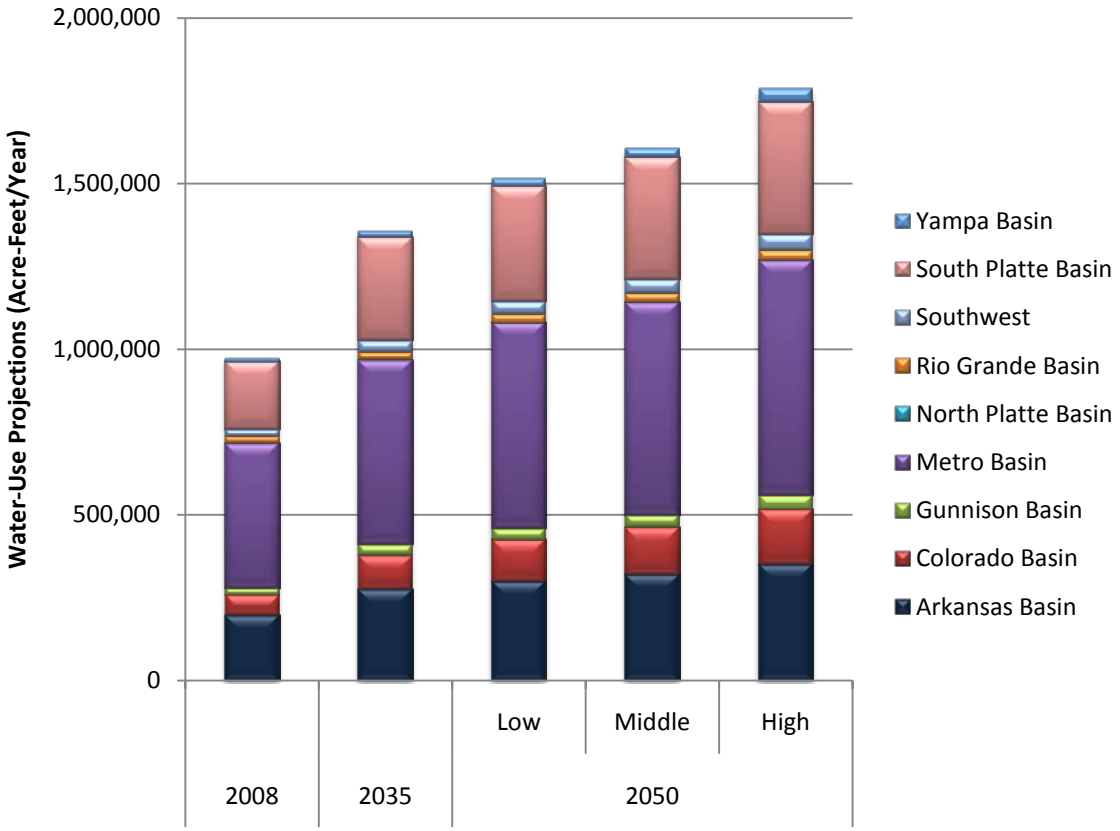

Figure ES-3. M&I Water Demands by Basin

Figure ES-4 summarizes projected SSI water usage statewide by sub-sector. Figure ES-4 indicates that among SSI needs, the Large Industry, Thermoelectric, and Energy sub-sectors are projected to use the most water in the future. Future SSI demands are projected to range from 236,000 acre-feet/year (AFY) to 322,000 AFY by 2050. Figure ES-5 summarizes statewide M&I and SSI water use projections including passive conservation for 2008, 2035, and the low, medium, and high scenario 2050 projections. Total statewide 2035 water demands are projected to be nearly 1.6 million AFY. 2050 water demands are projected to range from approximately 1.75 million AFY to nearly 2.1 million AFY. Figure ES-5 also shows that M&I water demands are estimated to exceed SSI demands for all of the future projections.

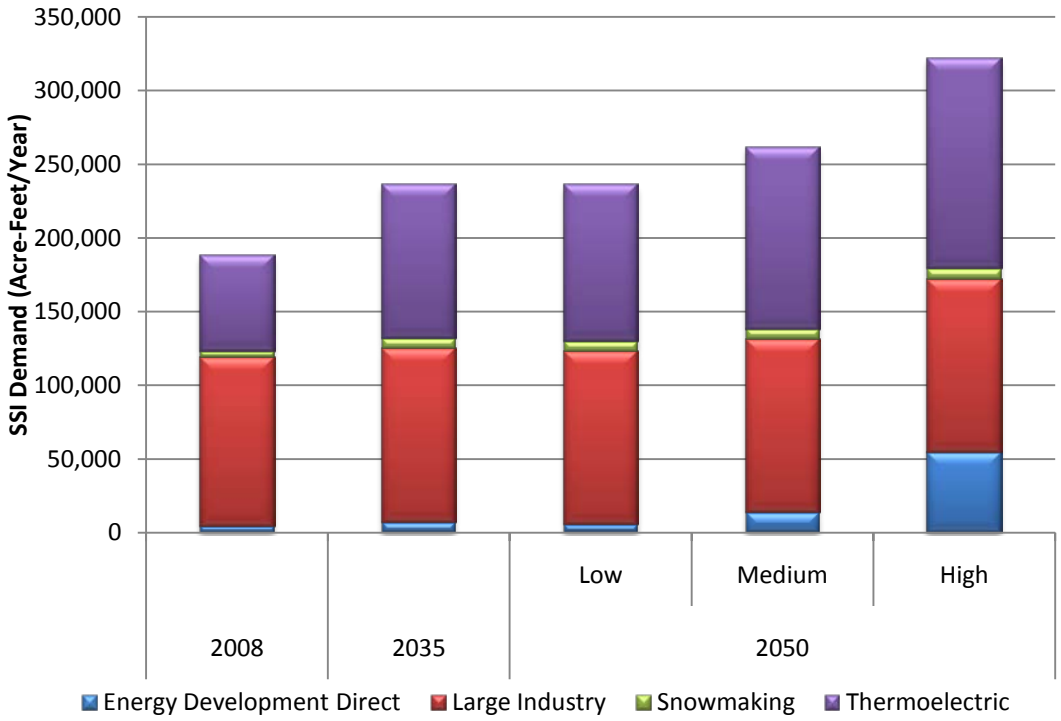

Figure ES-4. Statewide Self-Supplied Industrial (SSI) Demands by Sector

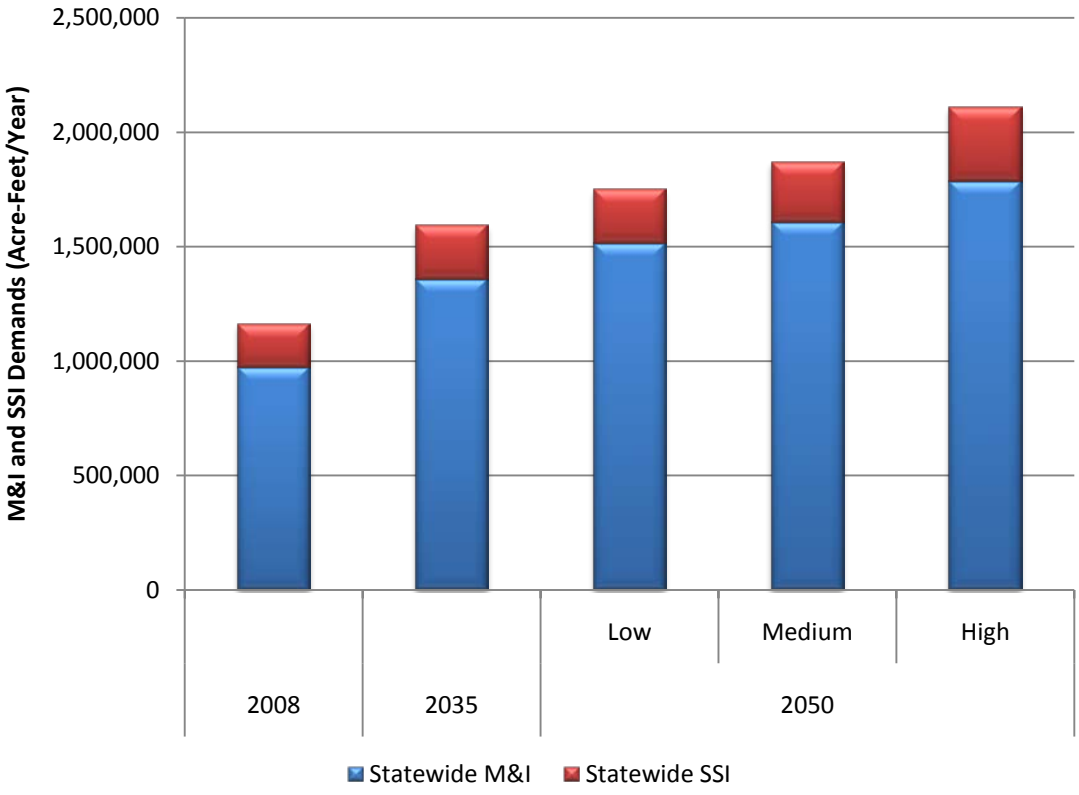

Figure ES-5. Statewide M&I and SSI Demands

2050 Water Use Projections Conclusions

Figure ES-6 summarizes statewide existing water use and systems and future water demands. Total statewide M&I demands including oil shale and other SSI water demands for the low, medium, and high scenario projections are 1.7 million AFY, 1.9 million AFY, and 2.1 million AFY, respectively. Current water use is just over 1.1 million AFY. CWCB is in the process of updating the M&I gap that was identified in SWSI through the year 2030. As part of the gap analysis, CWCB is extending the timeframe of the gap analysis to 2050 to match the M&I and SSI water demands described in this report. To complete the gap analysis effort, CWCB is updating the IPPs that were developed during SWSI 1. These IPPs specify the water provider's plans for meeting 2030 water needs. Once the IPPs are updated, the yield from the IPPs will be subtracted from the 2050 water needs shown in Figure ES-6 to update the M&I gaps across the state.

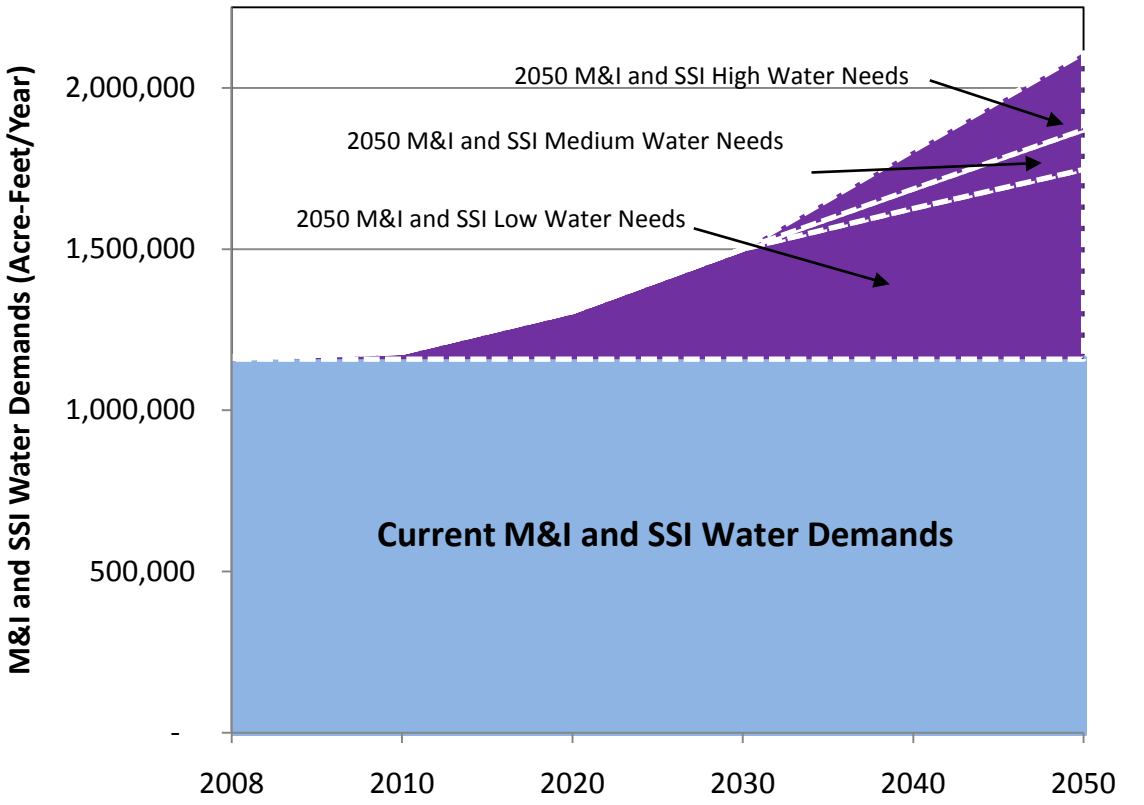

Figure ES-6. Existing and Future M&I and SSI Demands.

Following are the conclusions from State of Colorado's 2050 water use projections:

- Colorado's population is expected to nearly double by 2050 even after taking into account the current recession's impacts on Colorado's economy.
- The Front Range of Colorado will continue to be the most populous place in Colorado with over 80 percent of the state's population residing in the Arkansas, Metro, and South Platte Basins.
- The West Slope of Colorado will grow at the fastest rate of any area in Colorado between now and 2050. Population on the West Slope is expected to more than double in the next 40 years.
- Statewide M&I water usage rates have decreased by 18 percent. This decrease is due to a combination of drought response, conservation savings, and additional data collection efforts. Additional data collected during this effort has improved the original SWSI water usage information.
- Because population growth is the driving factor in water use across the state, water use is also expected to nearly double by 2050.

- Passive conservation will save approximately 154,000 AFY by 2050 or an 8 percent savings.
- The basins with the largest SSI water usage in 2050 are projected to be the Yampa-White, Arkansas, Metro, and South Platte Basins.
- Oil shale water demands have factored in recent information developed by the Colorado and Yampa-White Basin Roundtables' Energy Subcommittee that considered the amount of produced water that will be created during shale processing. In addition, recent work drafted by the Subcommittee has shown that energy needed to develop oil shale could be produced by combined cycle gas turbines, not coal power plants. Both of these considerations have reduced previous estimates of oil shale water demands.

Section 1
Introduction

1.1 Purpose for State of Colorado 2050 Municipal and Industrial Water Use Projections

In 2004, the Colorado Water Conservation Board (CWCB) completed the Statewide Water Supply Initiative (SWSI) Phase 1 Study. One of the key findings of the study was that while SWSI evaluated water needs and solutions through 2030, very few municipal and industrial (M&I) water providers have identified supplies beyond 2030. Beyond 2030, growing demands may require more aggressive solutions. Since the SWSI Phase 1 Study was completed, Colorado's legislature established the Water for the 21st Century Act. This act established the Interbasin Compact Process that provides a permanent forum for broad-based water discussions in the state. It creates two new structures: 1) the Interbasin Compact Committee (IBCC), and 2) the Basin Roundtables. There are nine Basin Roundtables based on Colorado's eight major river basins and the Denver metro area as shown in Figure 1-1.

As part of the Interbasin Compact Process, the Basin Roundtables are required to complete basinwide needs assessments. The needs assessments are to include:

- An assessment of consumptive water needs (municipal, industrial, and agricultural)
- An assessment of non-consumptive water needs (environmental and recreational)

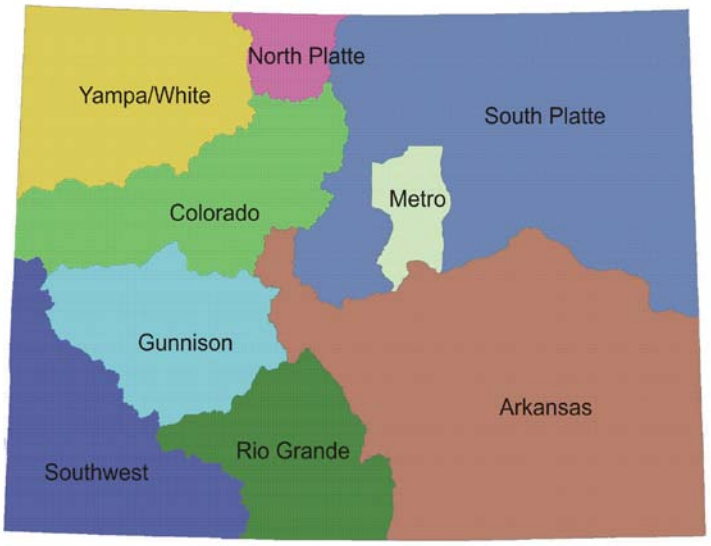

Figure 1-1. Colorado's Nine Basin Roundtables

- An assessment of available water supplies (surface and groundwater) and an analysis of any unappropriated waters
- Proposed projects or methods to meet any identified water needs and achieve water supply sustainability over time

This update of M&I water use projections will assist the Basin Roundtables in completing their consumptive needs assessments. The CWCB is currently in the process of updating the SWSI report based on efforts conducted by the Basin Roundtables and information from this report will be used as a common technical platform for the Basin Roundtable's M&I demands. This report uses a water use

forecast horizon of 2050 for a number of reasons. The CWCB determined that the forecast horizon for the water demand projections needed to be extended to the year 2050 to better represent the long-term water needs that the state will face. The West Slope Basin Roundtables suggested the 2050 timeframe for the demand projections so that potential growth rates on the West Slope could be better characterized. Infrastructure investments and commitment of water supplies also require a longer view into the future. In addition, several of the SWSI Identified Projects and Processes (IPPs) with Environmental Impact Statement (EIS) requirements have used a planning horizon of 2050. Finally, the 2050 timeframe matches the ongoing energy development study conducted by the Colorado and Yampa-White Basin Roundtables.

CWCB published a draft "State of Colorado 2050 Municipal and Industrial Water Use Projections" report in June 2009. This final report reflects feedback received from the Basin Roundtables and other interest groups on the draft report. Responses to comments received on the draft report are included in Appendix A. The Colorado State Demographer's Office (SDO) also provided a comment letter on this report's population projections and this is also included in Appendix A. This final report also incorporates updated water use information and updated population projections through April 2010 that account for the effects of the current recession as detailed in Section 2 of this report.

1.2 Report Objectives and Overview

Standard methods were adapted for use in updating future M&I water demands throughout Colorado. The objectives of this study were to develop a reconnaissance-level water use forecast that employs consistency in data collection and forecast methodology across the state and maximizes available data. The methods utilized in this approach are for the purpose of general statewide and basinwide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes. The elements of the current effort include: 1) updating statewide population projections and extending them to 2050, 2) extending the SWSI Phase 1 M&I water use projections to 2050 to project baseline demands and demands including passive conservation, 3) updating M&I per capita estimates, and 4) updating the self-supplied industrial (SSI) sector forecast.

The M&I demand forecast is aimed at capturing the water needs of an increased population. M&I demands are the water uses typical of municipal systems, including residential, commercial, light industrial, non-agricultural related irrigation, non-revenue water, and firefighting. For the current effort, the M&I demand forecast also captures households across the state that are self-supplied and thus not connected to a public water supply system. Table 1-1 contains the definitions of the M&I demand terms used throughout this report.

Table 1-1. Definition of M&I Demand Terms

Demand Terminology	Definition
M&I Demand	All the water uses of typical municipal systems, including residential, commercial, industrial, irrigation, and firefighting
SSI Demand	Large industrial water uses that have their own water supplies or lease raw water from others
M&I Demand and SSI Demand	The sum of M&I and SSI demand

The updated demands presented in this document represent baseline demands and also include baseline demands minus passive conservation. It is important to note that the M&I demand forecasts do not include potential increases in demand due to climate change or potential decreases in demand due to active conservation programs.

The remainder of this report contains the following sections:

- Section 2 summarizes the 2050 population projections for the state. Discussion includes a description of the methodology used and presents the population projections. Comparisons to the SWSI Phase 1 population forecast and current population are provided.

- Section 3 provides the M&I demand forecast results for baseline demands and demands including passive conservation. Discussion includes data collection efforts, forecast methodology, and results of the forecast by county and basin. Comparisons to the SWSI Phase 1 M&I demands forecast are provided.

- Section 4 discusses the updated SSI demand forecasts. Included in this section is information on the SSI sub-sectors: Large Industry, Snowmaking, Thermoelectric, and Energy Development. For each sub-sector, data collection, methodology, and results are discussed.

- Section 5 summarizes the conclusions of the 2050 population projections, M&I demand forecasts, and SSI demand forecasts on a basin and statewide basis.

Supplemental information to this report can be found in Appendix E of the 2004 SWSI Phase 1 Report: Statewide M&I and SSI Water Demand Projections (CWCB 2004).

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Section 2
2050 Population Projections

2.1 Population Projections Overview

One of the primary mandates of the Interbasin Compact Process is for the Basin Roundtables to develop a water needs assessment. Part of this needs assessment is to compare water supplies with projected water demand to identify future needs that must be met throughout the State of Colorado (state). This report addresses one part of those water demand projections, namely future economic and demographic activity, which serves as a foundation for the M&I water demand projections. This section presents population projections for the year 2050 for the state, each Basin Roundtable, and each county, along with year 2050 employment projections for the state and for each river basin. These projections, when applied to assumptions about water use patterns and conservation, will result in water demand projections.

2.2 Population Projections in Context of Long-term Economic Cycles

As described in this report, the future population of Colorado is largely dependent on the availability of jobs and growth of future employment opportunities. The projections included in this report rely upon assumptions about the economic conditions in Colorado, in the U.S., and internationally. More than ever before, international and U.S. economic and demographic conditions will affect the number and type of jobs available in Colorado. The projections in this report are also based on the assumption that, over the long-term, Colorado will experience an overall growth trend that includes both periods of slower and faster economic growth.

Colorado has experienced several periods of economic downturn or recession in the last 40 years; these periods are outlined briefly below:

1. The 1970s were characterized by two recessionary periods—one between 1973 and 1975 and a second in the 1979-80 period. The first was driven by an oil embargo and the second by rampant inflation.

2. The 1980s saw two economic downturns as well. The first, a recession in the 1981-82 period, was triggered by the second "energy crisis." The second downturn (not an official recession), which occurred during the 1986-87 period, was related to savings and loan failures along with financial and housing market dysfunction.

3. Except for a recession between mid 1990 and early 1991, the 1990s were mostly prosperous for Colorado, but the 2001-02 period produced a sharp downturn for the state as technology and telecommunication sectors almost collapsed in Colorado, as well as the U.S.

4. The Colorado, U.S., and global economies are currently experiencing the effects of a recessionary period that began in late 2007. The current recession began in the financial sector, resulting from large numbers of sub-prime home loan defaults, and eventually spread to other major sectors of the economy, including the insurance, auto, and manufacturing industries. This period has been categorized by large declines in stock values, tighter credit availability, relatively high unemployment rates, widespread home foreclosures, and decreased home values, as well as a drop in consumer confidence.

Historical population and employment changes in Colorado also reflect much slower growth or even declines during these recessionary periods. Between 1969 to 2009, population growth slowed to less than 1 percent per year in the late 1980s and was below 2 percent in 17 of those 40 years. Employment declines occurred in 4 of those 40 years. Employment growth of less than 1 percent occurred in another 4 of those years, while less than 2 percent growth occurred in still another 6 of those years.

However, it is important to note that the past 40 years has also been characterized by periods of rapid growth. State gross domestic product grew by more than 5 percent in 11 out of the past 40 years. Personal income also grew by more than 5 percent in 11 out of the past 40 years. Building permits have increased by more than 20 percent in 7 out of 40 years.

Similarly, annual population and employment growth has been substantially above average for some years during the 1969 to 2009 period. For 7 out of the 40 years, the Colorado population grew by more than 3 percent. State employment growth was also 4 percent or higher in 7 out of the past 40 years. One can conclude that the current recession lies within the state's historical experience of economic cycles. Specific details on these population growth rates and changes are described in Appendix B.

2.3 Population Projections Methodology

The first step in developing 2050 population projections was to determine if other suitable forecasts for the year 2050 economic or demographic activity had previously been prepared and might be useful in this endeavor. In general, local, regional, state, and federal forecasting agencies generally avoid making projections 40 years or more into the future. The U.S. Social Security Administration was one of the few agencies that prepared population projections for the U.S. for 2050; there was an actuarial interest in the solvency of the Social Security Trust Fund, which led to those projections. The U.S. Census has also prepared population projections to 2050 at the national level.

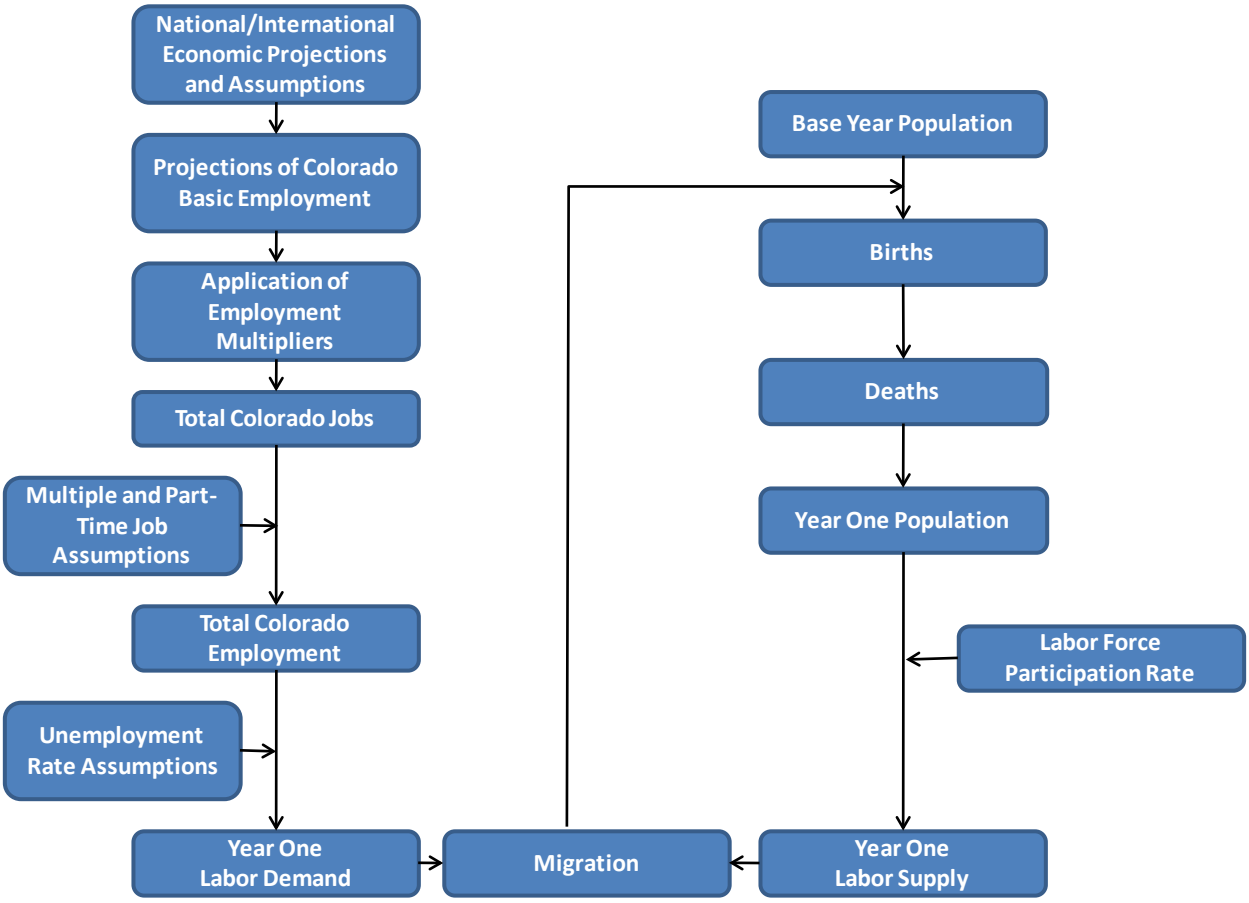
With this fact in mind, a population forecasting methodology that could meet the needs of the 2050 water demand projections was identified. To be suitable, the water demand projections would need to satisfy the following criteria:

- The forecasting methodology must be valid and widely acceptable, both by users of the results and demographic forecasting practitioners.
- The forecasting approach must be transparent and understandable to the extent possible.
- The projections must be replicable.
- In keeping with state-of-the-art practice employed by the SDO, the projections must be economically based and then linked to demographic factors in an integrated manner.
- The projections must be able to produce population forecasts for each county to the year 2050 under high, medium, and low economic development assumptions.

It was determined that the forecasting process and models utilized by the SDO, in conjunction with its consultant, the Center for Business and Economic Forecasting (CBEF), met all of those criteria. Therefore, the SDO forecasting process was adopted for the 2050 effort.

As of 2010, the SDO/CBEF projections are only available through the year 2035. It was determined that the forecasting models, equations, and algorithms could largely be extended or adjusted as needed from 2035 to 2050. To adjust the models from 2035 to 2050 assumptions regarding national and international driving forces behind Colorado's basic economic sectors were developed.

Basic economic sectors include those activities that bring money and economic stimulus into a geographic area. Employment was projected for each of Colorado's basic economic sectors on the basis of the assumptions for the driving forces behind those basic sectors. With projections of basic employment, industry-specific employment multipliers were applied to arrive at total Colorado jobs. Those Colorado job projections served as inputs to the 2050 version of the SDO and CBEF economic/ demographic models, the methodology of which is outlined in Figure 2-1.



Note: CBEF uses employment commuting pattern assumptions and historical growth capture rates to allocate job growth from the state to regions and counties.

Figure 2-1. SDO/CBEF Population Forecasting Methodology

Because of the uncertainty in projecting economic conditions and employment levels in 2050, low, medium, and high employment scenarios were developed for each key employment sector, leading to low, medium, and high population projections. Each of the scenarios reflects unique assumptions for the economy and for each employment sector. These driving influences are summarized in Appendix B (Exhibits 4 through 22).

2.3.1 SDO/CBEF Forecasting Model

The CBEF and the SDO have together created a forecasting model used to project employment and population for the state, each of 14 planning regions, and each of Colorado's 64 counties. This model currently combines both employment projections and assumptions of various demographic factors into estimates of population through the year 2035. The SDO/CBEF model is updated annually and provides the official population projection data for the State of Colorado. The projections in this report are based on a SDO/CBEF model last updated in October 2009 and modified in early April 2010 to reflect interim revisions of employment and population data for a small

number of counties. These revisions were incorporated into the SDO/ CBEF model prior to the work done to estimate the 2050 population. Therefore, the SDO's official population projections, as of November 2009, are slightly different than the revised model's projections that use the April 2010 interim revisions. Together, CBEF's employment projections and SDO's population assumptions create estimates of migration and commuting and ultimately result in population projections for the state, regions, and counties.

2.3.2 2050 Extension of Model

Figure 2-2 depicts the extension and modification of the SDO/CBEF model to produce 2050 population projections. Steps A through M show how the model projects population, beginning with projections of traditional and household basic jobs, as more fully described below. Essentially, assumptions of various employment and demographic factors are applied to projected basic jobs, ultimately resulting in population estimates.

In general, model algorithms from the 2020 through 2035 time period were applied to 2050. For example, military jobs were held constant at the 2035 level since no data sources were able to provide information on military actions or trends that far into the future. For several demographic assumptions, such as the unemployment rate and the labor force participation rate, half the difference between the 2030 and 2035 rates were used for the 2050 model projections.

One of the major elements in determining future population is examining how different economic factors vary based on future scenarios. Basic economic sectors are those activities that bring money into a particular economy, be it a state, a region, a county, or a community. The demand for goods and services is determined outside that geographic area, i.e., demand for oil is determined outside of Colorado, and the money that oil development brings into an area is circulated around that economy. This circulation process is often referred to as "the multiplier effect." The basic economic activity is therefore a crucial starting point in projecting future economic or demographic activity in a particular area.

A. Direct basic jobs (projected independently by sector)

TIMES

B. Non-basic resident service job ratio (one-half the difference in 2030 and 2035 ratio was applied)

EQUALS

C. Total jobs (sum of basic and non-basic jobs)

PLUS

D. Military jobs (value held constant from 2035 to 2050)

PLUS OR MINUS

E. Number of commuters (weighted average of years 2020 to 2035)

TIMES

F. Multiple job holding rate (2035 rates held constant to 2050)

EQUALS

G. Total Employment (sum of C, D, E, and F above)

TIMES

H. Unemployment rate (half the difference in 2030 and 2035 rates)

EQUALS

I. Civilian labor force (employment plus unemployment)

TIMES

J. Labor force participation rate (applied half the difference between 2030 and 2035 was used to produce 2040, 2045, and 2050 rates)

EQUALS

K. Non-institutional working age population (includes working population and those who could work)

TIMES

L. Ratio of working age population to total population (half the difference of 2030 and 2035 ratio was used to estimate 2040, 2045, and 2050 rates)

EQUALS

M. Total population (census based and modified for under/over counts)

Figure 2-2. Extending the SDO/CBEF Model to 2050

2.4 Colorado's Basic Economic Sectors

Colorado has two types of basic sectors—traditional basic and household basic. Traditional basic sectors are those such as agriculture, mining, or manufacturing where demand is determined outside the state, while the activity brings money into the state, stimulating the economy. Less well recognized, but of equal importance, are the household basic sectors, which result from individuals in the state, because of their demographic circumstance, representing a source of money and expenditures coming into Colorado. For example, retirees receive Social Security and pension support, and welfare recipients receive public assistance from governmental entities outside their local area. A listing of the traditional and household basic sectors is provided in Figure 2-3.

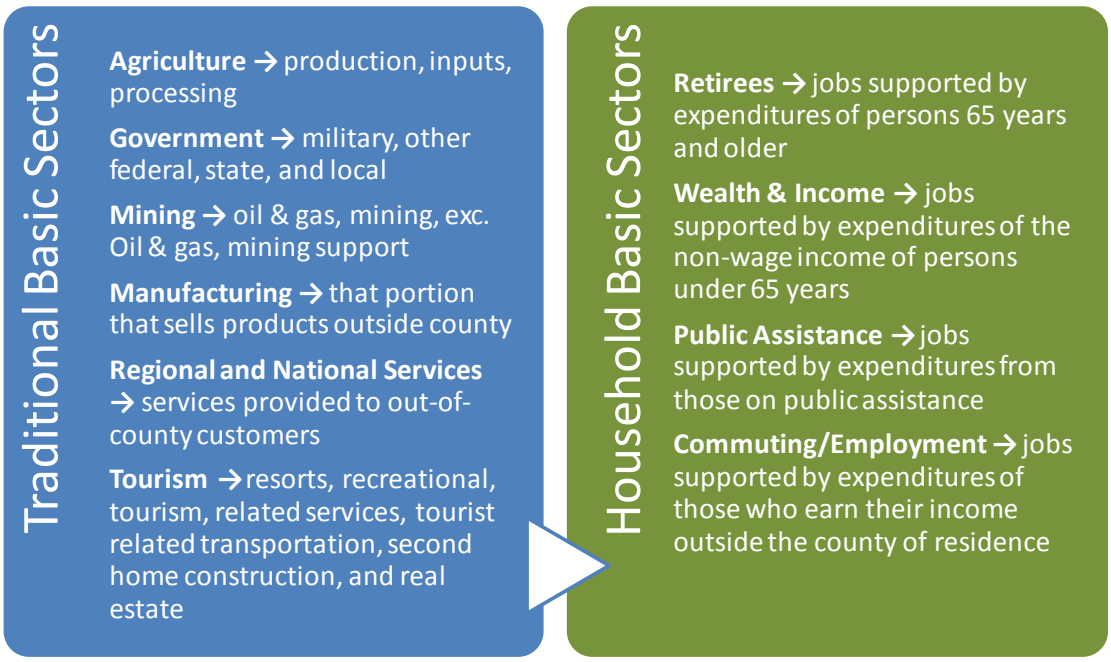


Figure 2-3. Colorado's Basic Employment Sectors

To estimate population demands to 2050, each of these basic economic sectors was varied based on assumptions for the low, medium, and high scenarios. Table 2-1 below shows an example of the driving influences for the low, medium, and high population scenarios for the tourism basic sector. For each basic sector, similar driving influences were considered for each population scenario. These driving influences are summarized in Appendix B (Exhibits 4 through 22).

Table 2-1. Example of Tourism Basic Sector Driving Influences for Population Projections

Driving Influences	Low	Medium	High
Labor shortage	• No improvement in housing shortage • No labor shortage solutions found	• Moderate improvement in work housing • Isolated success with alternative labor supply	• Worker housing constraint overcome • Alternative labor supplies widely used
Second homes	• Market saturated • 2007 use patterns remain	• Limited growth in new units • Modestly higher utilization	• Continued growth in units • Usage increase
Climate change	• No adaptive actions to mitigate effects • Three weeks loss from ski season • Early rapid run-off disrupts stream-based recreation	• Moderate adaptive actions to mitigate effects • One-and-a-half week loss from ski season • Snow conditions deteriorate somewhat • Early rapid run-off disrupts stream-based recreation, market adapts somewhat • Refuge from global warming marketed to some effect	• Major adaptive actions to mitigate effects • No loss from ski season • Reduced snow conditions managed well • Stream-based recreation market adjusts to early rapid run-off • Summer season in mountains big as a refuge from global warming

2.5 Employment Projections

To examine the relative importance of different industries across the state, a comparison of 2007 and 2050 employment by industry was completed at the basin level. The employment by industry information for 2007 was the most recent information from the SDO at the time of this report update. Detailed employment projections are provided in Appendix B. A summary of key findings and observations for this analysis is below:

- Statewide, in 2050 slightly more than half of total jobs (52 percent) are projected to be in traditional basic industries and household basic sectors and slightly less than half (48 percent) are projected to be resident service jobs. Agriculture, mining, manufacturing, and government sector jobs are projected to increase through 2050, but the percentage of jobs in these sectors as a portion of total jobs will decrease compared to 2007 levels. The major drivers of growth in the state will be household basic jobs (those jobs created through the spending of retirees, public assistance recipients, investment income recipients, and commuters) and regional and national service jobs. Household basic jobs will experience a large amount of growth mainly due to the aging of the population. Of the household basic sectors, jobs based on retiree spending will grow by the largest number and the fastest rate. Regional and national service jobs will be a leading sector of growth in the state due to the assumption of moderate economic growth in the U.S., the growth of Colorado service sectors (healthcare, technology, and construction) as a result of U.S. economic growth and the development of mining, renewable fuels, and other

high technology sectors. Tourism is also anticipated to grow in importance in Colorado by 2050, due to moderate growth of the U.S. economy, international economic expansion, and the identity of Colorado as a tourist destination.

- Patterns of employment growth in the Arkansas Basin are similar to those seen at the statewide level. Regional and national service jobs, along with household basic jobs, made up the majority of basic sector employment in 2007. Household basic jobs, tourism jobs, and regional and national service jobs will be the drivers of growth in the basin by 2050. Employment in these sectors is anticipated to grow by 193 percent, 131 percent, and 117 percent, respectively, between 2007 and 2050. In comparison, employment in other basic sectors (agriculture, mining, manufacturing, and government) will increase by 40 percent or less over the same period.

- In the Colorado Basin, tourism jobs comprised the largest portion of basic sector employment in 2007, followed by regional and national service jobs and household basic jobs. Household basic jobs are expected to grow at the fastest rate of any sector between 2007 and 2050, but tourism will remain the basin's largest base of employment. Mining is the only sector in the basin that is expected to experience decreased employment by 2050.

- In the Gunnison Basin, household basic jobs made up the largest portion of basic sector employment in 2007. These jobs will grow at the fastest rate of any basic sector and will remain the largest source of employment in 2050, followed by tourism and regional and national services. Other sectors will grow at slower rates, with decreased employment anticipated in the mining sector by 2050.

- Agriculture was the largest basic employment sector in the North Platte Basin in 2007 and is anticipated to remain the most important sector by 2050. Household basic jobs will remain the second most important sector in the basin, with a decreasing share of total jobs. Regional and national service jobs will grow at the fastest rate of any sector between 2007 and 2050, increasing in share of total jobs.

- Agriculture was the largest basic employment sector in the Rio Grande Basin in 2007, but is expected to be slightly behind household basic sectors by 2050. The portion of mining jobs compared to total jobs in the basin is expected to increase by 2050; the same pattern is anticipated in regional and national service jobs and tourism jobs.

- The South Platte Basin and Metro Basin[1] have the largest employment of all basins, totaling over 2 million jobs in 2007 and over 3.4 million job opportunities are expected by 2050. Regional and national service jobs led employment in 2007 and

[1] The Metro Basin includes the following counties: Adams, Arapahoe, Broomfield, Denver, Douglas, Elbert, and Jefferson Counties. The South Platte Basin includes the following counties: Boulder, Cheyenne, Clear Creek, Gilpin, Kit Carson, Larimer, Lincoln, Logan, Morgan, Park, Phillips, Sedgwick, Teller, Washington, Weld and Yuma.

will remain the largest source of employment in the basin in 2050. Household basic sector employment is anticipated to grow more rapidly than other basic sectors, about 174 percent between 2007 and 2050. Tourism jobs are expected to grow by about 83 percent and other basic sector employment will grow by 35 percent or less over the same period.

- Tourism was the most important basic sector in the Southwest Basin in 2007, followed by household basic jobs and regional and national service jobs. Similar to the Colorado Basin, household basic jobs are expected to grow at the fastest rate of any sector between 2007 and 2050, but tourism will remain the Southwest Basin's largest source of employment, increasing in its share of total employment. By 2050, mining jobs in the basin will have decreased compared to 2007 mining employment.

- In the Yampa Basin, tourism was the leading sector in 2007, followed by regional and national services; however, by 2050 regional and national service are expected to be the leading sector, with both mining and tourism about equal for second place. Mining jobs in the basin are expected to grow by over 400 percent between 2007 and 2050.

2.6 2050 Population Projection Results

Between the year 2008 and 2050, the State of Colorado is projected to grow from approximately 5.1 million people to between 8.6 million and 10.5 million people, or slightly less than a doubling of the population under medium economic development assumptions. Under low economic development assumptions, state population is projected to grow to about 8.4 million people, or by about 65 percent. Under high economic development assumptions, including a 550,000 barrel per day oil shale industry, the State's population is projected to grow to just over 10.5 million people, or by 106 percent, as compared to the year 2008. On average, statewide population projections from 2008 forward indicate an increase of about 1.4 million people every 15 years.

Figure 2-4 at the end of this section and Table 2-2 show how population growth will vary across the state during the next 40 years. Based on these projections, the Arkansas, Metro, and South Platte Basins will continue to have the largest population in the state. However, the West Slope will continue to grow at a faster rate than the front range of Colorado.

Table 2-2. Population Projections by River Basin

Basin	2008	2035	Percent Change 2008 to 2035	Percent Average Annual Growth Rate	2050			Percent Change 2008 to 2050	Percent Average Annual Growth Rate
					Low	Medium	High		
Arkansas	948,000	1,451,000	53	1.6	1,581,000	1,688,000	1,841,000	67-94	1.2-1.6
Colorado	307,000	558,000	82	2.2	661,000	725,000	832,000	115-171	1.8-2.4
Gunnison	105,000	184,000	75	2.1	206,000	220,000	240,000	96-129	1.6-2.0
Metro	2,513,000	3,622,000	44	1.4	4,018,000	4,144,000	4,534,000	60-80	1.1-1.4
North Platte	1,500	1,800	20	0.7	2,000	2,200	2,500	33-67	0.7-1.2
Rio Grande	50,000	68,000	36	1.2	74,000	80,000	87,000	48-74	0.9-1.3
South Platte	977,000	1,622,000	66	1.9	1,808,000	1,902,000	2,605,000	85-167	1.5-1.8
Southwest	105,000	185,000	76	2.1	204,000	224,000	249,000	94-137	1.6-2.1
Yampa-White	45,000	81,000	80	2.1	94,000	117,000	153,000	109-240	1.8-3.0
TOTAL	**5,051,500**	**7,772,800**	**54**	**1.6**	**8,648,000**	**9,102,200**	**10,543,500**	**71-109**	**1.3-1.6**

Figures 2-5 through 2-13 at the end of this section show population projections through 2050 for each basin for the low, medium, and high economic development assumptions. Summary results for individual basins follow:

- Figures 2-5 through 2-7 show the population projections for the Arkansas, Metro, and South Platte Basins. The Arkansas River Basin population is projected to increase by about 78 percent between 2008 and 2050 under medium economic development assumptions; El Paso County will account for much of the growth and will remain the largest population center in that basin. As the most populous river basins in the state, the South Platte and Metro Basins are projected to grow from approximately 3.5 million people in the year 2008 to 6.0 million people by the year 2050, under the medium economic development assumptions. This amounts to an increase of about 2.5 million people, or about 73 percent, during that period. About 69 percent of all Colorado residents resided in the South Platte Basin in the year 2008; by the year 2050, that proportion will decrease only slightly to about two-thirds.

- Figures 2-8 through 2-11 show populations for the West Slope basins (Colorado, Gunnison, Southwest, and Yampa-White). The Colorado River Basin is expected to grow by 2.4 times between the year 2008 and 2050 with considerable growth projected by all counties in that basin, especially Garfield and Mesa Counties. The Gunnison River Basin is projected to grow by about 2.1 times between 2008 and 2050, under the medium scenario, with Mesa and Montrose Counties being the most populous in that region. The Southwest Basin is projected to grow by about 2.1 times between the year 2008 and 2050 under medium economic development assumptions. La Plata County will remain the most populous county in that basin and will continue to experience robust growth. The Yampa-White River Basin population is projected to increase by about 2.6 times between 2008 and 2050, under medium economic development assumptions, increasing from about 45,000 to about 117,000 residents during that period. This increase is mainly due to assumptions about increased mining activity in the area.

- Figures 2-12 and 2-13 show the population projections for the North Platte and Rio Grande Basins. The North Platte River Basin, which consists of only Jackson County, is projected to grow from about 1,500 people in 2008 to about 2,200 people by the year 2050; an increase of about 44 percent. The Rio Grande Basin is projected to increase from approximately 50,000 people in the year 2008 to 80,000 people by the year 2050; an increase of about 60 percent.

Figures 2-14 through 2-23 at end of this section show comparisons of the population projections through the year 2030 that were used in SWSI versus population projections developed as part of this effort during April 2010. Figure 2-14 shows the statewide comparison and indicates that the current projections are slightly higher than the SWSI projections. There is a similar trend for the following basins—Arkansas (Figure 2-15), Colorado (Figure 2-16), Gunnison (Figure 2-17), Metro (Figure 2-18), North Platte (Figure 2-19), Rio Grande (Figure 2-20), and South Platte (Figure 2-21). For the Southwest Basin (Figure 2-22), SWSI population projections were lower than current projections. The Yampa-White Basin's current population projections are significantly higher in the years 2025 and 2030 than the SWSI populations due to changes in projections related to energy development.

Figure 2-4 State of Colorado Population Projections through 2050

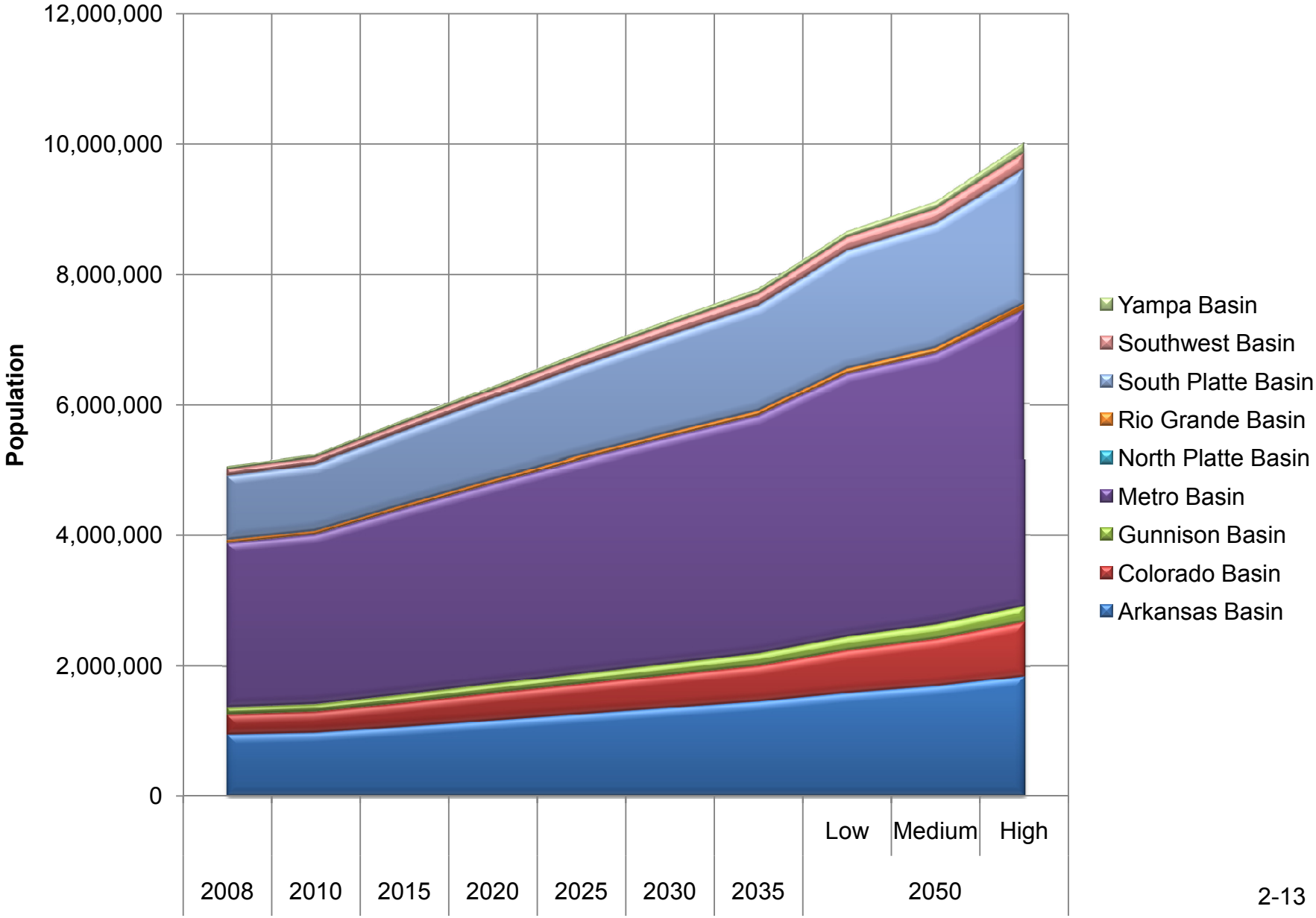
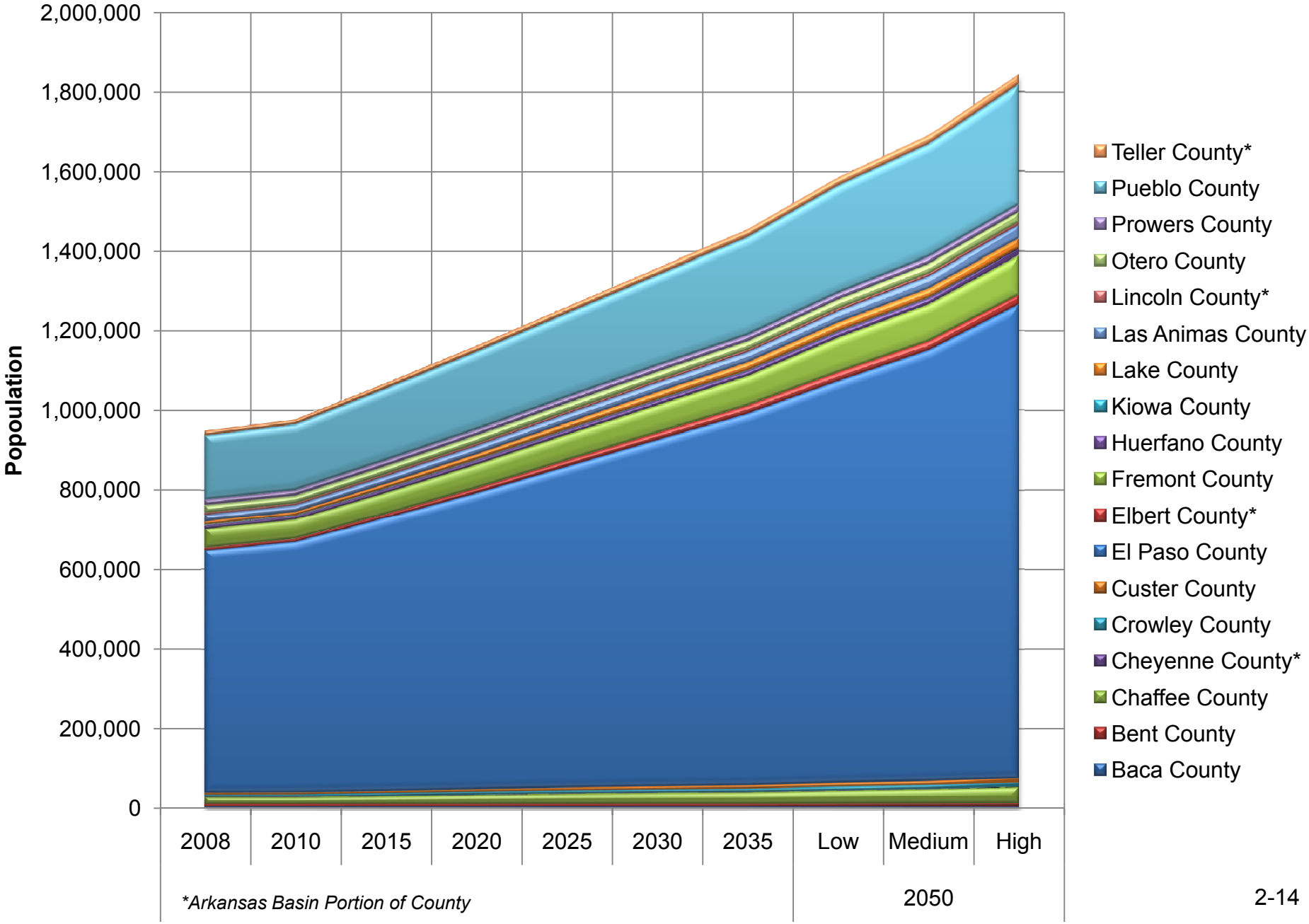


Figure 2-5 Arkansas Basin Population Projections through 2050



Arkansas Basin Portion of County

Figures 2-6 Metro Basin Population Projections through 2050

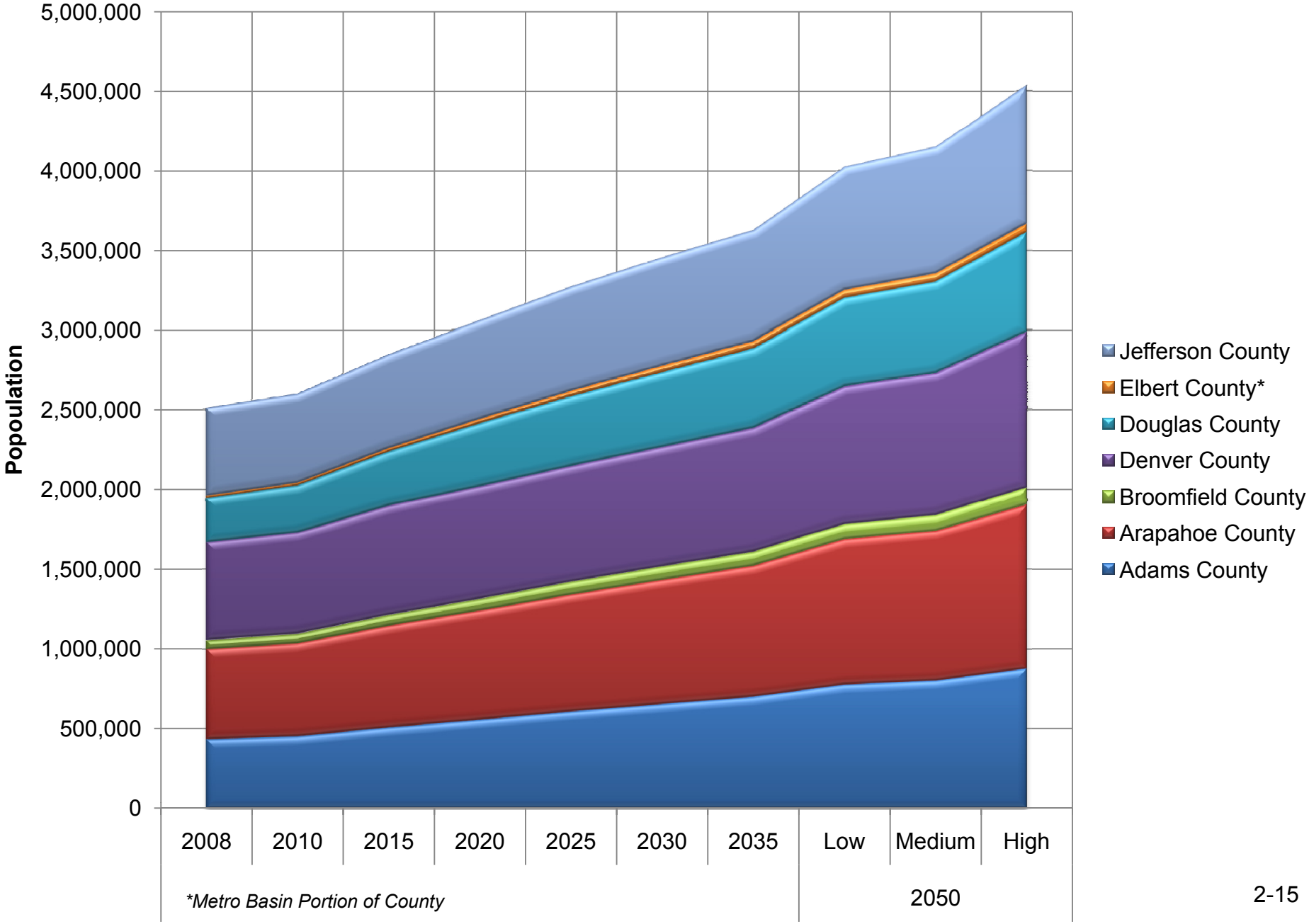


Figure 2-7 South Platte Basin Population Projections through 2050

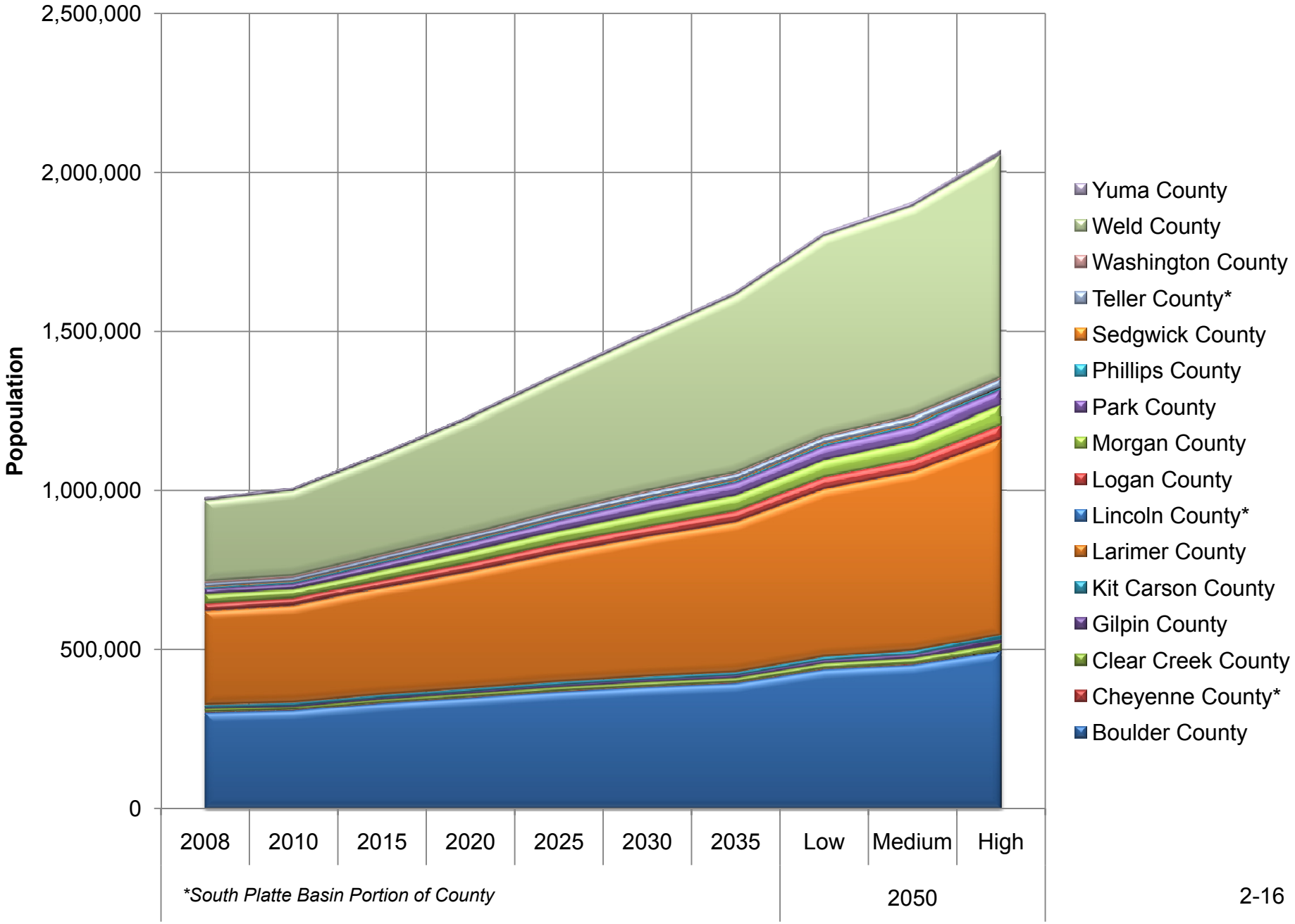
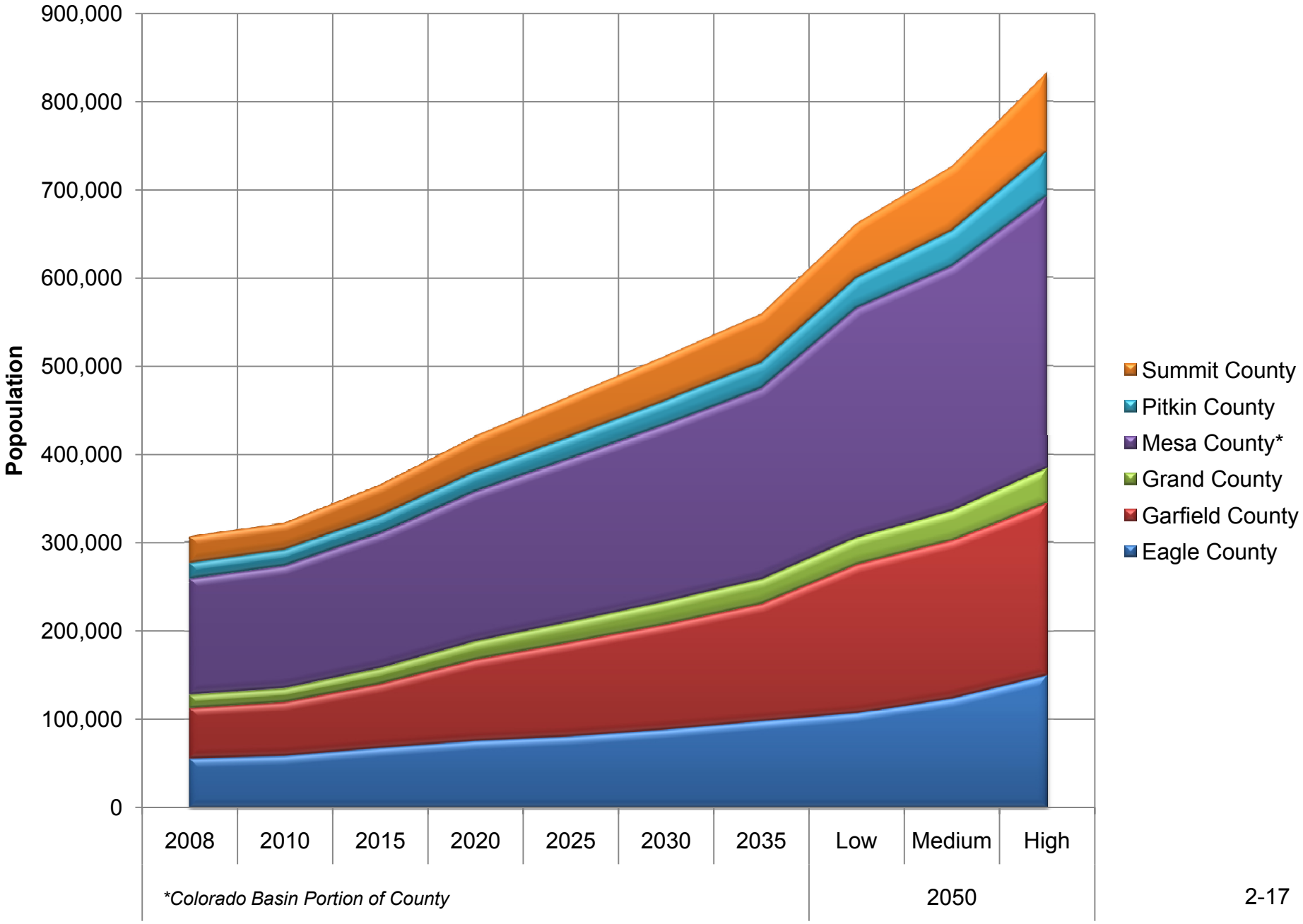


Figure 2-8 Colorado Basin Population Growth



*Colorado Basin Portion of County

Figure 2-9 Gunnison Basin Population Growth

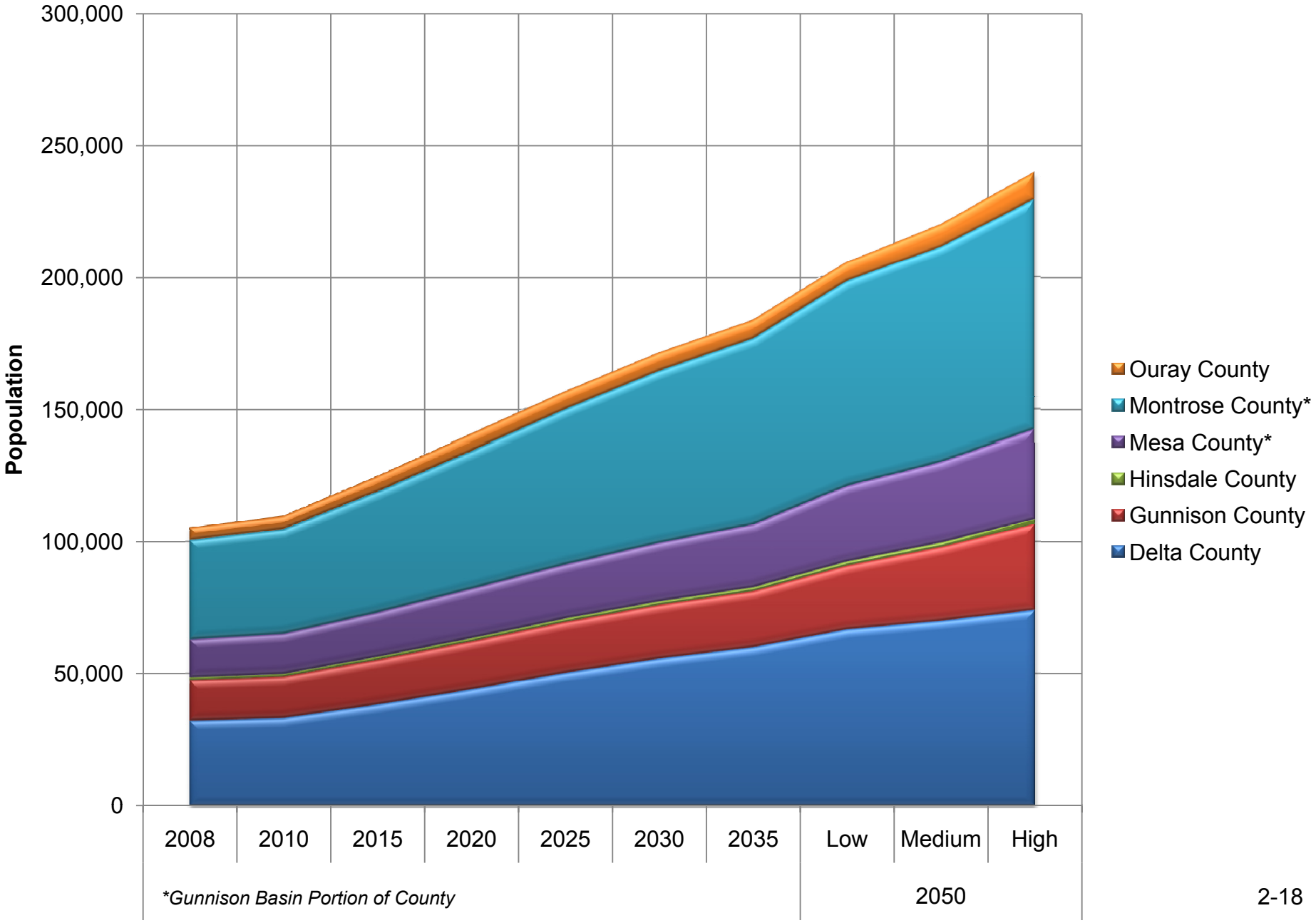


Figure 2-10 Southwest Basin Population Growth

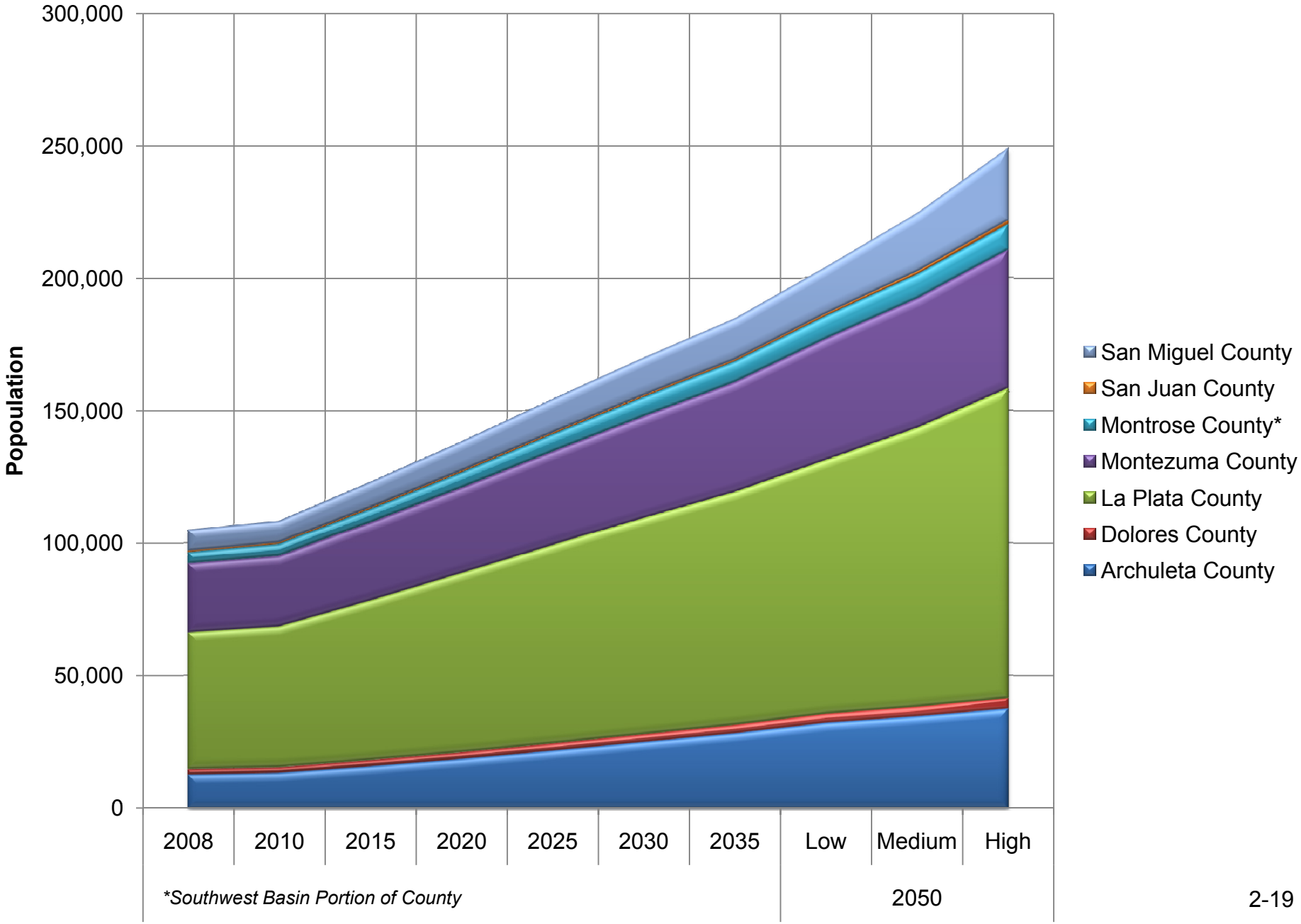


Figure 2-11 Yampa Basin Population Growth

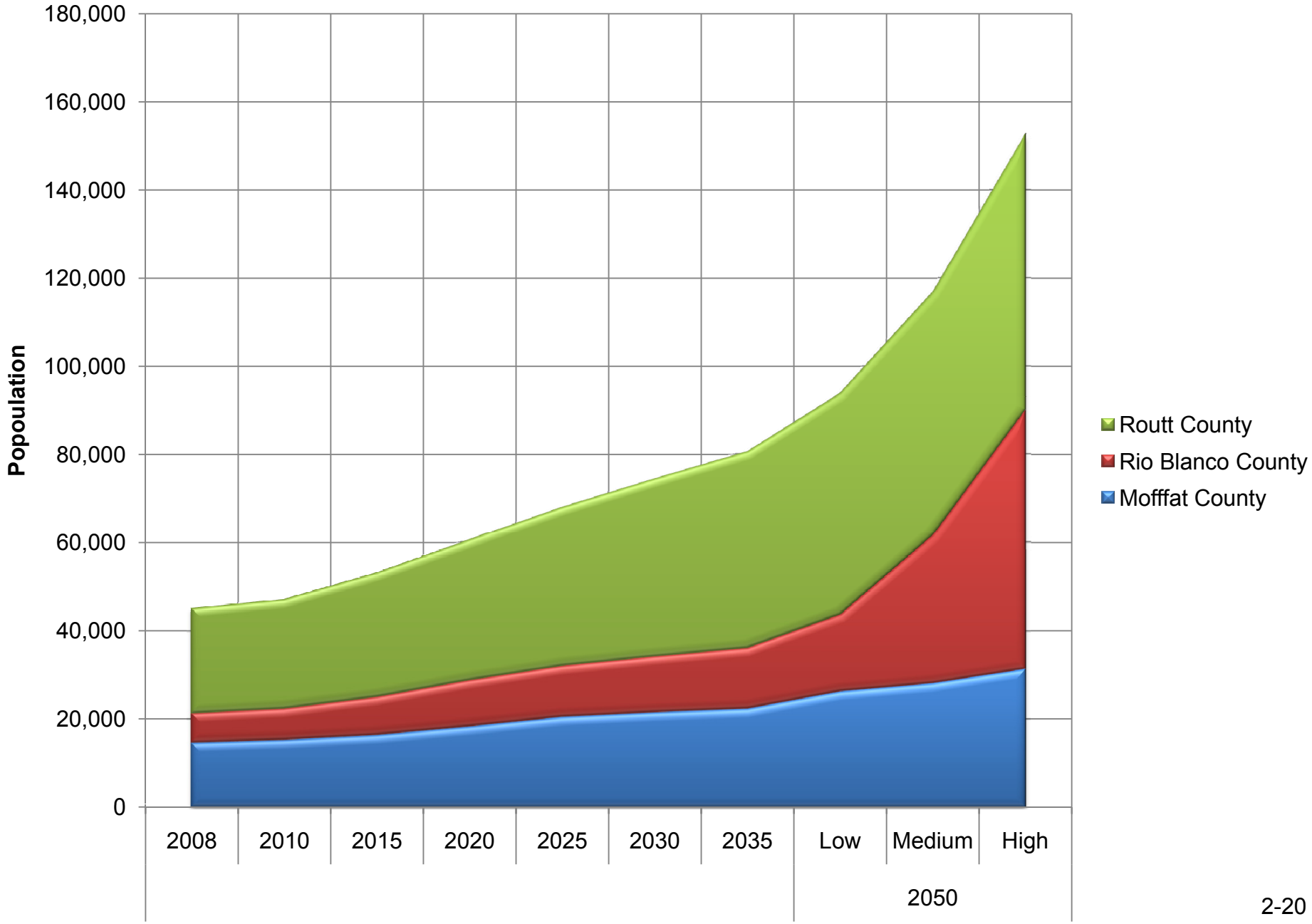


Figure 2-12 North Platte Basin Population Growth

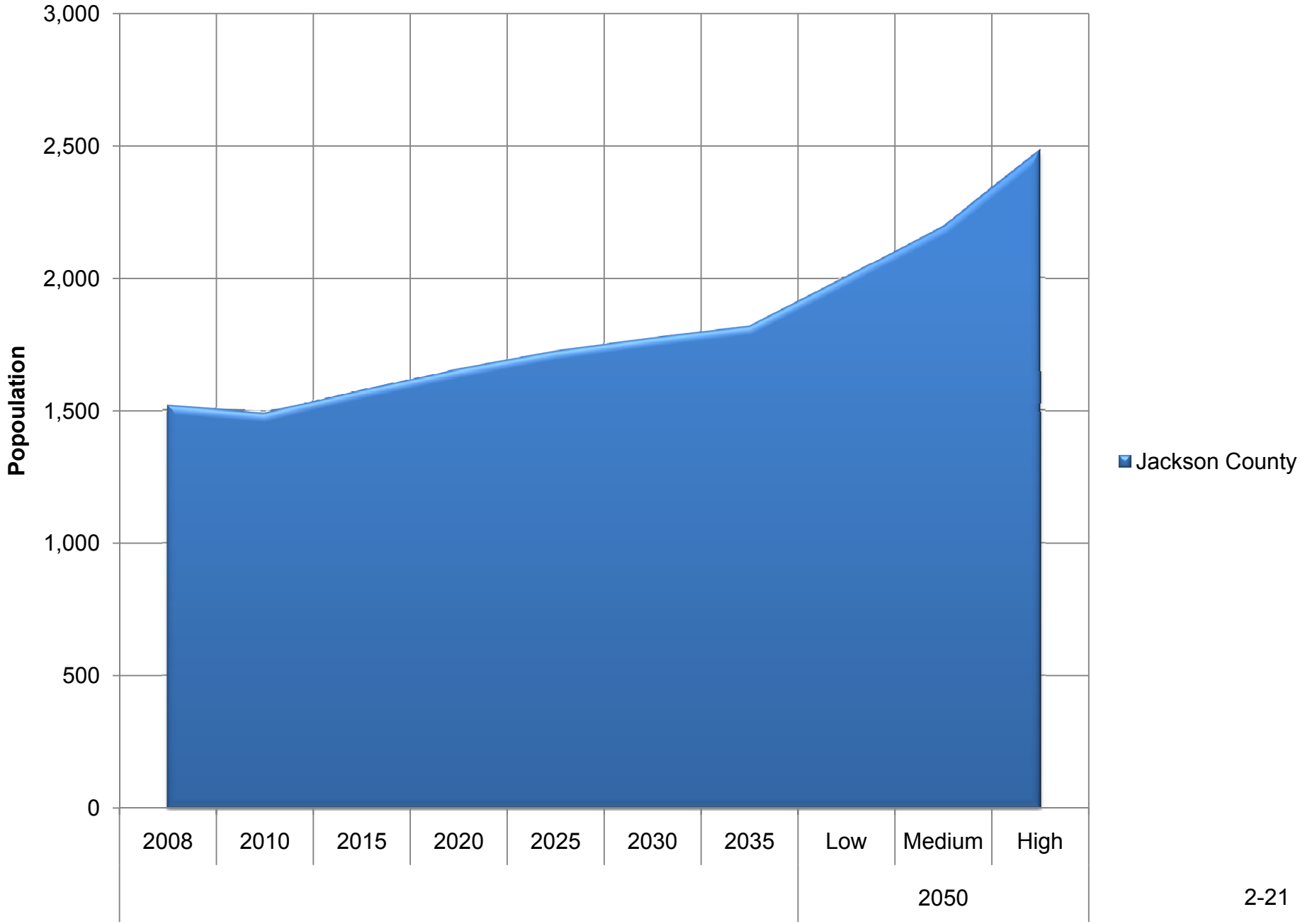


Figure 2-13 Rio Grande Population Growth

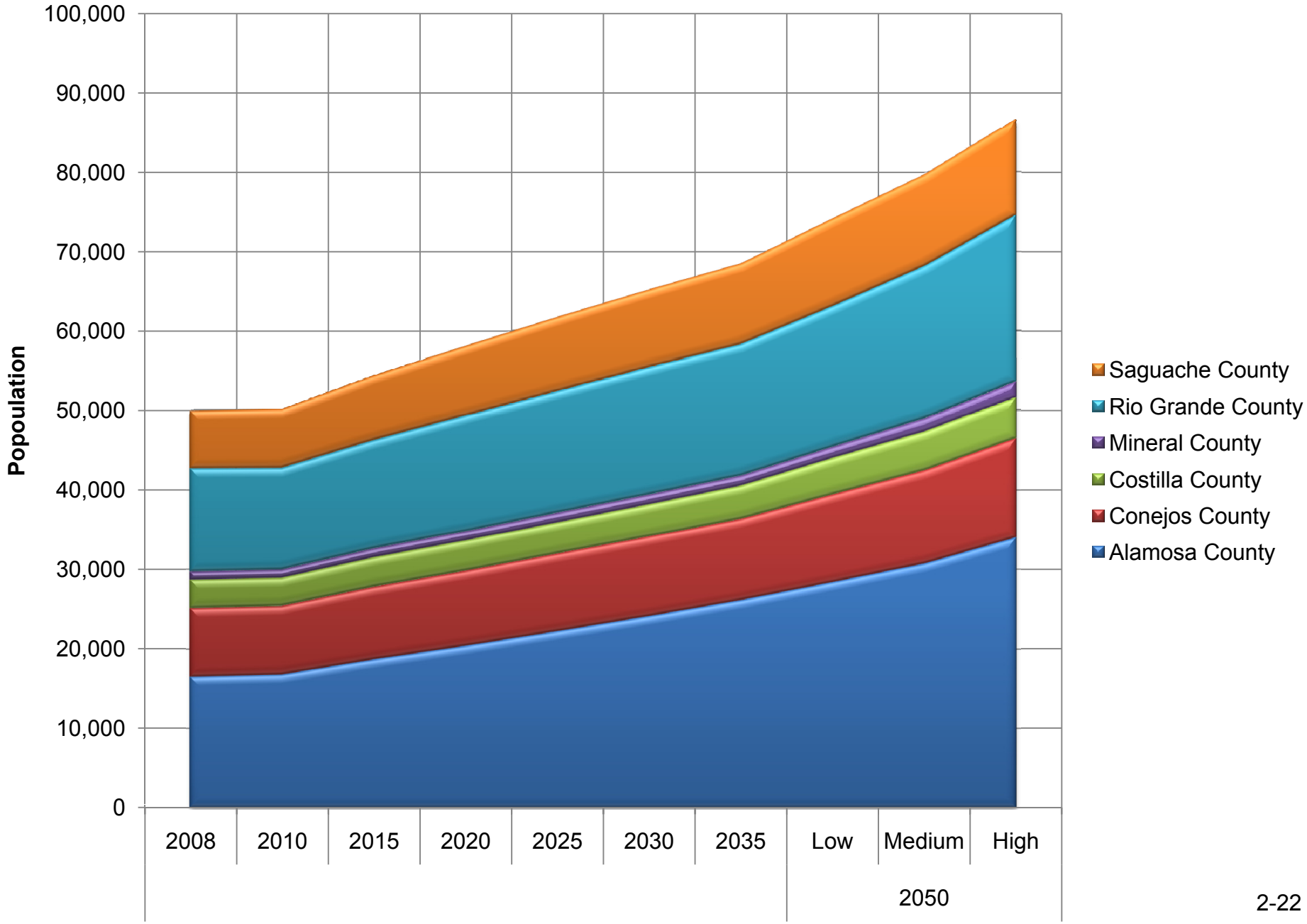


Figure 2-14 Statewide Comparison of SWSI and Current Population Projections

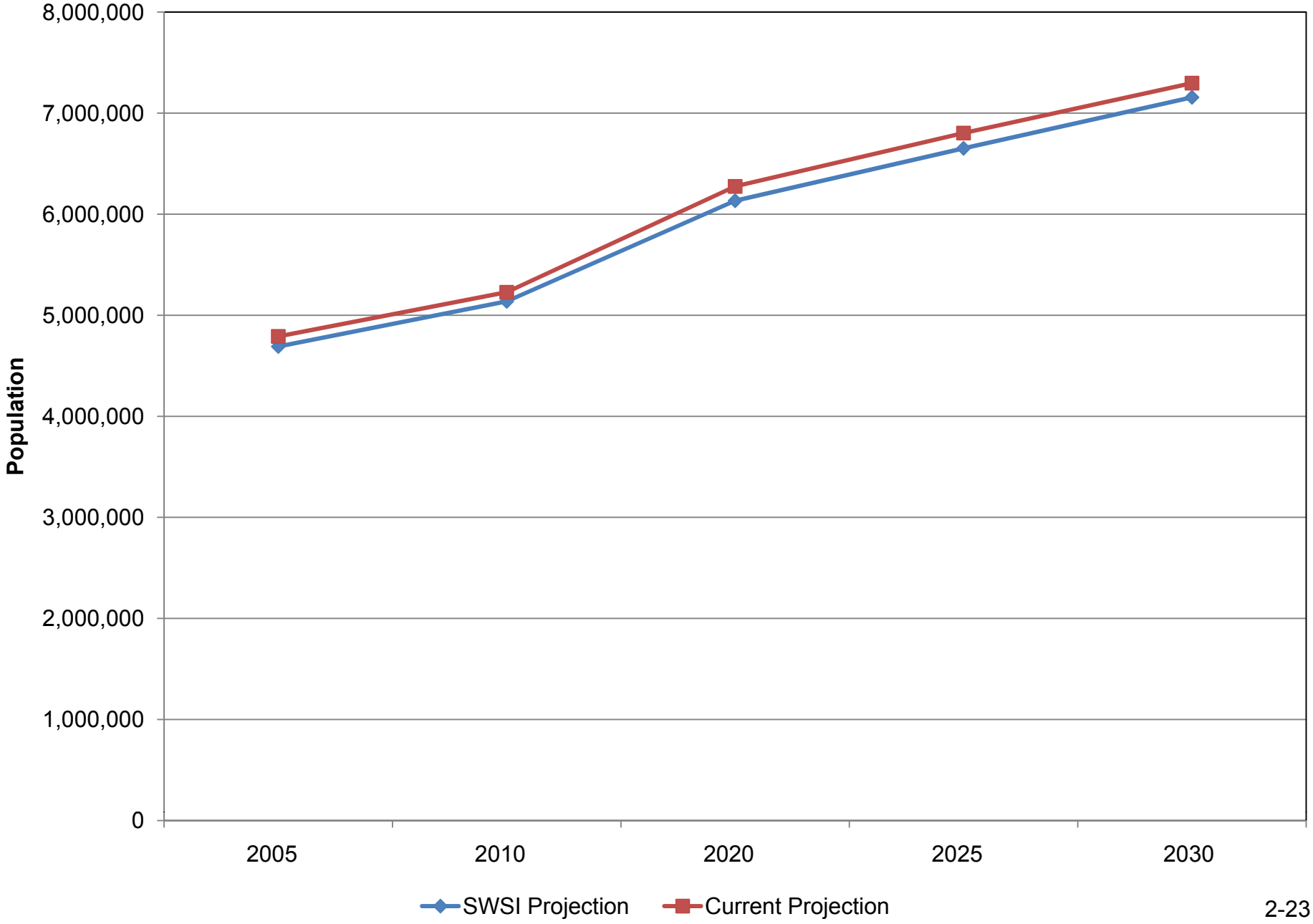


Figure 2-15 Comparison of SWSI and Current Population Projections for Arkansas Basin

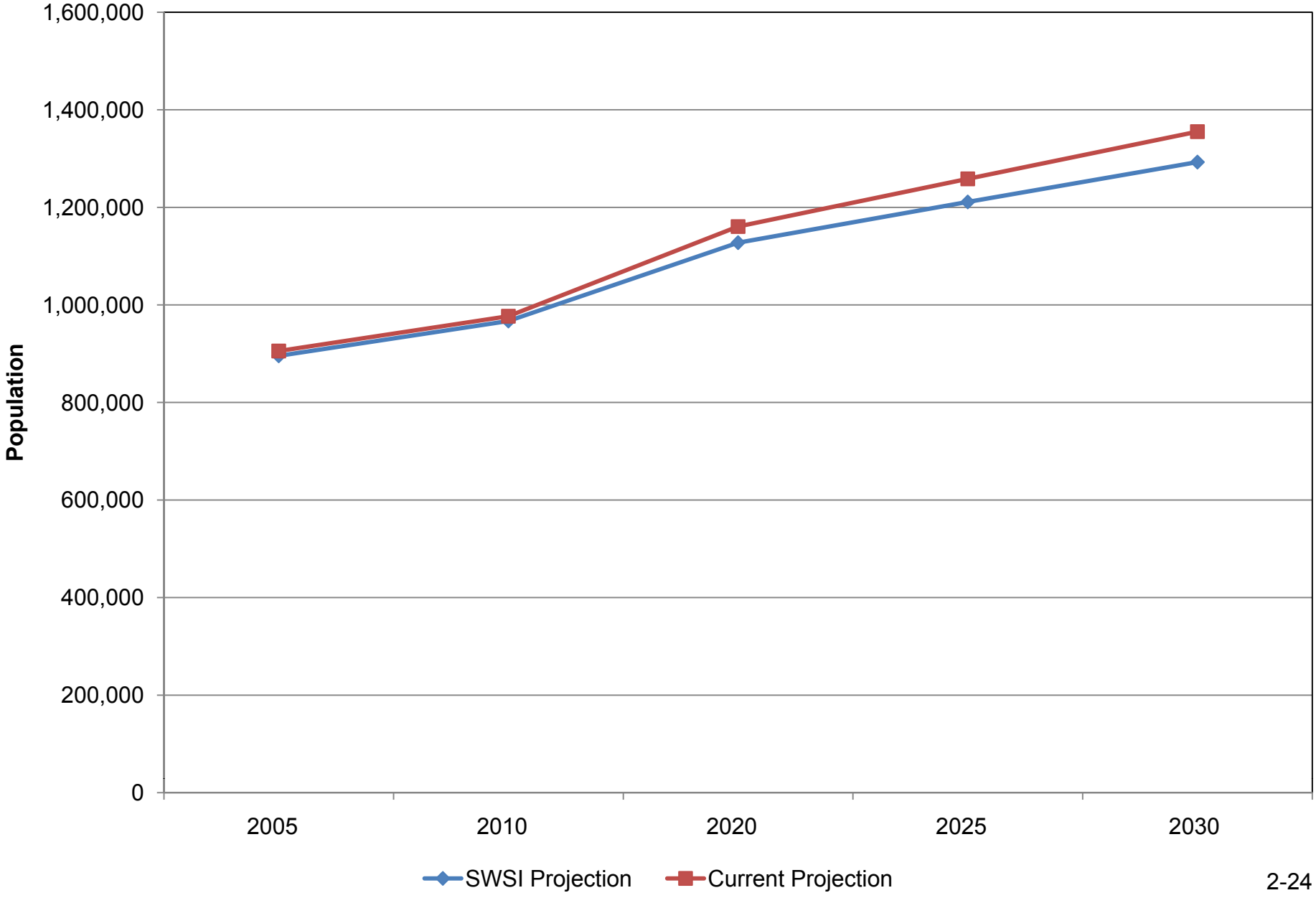


Figure 2-16 Comparison of SWSI and Current Population Projections for Colorado Basin

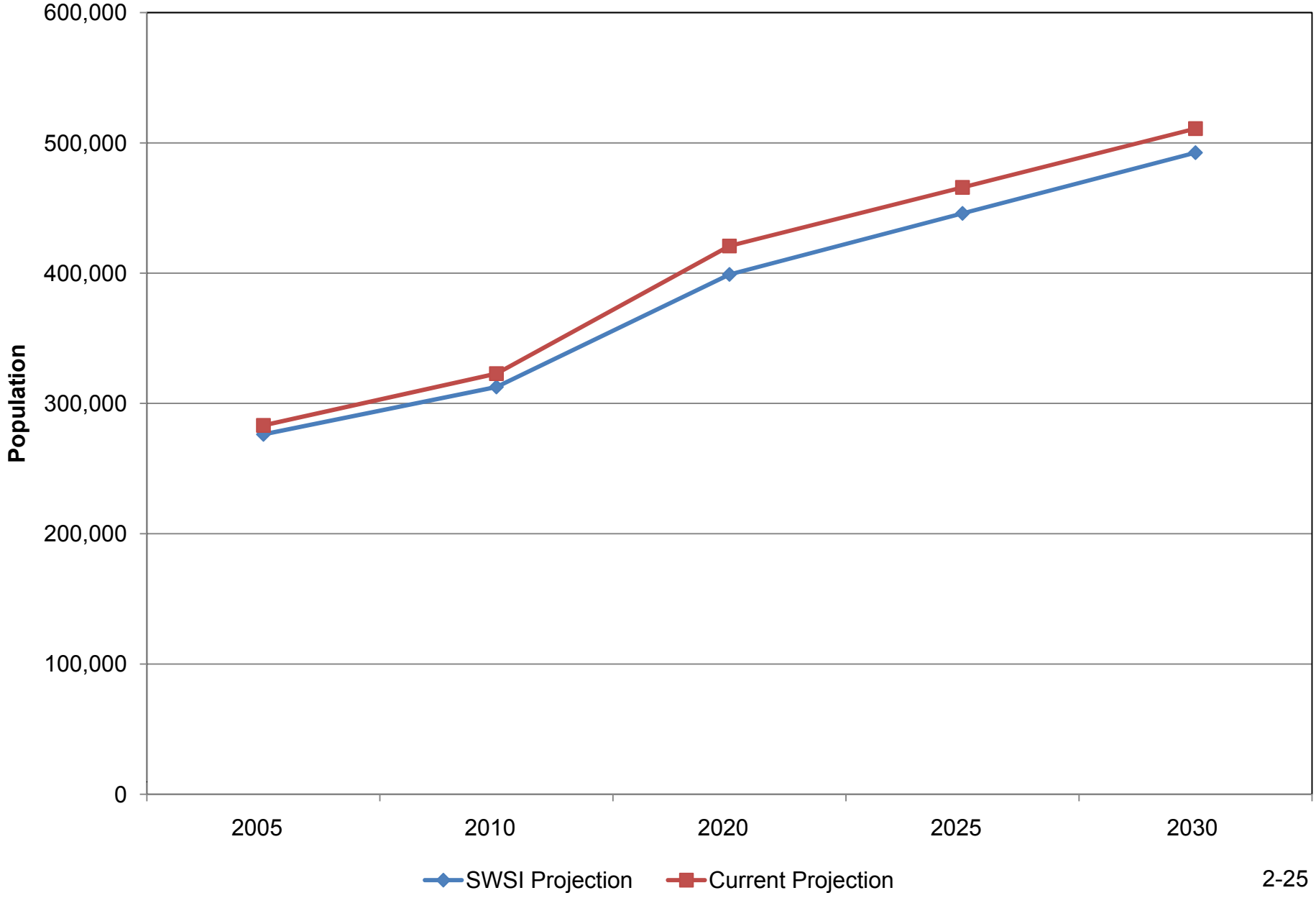


Figure 2-17 Comparison of SWSI and Current Population Projections for Gunnison Basin

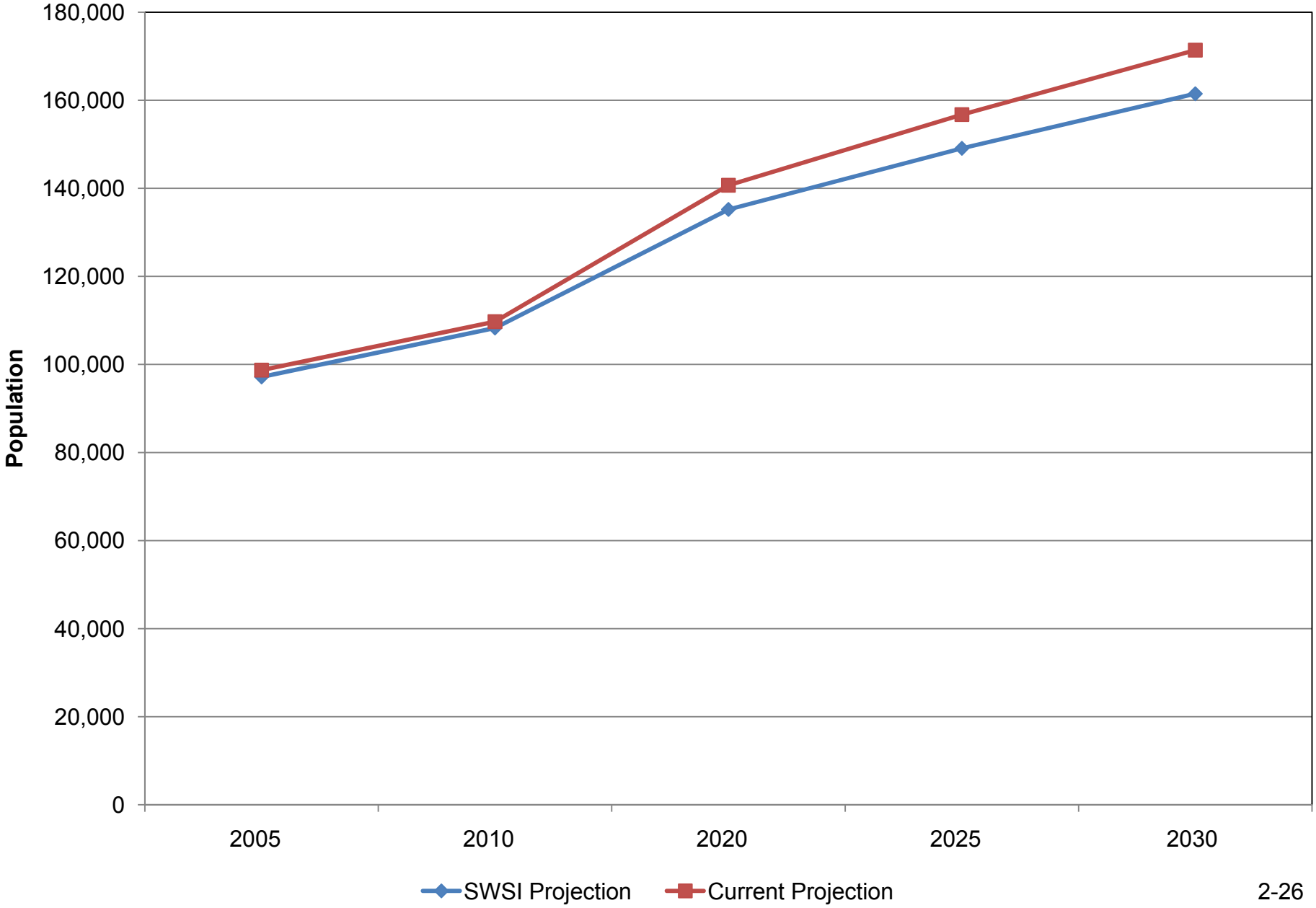


Figure 2-18 Comparison of SWSI and Current Population Projections for Metro Basin

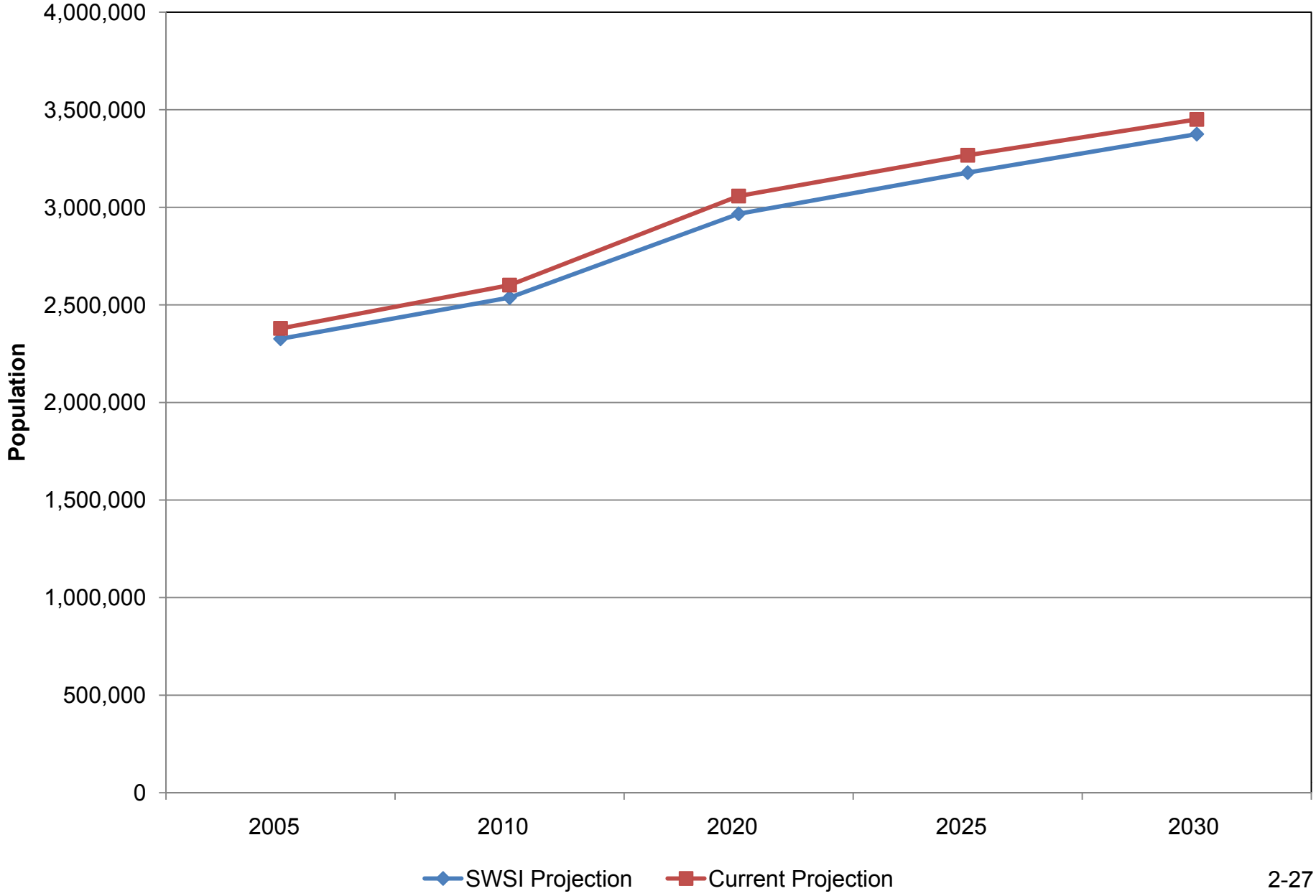


Figure 2-19 Comparison of SWSI and Current Population Projections for North Platte Basin

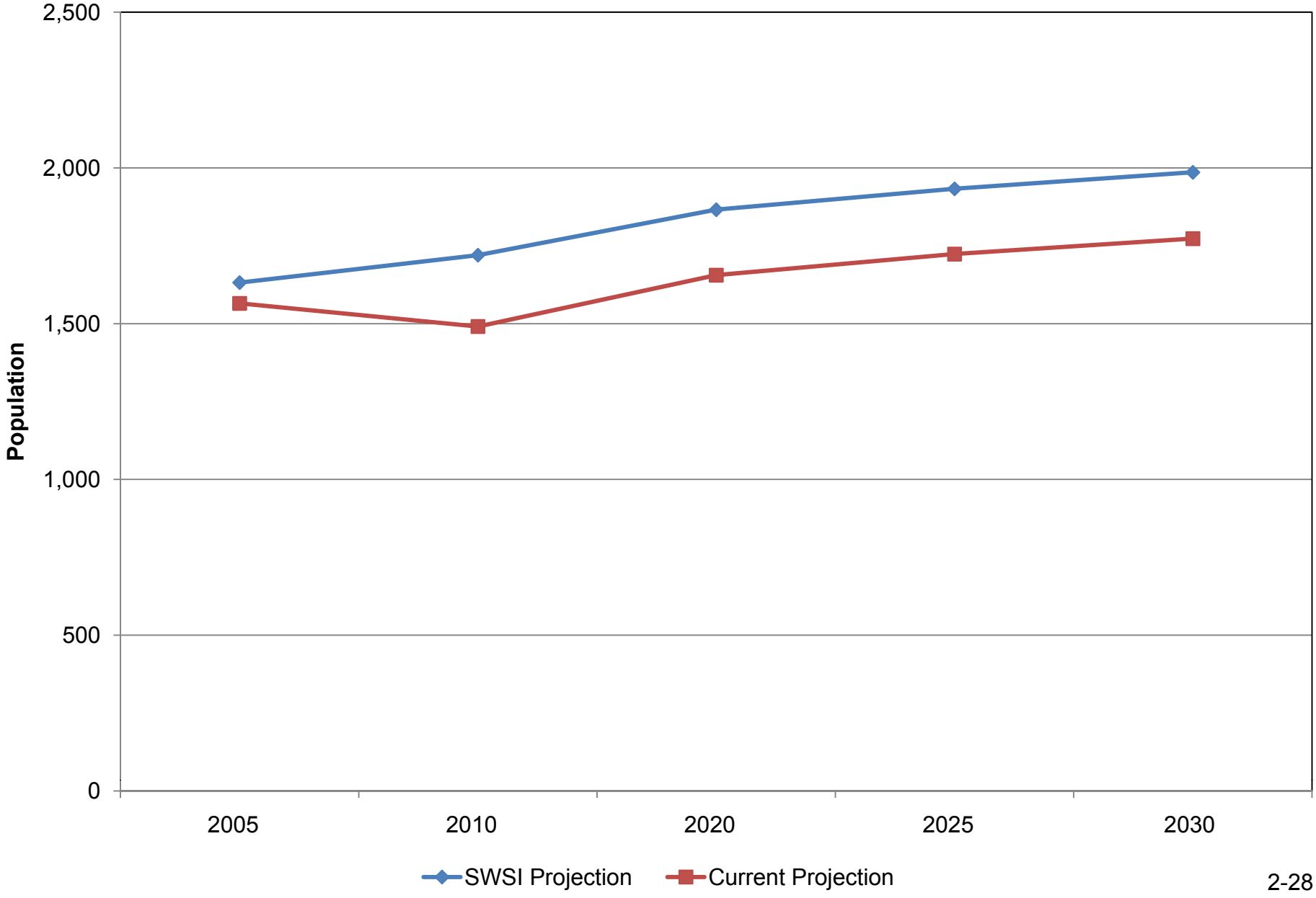


Figure 2-20 Comparison of SWSI and Current Population Projections for Rio Grande Basin

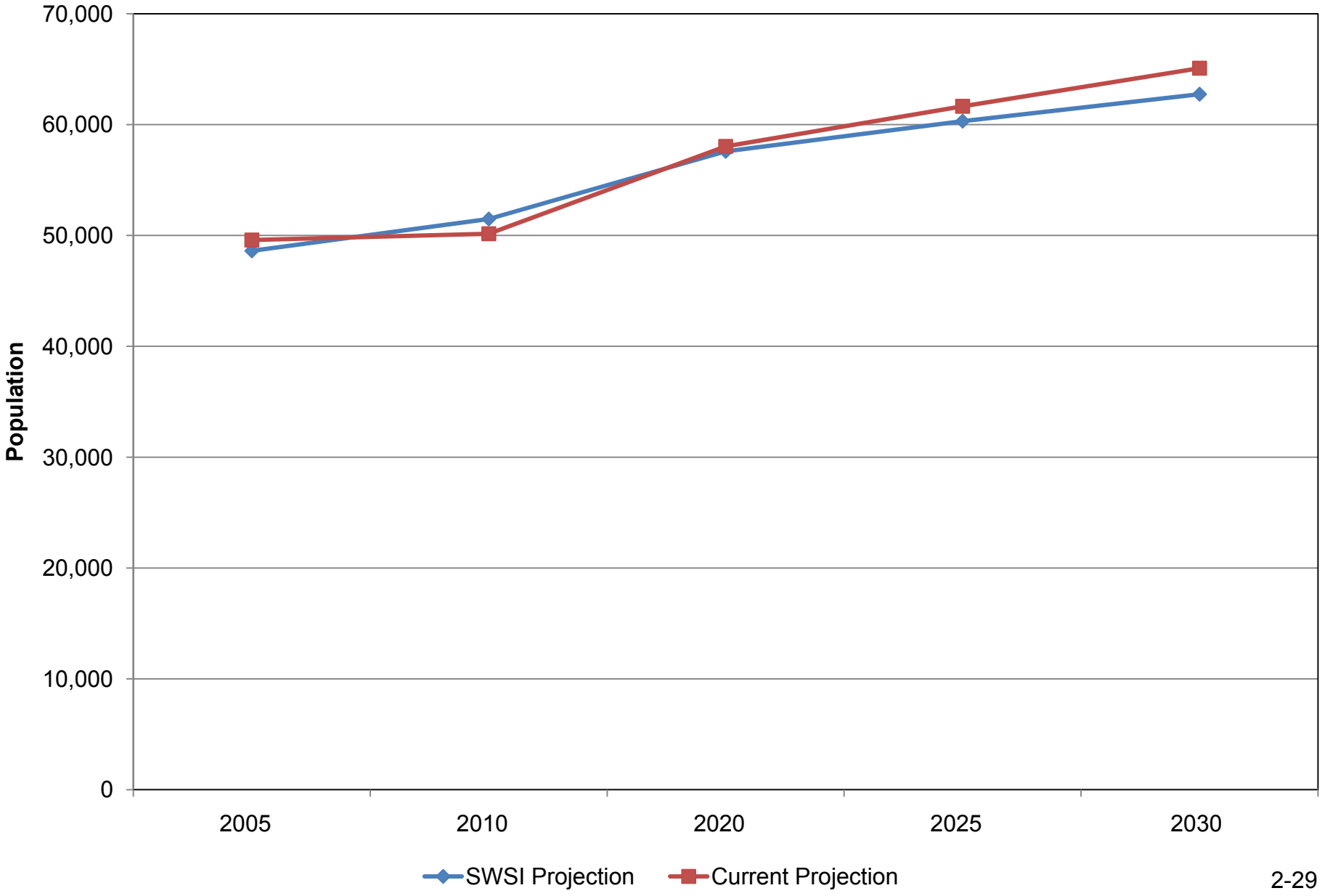


Figure 2-21 Comparison of SWSI and Current Population Projections for South Platte Basin

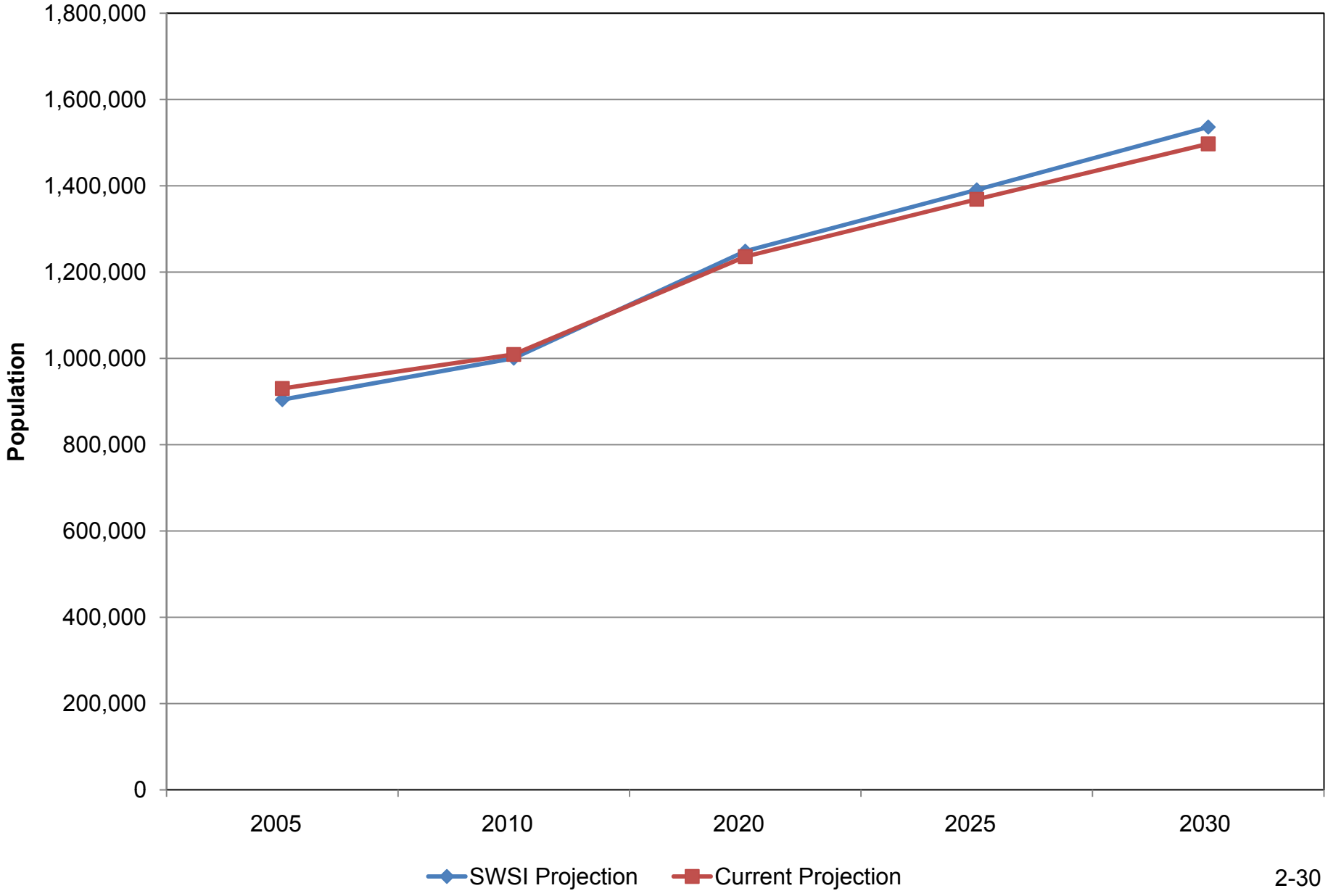


Figure 2-22 Comparison of SWSI and Current Population Projections for Southwest Baisn

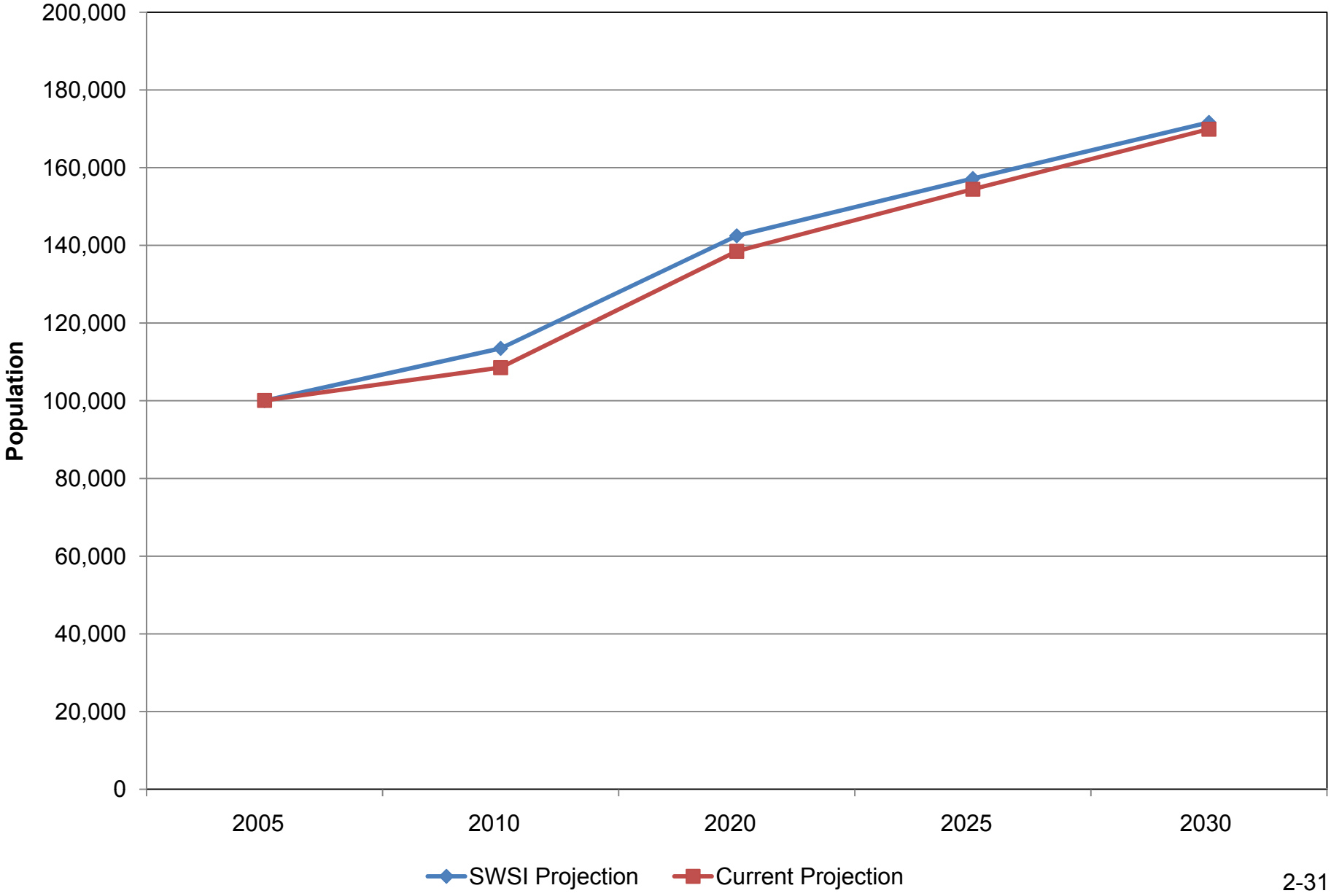
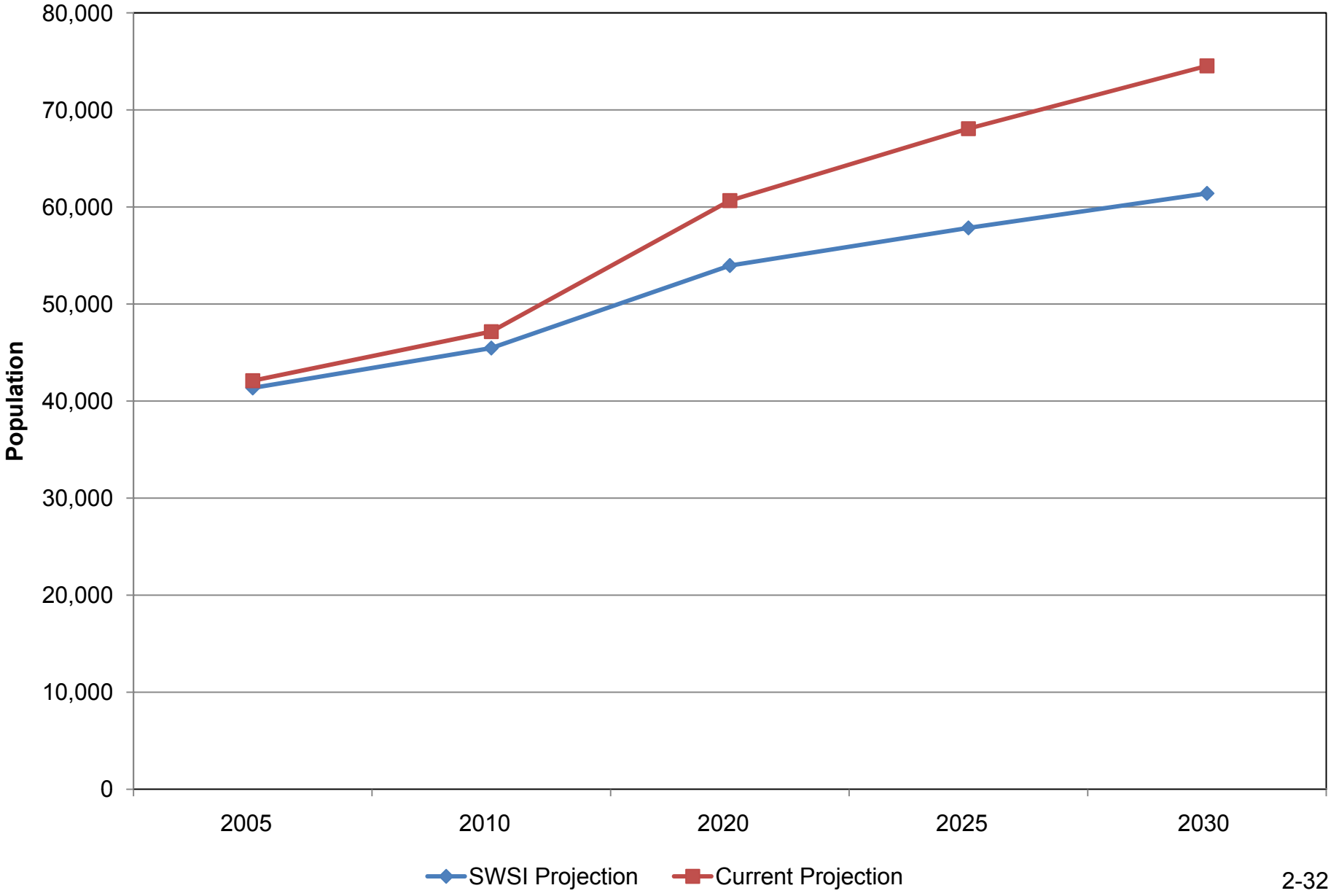


Figure 2-23 Comparison of SWSI and Current Population Projections for Yampa Baisn



Section 3
Municipal and Industrial Water Use

3.1 Municipal and Industrial Water Use Forecast Methodology

The methodology used for the M&I water demands forecast in this update is identical to the methodology employed in the SWSI Phase 1 Study (CWCB 2004). The methods utilized in this approach are for the purpose of general statewide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes. Several other methodologies were considered, such as the use of single-family equivalents (SFE). While these methods are appropriate for individual communities in determining current water use rates, this information is not available consistently across the state in a manner that would be needed to complete a statewide analysis of water demands in 2050. County and statewide population projections are the most accepted predictor of future growth for the state. Therefore, it was determined the SWSI Phase 1 methodology was most appropriate. The methodology employed is a commonly accepted forecast methodology for statewide water supply planning purposes, but is not appropriate for project-specific purposes or for direct comparisons between basins or counties.

The M&I water demands forecast is developed by multiplying the population projections outlined in Section 2 by a rate of use (see Equation 3-1 below). The rate of use is systemwide gallons per capita per day (gpcd). Systemwide gpcd data was collected from local water providers (see Section 3.2 below and Appendix C) and aggregated to the county level on weighted basis. Service area population and total water deliveries were obtained from local water providers. A systemwide gpcd was calculated for each participating local water provider by dividing the total water deliveries by the service area population (Equation 3-2 below). It is important to note that the service area population estimates represent permanent populations. Therefore, the resulting water use rate (gpcd) incorporates water used by tourists, students, and other transient populations because the water used by the transient population is indexed to the permanent population along with the water use of the permanent population. The resulting gpcd also incorporates commercial and light industrial water use supplied by the water provider. For statewide planning purposes, this is a consistent approach to account for water use by transient populations, commercial, and light industry. Comparisons of gpcds between counties and basins should not be made directly, since differences in the amount of industry, tourism, and outdoor water use varies significantly between geographic regions.

Equation 3-1:

$$\text{2050 M\&I Demands} = \text{2050 Population Projections} \times \text{Systemwide gpcd}$$

Equation 3-2:

$$\text{Systemwide gpcd} = \text{Total Water Deliveries} \div \text{Total Service Area Permanent Population}$$

Because 2050 population projects were developed at the county level, the systemwide gpcd values needed to be aggregated from the water provider level to the county level. A weighting process was applied to develop a county average systemwide gpcd based upon the portion of the county population serviced by each water provider. For example, in Summit County, there are 9 water providers and to calculate the county average gpcd as shown in Equation 3-3 each water provider's systemwide gpcd was multiplied by their service area population and added together. This value was then divided by the sum of each water provider's service area population.

Equation 3-3 to determine County Average gpcd:

$$\frac{\sum_{i=1}^{n} \begin{array}{c}\text{Community gpcd}_1 \times \text{Community Service Area Population}_1 + \text{Community gpcd}_2 \times \\ \text{Community Service Area Population}_2 + \cdots \text{Community gpcd}_n \times \text{Community Service Area Population}_n\end{array}}{\sum_{i=1}^{n} \begin{array}{c}\text{Community Service Area Population}_1 + \text{Community Service Area Population}_2 + \cdots \\ \text{Community Service Area Population}_n\end{array}}$$

Once the county level M&I demand forecast was developed, basin level M&I water use rates were calculated for the nine Basin Roundtable areas as shown in Equation 3-4. Basin M&I demands were aggregated from the county demands based on the portion of the county within the basin. For example, 38 percent of Cheyenne County is within the Arkansas Basin and 62 percent within in the South Platte Basin. Thus, 38 percent of Cheyenne County's M&I water demand was allocated to the Arkansas Basin and 62 percent to the South Platte Basin. Six counties are located in more than one basin. For counties that fall entirely within one basin, all M&I water demands were allocated to the given basin. The complete list of county area percentages by basin is available in Appendix D.

Equation 3-4 for Weighted Basin gpcd:

$$\frac{\sum_{i=1}^{n} \begin{array}{c}\text{County Level gpcd}_1 \times \text{County Population in Basin}_1 + \text{County Level gpcd}_2 \\ \times \text{County Population in Basin}_2 + \cdots \text{County Level gpcd}_n \times \text{County Population in Basin}_n\end{array}}{\text{Basin Population}}$$

3.2 Passive Water Conservation Savings

The methodology for the M&I water demands projections outlined above develops baseline water demand estimates. In addition, CWCB has updated the passive conservation analysis (CWCB 2010) and these savings are "embedded" or subtracted from the baseline estimates. While the 1992 National Energy Policy Act was considered in the passive conservation savings estimates, recent legislation enacted in California, such as the 2002 California Energy Commission (CEC) Water Efficiency Standards and the 2007 California Assembly Bill 715, was evaluated in terms of market impact in Colorado. In fact, the legislation in California has arguably had a greater impact on Colorado's urban water use than the 1992 Federal Act. This is

primarily due to the size and power of California's economy. Creating and satisfying demand in California dominates the manner in which manufacturers and suppliers operate in the Western U.S. For the analysis, passive water savings were calculated to occur as a result of retrofitting housing stock and businesses that exist prior to 2016. Future water demand reductions associated with passive savings were calculated for each year beginning in 1996, which was when benchmark toilet flushing volume data from Denver was available. The calculations used to estimate future demand reductions from passive conservation were developed for minimum and maximum scenarios based on the assumptions related to the retrofit of existing housing and commercial construction with high-efficiency toilets, clothes washers, and dishwashers. The calculations based on these assumptions were used to estimate a range of future passive water savings in each county for each year starting in 2000 and continuing until 2050. The total range of savings expected from passive conservation through 2050 is 19 to 33 gpcd (CWCB 2010). The upper range of these savings were applied to the county level baseline estimates described above to assess what the 2050 demands would be on a low, medium and high basis with passive conservation. As stated in the "SWSI Conservation Levels Analysis" report (CWCB 2010) there are three major reasons for applying the high passive conservation savings:

1. Water and energy savings will become increasingly important to water customers as water and fuel costs rise. As water customers seek more efficiency in their homes and businesses, high efficiency fixtures and appliances will become increasingly efficient as technology improves and customers strive to reduce their variable costs related to water and energy.

2. The potential exists to realize substantial permanent water demand reductions in the future if appropriate regulations and ordinances are developed to address water use in existing and new construction.

3. The impact of commercial retrofits (e.g., restaurants, motels, ski area condominiums, centralized laundries, commercial laundries, bars, etc.), is not well captured in the passive savings analyses since information regarding numbers of and ages of individual types of commercial properties were not available.

3.3 Data Collection Summary

Provider water use and service population data were gathered from various sources and organized to create a database. The database built upon existing information from 254 water providers gathered for the SWSI Phase 1 Study. Efforts were made to update the data for these providers as part of the June 2009 draft version of this report. The CWCB also worked with water providers across the state through the first part of 2010 to collect additional data.

Based on these efforts (described in more detail below), data were found for an additional 83 providers not included in the SWSI Phase 1 database. In all, updated per capita estimates were collected for 214 water providers covering 87 percent of the population in Colorado.

Data for updating the per capita values were obtained spanning several years, which were each handled in the following manner:

- For data representing years from 2003-2009 the most recent year was used to directly calculate usage rates.
- If information was only available for years prior to 2003, water use information was averaged to account for the 2002 drought.
- For four counties (Cheyenne, Lake, Saguache, San Juan), no provider-level data were obtained. For these counties, the weighted basin average (Equation 3-4) for these counties was assigned.

Water provider water use rate information was collected from a variety of sources such as conservation plans, master plan reports, the 2007 Colorado Drought and Water Supply Update (CDWSU), and water provider interviews. According to the Water Conservation Act of 2004, there are minimum standards for CWCB approved water conservation plans, including a characterization of water use. Thus, these plans typically have detailed water use and service area population information. The plans are accessible through the CWCB website and often on the providers' website.

Individual water providers' websites were searched for additional documentation on water use. A small number of master plans were found with water use information. Independent studies with water use information were obtained from various sources, such as the Windy Gap Firming Project Purpose and Need Report from 2005. Additionally, water use data were obtained from the CDWSU, a study conducted for the CWCB. The study provided water use and service area population information for approximately 95 providers.

CWCB staff conducted outreach interviews in 2010 to most municipal water providers with deliveries of 2,000 acre-feet per year (AFY) or more, and in addition the top three water providers in each basin. Not every water provider responded, however, with significant Basin Roundtable assistance, many water providers submitted data in addition to the original list. While much of this outreach was used to determine what projects and methods water providers are pursuing to meet their future needs, water demand data was also confirmed. Specifically, water providers were asked to provide treated water deliveries for their most recent representative year along with population served. Typically, water providers submitted information from 2008. In addition, CWCB reviewed the updated information and where values varied significantly from the SWSI Phase 1 data, water providers were contacted to verify that the most recent data summarized in the new information were correct. Data sources for water provider data are included in Appendix C of this report. Multiple data were identified for a few providers, as indicated.

For consistency and to avoid any double counting in the M&I water demands forecast, water provided to large industries or agricultural users was removed from the provider per capita estimates. Including large industry water use in per capita estimates can be misleading and skew the M&I water demands forecast. Thus, these large industries were added to the SSI sector, as discussed in Section 4. Agricultural demands are estimated as a separate sector and were removed to avoid double counting. Agricultural demands are not discussed in this memorandum but are detailed in a recent technical memorandum developed by CWCB (CWCB 2010b).

3.4 Municipal and Industrial Water Use Forecast Results

Results of the M&I baseline county water demands forecast are presented in Table 3-1 at the end of this section and results of the M&I county forecasts with passive conservation are shown in Table 3-2 at the end of this section. The low, medium, and high population projections result in 2050 low, medium, and high water demand estimates for both the baseline and passive estimates in Tables 3-1 and 3-2. In addition, the following information is included in Tables 3-1 and 3-2:

- SWSI Phase 1 per capita estimates
- The number of utilities in the database
- The number of utilities that were updated through this effort
- The updated weighted gpcd for the county
- The percentage of county population represented through the updated gpcd

Table 3-3 and Figure 3-1 at the end of this section summarize M&I water usage and demands at the basin and statewide level for baseline conditions and water usage considering passive conservation. As shown in Table 3-3, statewide water use has decreased since the SWSI Phase 1 efforts from 210 to 172 gpcd. That is an 18 percent reduction in per person daily water use statewide. For most counties, systemwide gpcd has declined since SWSI Phase 1. According to the data collected during this effort and summarized in Table 3-1, 18 counties show an increase in gpcd demands since SWSI Phase 1. These increases or decreases in systemwide gpcd may be due to a combination of factors including conservation efforts, behavioral changes from the 2002 drought (i.e., a "drought shadow"), changes in a community's socio-economic conditions, and/or better data. Better information accounts for a significant portion of these observed changes. For example, data were collected in the Gunnison Basin that more accurately represents water use in that region. Also, the addition of the 83 providers to the current database and their gpcd values have added to the data accuracy and may account for some of the observed changes since the SWSI Phase 1 estimates. In addition, much of the data collected in SWSI gathered planning numbers for AFY deliveries and gpcd values rather than actual treated water deliveries.

After savings from passive conservation estimates are removed, statewide municipal water demands are estimated to increase from 975,000 AFY to 1.36 million AFY by 2035 requiring an additional 383,000 AFY of water to meet Colorado's municipal water needs in 2035. Based on the population projections discussed in Section 2, total 2050 M&I water demands with passive conservation could range from 1.5 to 1.8 million AFY. By 2050, Colorado will need between 538,000 and 812,000 AFY of additional water to meet municipal demands. Passive conservation savings will result in approximately 154,000 AFY reduction or just over 8 percent decrease in M&I water demands by 2050 for the median demand scenario. These future water demands and summary of water demands for baseline conditions and with passive conservation are summarized in Table 3-3 and in Figure 3-1 at the end of this section.

Table 3-1 Baseline M&I Forecast by County

Statistical Data						Water Demand (AFY)				
County	SWSI 1 (gpcd)	No. Utilities in Database	No. Utilities Updated	Updated (gpcd)	Percent of Population Updated	2008	2035	2050 Low	2050 Medium	2050 High
Adams	167	13	6	142	90%	69,000	111,000	123,000	127,000	139,000
Alamosa	269	2	1	258	51%	5,000	8,000	8,000	9,000	10,000
Arapahoe	196	39	6	164	73%	104,000	151,000	168,000	173,000	190,000
Archuleta	212	2	1	182	73%	3,000	6,000	7,000	7,000	8,000
Baca	255	3	3	329	38%	2,000	2,000	2,000	2,000	2,000
Bent	181	5	4	113	69%	1,000	1,000	1,000	1,000	1,000
Boulder	211	12	9	176	96%	59,000	77,000	86,000	89,000	97,000
Broomfield	218	1	1	177	98%	11,000	17,000	19,000	20,000	22,000
Chaffee	310	3	3	297	51%	6,000	10,000	11,000	12,000	13,000
Cheyenne*	**212**	0	0	**183**	0%	400	500	1,000	1,000	1,000
Clear Creek	282	4	4	224	44%	2,000	4,000	4,000	5,000	5,000
Conejos	425	2	1	521	10%	5,000	6,000	6,000	7,000	7,000
Costilla	138	1	1	193	19%	1,000	1,000	1,000	1,000	1,000
Crowley	142	5	2	141	11%	1,000	1,000	2,000	2,000	2,000
Custer	226	1	0	226	0%	1,000	2,000	2,000	3,000	3,000
Delta	210	9	8	165	73%	6,000	11,000	12,000	13,000	14,000
Denver	225	1	1	163	188%	112,000	142,000	158,000	162,000	178,000
Dolores	204	1	1	242	11%	1,000	1,000	1,000	1,000	1,000
Douglas	215	8	5	146	65%	46,000	81,000	90,000	93,000	102,000
Eagle	286	8	8	209	94%	13,000	23,000	25,000	29,000	35,000
El Paso	195	13	9	172	84%	117,000	179,000	194,000	208,000	229,000
Elbert*	113	1	1	111	3%	3,000	8,000	9,000	9,000	9,000
Fremont	232	5	2	219	78%	12,000	18,000	21,000	23,000	24,000
Garfield	225	6	6	198	53%	13,000	29,000	37,000	39,000	43,000
Gilpin	**206**	2	2	75	12%	500	1,000	1,000	1,000	1,000
Grand	212	7	3	250	29%	4,000	8,000	8,000	10,000	11,000
Gunnison	188	4	2	197	47%	3,000	5,000	5,000	6,000	7,000
Hinsdale	**226**	1	1	375	153%	400	1,000	1,000	1,000	1,000
Huerfano	115	4	1	155	47%	1,000	2,000	2,000	3,000	3,000
Jackson	267	1	1	310	41%	1,000	1,000	1,000	1,000	1,000
Jefferson	164	37	15	152	28%	94,000	118,000	131,000	135,000	148,000
Kiowa	327	1	1	325	47%	1,000	1,000	1,000	1,000	1,000
Kit Carson	301	2	2	334	49%	3,000	4,000	4,000	4,000	5,000
La Plata	192	6	2	169	41%	10,000	17,000	18,000	20,000	22,000
Lake	**212**	0	0	**183**	0%	2,000	4,000	5,000	5,000	5,000
Larimer	241	12	9	178	102%	59,000	95,000	105,000	112,000	123,000
Las Animas	222	2	1	221	69%	4,000	6,000	7,000	8,000	8,000

Table 3-1 Baseline M&I Forecast by County

Statistical Data						Water Demand (AFY)				
County	SWSI 1 (gpcd)	No. Utilities in Database	No. Utilities Updated	Updated (gpcd)	Percent of Population Updated	2008	2035	2050 Low	2050 Medium	2050 High
Lincoln*	253	2	1	254	14%	2,000	2,000	2,000	3,000	3,000
Logan	180	1	1	319	57%	8,000	12,000	13,000	14,000	15,000
Mesa*	154	6	6	127	101%	21,000	34,000	41,000	43,000	48,000
Mineral	296	1	0	296	0%	300	400	500	1,000	1,000
Moffat	190	2	2	194	69%	3,000	5,000	6,000	6,000	7,000
Montezuma	216	4	3	172	80%	5,000	8,000	9,000	9,000	10,000
Montrose*	207	6	6	187	92%	9,000	16,000	18,000	19,000	20,000
Morgan	341	4	4	241	82%	8,000	13,000	14,000	15,000	16,000
Otero	243	24	18	185	88%	4,000	5,000	5,000	5,000	5,000
Ouray	383	2	2	157	41%	1,000	1,000	1,000	2,000	2,000
Park	198	3	3	110	5%	2,000	5,000	5,000	6,000	6,000
Phillips	357	1	1	390	49%	2,000	2,000	2,000	2,000	3,000
Pitkin	681	2	2	284	46%	6,000	9,000	11,000	13,000	16,000
Prowers	287	4	3	232	79%	4,000	4,000	4,000	4,000	5,000
Pueblo	254	7	5	206	89%	37,000	56,000	62,000	65,000	70,000
Rio Blanco	292	2	2	262	66%	2,000	4,000	5,000	10,000	17,000
Rio Grande	406	3	1	306	36%	4,000	6,000	6,000	7,000	7,000
Routt	237	6	4	243	59%	6,000	12,000	14,000	15,000	17,000
Saguache	**332**	0	0	**274**	0%	2,000	3,000	3,000	4,000	4,000
San Juan	**208**	0	0	**182**	0%	100	100	200	200	300
San Miguel	251	2	1	289	29%	3,000	5,000	6,000	7,000	9,000
Sedgwick	312	1	1	322	12%	1,000	1,000	1,000	1,000	1,000
Summit	327	9	8	246	76%	8,000	15,000	17,000	20,000	25,000
Teller*	173	3	0	173	0%	4,000	7,000	8,000	8,000	9,000
Washington	313	2	1	320	32%	2,000	2,000	2,000	2,000	2,000
Weld	286	14	14	186	80%	53,000	116,000	130,000	136,000	145,000
Yuma	263	2	2	281	53%	3,000	4,000	4,000	4,000	5,000

Notes:
Statewide forecast is a sum of county demand. Comparisons of gpcds between counties and basins should not be made directly, since differences in the amount of industry, tourism, and outdoor water use varies significantly between geographic regions.
Basin weighted averages were applied to counties with unknown per capita use. These counties are indicated in the table with bold values.
*County crosses basin lines. This forecast is for the entire county.

Table 3-2 M&I Forecast by County with Passive Conservation

Statistical Data						Water Demand (AFY)				
County	SWSI 1 (gpcd)	No. Utilities in Database	No. Utilities Updated	Updated (gpcd)	Percent of Population Updated	2008	2035	2050 Low	2050 Medium	2050 High
Adams	167	13	6	142	90%	69,000	98,000	109,000	113,000	125,000
Alamosa	269	2	1	258	51%	5,000	7,000	8,000	8,000	9,000
Arapahoe	196	39	6	164	73%	104,000	136,000	151,000	156,000	173,000
Archuleta	212	2	1	182	73%	3,000	5,000	6,000	7,000	7,000
Baca	255	3	3	329	38%	2,000	1,000	2,000	2,000	2,000
Bent	181	5	4	113	69%	1,000	1,000	1,000	1,000	1,000
Boulder	211	12	9	176	96%	59,000	69,000	77,000	80,000	88,000
Broomfield	218	1	1	177	98%	11,000	16,000	17,000	18,000	20,000
Chaffee	310	3	3	297	51%	6,000	9,000	10,000	11,000	13,000
Cheyenne*	**212**	0	0	**183**	0%	400	400	500	500	600
Clear Creek	282	4	4	224	44%	2,000	4,000	4,000	4,000	5,000
Conejos	425	2	1	521	10%	5,000	6,000	6,000	7,000	7,000
Costilla	138	1	1	193	19%	1,000	1,000	1,000	1,000	1,000
Crowley	142	5	2	141	11%	1,000	1,000	1,000	1,000	1,000
Custer	226	1	0	226	0%	1,000	2,000	2,000	2,000	3,000
Delta	210	9	8	165	73%	6,000	10,000	11,000	12,000	13,000
Denver	225	1	1	163	188%	112,000	125,000	139,000	144,000	160,000
Dolores	204	1	1	242	11%	1,000	1,000	1,000	1,000	1,000
Douglas	215	8	5	146	65%	46,000	73,000	81,000	84,000	93,000
Eagle	286	8	8	209	94%	13,000	21,000	23,000	27,000	33,000
El Paso	195	13	9	172	84%	117,000	162,000	175,000	189,000	211,000
Elbert*	113	1	1	111	3%	3,000	8,000	9,000	9,000	9,000
Fremont	232	5	2	219	78%	12,000	17,000	20,000	21,000	23,000
Garfield	225	6	6	198	53%	13,000	27,000	35,000	37,000	41,000
Gilpin	**206**	2	2	75	12%	500	1,000	1,000	1,000	1,000
Grand	212	7	3	250	29%	4,000	7,000	8,000	9,000	11,000
Gunnison	188	4	2	197	47%	3,000	4,000	5,000	6,000	7,000
Hinsdale	**226**	1	1	375	153%	400	1,000	1,000	1,000	1,000
Huerfano	115	4	1	155	47%	1,000	2,000	2,000	2,000	3,000
Jackson	267	1	1	310	41%	1,000	1,000	1,000	1,000	1,000
Jefferson	164	37	15	152	28%	94,000	105,000	116,000	120,000	133,000
Kiowa	327	1	1	325	47%	1,000	1,000	1,000	1,000	1,000
Kit Carson	301	2	2	334	49%	3,000	3,000	4,000	4,000	4,000
La Plata	192	6	2	169	41%	10,000	15,000	17,000	18,000	21,000
Lake	**212**	0	0	**183**	0%	2,000	4,000	4,000	4,000	5,000
Larimer	241	12	9	178	102%	59,000	86,000	97,000	103,000	114,000
Las Animas	222	2	1	221	69%	4,000	6,000	6,000	7,000	8,000

Table 3-2 M&I Forecast by County with Passive Conservation

Statistical Data						Water Demand (AFY)				
County	SWSI 1 (gpcd)	No. Utilities in Database	No. Utilities Updated	Updated (gpcd)	Percent of Population Updated	2008	2035	2050 Low	2050 Medium	2050 High
Lincoln*	253	2	1	254	14%	2,000	2,000	2,000	2,000	3,000
Logan	180	1	1	319	57%	8,000	11,000	12,000	13,000	14,000
Mesa*	154	6	6	127	101%	21,000	30,000	36,000	39,000	44,000
Mineral	296	1	0	296	0%	300	400	400	500	600
Moffat	190	2	2	194	69%	3,000	4,000	5,000	6,000	6,000
Montezuma	216	4	3	172	80%	5,000	7,000	8,000	9,000	9,000
Montrose*	207	6	6	187	92%	9,000	15,000	17,000	18,000	19,000
Morgan	341	4	4	241	82%	8,000	12,000	14,000	14,000	16,000
Otero	243	24	18	185	88%	4,000	4,000	4,000	5,000	5,000
Ouray	383	2	2	157	41%	1,000	1,000	1,000	1,000	2,000
Park	198	3	3	110	5%	2,000	4,000	5,000	5,000	5,000
Phillips	357	1	1	390	49%	2,000	2,000	2,000	2,000	3,000
Pitkin	681	2	2	284	46%	6,000	9,000	10,000	12,000	15,000
Prowers	287	4	3	232	79%	4,000	4,000	4,000	4,000	4,000
Pueblo	254	7	5	206	89%	37,000	52,000	57,000	60,000	65,000
Rio Blanco	292	2	2	262	66%	2,000	4,000	5,000	10,000	17,000
Rio Grande	406	3	1	306	36%	4,000	5,000	6,000	6,000	7,000
Routt	237	6	4	243	59%	6,000	11,000	13,000	14,000	16,000
Saguache	**332**	0	0	**274**	0%	2,000	3,000	3,000	3,000	4,000
San Juan	**208**	0	0	**182**	0%	100	100	200	200	300
San Miguel	251	2	1	289	29%	3,000	5,000	5,000	7,000	9,000
Sedgwick	312	1	1	322	12%	1,000	1,000	1,000	1,000	1,000
Summit	327	9	8	246	76%	8,000	14,000	16,000	19,000	24,000
Teller*	173	3	0	173	0%	4,000	6,000	7,000	8,000	8,000
Washington	313	2	1	320	32%	2,000	2,000	2,000	2,000	2,000
Weld	286	14	14	186	80%	53,000	108,000	121,000	128,000	137,000
Yuma	263	2	2	281	53%	3,000	4,000	4,000	4,000	4,000

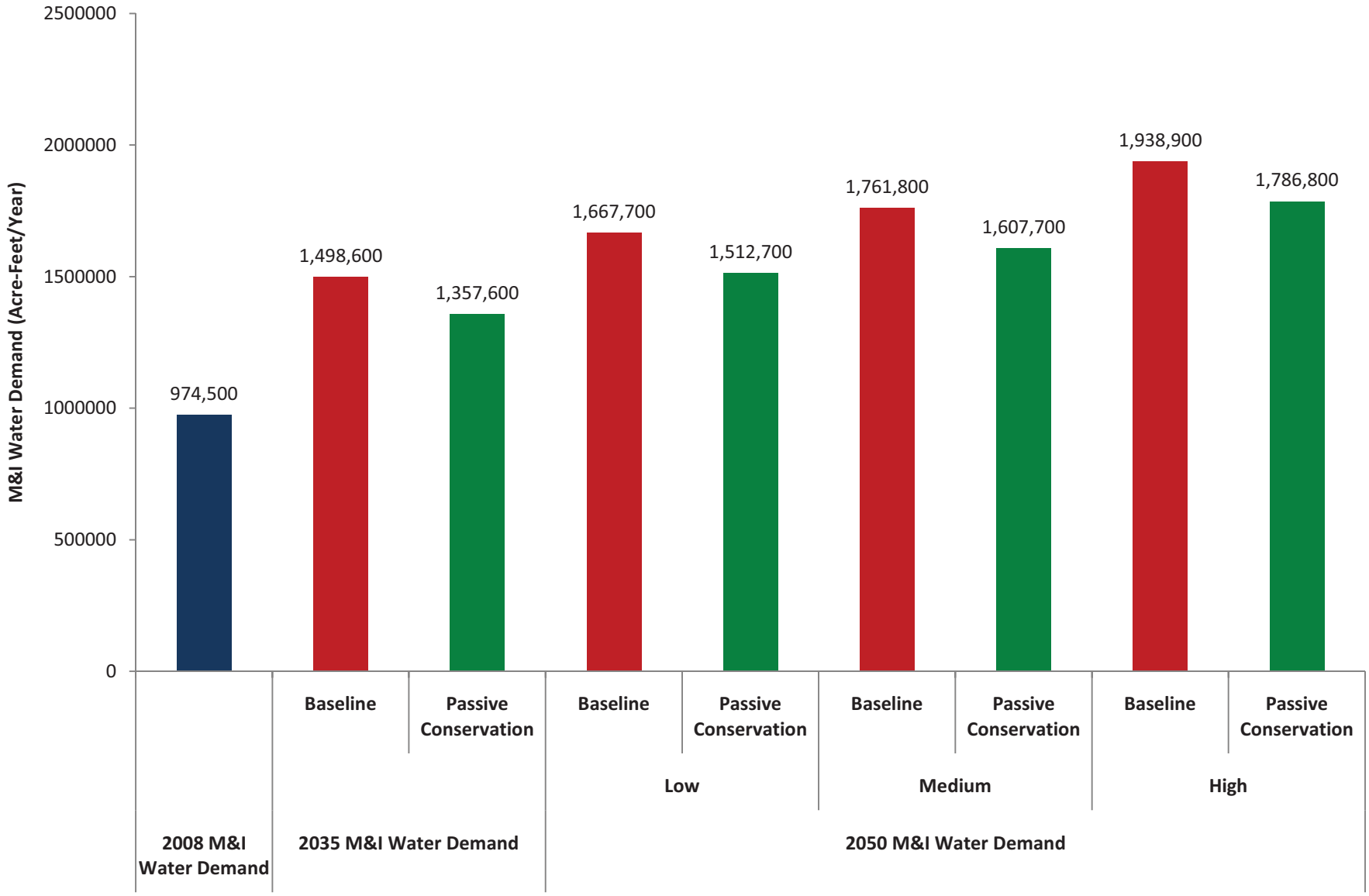
Notes:
Statewide forecast is a sum of county demand. Comparisons of gpcds between counties and basins should not be made directly, since differences in the amount of industry, tourism, and outdoor water use varies significantly between geographic regions.
Basin weighted averages were applied to counties with unknown per capita use. These counties are indicated in the table with bold values.
*County crosses basin lines. This forecast is for the entire county.

Table 3-3 M&I Forecast by River Basin

Basin	No. Utilities in Database	No. Updated since SWSI	SWSI GPCD	GPCD based on Update	Water Demand (AF) 2008	Baseline Water Demands (AFY)				Water Demands with Passive Conservation (AFY)			
						2035	2050 Low	2050 Medium	2050 High	2035	2050 Low	2050 Medium	2050 High
Arkansas	65	40	214	185	196,000	299,000	327,000	349,000	380,000	273,000	298,000	320,000	352,000
Colorado	55	46	244	182	63,000	115,000	135,000	150,000	174,000	106,000	125,000	140,000	164,000
Gunnison	21	18	226	174	20,000	36,000	40,000	43,000	46,000	33,000	36,000	39,000	43,000
Metro	100	35	191	155	437,000	627,000	695,000	717,000	785,000	557,000	620,000	642,000	709,000
North Platte	1	1	267	310	500	600	700	800	900	600	700	700	800
Rio Grande	9	4	332	314	18,000	24,000	26,000	27,000	30,000	22,000	24,000	26,000	28,000
South Platte	60	53	220	188	206,000	338,000	377,000	397,000	430,000	311,000	347,000	367,000	401,000
Southwest	16	9	246	183	22,000	38,000	42,000	47,000	52,000	35,000	39,000	43,000	49,000
Yampa-White	10	8	230	230	12,000	21,000	25,000	31,000	41,000	20,000	23,000	30,000	40,000
Statewide	337	214	210	172	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

Notes: Forecast is produced by aggregating the county forecast. If a county falls within two basins, the demand is split according to the portion of population in each basin.

Figure 3-1. Comparison of M&I Demands for Baseline and with Passive Conservation



Section 4
Self-Supplied Industrial Water Use

4.1 Self-Supplied Industrial Water Use Forecast

Standard methods were adapted for use in the SWSI Phase 1 Study for estimating future SSI water demands throughout Colorado (CWCB 2004). SSI water demands include water use by self-supplied and municipal provided large industries. The sub-sectors that are included in SSI are: large industries, water needed for snowmaking, thermoelectric power generation, and energy development. These industries represent economic growth within the state and the availability of water resources is imperative to their growth. Because of the diversity of the SSI sub-sectors, this section is organized to discuss each sub-sector separately, including data collection efforts and forecast assumptions and methodology. A final section is included to present all SSI water demands forecast results by county and basin. Sources of information used to develop the SSI estimates are detailed in Appendix E.

4.1.1 Large Industry

The goal of this sub-sector is to identify large self-supplied industries in Colorado with significant water demands. Most efforts in identifying these industries occurred during the SWSI Phase 1 Study. During this update, three large industries that receive their water from municipalities were identified and added to the SWSI Phase 1 database. Results of the large industry sub-sector water demands forecast are provided in Table 4-1. No low, medium, and high growth scenarios are considered for this sub-sector.

Table 4-1. Large Industry Demands (AFY)

County	2008	2035/2050
Jefferson	52,400	52,400
Moffat	2,600	3,900
Morgan	2,100	2,100
Pueblo	49,400	49,400
Routt	3,500	5,600
Weld	4,500	4,500
Total	**114,500**	**117,900**

In the SWSI Phase 1 Study, large industries were identified in four counties. In Jefferson County, the Coors Brewing Company was recognized as a large user and included in the SSI water demands. In Moffat County, the mining industry water use was identified as a large user, as reported in the Yampa Valley Water Demand Study (1998). The Colorado Steel Company in Pueblo County uses large quantities of water and is included in the SSI water demands. Finally, demands from the mining industry and golf courses were identified from Routt County and included in this sector.

While reviewing data for the M&I water demands forecast, three large industries were identified and their water use was removed from the M&I water demands forecast and added to the large industry sub-sector water demands forecast. Cargill

Inc., a food service industry, receives both potable and nonpotable water from the Fort Morgan municipality in Morgan County. The City of Greeley provides water to the Swift Company and Kodak. In accordance with Greeley's demand forecast, these demands are held constant to 2050 for Weld County. Sources of information used to develop the SSI estimates for large industry are detailed in Appendix E.

4.1.2 Snowmaking

The ski industry in Colorado is the cornerstone of tourism and economic activity for a large region of the state. While the water used by the ski resorts does not have a high consumption rate, it is water removed from the stream system and thus important to estimate. The forecast methodology employed in this update differs from the SWSI Phase 1 forecast methodology. Additional data were identified that proved useful in developing water use demands for snowmaking.

For this effort, several pieces of information were obtained: current snowmaking acres for each ski resort, current amount of water used for snowmaking, and expected future water use for snowmaking. Water use information was not available for all ski resorts. For these resorts, the known water use data were used to estimate current and future snowmaking demand. Steps in calculating current and future snowmaking demand are outlined below.

All ski resorts located in Colorado were researched to identify their snowmaking potential. Of the 28 ski resorts identified, 23 were identified as snowmaking resorts. The number of snowmaking acres was obtained from both the resorts' website and OnTheSnow.com, a snow sports website.

Next, regional water use studies were reviewed to identify estimates of current and future projected water demand for snowmaking. Table 4-2 summarizes these estimates and provides a summary of current water use, future water use, and the source of the information.

Table 4-2. Summary of Study Estimates of Current and Future Snowmaking at Selected Colorado Resorts

County	Snowmaking Facility	Estimate Average Annual Snowmaking Water Demand (AFY)		Source
		2008	2050	
Clear Creek	Echo Mountain	25	25	Upper Mountain Counties Study (Clear Creek County et al 2010)
Clear Creek	Loveland	60	60	Upper Mountain Counties Study (Clear Creek County et al 2010)
Eagle	Vail	600	600	Upper Colorado River Basin Information Report (CWCB 2007)
Grand	Winter Park/Mary Jane	200	480	UPCO Study (Grand County et al 2003)
Gunnison	Crested Butte	260	650	Gunnison Basin Roundtable Needs Assessment (Roark Kiklevich personal communication)
Pitkin	Aspen (all resorts)	500	500	Rocky Mountain News (2005)

Table 4-2. Summary of Study Estimates of Current and Future Snowmaking at Selected Colorado Resorts

County	Snowmaking Facility	Estimate Average Annual Snowmaking Water Demand (AFY)		Source
		2008	2050	
Routt	Steamboat	275	275	Yampa River Basin Information Report (CWCB 2009)
Summit	Keystone	630	1160	Upper Colorado River Basin Water Resources Planning Model User's Manual (CWCB 2009) and UPCO Study (Grand County et al 2003)
Summit	Breckenridge	450	690	UPCO Study (Grand County et al 2003)
Summit	Arapahoe Basin	90	350	UPCO Study (Grand County et al 2003)

For the resorts with available water demand data, the water use in AFY was divided by snowmaking acres to develop a water use factor (WUF) defined as AFY per acre. An average WUF was found for each basin. The basin average WUF was multiplied by the snowmaking acres to estimate water use for the remaining facilities. There was no known WUF for facilities in the Southwest Basin, so the average WUF from the West Slope basins were applied.

Attempts were made to verify the methodology assumptions and to obtain data on future snowmaking with Colorado Ski Country USA (www.coloradoski.com). However, several phone call attempts did not produce results. To stay within the bounds of the known data, water use was held constant for resorts with no known future expansions. Also, for resorts with known expansions, build out was assumed to be 2050. Results of the forecast for the snowmaking industry are shown in Table 4-3. At this time, no low, medium, or high growth scenario is considered for 2050.

Table 4-3. Estimated Snowmaking Water Demands (AFY)

County	2008	2050
Boulder	230	230
Clear Creek	90	90
Eagle	600	600
Garfield	20	20
Grand	350	630
Gunnison	260	650
La Plata	230	230
Mesa	50	50
Pitkin	560	560
Routt	290	570
San Miguel	180	180
Summit	1,600	2880
Total	**4,460**	**6,690**

4.1.3 Thermoelectric Power Generation

Water use at coal-fired and natural gas power facilities is included in the SSI water demands estimates. In 2006, nearly 95 percent of Colorado's electricity was produced from coal (71 percent) and natural gas (23 percent) (Department of Energy 2008). Although Colorado's State Legislature has adopted a state Renewable Electricity Standard that requires 20 percent of the state's electric portfolio to be from renewable resources of energy by 2020, demand for coal-fired and natural gas energy production will remain significant into the future. Generation facilities using fossil fuels require cooling systems to condense steam turbine exhaust. Cooling water is the most economical method to condense steam.

For the SWSI Phase 1 Study, estimates of current and future water use at various power generation facilities in Colorado were obtained from power producers (CWCB 2004). For this update, SWSI Phase 1 baseline estimates generated during SWSI Phase 1 were assumed to stay constant until 2035. SWSI Phase 1 estimates were modified to include Phase I and Phase 2 of the Colorado and Yampa-White Basin's Energy Study. These demands account for scenarios of energy development in the Yampa-White and Colorado Basins, as discussed in the next section. The Moffat County 2035 and 2050 thermoelectric power water demand scenarios were adapted to account for the direct electricity needs of energy development presented Phase 1 and Phase 2 of the Energy Study for natural gas, coal, and uranium development. Energy water needs for oil shale development are described in the next section. Results from Phase 2 of the Energy Study still need approval by both the Colorado and Yampa-White Basin Roundtables.

To extend 2035 projections to 2050 for the remaining counties (Adams, Boulder, Denver, Larimer, Montrose, Morgan, Pueblo, Routt, and Weld), percent increases were assumed for the low, medium, and high scenarios, respectively, as follows: 5 percent, 25 percent, and 50 percent. These percentages were based on expected population increases throughout the state. Table 4-4 provides the estimates of thermoelectric water demands with 2050 low, medium, and high scenarios.

Table 4-4. Estimated Thermoelectric Power Generation Water Demands (AFY)

County	2008	2035	2050		
			Low	Med	High
Adams	9,600	9,600	10,100	12,000	14,400
Boulder	2,900	2,900	3,100	3,700	4,400
Denver	2,400	2,400	2,500	3,000	3,500
Larimer	5,200	11,200	11,700	14,000	16,700
Moffat	17,500	26,900	24,700	26,200	26,900
Montrose	1,900	3,900	4,100	4,900	5,900
Morgan	5,900	13,900	14,600	17,400	20,900
Pueblo	9,000	14,700	15,400	18,400	22,100
Routt	2,700	11,400	12,000	14,300	17,100
Weld	7,400	7,400	7,800	9,300	11,100
Total	**64,500**	**104,300**	**106,000**	**123,200**	**143,000**

4.1.4 Energy Development

In September of 2008, the Colorado and Yampa-White Basin Roundtables released a Phase I Energy Development Water Needs Assessment Report that assessed the water needs in northwest Colorado for energy development. The report estimated water demands needed to support the extraction and production of natural gas, coal, uranium, and oil shale through 2050 (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2008). Since the 2008 report, the Colorado and Yampa-White Basin Roundtables have continued to refine water demand estimates for oil shale development through Phase 2 of the Energy Study. This report also includes recent work completed to address water demands for oil shale development that was released to CWCB on June 29, 2010 after receiving approval from the joint roundtable subcommittee (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010) and Appendix F. Results of the Phase 2 effort still need to be confirmed by the Colorado and Yampa-White Roundtables.

No indirect water uses or water demands that result from the increase in the region's population due to energy development and production are included in this SSI water demands forecast update. Demands incurred from increased populations are captured in the M&I water demands forecast described in Sections 2 and 3.

Increases in thermoelectric power demands caused by energy development are also estimated by the Basin Roundtable effort described above and have been categorized as direct and indirect. These water demands were aggregated to the "thermoelectric" sub-sector described previously (Section 2.1.3). For energy development in northwest Colorado, all increases in power generation for non-oil shale related energy industries were allocated to the Craig power plant in Moffat County as indicated in Table 4-4 above. As recommended in the Draft Energy Water Use Technical Memorandum, oil shale energy requirements are assumed to use power generated from onsite combined gas turbines (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010) and Appendix F. Subsequent summary tables in the remainder of this section include energy generation for oil shale in the energy development sub-sector.

Direct water demands include the water required for the construction, operation, production, and reclamation needed to support the energy extractions and development processes. For the natural gas sector, Figure 3-2 from the Phase 1 Energy Study report was used to allocate demands to counties and is included as Figure 4-1 below. The analysis completed by the roundtables found that for natural gas generation, activity was shifted from Garfield County to Rio Blanco County over the 40-year timeframe. For the coal sector, two mines were assumed in Moffat County and one each in Rio Blanco, Garfield, and Routt Counties. For the uranium sector, all future activity was allocated to Moffat County except for the long-term high scenario, which was allocated half to Moffat County and half to Mesa County (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2008).

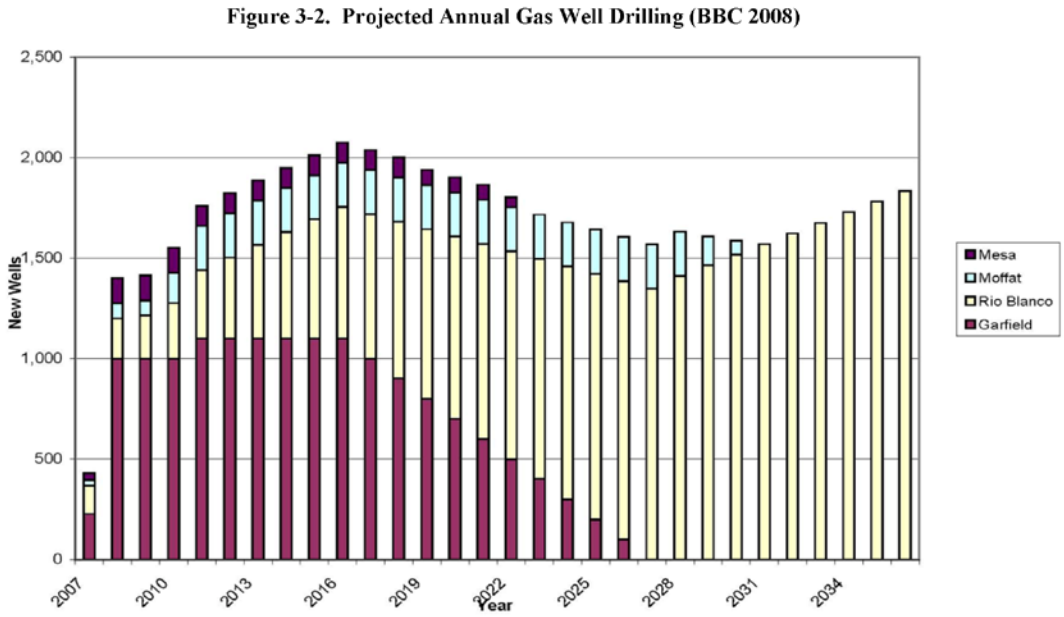


Figure 4-1 Natural Gas Production Estimates from the Energy Study Phase 1

As described in Appendix B of this report, 2050 population projections are based on an oil shale industry of 0 barrels/day for the low scenario, 150,000 barrels/day for the medium (100,000 *in situ*, 50,000 above-ground), and 550,000 barrels/day for the high scenario (500,000 *in situ*, 50,000 above-ground). The selected medium and high barrels of water required per barrel of oil values were paired with the medium and high production scenarios. While this is not thought to represent the potential long-term or build-out needs of the oil shale industry, this production level was chosen to represent values for 2050 as build-out of the oil shale industry is not expected between now and 2050. Build-out values for oil shale are covered in the following section.

Direct water use estimates and scenarios from the Draft Phase 2 of the Energy Study were used to estimate 2050 direct water needs for oil shale production. The water uses detailed in the Phase 2 study include indirect and direct water needs for construction/pre-production, electrical energy (combined cycle gas turbines used onsite), production, reclamation, spent shale disposal, upgrading, and production work force (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010). For this effort, indirect thermoelectric energy estimates were included in Section 4.1.2 as described above and the water needs for the production work force were accounted for in the population projections and M&I water demands sections of this report (Sections 2 and 3).

Oil shale estimates were disaggregated to the county level, making the following assumptions for Table 4-10 that summarizes energy development at the county level:

- Above-ground development was assumed to be conducted in Garfield County.

- Upgrading for above-ground was assumed to occur in Mesa County
- All *in situ* related water requirements, including upgrading, were included in Rio Blanco County's SSI projections.

The following Table 4-5 was adapted from the Draft Energy Water Use Technical Memorandum to include direct water use for oil shale development as indirect demands are incorporated in Section 3 of this report (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010).

Table 4-5. Estimates of Direct Water Use for Oil Shale (barrel of water per barrel of oil or bbl/bbl)

Water Use Category	*In Situ* Retorting		Above-Ground Retorting	
	Low	High	Low	High
Construction/Pre-production	0.02	0.16	0.01	0.07
Electrical Energy	0.41	1.00	0.17	0.26
Production	—	—	0.47	0.47
Reclamation	0.45	0.54	0.02	0.17
Spent Shale Disposal	—	—	0.80	1.60
Upgrading	0.57	1.60	0.60	1.60

The Draft Energy Water Use Technical Memorandum also estimated the amount of water produced as a byproduct of shale oil production (Table 4-6). Only one estimate of the rate of water production was obtained for each of *in situ* and above-ground retorting; therefore, no quantitative information can be provided regarding the uncertainty of this estimate. Because of the nature of the processes, methods using combustion heating can be expected to produce more byproduct water than methods using electrical heating or solvents (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010).

Table 4-6. Estimates of Water Co-Produced when Retorting Oil Shale (bbl/bbl)

In Situ Retorting	Above-Ground Retorting
0.80	0.30

As part of the Energy Study Phase 2, both unit water use rates and the configuration of a future oil shale industry were considered uncertain. Therefore, a range of water use estimates were developed with the view that the actual future level of water use will be contained between a low and high estimate to a reasonable degree of certainty. In developing a range of water use estimates, a variety of assumptions were made about the mix of production and upgrading technologies that will make up the future oil shale industry, and about the water use intensity of those individual technologies. Tables 4-7 and 4-8 present direct unit water use estimates for plausible industry configurations based on Energy Study Phase 2 results (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010). As discussed previously, indirect water use for oil shale development through 2050 are included in the population estimates in Section 2 and the M&I demand projection in Section 3 of this report.

Table 4-7. *In Situ* Industry Configurations and Direct Unit Water Use

In Situ Scenario	Scenario Description	Unit Use (bbl/bbl)
IS-1	Down-hole combustion heating offsite upgrading. Low estimates.	-0.33
IS-2	Down-hole combustion heating, offsite upgrading. High estimates.	-0.1
IS-3	Shell *in situ* conversion process (ICP), offsite upgrading. Low estimates.	0.07
IS-4	Shell ICP, onsite upgrading. Low estimates.	0.65
IS-5	Shell ICP, offsite upgrading. High estimates.	0.9
IS-6	Down-hole combustion heating onsite upgrading. High estimates.	1.5
IS-7	Shell ICP, onsite upgrading. High process, low upgrading.	1.47

The Draft Energy Water Use Technical Memorandum selected *in situ* scenarios 1, 4, and 7 to represent the low, medium, and high levels of water use. Scenario 1 assumes an industry that uses combustion heating to heat formations to recover oil, and that upgrades kerogen products outside the study area. The use of combustion heating eliminates the direct and indirect water use required for electrical generation for electric heating. Combustion heating is likely to produce more byproduct water than electrical heating or solvent recovery. A solvent-recovery scenario has not been included. Like Scenario 1, it would not require water to support electrical generation, but it would also not produce much, if any, byproduct water. Accordingly, it would be a low water use scenario, but would not be expected to have lower water use than Scenario 1. Scenario 7 assumes an industry that uses the Shell *in situ* conversion process. This process uses electrical heating and therefore requires water to supply the direct and indirect water needs of generation. Scenario 7 assumes that the kerogen product would require upgrading in the study area, but assumes a lower unit water use for this process to reflect the reported ability of the Shell process to produce a more refined product. Scenarios 6 and 7 are equivalent in terms of water use estimates based on the information available to the Study. However, because the Shell process is likely to produce less byproduct water, the actual water use of Scenario 7 may be greater than shown in Table 4-8. However, at this time sufficient information is not available to refine the estimate of water use further. Scenario 4 is similar to Scenario 7 except that low estimates for water use intensity are used (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010).

Table 4-8. Above-Ground Industry Configurations and Direct Unit Water Use

Above-Ground Scenario	Scenario Description	Unit Use (bbl/bbl)
AG-1	Offsite electricity, offsite upgrading. Low estimates	1.0
AG-2	Offsite electricity, onsite upgrading. Low estimates	1.6
AG-3	Onsite electricity, onsite upgrading. Low estimates	1.77
AG-4	Offsite electricity, offsite upgrading. High estimates	2.01
AG-5	Offsite electricity, onsite upgrading. High estimates	3.61
AG-6	Onsite electricity, onsite upgrading High estimates,	3.87

The Draft Energy Water Use Technical Memorandum selected above-ground Scenarios 1, 3, and 6 to represent the low, medium, and high levels of water use. Scenario 1 assumes that electricity is taken from the grid, that upgrading is done outside the study area, and that lower levels of water use intensity will occur. Scenario 6 assumes that electricity is generated onsite, that upgrading takes place in the study area, and that higher levels of water use intensity occur. Scenario 3 assumes that electricity is generated onsite, that upgrading takes place in the study area, but that lower levels of water us intensity occur.

These "barrel of water per barrel of oil" estimates were then applied to two scenarios, representing medium and high 2050 oil shale production scenarios. Specifically, the medium production scenario assumes 100,000 bbl/day of *in situ* and 50,000 bbl/day of above-ground oil shale extraction and the high scenario assumes and industry at 500,000 bbl/day of *in situ* and 50,000 bbl/day of above-ground oil shale extraction. The results are summarized in Table 4-9.

Table 4-9. Total Direct Water Use for Selected Scenarios

Medium Scenario (100,000 bbl/day *in situ* and 50,000 bbl/day above-ground				**High Scenario (500,000 bbl/day *in situ* and 50,000 bbl/day above-ground**			
In Situ (IS-4)		Above-ground (AG-3)		*In Situ* (IS-7)		Above-ground (AG-6)	
bbl/bbl	AFY	bbl/bbl	AFY	bbl/bbl	AFY	bbl/bbl	AFY
0.65	3,100	1.77	4,200	1.47	34,600	3.87	9,100
Medium Scenario Total		**7,300 AFY**		**High Scenario Total**		**43,700 AFY**	

The Draft Energy Water Use Technical Memorandum describes several uncertainties (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010):

- There are uncertainties concerning the size of the future oil shale industry.
- There are uncertainties concerning the split between *in situ* and above-ground retorting. The estimate of 50,000 bbl/day production from above-ground retorting used in the analysis may understate the future value. For every 50,000 bbl/day increase in production from above-ground retorting, total, industry-wide water use for the *high* scenario will increase by about 10,000 AFY. This increase in water use will occur predominantly in the Colorado River Basin, along with a related increase in population.
- There are uncertainties concerning the water intensity of individual industrial processes.
- There are uncertainties concerning the mix of *in situ* retorting processes.
- There are uncertainties concerning the source of electrical energy for formation heating. The report concludes that the likely source of electrical power generation would be through combined cycle gas turbines using gas produced through the production process onsite. Those estimates are embedded in the above figures for scenarios that assume electrical power generation will be used for oil shale extraction. However, if electricity is generated by coal-fired thermal generation

within the study area, rather than combined cycle gas turbines, total water use for the *high* scenario would increase by approximately 57,000 AFY. In addition, population would also increase, because coal-fired thermal generation is more labor-intensive than the combined cycle gas turbines.

- There are uncertainties concerning the rate at which byproduct water is produced and the degree to which byproduct water will be re-used for process purposes. If byproduct water from in situ production is not used to satisfy process needs, total water use for the *high* scenario will increase by an additional 20,000 AFY.

- These factors, in turn, will be influenced by the economic, political, regulatory, and social conditions that exist at the time an oil shale industry develops decades in the future.

In addition to energy industry in northwest Colorado, the Rio Grande Basin expects that within the next 40 to 50 years a solar energy development industry will occur in the Rio Grande Basin. Some of the technologies proposed are water intensive and recent estimates by the Basin Roundtable have identified a potential range of 1,200 to 2,000 AFY demand for solar energy development by 2050 (Mike Gibson 2009).

Table 4-10 shows the estimated energy development direct water demands for the Colorado counties where water demands for energy production will be required by 2050. Water demands for energy development have the potential to increase over six times 2008 levels by 2050 for the high scenario.

Table 4-10. Estimated Energy Development Direct Water Demands (AFY)

County	2008	2035	2050		
			Low	Med	High
Alamosa	—	300	1,200	1,500	2,000
Garfield	2,000	500	200	3,300	6,900
Mesa	300	—	—	1,400	3,800
Moffat	800	1,500	400	1,200	2,300
Rio Blanco	700	4,000	3,000	5,800	37,900
Routt	500	500	500	500	1,600
Total	4,300	6,800	5,300	13,700	54,500

4.1.4.1 Oil Shale Build-out Water Demands

Phase 2 of the Energy Study considered the water demands for an oil shale industry at build-out conditions. Table 4-11 summarizes the total indirect and direct water demands for the build-out industry scenario of 1.5 million barrels/day *in situ* production and 50,000 barrels/day above-ground production. This table shows build-out direct water demands for the low, medium, and high scenarios defined in Phase 2 of the Energy Study. These numbers represent the same barrel of water per barrel of oil scenarios as detailed above in Table 4-9 above. The low scenario is presented as a negative number due to subtracting the amount of water that is produced as a byproduct of shale oil production (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010).

Table 4-11. Direct Water Use Scenarios for Build-out Oil Shale Industry (AFY)

Oil Shale Development Method	Low	Medium	High
In situ development	-23,000	46,000	104,000
Above-ground development	2,300	4,200	9,100
Total	-20,700	50,200	113,100

As discussed in the previous section, there is a great deal of uncertainty in these demand projections, specifically for the build-out scenario (Colorado, Yampa, and White River Basin Roundtables Energy Subcommittee 2010):

- If electricity is generated by coal-fired thermal generation within the study area, rather than combined cycle gas turbines, total water use for the high scenario would increase by approximately 170,000 AFY. Population will also increase, because coal-fired thermal generation is more labor-intensive than the combined cycle gas turbines.

- If byproduct water from *in situ* production is not used to satisfy process needs, total water use for the *high* scenario will increase by an additional 60,000 AFY.

These values have been approved at the subcommittee level. In July and August of 2010 the subcommittee will seek roundtable approval.

Direct and indirect oil shale demands have decreased from the initial Phase I Energy Study estimate of 378,310 AFY to 120,000 AFY for the high long-term scenario due to three primary factors:

1. Phase 1 of the study assumed that electrical energy needed in the oil shale production process would be generated through coal-fired power plants, requiring 244,500 AF of water. Phase 2 of the study indicates that the down-hole combustion oil shale extraction process does not require electric energy, and those that do can rely on natural gas produced on site. Combined cycle gas turbines used on site require less employees than coal-fired power plants do and a high of just 20 percent of the water needed for electrical generation.

2. Phase 1 of the study did not factor in water produced from the oil shale production process. Phase 2 assumes that the regulatory framework will require oil and gas companies to treat produced water rather than allow for deep well injection without treatment. It is assumed, therefore, that this water will then be used on-site for the water requirements of oil shale production or be able to be used downstream for other demands. The build out scenario estimates that this is approximately 38,000 AFY.

3. A survey to the oil and gas industry allowed for refinement of the water use projections with the most current technologies.

4.2 Self-Supplied Industry Demands Summary

Table 4-12 shows results of the updated SSI water demands forecast by county and Table 4-13 presents results by basin. As shown, Moffat County could experience a significant increase in water demands, attributable to the electricity needed for energy development. Rio Blanco County could also experience a significant increase in water demands if the oil shale industry experiences significant growth. Both of these counties are located in the Yampa-White Basin. For the remaining counties and basins, increased demands are attributable to increases in thermoelectric power generation. The North Platte Basin does not have any SSI water demands identified at this time. There has been some discussion of oil and gas development in the North Platte Basin but at this time, water needs for this industry have not been quantified.

Table 4-12. Summary of Self-Supplied Industry Water Demands (AF)

County	Sub-Sector	2008	2035	2050 Low	2050 Med	2050 High
Adams	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	-	-	-	-	-
	Thermoelectric	9,600	9,600	10,100	12,000	14,400
	Total	9,600	9,600	10,100	12,000	14,400
Alamosa	Energy Development	-	600	1,200	1,500	2,000
	Large Industry	-	-	-	-	-
	Snowmaking	-	-	-	-	-
	Thermoelectric	-	-	-	-	-
	Total	-	600	1,200	1,500	2,000
Boulder	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	230	230	230	230	230
	Thermoelectric	2,900	2,900	3,100	3,700	4,400
	Total	3,130	3,130	3,330	3,930	4,630
Clear Creek	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	90	90	90	90	90
	Thermoelectric	-	-	-	-	-
	Total	90	90	90	90	90
Denver	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	-	-	-	-	-
	Thermoelectric	2,400	2,400	2,500	3,000	3,500
	Total	2,400	2,400	2,500	3,000	3,500
Eagle	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	600	600	600	600	600
	Thermoelectric	-	-	-	-	-
	Total	600	600	600	600	600
Garfield	Energy Development	2,000	500	200	3,300	6,900
	Large Industry	-	-	-	-	-
	Snowmaking	20	20	20	20	20
	Thermoelectric	-	-	-	-	-
	Total	2,020	520	220	3,320	6,920
Grand	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	350	630	630	630	630
	Thermoelectric	-	-	-	-	-
	Total	350	630	630	630	630

Table 4-12. Summary of Self-Supplied Industry Water Demands (AF)

County	Sub-Sector	2008	2035	2050 Low	2050 Med	2050 High
Gunnison	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	260	650	650	650	650
	Thermoelectric	-	-	-	-	-
	Total	260	650	650	650	650
Jefferson	Energy Development	-	-	-	-	-
	Large Industry	52,400	52,400	52,400	52,400	52,400
	Snowmaking	-	-	-	-	-
	Thermoelectric	-	-	-	-	-
	Total	52,400	52,400	52,400	52,400	52,400
La Plata	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	230	230	230	230	230
	Thermoelectric					
	Total	230	230	230	230	230
Larimer	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	-	-	-	-	-
	Thermoelectric	5,200	11,200	11,700	14,000	16,700
	Total	5,200	11,200	11,700	14,000	16,700
Mesa	Energy Development	300	-	-	1,400	3,800
	Large Industry	-	-	-	-	-
	Snowmaking	50	50	50	50	50
	Thermoelectric	-	-	-	-	-
	Total	350	50	50	1,450	3,850
Moffat	Energy Development	800	1,500	400	1,200	2,300
	Large Industry	2,600	3,900	3,900	3,900	3,900
	Snowmaking	-	-	-	-	-
	Thermoelectric	17,500	26,900	24,700	26,200	26,900
	Total	20,900	32,300	29,000	31,300	33,100
Montrose	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	-	-	-	-	-
	Thermoelectric	1,900	3,900	4,100	4,900	5,900
	Total	1,900	3,900	4,100	4,900	5,900
Morgan	Energy Development	-	-	-	-	-
	Large Industry	2,100	2,100	2,100	2,100	2,100
	Snowmaking	-	-	-	-	-
	Thermoelectric	5,900	13,900	14,600	17,400	20,900
	Total	8,000	16,000	16,700	19,500	23,000
Pitkin	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	560	560	560	560	560
	Thermoelectric	-	-	-	-	-
	Total	560	560	560	560	560
Pueblo	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
	Total	58,400	64,100	64,800	67,800	71,500
Rio Blanco	Energy Development	700	4,000	3,000	5,800	37,900
	Large Industry	-	-	-	-	-
	Snowmaking	-	-	-	-	-
	Thermoelectric	-	-	-	-	-
	Total	700	4,000	3,000	5,800	37,900

Table 4-12. Summary of Self-Supplied Industry Water Demands (AF)

County	Sub-Sector	2008	2035	2050 Low	2050 Med	2050 High
Routt	Energy Development	500	500	500	500	1,600
	Large Industry	3,500	5,600	5,600	5,600	5,600
	Snowmaking	290	570	570	570	570
	Thermoelectric	2,700	11,400	12,000	14,300	17,100
	Total	6,990	18,070	18,670	20,970	24,870
San Miguel	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	180	180	180	180	180
	Thermoelectric	-	-	-	-	-
	Total	180	180	180	180	180
Summit	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	1,600	2,880	2,880	2,880	2,880
	Thermoelectric	-	-	-	-	-
	Total	1,600	2,880	2,880	2,880	2,880
Weld	Energy Development	-	-	-	-	-
	Large Industry	4,500	4,500	4,500	4,500	4,500
	Snowmaking	-	-	-	-	-
	Thermoelectric	7,400	7,400	7,800	9,300	11,100
	Total	11,900	11,900	12,300	13,800	15,600
Statewide Total		187,760	235,990	235,890	261,490	322,090

Table 4-13. Summary of Self-Supplied Industry Demands by Basin (AF)

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
	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	-	-	-	-	-
	Total	5,480	5,240	4,940	9,440	15,440
Gunnison	Energy Development	-	-	-	-	-
	Large Industry	-	-	-	-	-
	Snowmaking	260	650	650	650	650
	Thermoelectric	-	-	-	-	-
	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
	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	-	-	-	-	-
	Total	-	600	1,200	1,500	2,000

Table 4-13. Summary of Self-Supplied Industry Demands by Basin (AF)

Basin	Sub-Sector	2008	2035	2050 Low	2050 Med	2050 High
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
	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
	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
	Total	28,590	54,370	50,670	58,070	95,870
Total All Basins		187,760	235,990	235,890	261,490	322,090

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Section 5
State of Colorado 2050 Water Use Projections: Summary and Conclusions

5.1 2050 Water Use Projections Summary

Water usage rates were updated from the SWSI Phase 1 Study as described in Section 3 and summarized by basin as shown in Figure 5-1 at the end of this section. Figure 5-1 shows the SWSI Phase 1 water usage rates, water usage rate developed for the 2009 draft version of this report, and water usage rates based on recent data collection efforts. The water usage rates shown in Figure 5-1 are systemwide water usage rate values. As discussed in Section 3, systemwide water usage rates are appropriate for statewide planning but should not be used for comparisons between basins. For all basins except the North Platte and Yampa-White, water usage rates decreased between SWSI Phase 1 water usage rates and the updated rates. CWCB has collected a significant amount of new water usage information across the state as described in Section 3, which is a factor in the changes between the SWSI Phase 1 and current values. For the basins with decreases in usage, the changes in demands may also be due to conservation savings that are permanent, lingering effects of the 2002 drought, and/or economic factors resulting in the observed demand decreases.

Figure 5-1, at the end of this section, shows that statewide there is nearly 20 percent decrease between SWSI Phase 1 and the updated water usage rates. The basin with the largest decreases between SWSI Phase 1 and the updated water usage rates is the Colorado Basin followed by the South Platte Basin, Gunnison Basin, and Metro Basin. As indicated in Section 3, the differences between updated gpcd values and SWSI gpcds are due to a wide variety of reasons not necessarily related to actual gpcd decreases. In addition, comparisons between basins are not recommended, as different communities have different gpcd drivers (e.g., industry, transient population, metered outdoor water use, climate).

Figure 5-2, at the end of this section, presents a comparison of the baseline M&I and SSI water demands compared to M&I and SSI water demands with passive conservation. Passive conservation results in a savings of 154,000 AFY by 2050, which is just over an 8 percent savings from baseline demands for the 2035, 2050 low, and 2050 medium forecasts. For the 2050 high forecast, passive conservation results in just over a 6 percent savings from baseline (CWCB 2010).

As discussed in Section 2, Colorado's population is projected to nearly double by the year 2050. Figure 5-3, at the end of this section, shows results for the M&I water demands forecasts for the major river basins for 2008, 2035, and the low, medium, and high scenario 2050 projections. Because the major driver for water use is population growth, M&I water usage is also expected to nearly double. The majority of M&I water usage will be in the Arkansas, Colorado, Metro, and South Platte Basins.

Section 4 summarized projected SSI water usage. A major update from the SWSI Phase 1 Study is the consideration of the Energy Development Study Phase 1 and Phase 2 results for northwestern Colorado. Figure 5-4 at the end of this section shows projected statewide SSI water demands by sub-sector. Figure 5-4 indicates that the Large Industry and Thermoelectric sub-sectors are projected to use the most water in the future.

Figure 5-5 at the end of this section summarizes statewide M&I and SSI water demands forecasts for 2008, 2035, and the low, medium, and high scenario 2050 projections. Total statewide 2035 water demands are projected to be nearly 1.6 million AFY. 2050 water demands are projected to range from approximately 1.75 million AFY to nearly 2.1million AFY. Figure 5-5 also shows that statewide, M&I water demands are estimated to exceed SSI water demands for all of the future projections.

Figures 5-6 through 5-30 at the end of the section present water demands forecasts by basin. For each basin, a chart was developed to show M&I water demands forecasts for M&I by county, for SSI by sub-sector, and a summary chart of the combined M&I and SSI forecasted water demands for 2008, 2035, and low, medium, and high scenarios for 2050. Basin-specific results are discussed below.

- **Arkansas Basin (Figures 5-6 through 5-8)**: The counties with the highest forecasted M&I water demands in the Arkansas Basin are El Paso, Pueblo, and Fremont Counties. Large industry and thermoelectric needs comprise all of the SSI water needs for the basin. The majority of the demand in the Arkansas Basin is from M&I water needs. These M&I needs are expected to be nearly 1.6 times higher than 2008 levels by 2050.

- **Colorado Basin (Figures 5-9 through 5-11):** The counties with the highest forecasted M&I water demands in the Colorado Basin are Pitkin, Garfield, and Mesa Counties. M&I water demands in the Colorado Basin are projected to nearly double in the next 40 years. The Colorado Basin SSI forecasted water demands vary based on the low, medium, or high scenario. For the low scenario, SSI demands are mostly from snowmaking. For the middle scenario, there is a nearly even split between snowmaking and energy development demands. The high scenario shows that SSI demands will mostly be comprised of energy development demands.

- **Gunnison Basin (Figures 5-12 through 5-14):** Gunnison Basin M&I water demands forecasts indicate that Montrose and Delta Counties will have the highest M&I water needs in the basin. M&I demands are expected to nearly double in the Gunnison basin by 2050. SSI water demands in the basin will be dominated by snowmaking, and M&I water needs in the basin greatly exceed the SSI water needs.

- **Metro Basin (Figures 5-15 through 5-17):** The counties with the highest forecasted M&I water demands in the Metro Basin are Arapahoe, Denver, and Jefferson counties followed closely by Adams and Douglas counties. The Metro Basin's M&I

demands are projected to grow nearly 1.5 time 2008 levels by 2050. The majority of SSI demands in the basin are from large industry.

- **North Platte Basin (Figure 5-18):** Jackson County M&I water demands in the North Platte Basin are projected to grow from 500 AFY (2008) to nearly 800 AFY in 2050. As discussed in Section 4, the North Platte Basin does not have any SSI water demands.

- **Rio Grande Basin (Figures and 5-19 through 5-21):** Alamosa, Conejos, and Rio Grande Counties have the greatest current and future water demands. M&I demands in the basin are projected to increase from nearly 18,000 AFY (2008) to nearly 28,000 AFY by 2050. The SSI demands in the basin are primarily related to solar energy development.

- **South Platte Basin (Figures 5-22 through 5-24):** M&I demands in the South Platte Basin are projected grow nearly 1.8 times higher than current levels in the next 40 years. The counties with the highest forecasted M&I water demands are Weld County, Larimer County, and Boulder County. The major SSI water needs in the basin are for thermoelectric power. M&I water demands are projected to be larger than SSI water demands.

- **Southwest Basin (Figures 5-25 through 5-27):** Archuleta, La Plata, and Montezuma Counties have the highest M&I water demands in the basin, currently and for 2050 projections. M&I demands in the Southwest Basin are projected to more than double in the next 40 years. The largest SSI water demand sector in the basin is thermoelectric power. M&I water demands are forecasted to be greater than SSI water demands.

- **Yampa-White Basin (Figures 5-28 through 5-30):** Routt County has the largest M&I demands in the Yampa-White Basin. The largest SSI water demand is for thermoelectric power. However, for the 2050 high scenario water demands for oil shale nearly equal those for thermoelectric power. The Yampa-White Basin is the only basin in the state where SSI water needs exceed M&I water needs. The M&I water needs in the basin are expected to more than double in the next 40 years.

5.2 2050 Water Use Projections Conclusions and Next Steps

Figure 5-31 at the end of this section summarizes statewide existing water use and systems and future water demands. Total statewide M&I demands including oil shale and other SSI water demands for the low, medium, and high scenario projections are 1.7 million AFY, 1.9 million AFY, and 2.1 million AFY, respectively. Current water use is just over 1.1 million AFY. CWCB is in the process of updating the M&I gap that was identified in SWSI through the year 2030. As part of the gap analysis, CWCB is extending the timeframe of the gap analysis to 2050 to match the M&I and SSI water demands described in this report. To complete the gap analysis effort, CWCB is updating the IPPs that were developed during SWSI 1. These IPPs specify the water

provider's plans for meeting 2030 water needs. Once the IPPs are updated, the yield from the IPPs will be subtracted from the 2050 water needs shown in Figure 5-31 to update the M&I gaps across the state.

Following are the conclusions from State of Colorado's 2050 water use projections:

- Colorado's population is expected to nearly double by 2050 even after taking into account the current recession's impacts on Colorado's economy.
- The Front Range of Colorado will continue to be the most populous place in Colorado with over 80 percent of the state's population residing in the Arkansas, Metro, and South Platte Basins.
- The West Slope of Colorado will grow at the fastest rate of any area in Colorado between now and 2050. Population on the West Slope is expected to more than double in the next 40 years.
- Statewide M&I water usage rates have decreased by 18 percent. This decrease is due to a combination of drought response, conservation savings, and additional data collection efforts. Additional data collected during this effort has improved the original SWSI water usage information.
- Because population growth is the driving factor in water use across the state, water use is also nearly expected to double by 2050.
- Passive conservation will save approximately 154,000 AFY by 2050 or an 8 percent savings.
- The basins with the largest SSI water usage in 2050 are projected to be the Yampa-White, Arkansas, Metro, and South Platte Basins.
- Oil shale water demands have factored in recent information developed by the Colorado and Yampa-White Basin Roundtables' Energy Subcommittee that considered the amount of produced water that will be created during shale processing. In addition, recent work completed by the subcommittee has shown that energy needed to develop oil shale could be produced by combined cycle gas turbines, not coal power plants. Both of these considerations have reduced previous estimates of oil shale water demands.

Figure 5-1. M&I Water Usage Rate by Basin

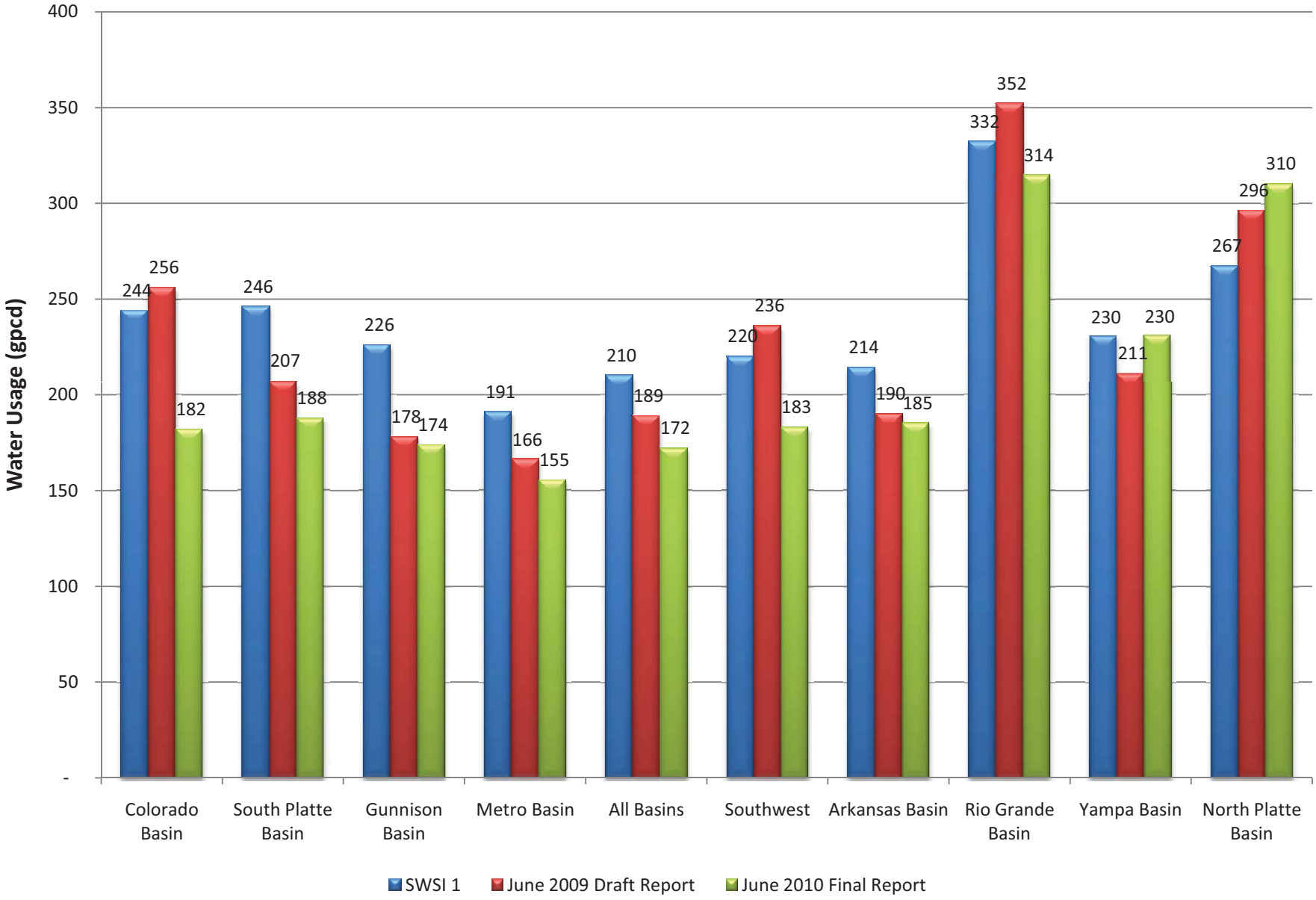
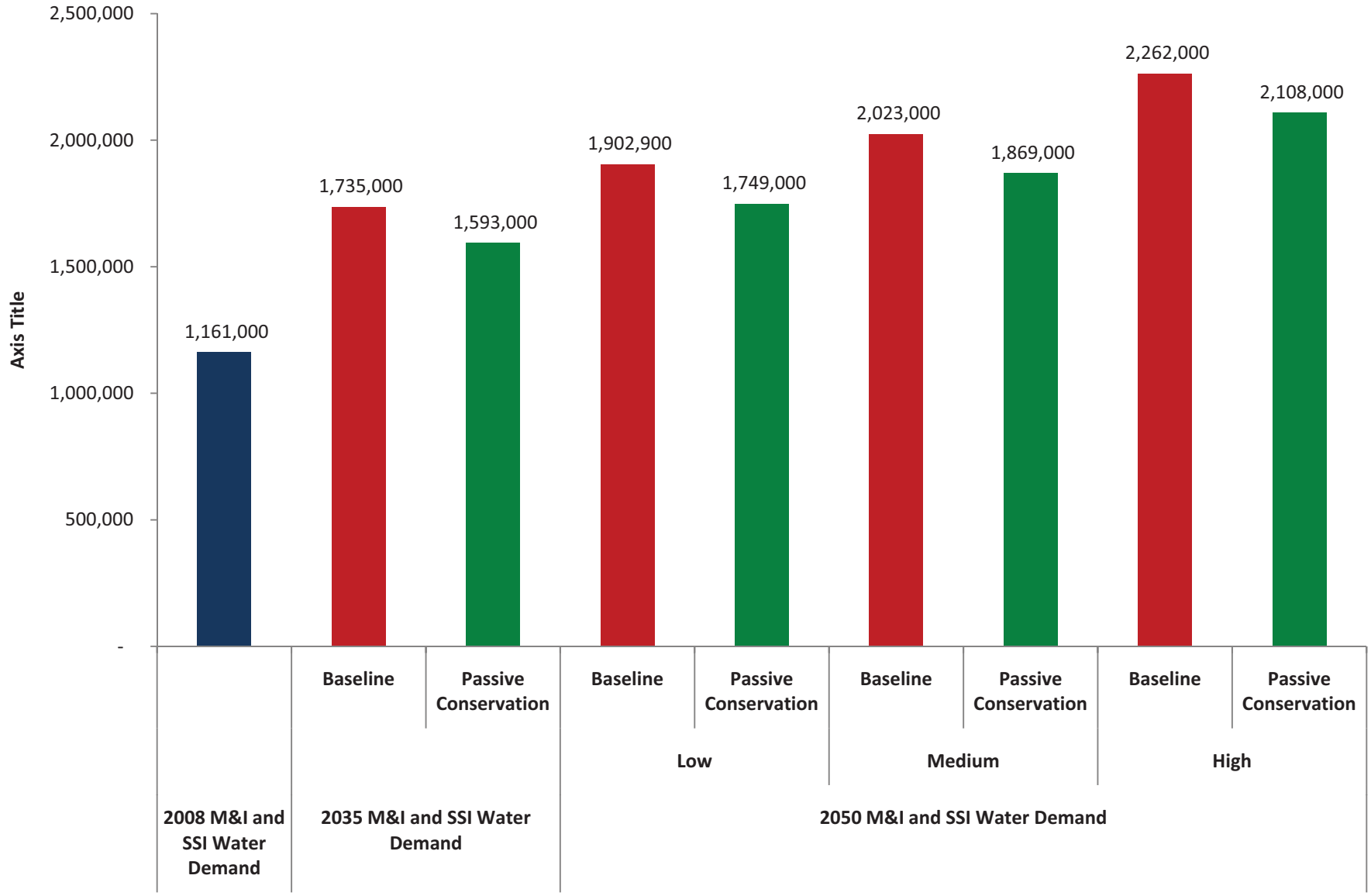


Figure 5-2. Comparison of M&I and SSI Demands for Baseline and with Passive Conservation



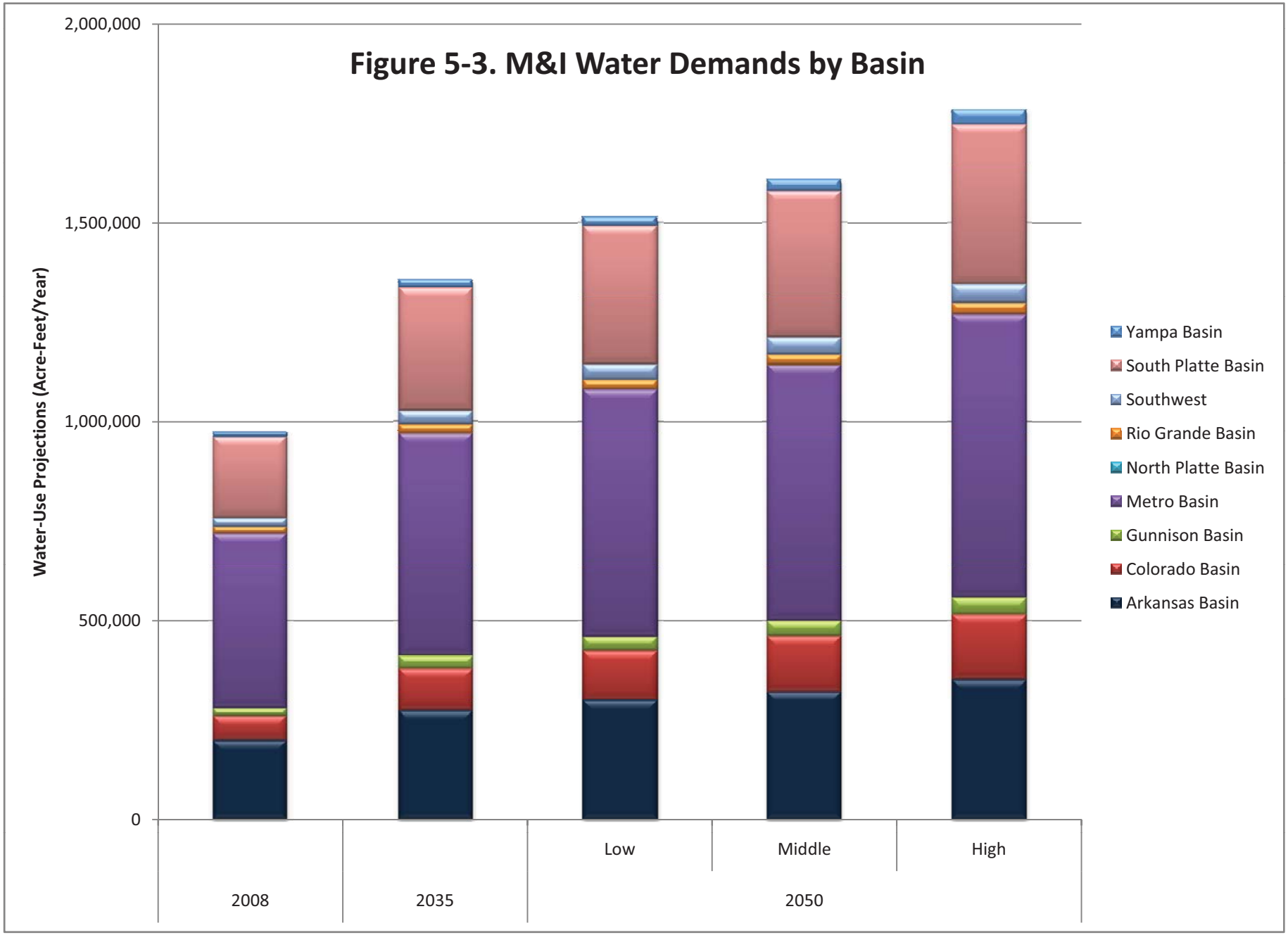


Figure 5-3. M&I Water Demands by Basin
Water-Use Projections (Acre-Feet/Year)
2,000,000
1,500,000
1,000,000
500,000
0
2008
2035
Low
Middle
High
2050
Yampa Basin
South Platte Basin
Southwest
Rio Grande Basin
North Platte Basin
Metro Basin
Gunnison Basin
Colorado Basin
Arkansas Basin

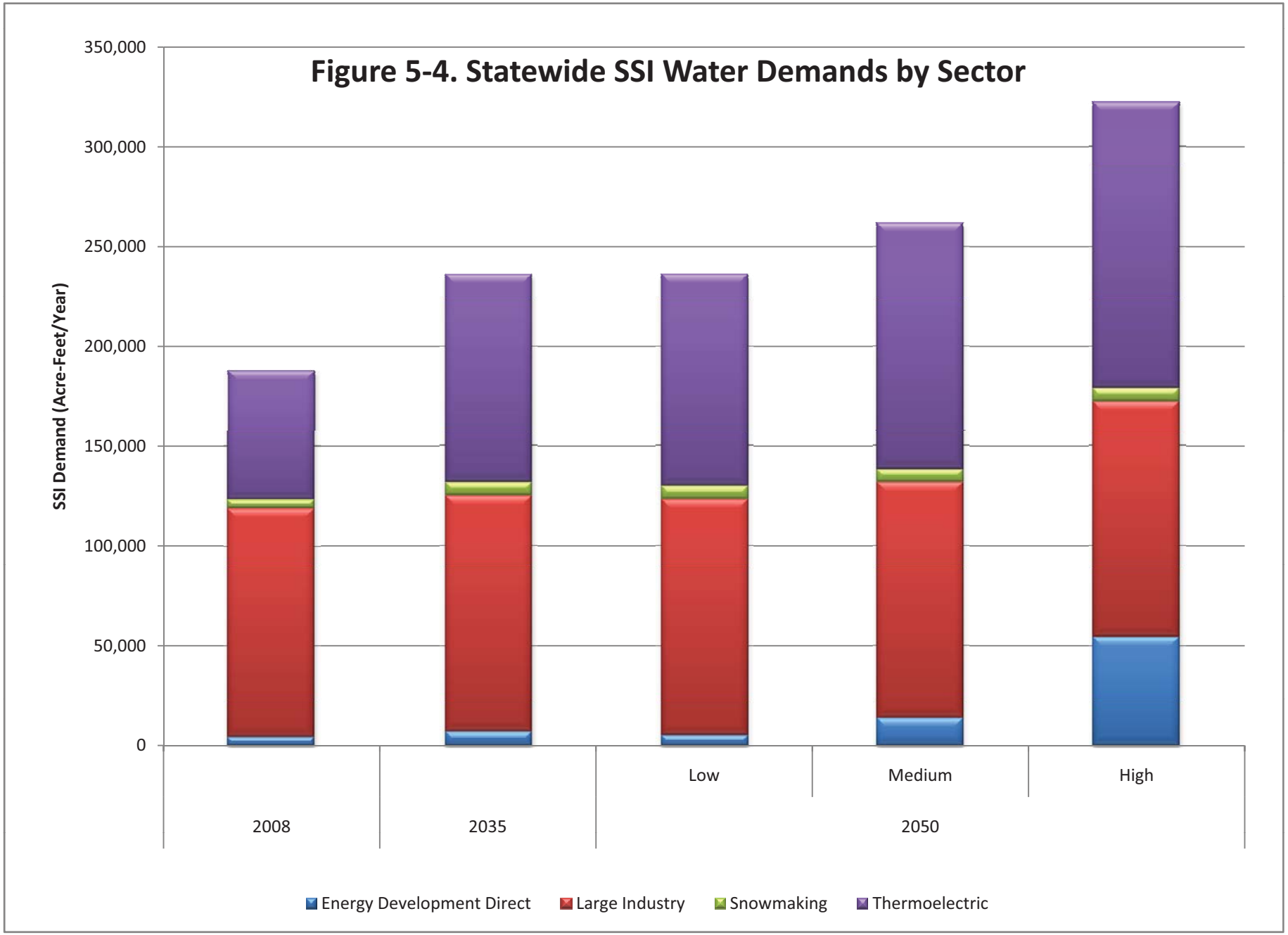


Figure 5-4. Statewide SSI Water Demands by Sector
SSI Demand (Acre-Feet/Year)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
2008
2035
Low
Medium
High
2050
Energy Development Direct
Large Industry
Snowmaking
Thermoelectric

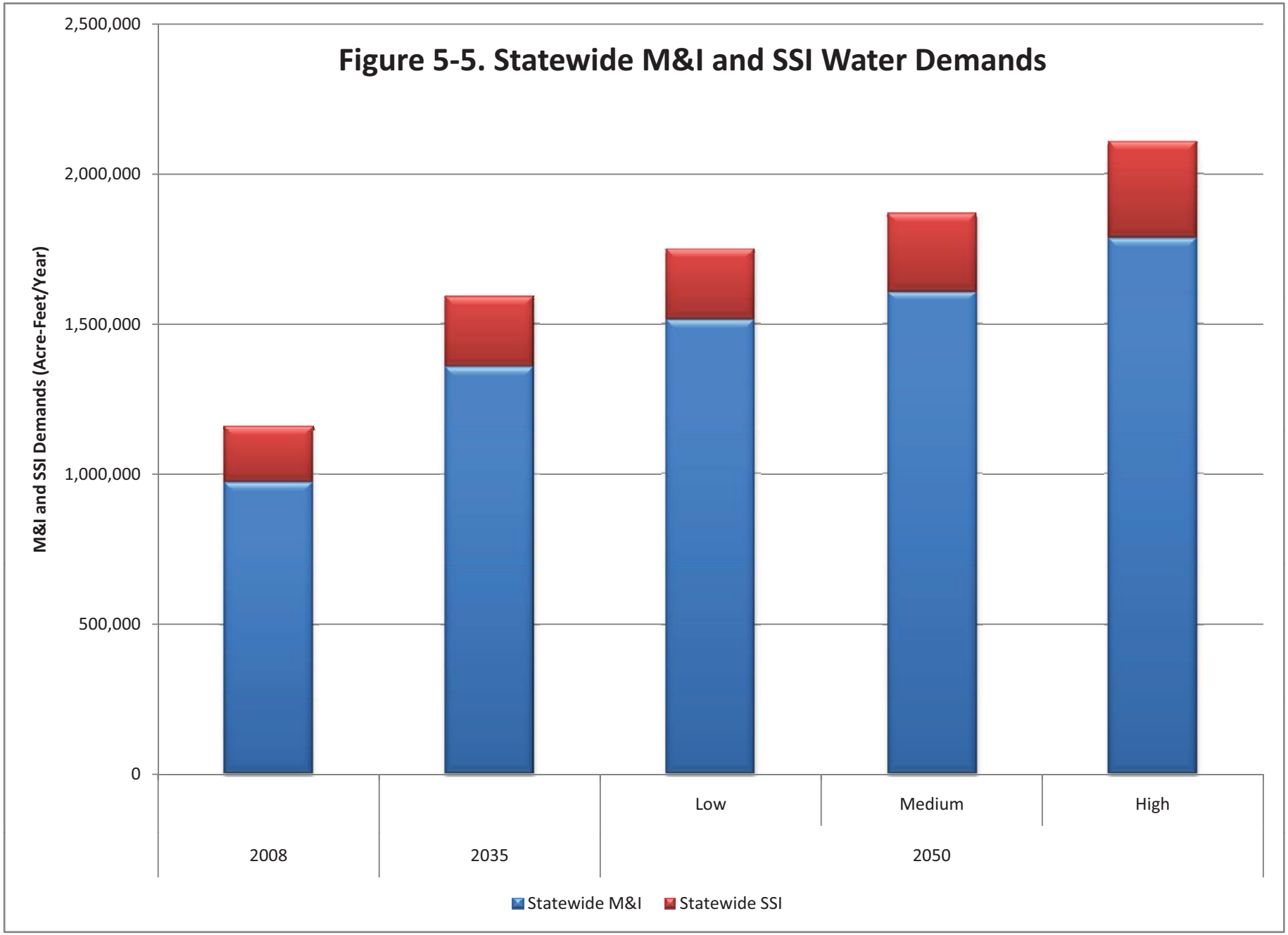


Figure 5-5. Statewide M&I and SSI Water Demands
M&I and SSI Demands (Acre-Feet/Year)
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
2008
2035
Low
Medium
High
2050
Statewide M&I
Statewide SSI

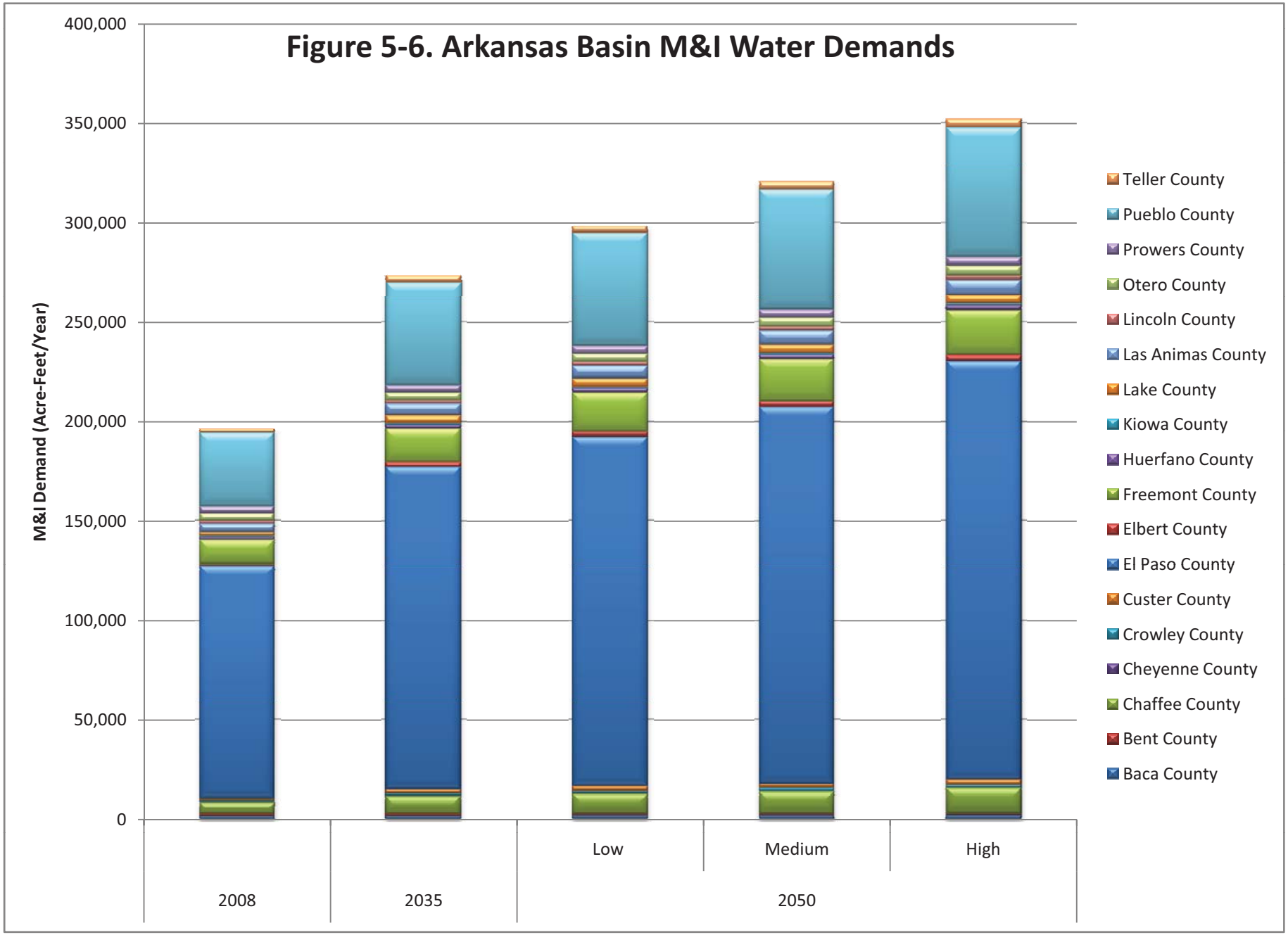
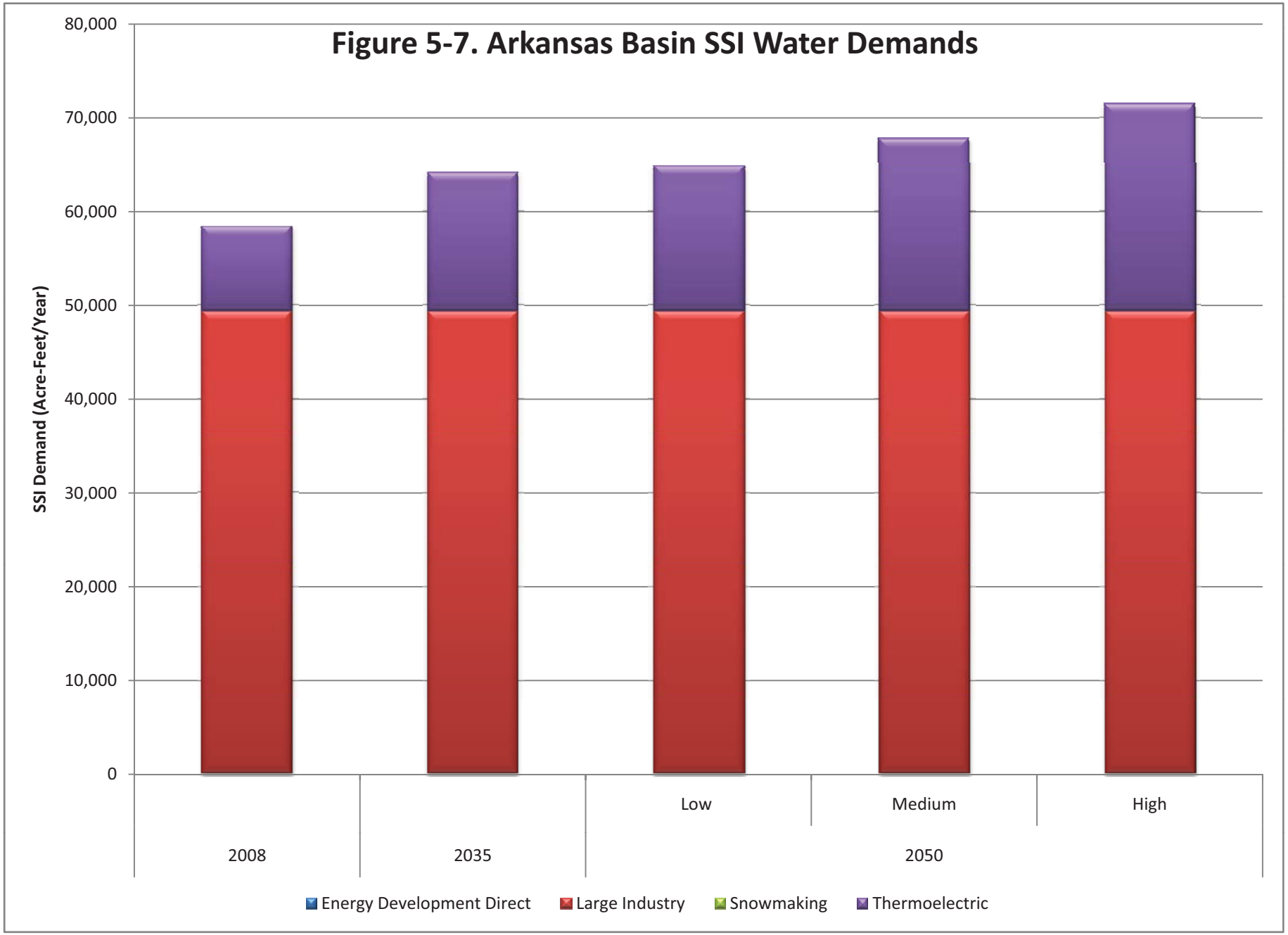


Figure 5-6. Arkansas Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
2008
2035
Low
Medium
High
2050
Teller County
Pueblo County
Prowers County
Otero County
Lincoln County
Las Animas County
Lake County
Kiowa County
Huerfano County
Freemont County
Elbert County
El Paso County
Custer County
Crowley County
Cheyenne County
Chaffee County
Bent County
Baca County

Figure 5-7. Arkansas Basin SSI Water Demands



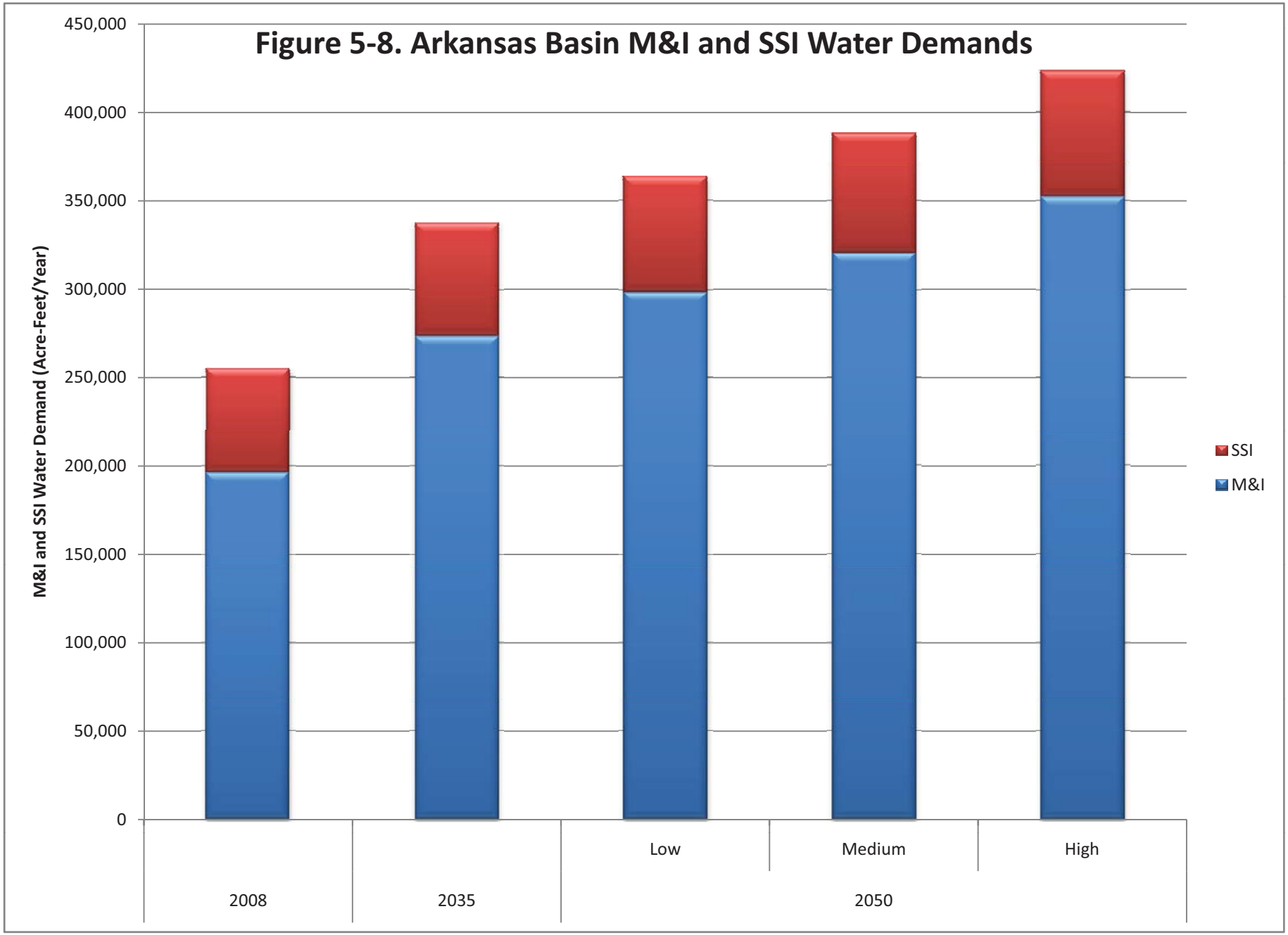


Figure 5-8. Arkansas Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

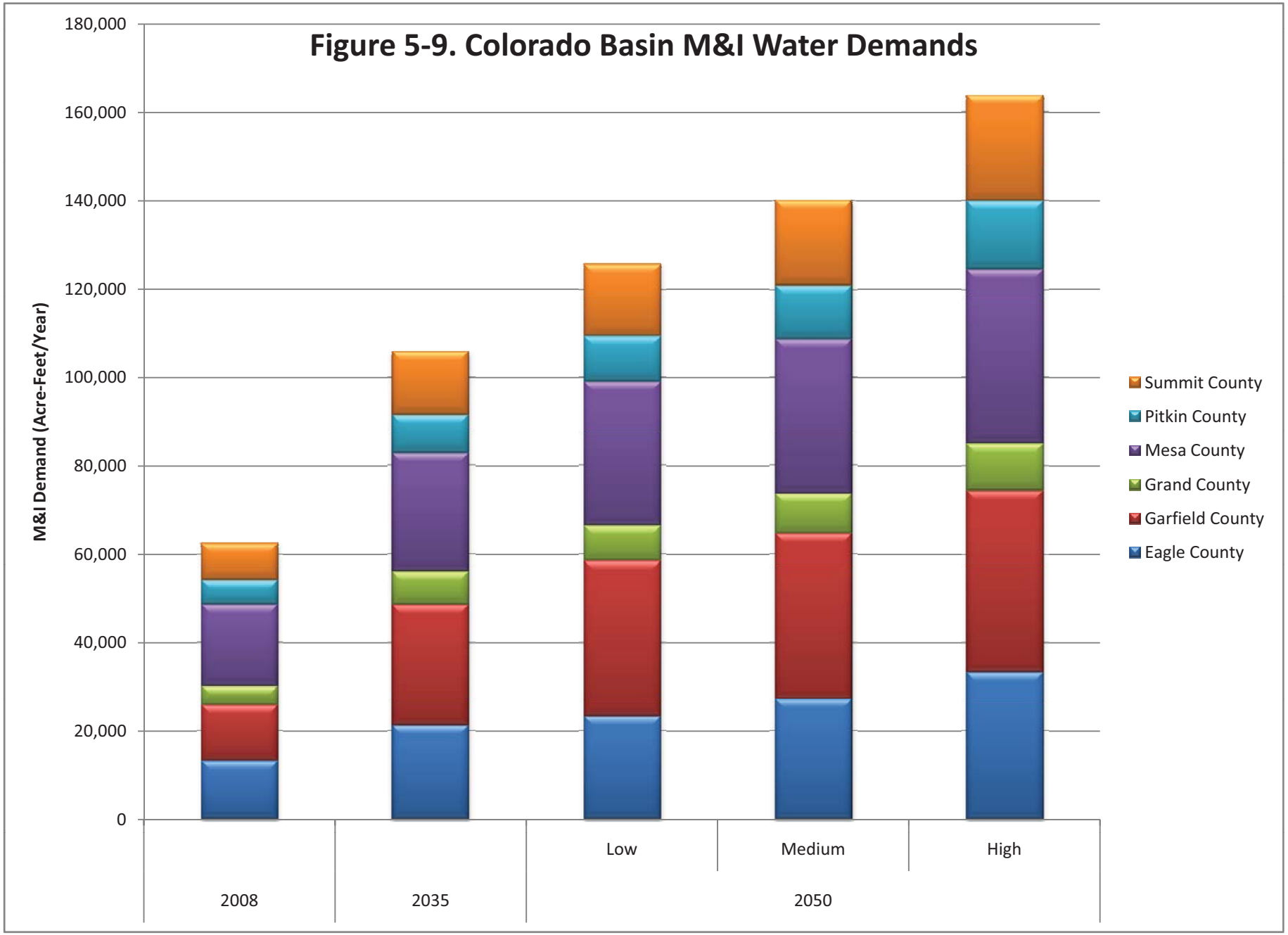


Figure 5-9. Colorado Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
2008
2035
Low
Medium
High
2050
Summit County
Pitkin County
Mesa County
Grand County
Garfield County
Eagle County

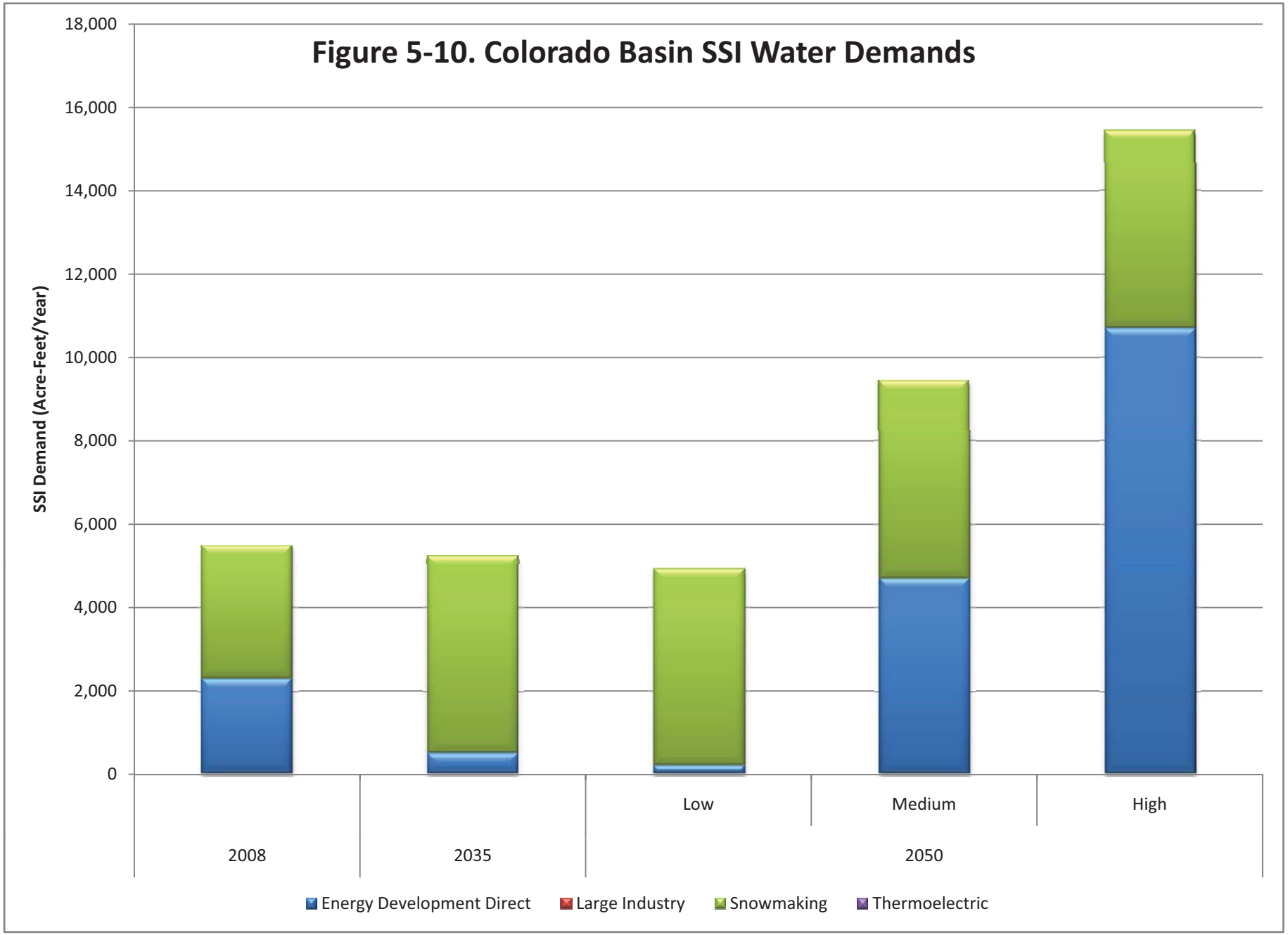


Figure 5-10. Colorado Basin SSI Water Demands
SSI Demand (Acre-Feet/Year)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2008
2035
Low
Medium
High
2050
Energy Development Direct
Large Industry
Snowmaking
Thermoelectric

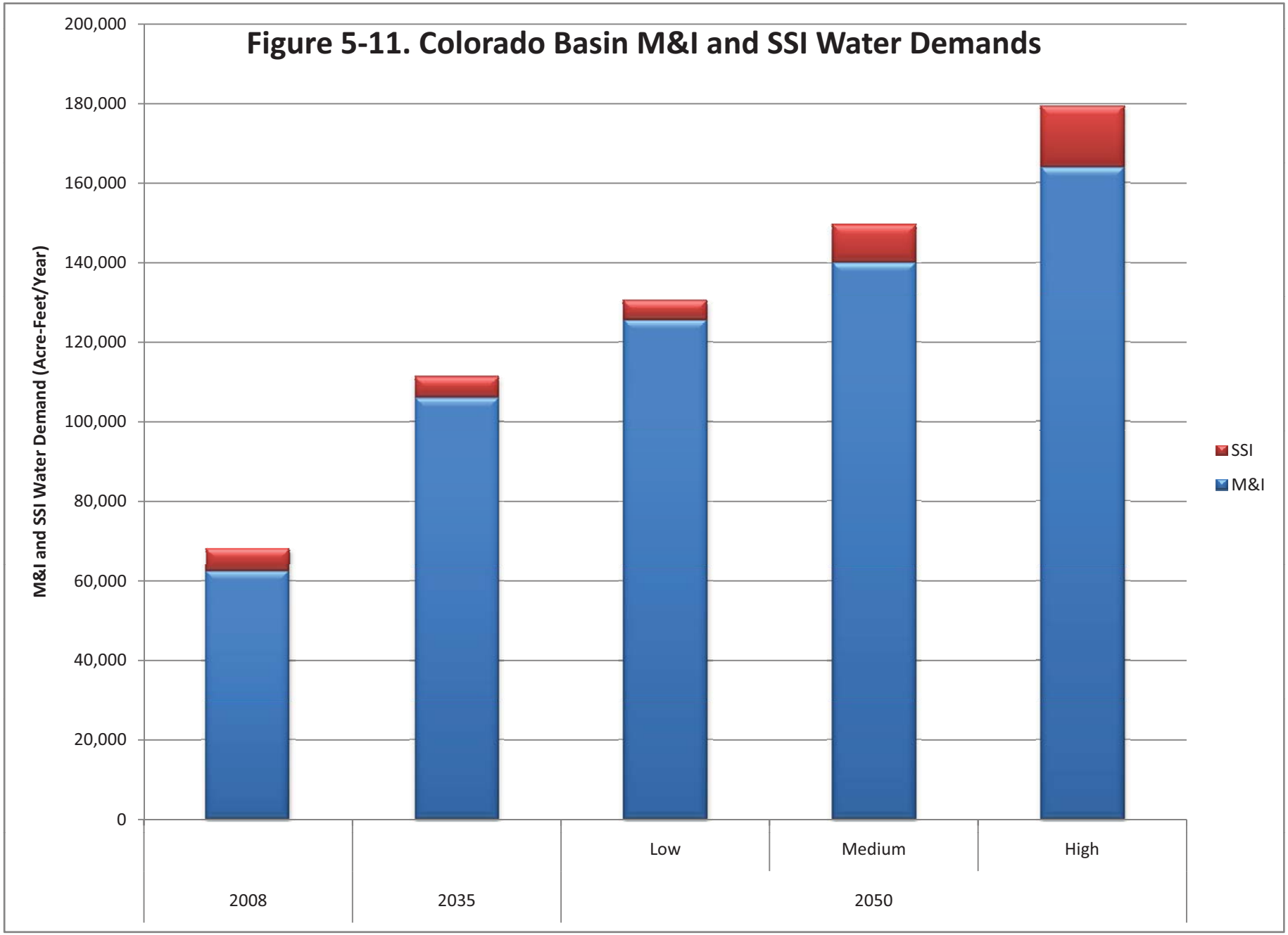


Figure 5-11. Colorado Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

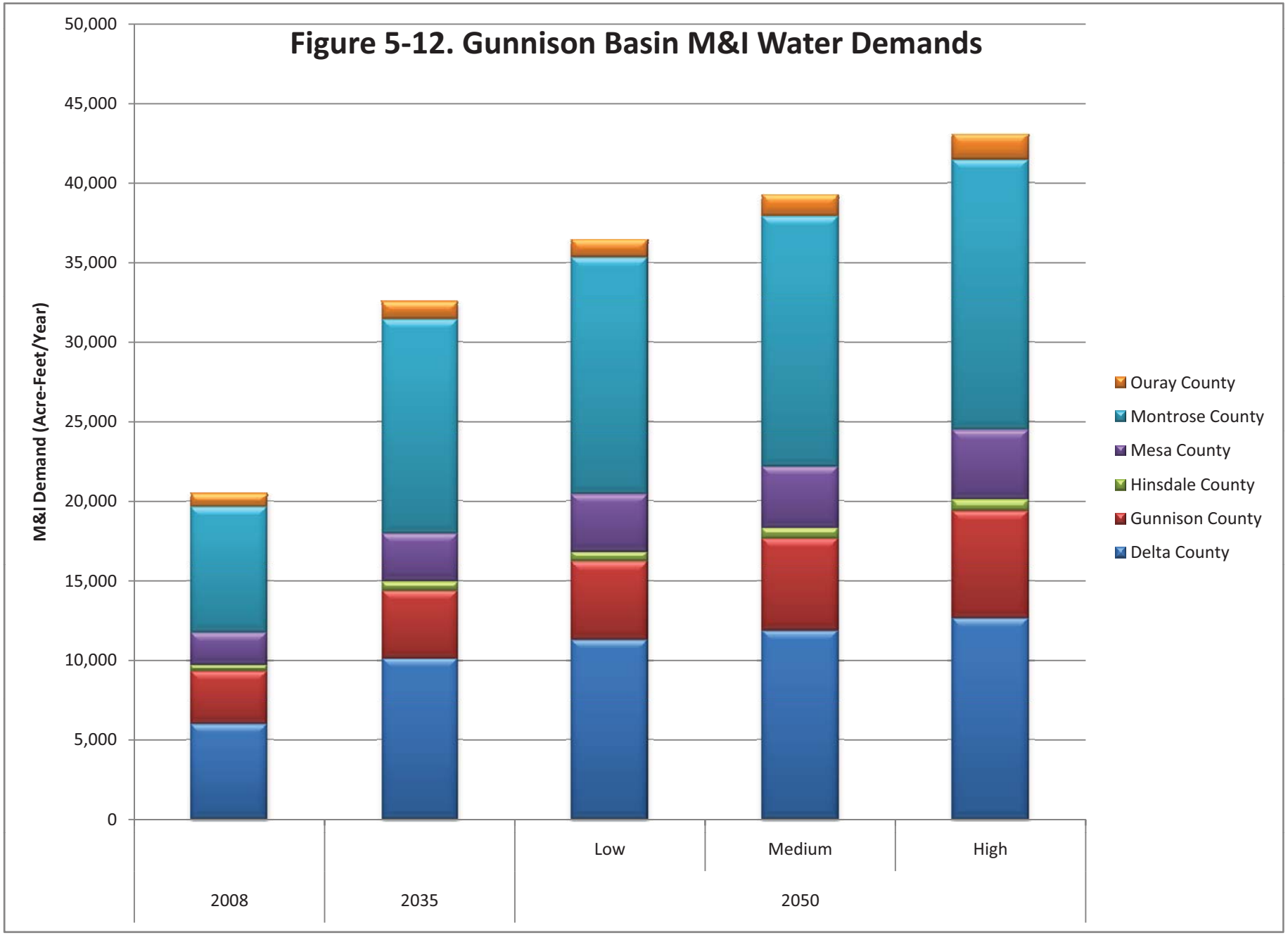
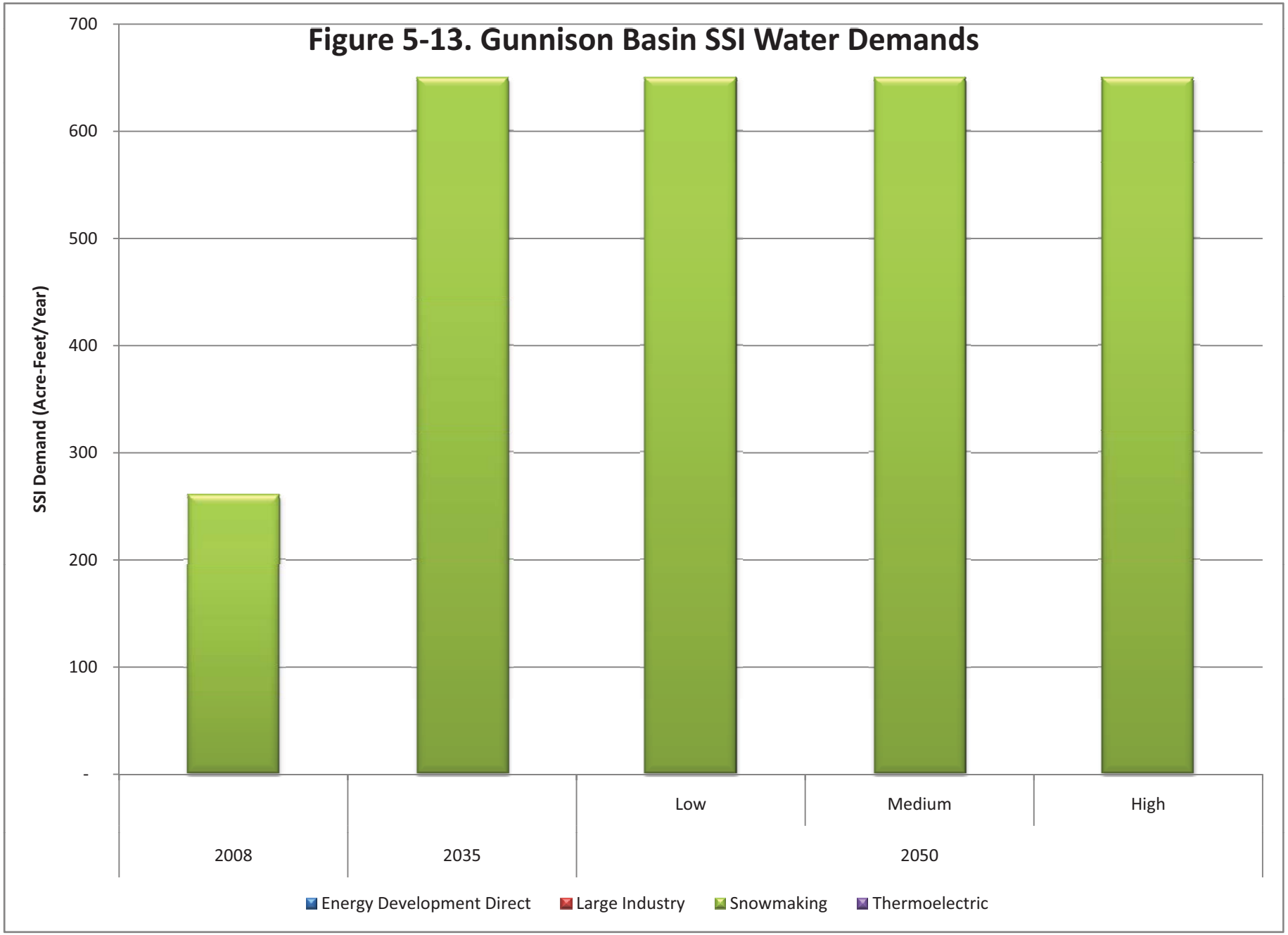


Figure 5-12. Gunnison Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2008
2035
Low
Medium
High
2050
Ouray County
Montrose County
Mesa County
Hinsdale County
Gunnison County
Delta County

Figure 5-13. Gunnison Basin SSI Water Demands



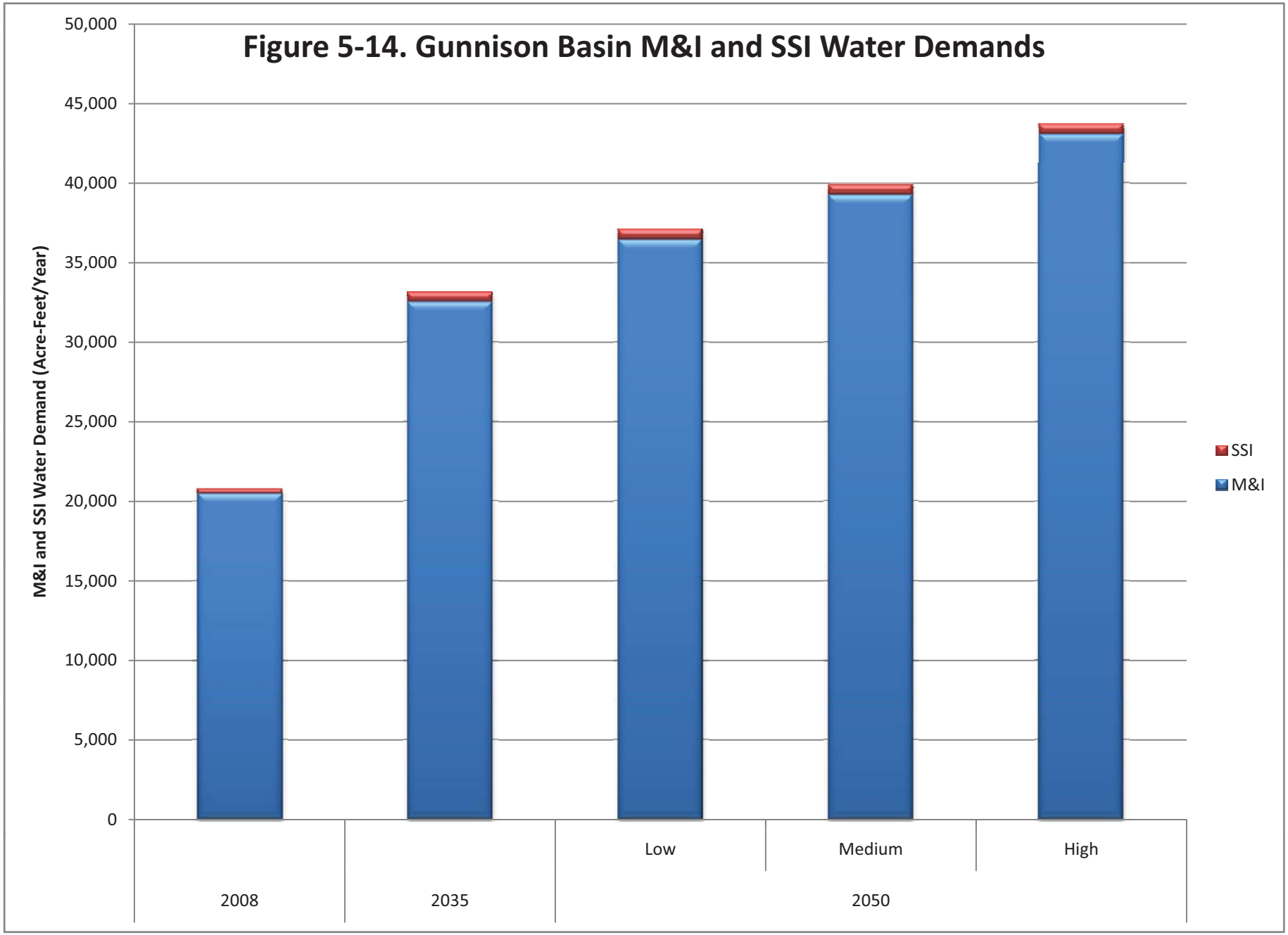


Figure 5-14. Gunnison Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

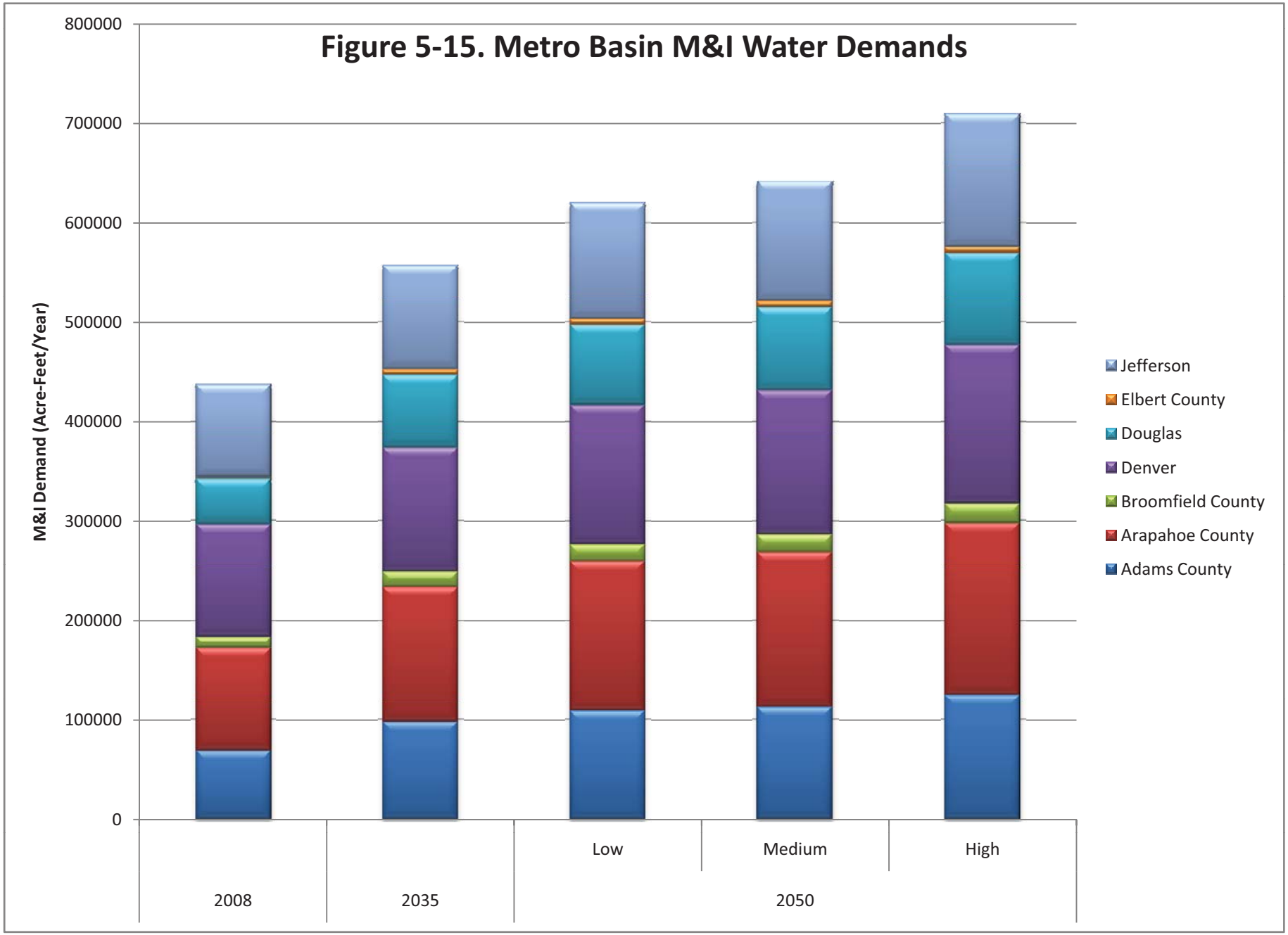


Figure 5-15. Metro Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
800000
700000
600000
500000
400000
300000
200000
100000
0
2008
2035
Low
Medium
High
2050
Jefferson
Elbert County
Douglas
Denver
Broomfield County
Arapahoe County
Adams County

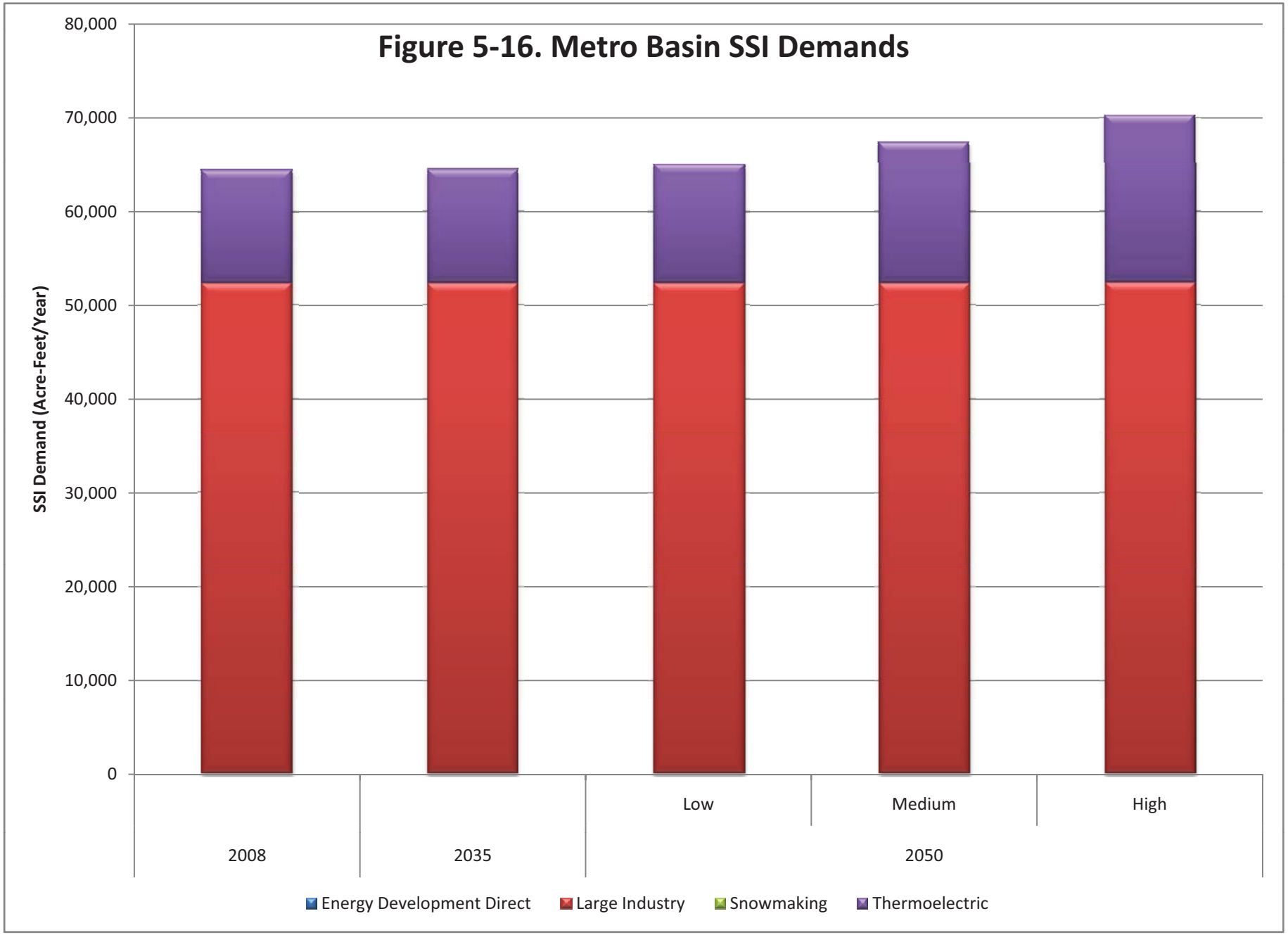


Figure 5-16. Metro Basin SSI Demands
SSI Demand (Acre-Feet/Year)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
2008
2035
Low
Medium
High
2050
Energy Development Direct
Large Industry
Snowmaking
Thermoelectric

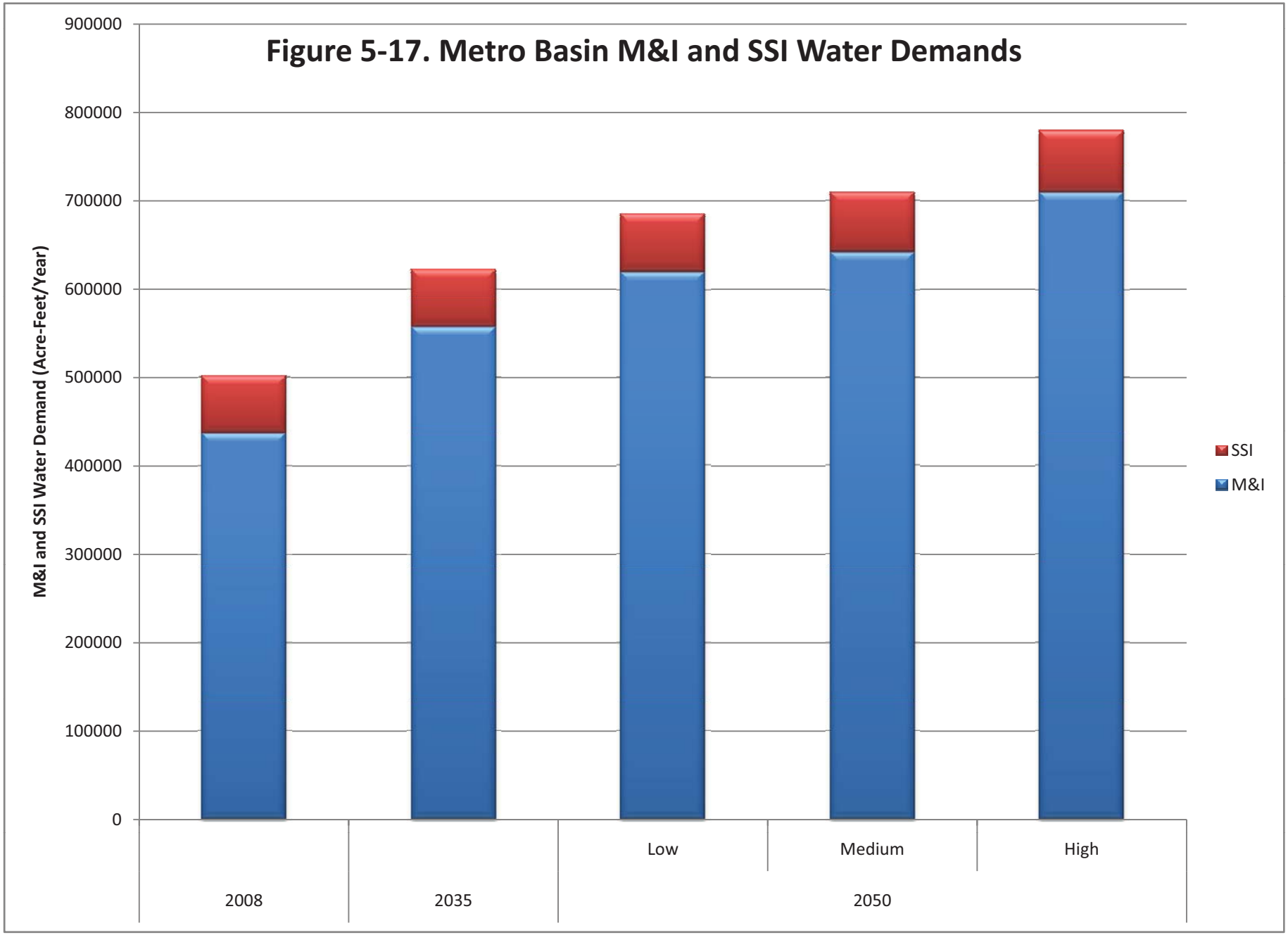


Figure 5-17. Metro Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

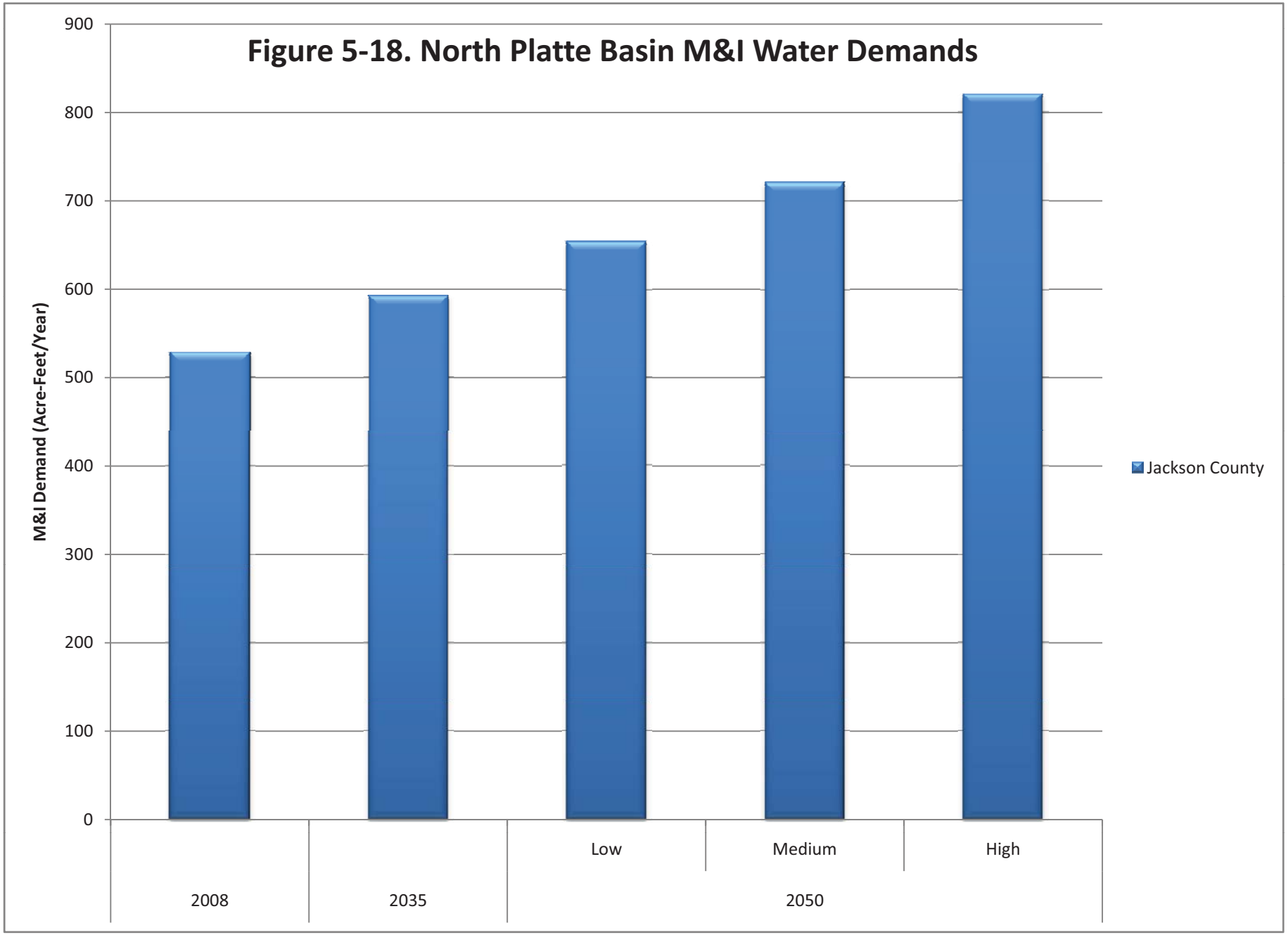


Figure 5-18. North Platte Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
900
800
700
600
500
400
300
200
100
0
2008
2035
Low
Medium
High
2050
Jackson County

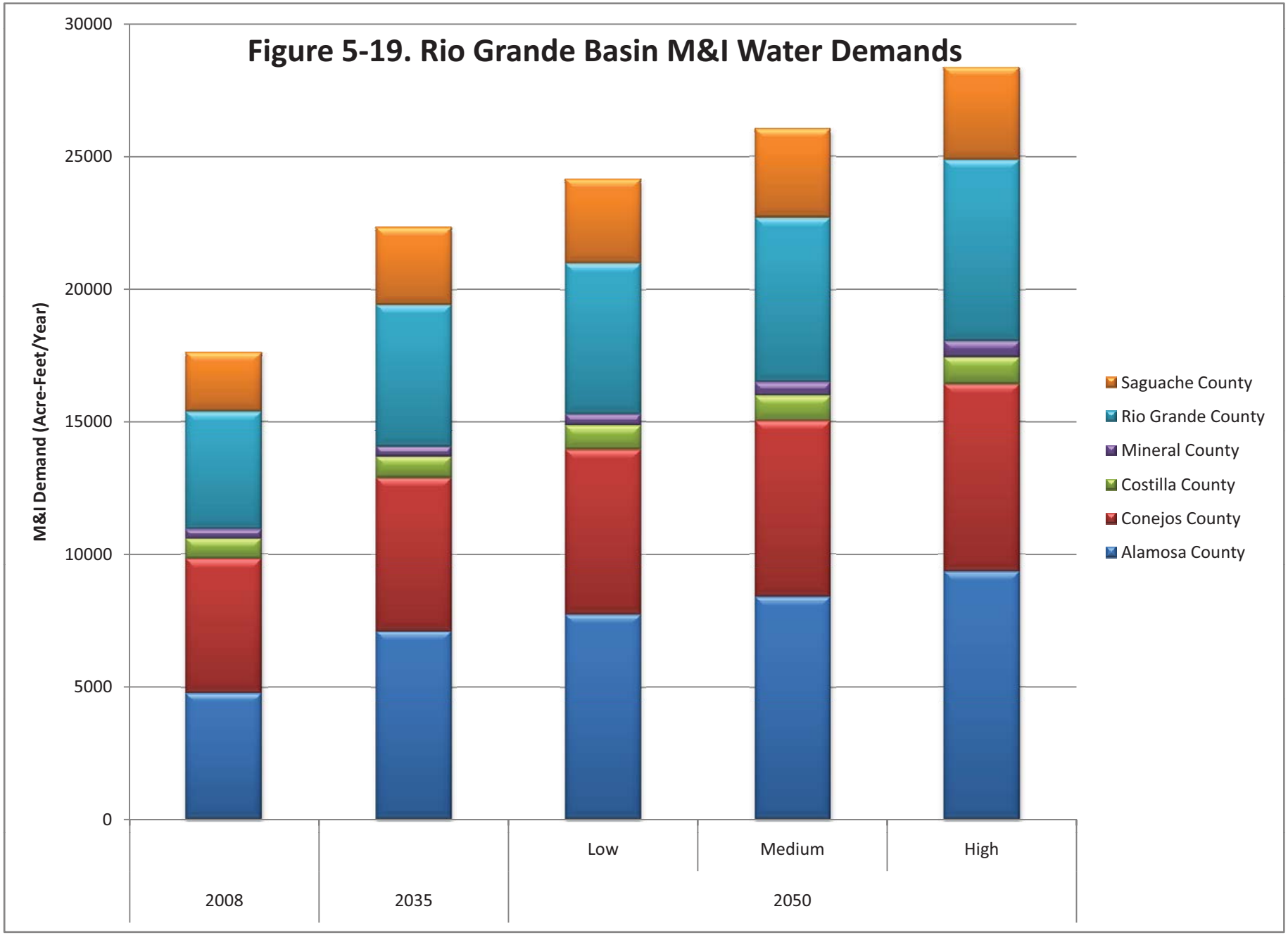


Figure 5-19. Rio Grande Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
30000
25000
20000
15000
10000
5000
0
2008
2035
Low
Medium
High
2050
Saguache County
Rio Grande County
Mineral County
Costilla County
Conejos County
Alamosa County

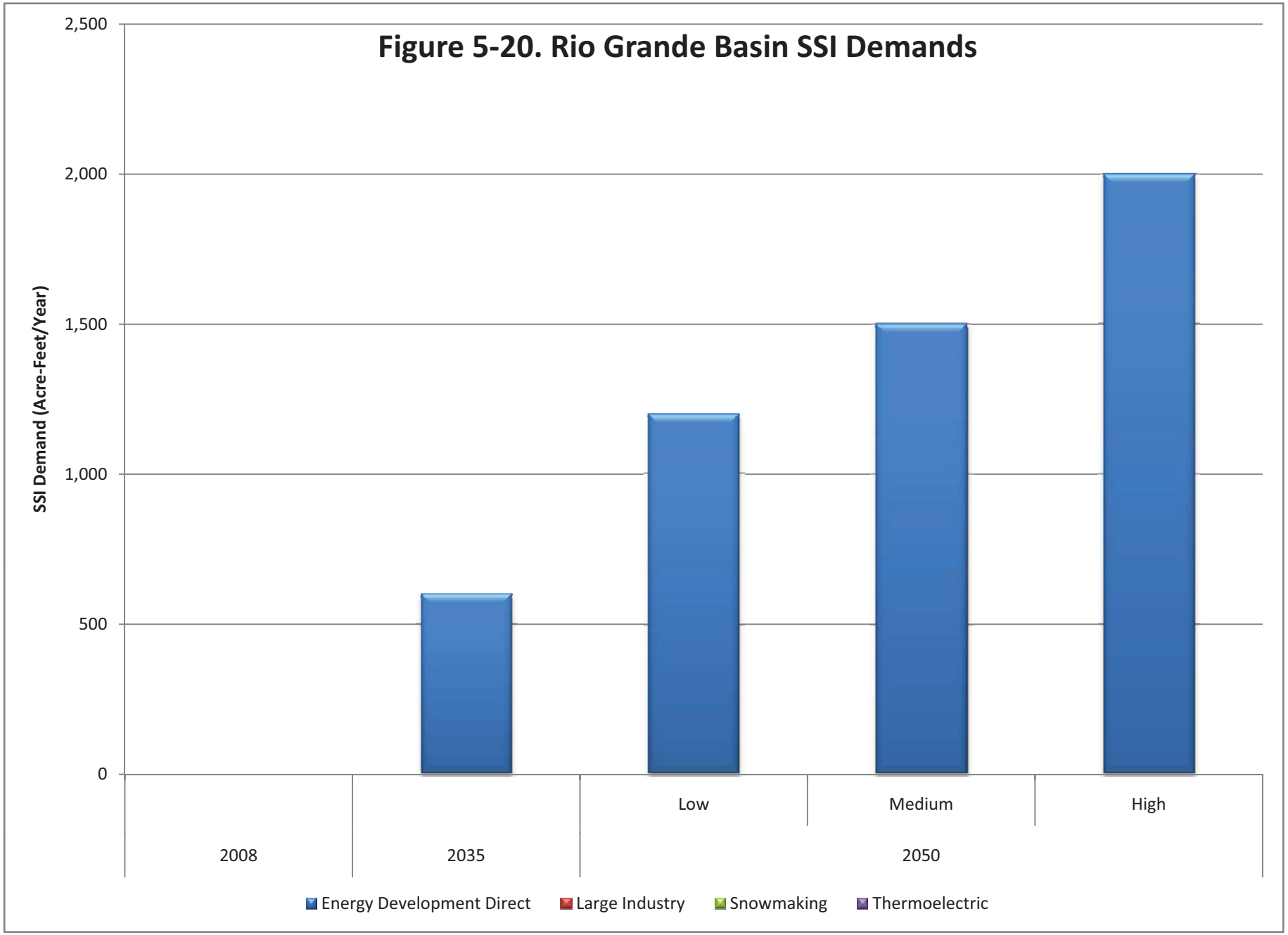


Figure 5-20. Rio Grande Basin SSI Demands
SSI Demand (Acre-Feet/Year)
2,500
2,000
1,500
1,000
500
0
2008
2035
Low
Medium
High
2050
Energy Development Direct
Large Industry
Snowmaking
Thermoelectric

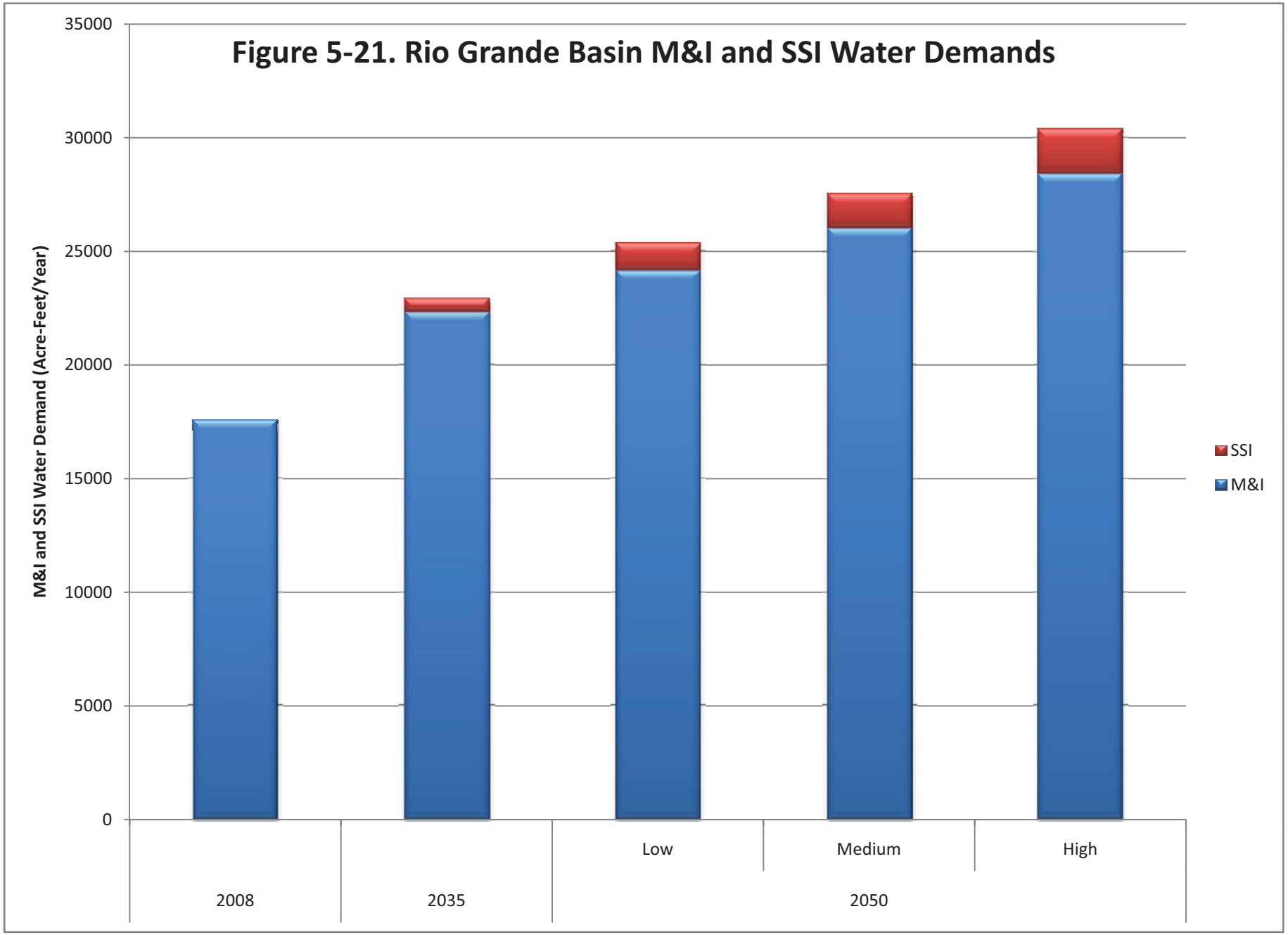


Figure 5-21. Rio Grande Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
35000
30000
25000
20000
15000
10000
5000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

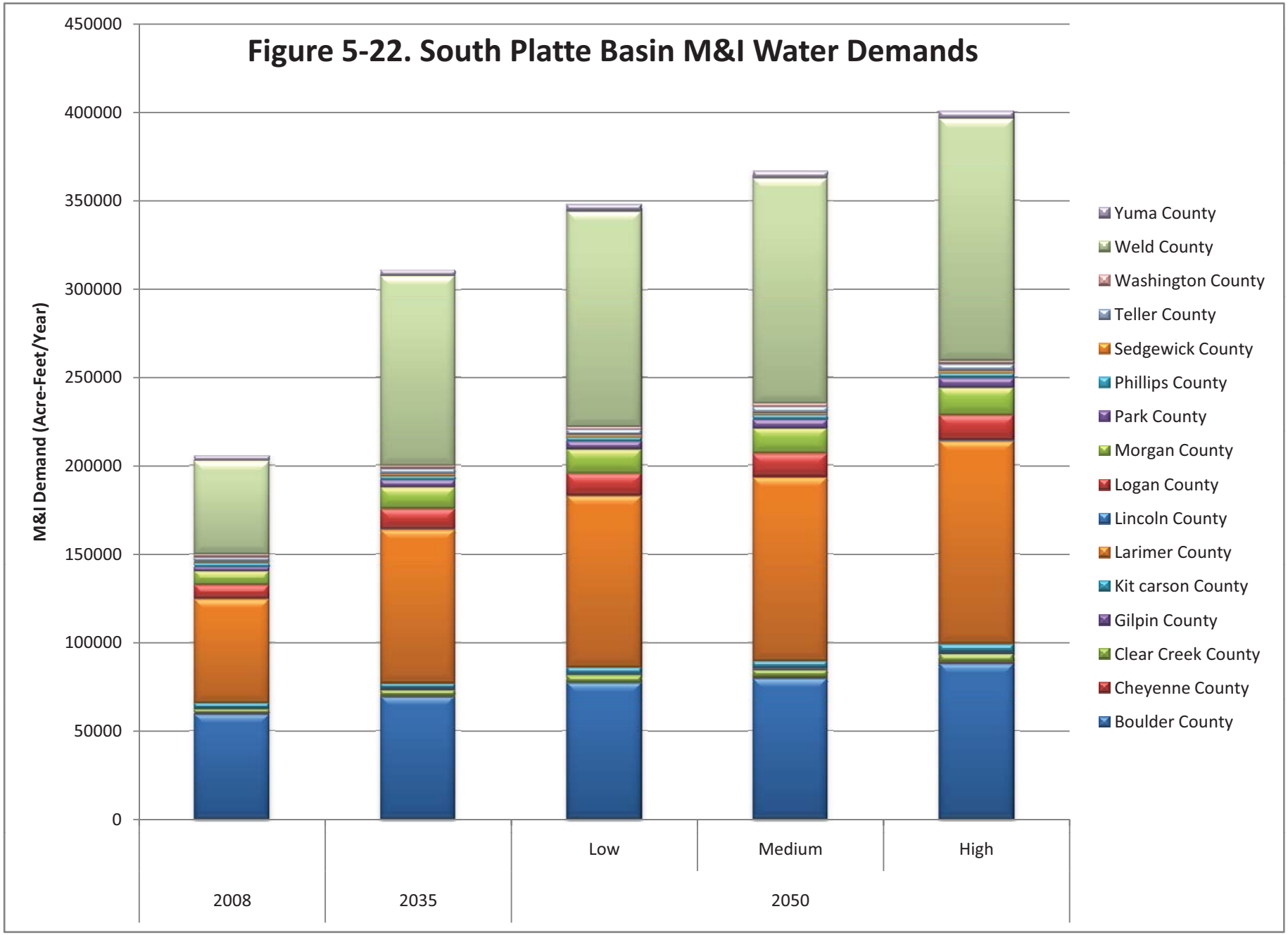


Figure 5-22. South Platte Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
2008
2035
Low
Medium
High
2050
Yuma County
Weld County
Washington County
Teller County
Sedgewick County
Phillips County
Park County
Morgan County
Logan County
Lincoln County
Larimer County
Kit carson County
Gilpin County
Clear Creek County
Cheyenne County
Boulder County

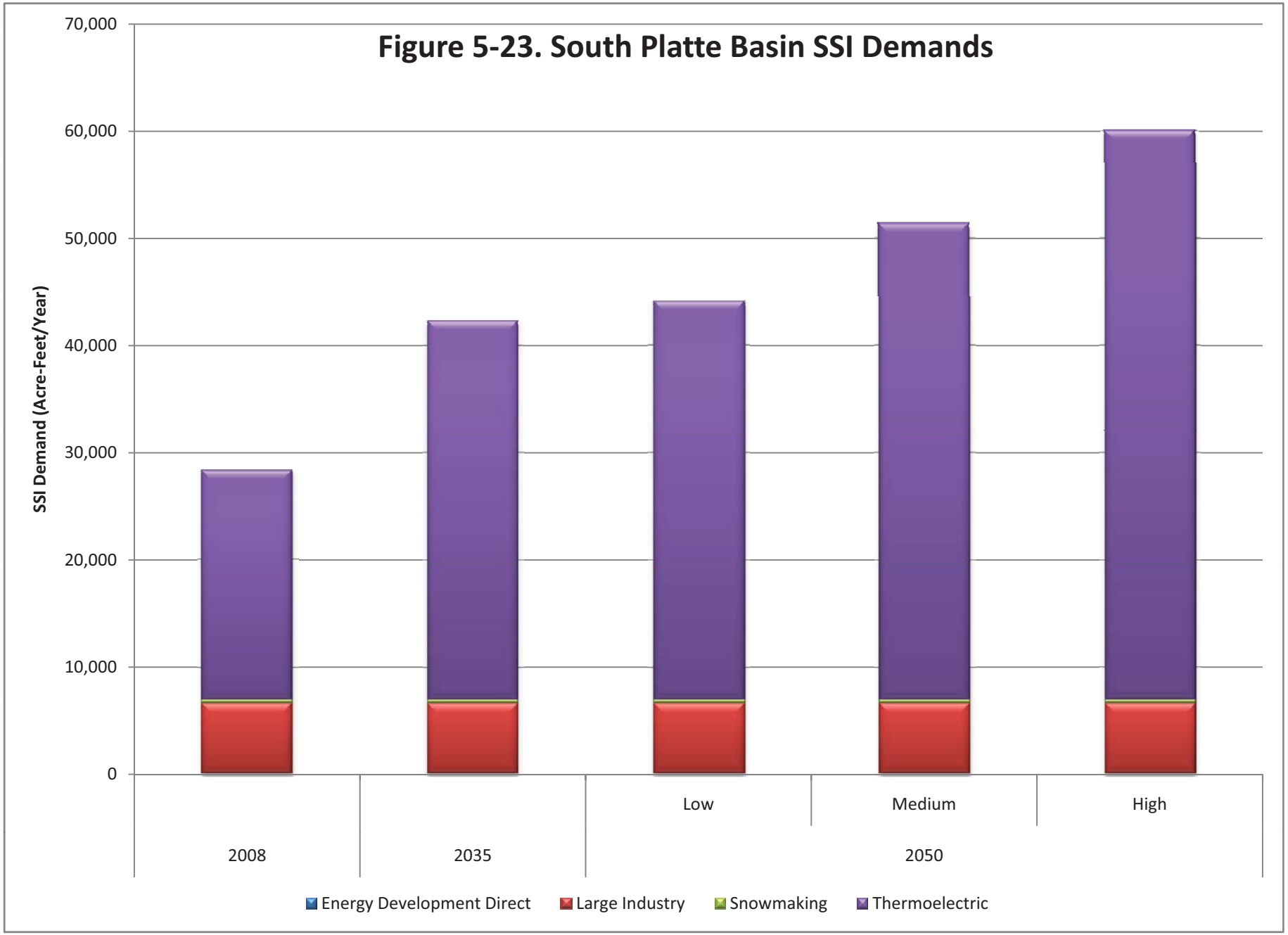


Figure 5-23. South Platte Basin SSI Demands
SSI Demand (Acre-Feet/Year)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
2008
2035
Low
Medium
High
2050
Energy Development Direct
Large Industry
Snowmaking
Thermoelectric

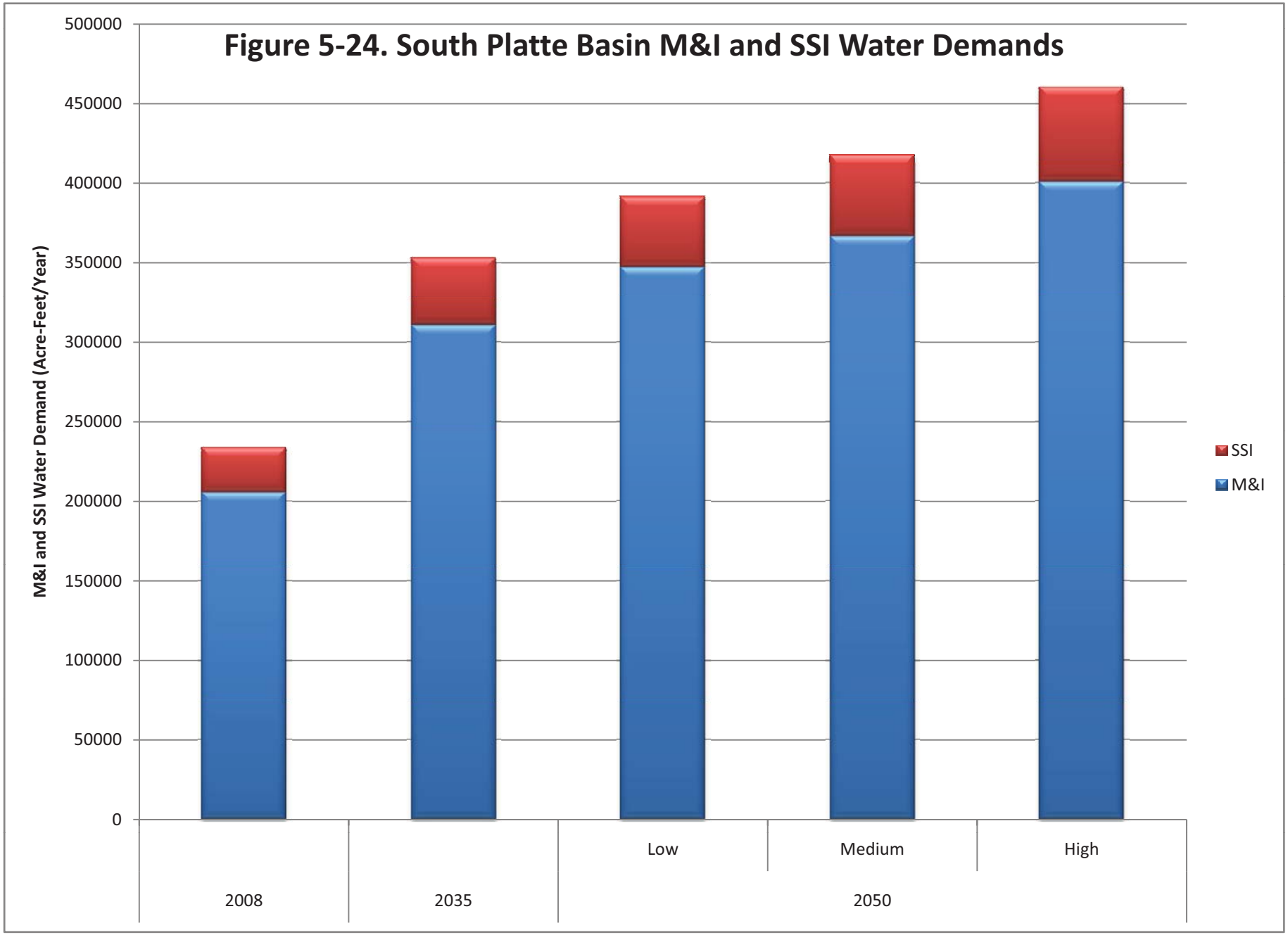


Figure 5-24. South Platte Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

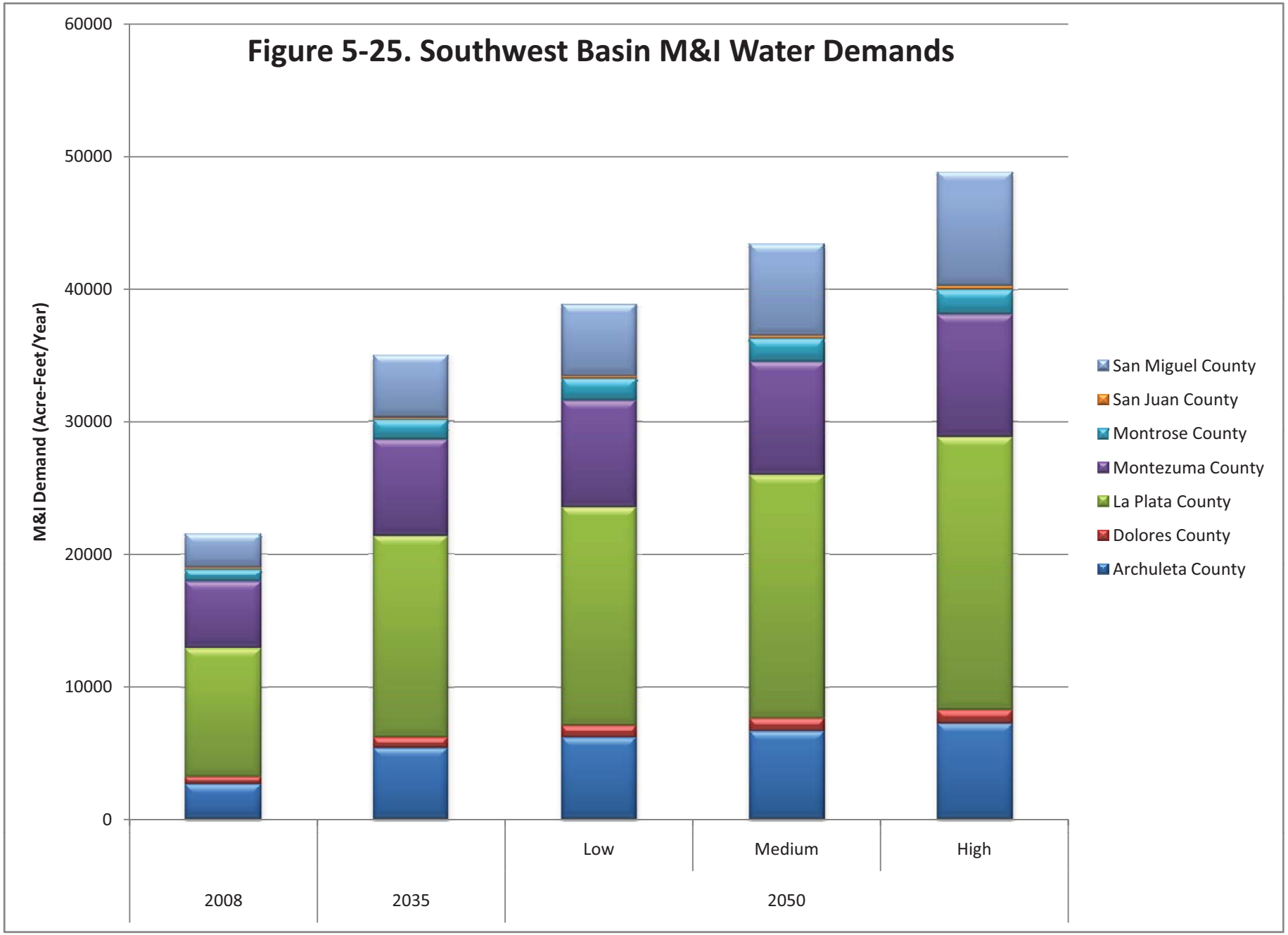


Figure 5-25. Southwest Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
60000
50000
40000
30000
20000
10000
0
2008
2035
Low
Medium
High
2050
San Miguel County
San Juan County
Montrose County
Montezuma County
La Plata County
Dolores County
Archuleta County

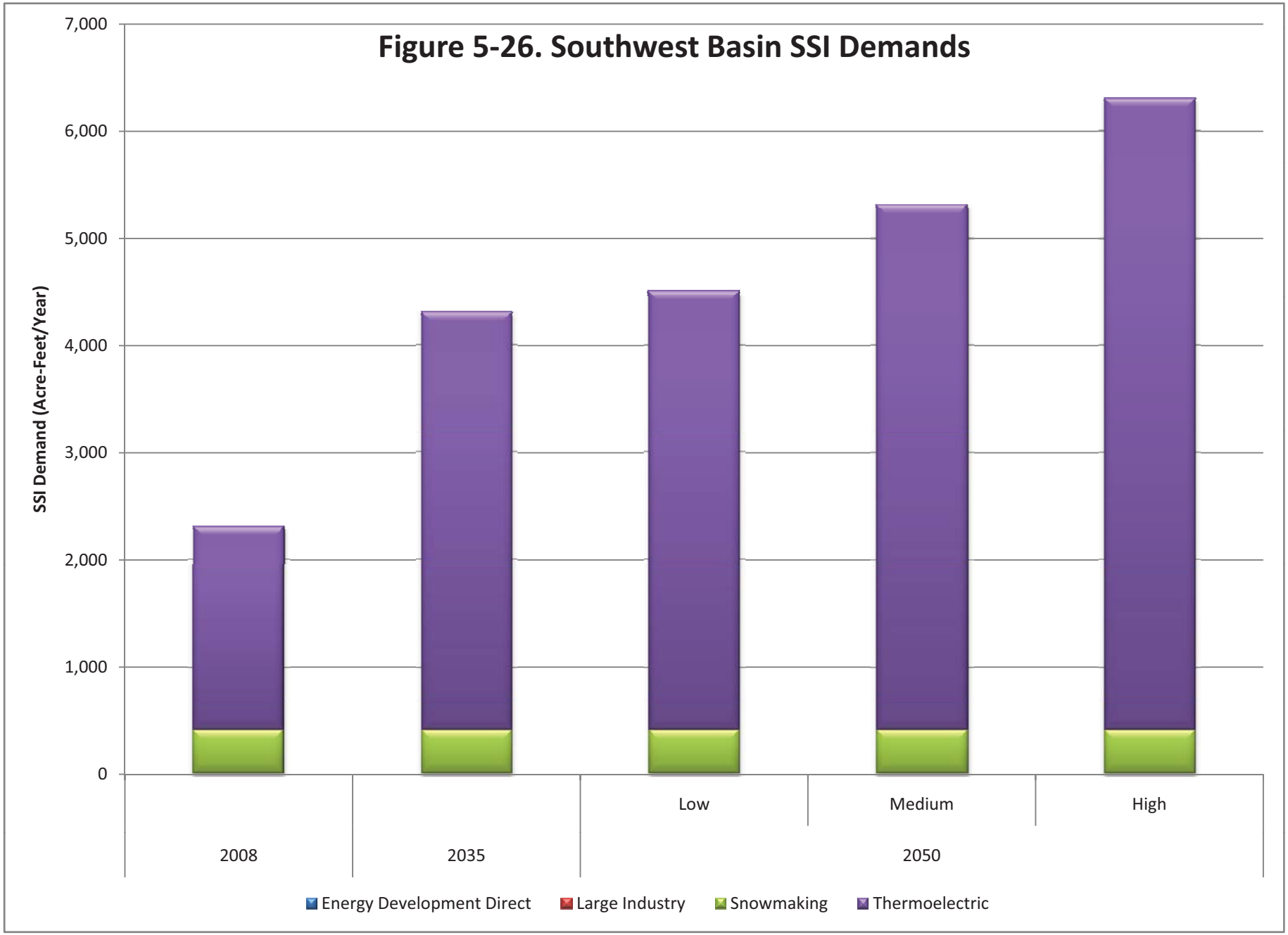


Figure 5-26. Southwest Basin SSI Demands
SSI Demand (Acre-Feet/Year)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2008
2035
Low
Medium
High
2050
Energy Development Direct
Large Industry
Snowmaking
Thermoelectric

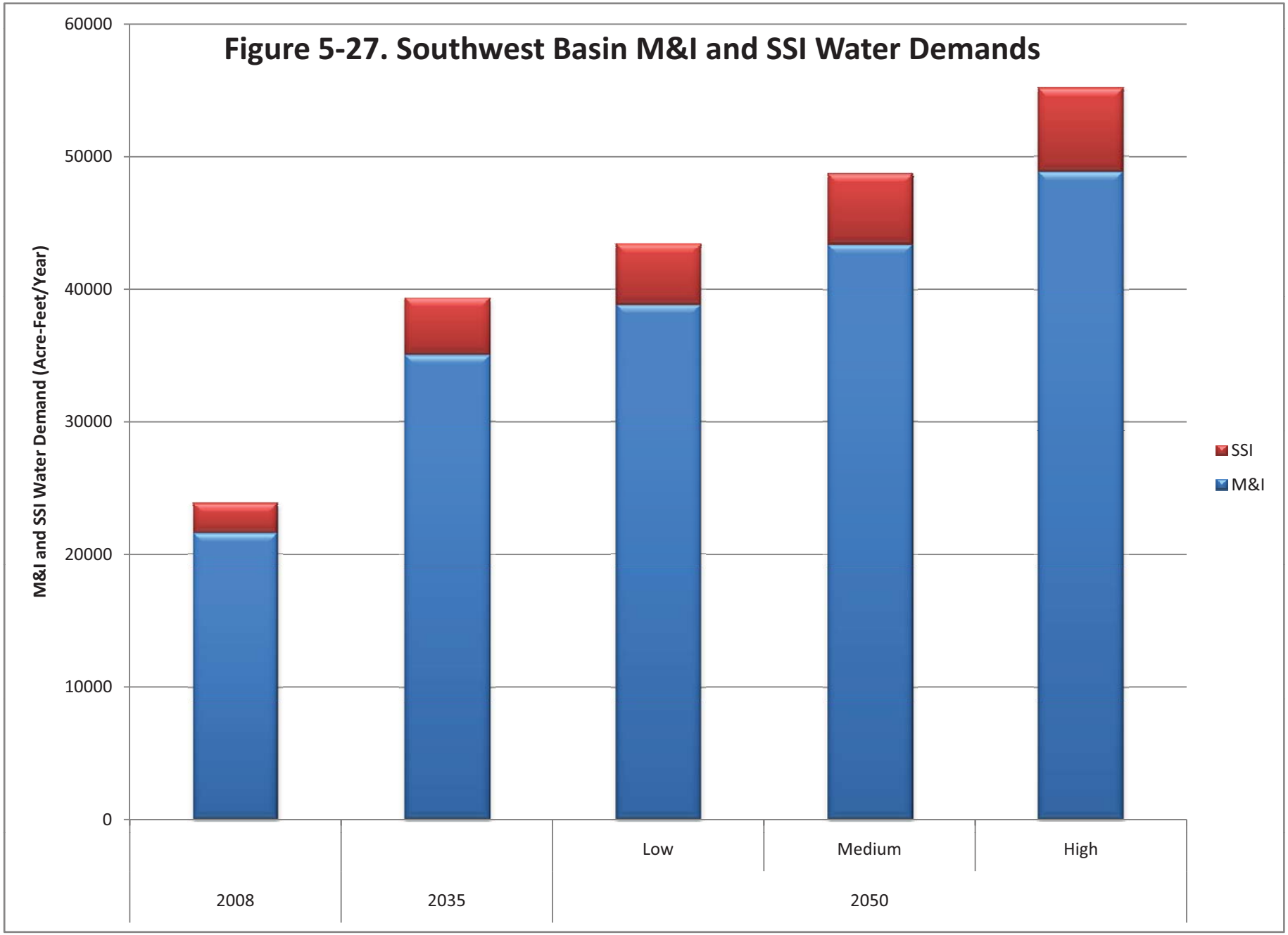


Figure 5-27. Southwest Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
60000
50000
40000
30000
20000
10000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

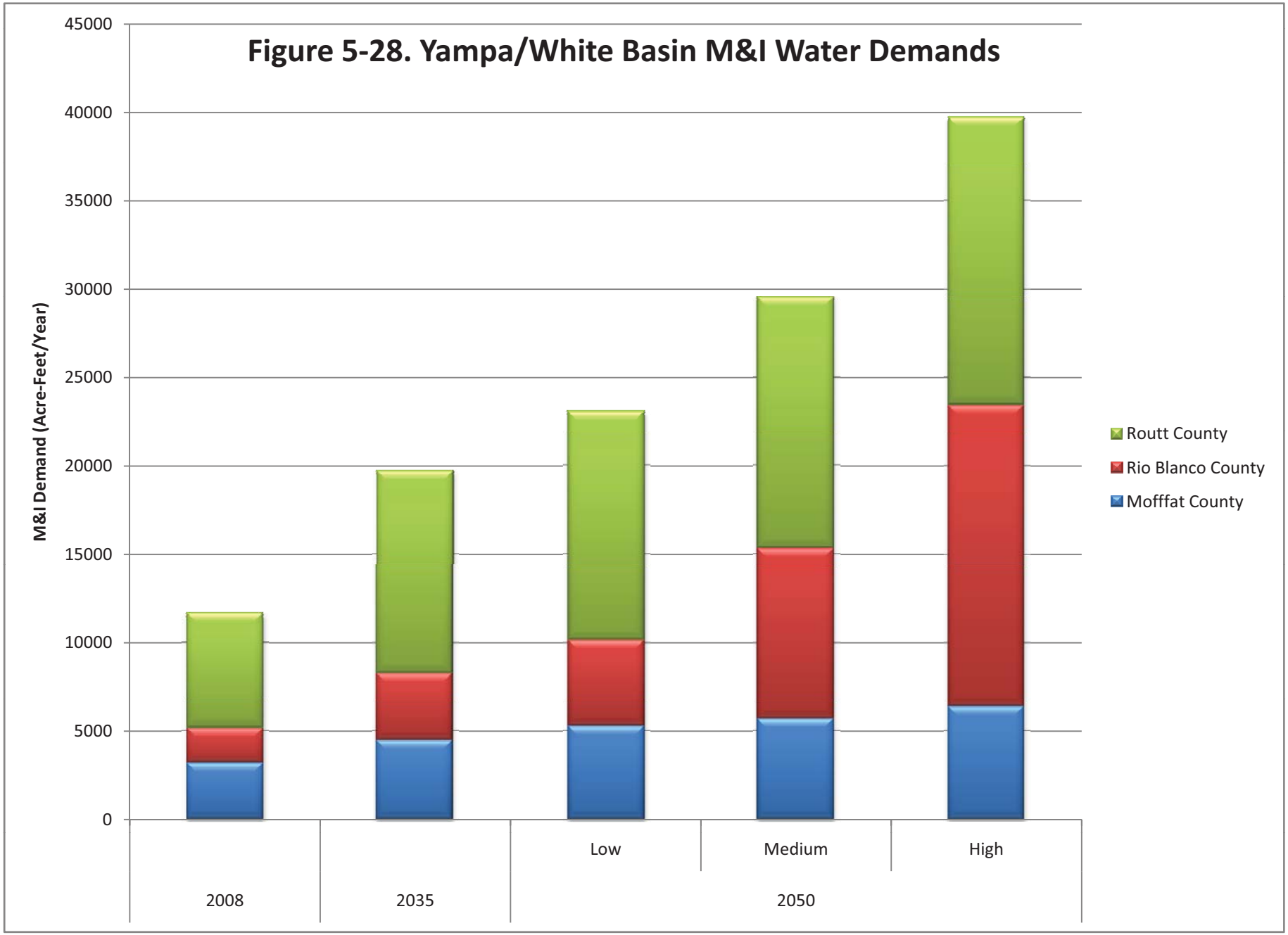
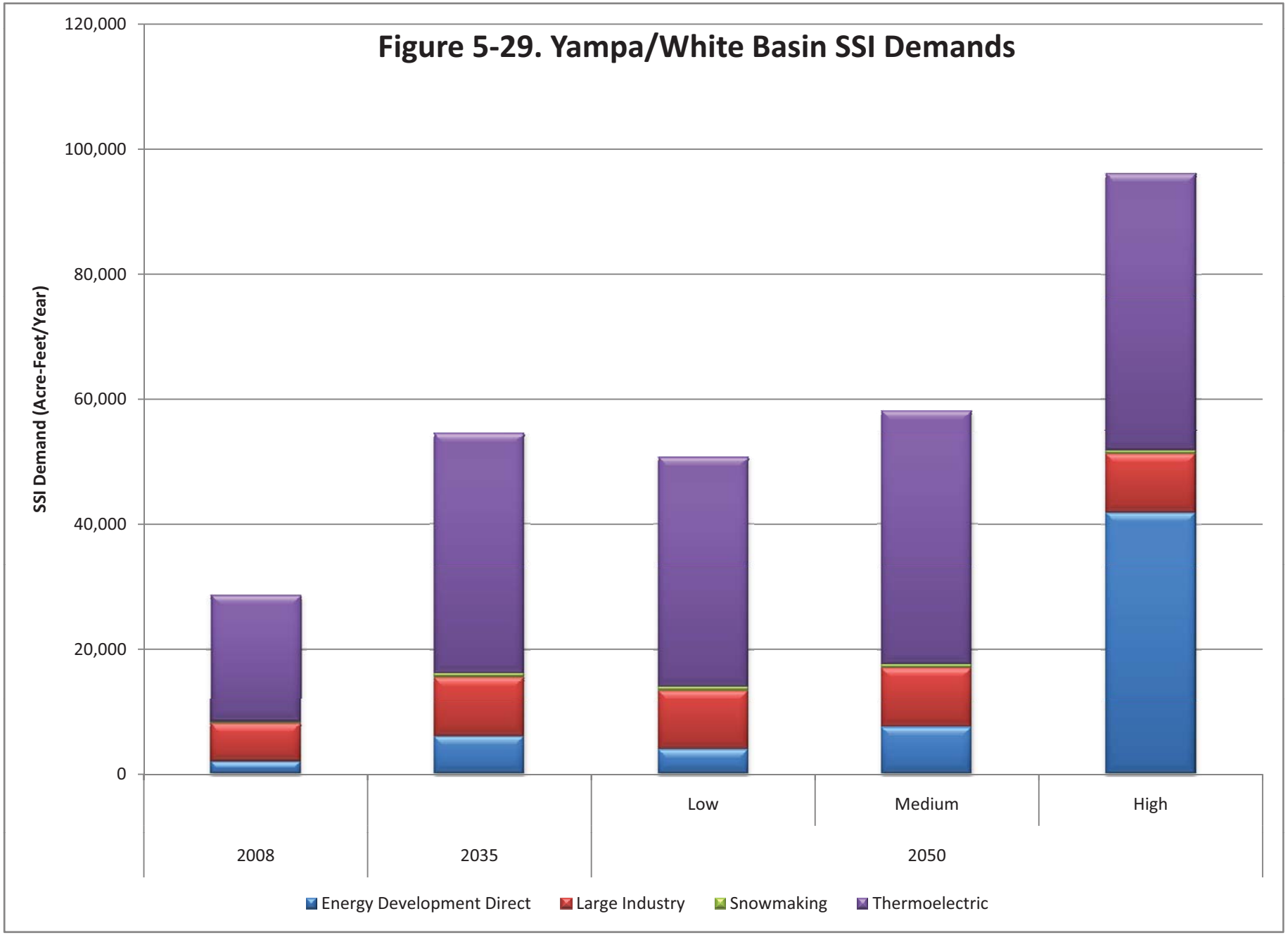


Figure 5-28. Yampa/White Basin M&I Water Demands
M&I Demand (Acre-Feet/Year)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2008
2035
Low
Medium
High
2050
Routt County
Rio Blanco County
Mofffat County

Figure 5-29. Yampa/White Basin SSI Demands



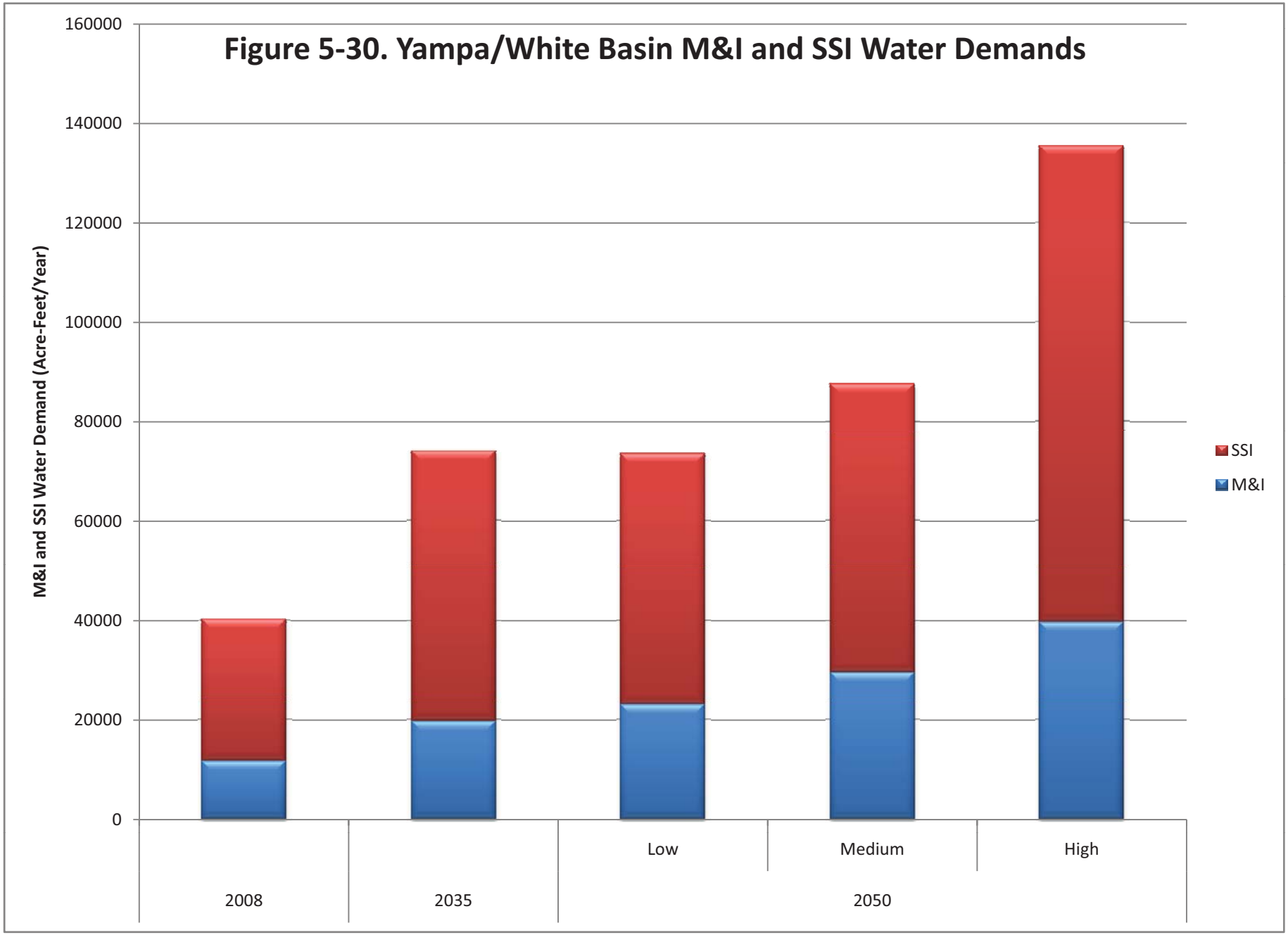
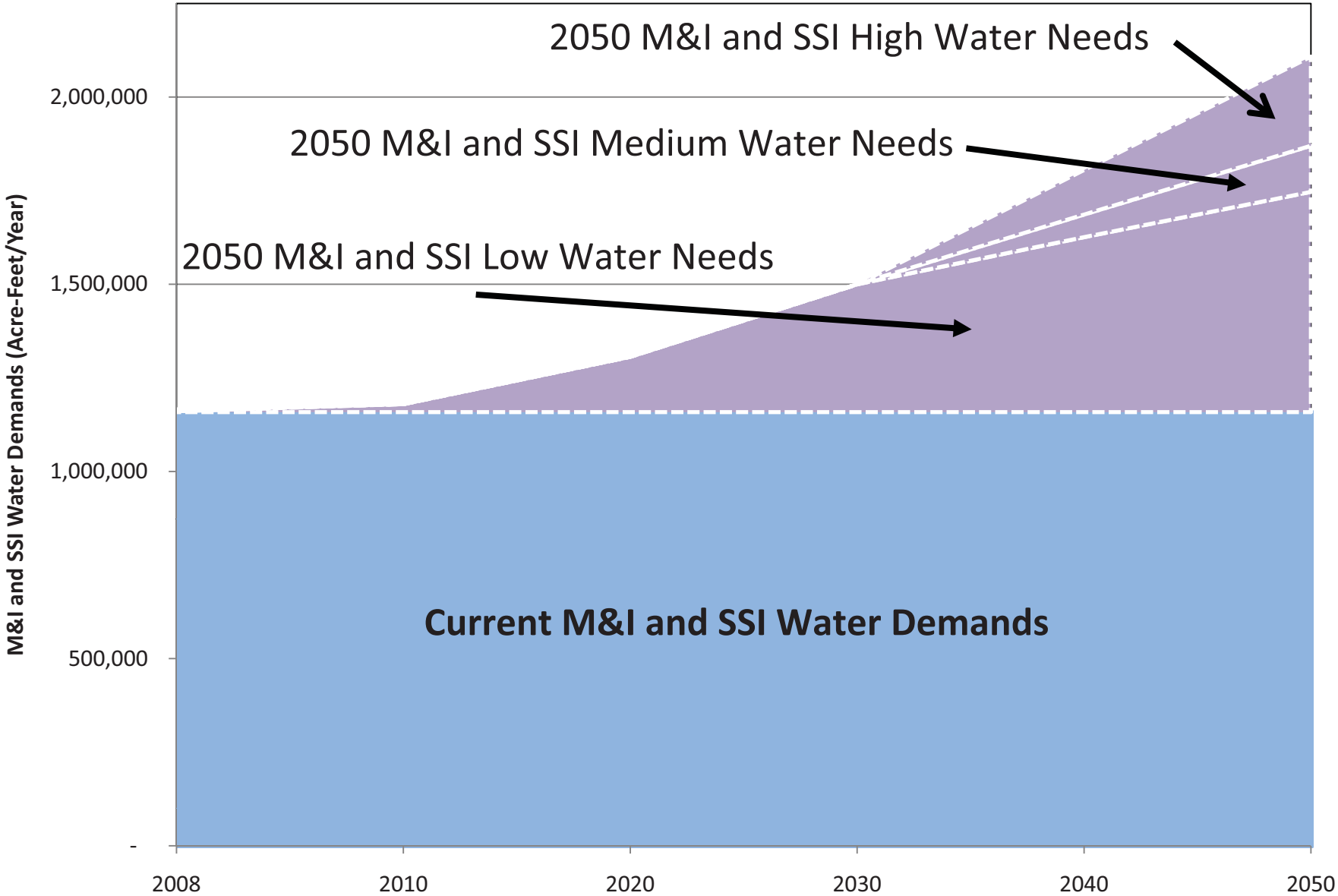


Figure 5-30. Yampa/White Basin M&I and SSI Water Demands
M&I and SSI Water Demand (Acre-Feet/Year)
160000
140000
120000
100000
80000
60000
40000
20000
0
2008
2035
Low
Medium
High
2050
SSI
M&I

Figure 5-31 2050 M&I and SSI Demands



Section 6
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Appendix A
Response to Comments on July 2009 Draft State of Colorado 2050 Municipal and Industrial Water Use Projections

STATE OF COLORADO

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Bill Ritter, Jr.
Governor

Susan E. Kirkpatrick
Executive Director

April 23, 2010

Eric Hecox
Water Supply Planning Section Chief
1313 Sherman St, Room 721
Denver, CO 80203

Dear Eric:

I am writing this letter to answer and clarify some of the comments that were submitted in response to the Draft Colorado Water Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections published in June 2009.

The State Demography Office produces and updates its population forecasts on an annual basis taking into account current and projected economic conditions. The population projections for the CWCB report have been revised since the June 2009 draft using the most current data available and taking into account the current economic downturn. The revision in the current forecast to account for the current recession has a larger impact in the next 5 to 10 years than it does in the next 30. Overall our 2035 forecast was revised down by approximately 200,000 people or by approximately 2%.

Our population forecasts are long term forecasts and therefore you will not see the cyclic nature of growth in the forecasts. We realize booms and busts exist but it is impossible to predict them. The goal of the long term forecasts is to have the booms and busts average out in the long run. Recent history has shown that is possible. In 1985 we produced forecasts for 2000. During that time period we had the bust of the late 1980s and the booms of the 1990s. The forecast produced in 1985 did not include either the boom or the bust but the resulting forecast was impressively close to the results from Census 2000.

The relationship between population and the economy tends to be lagged, meaning that you will not necessarily see an immediate change in population when there is a change in jobs (increase or decrease). Migration data for July 2008 - July 2009 using IRS filings showed a net migration to the state of 48,000 even though the state had lost around 130,000 jobs during that same time period. Similarly, historical data shows when we have

seen increases in jobs it will take 6 to 12 months for the migration to begin to increase due to the excess supply of workers.

Colorado population forecasts produced by the State Demography Office are subject to uncertainty. There is uncertainty related to birth and death rates as well as to migration rates (impacted by the economy). The CWCB contracted with a consultant to extend our forecasts from 2035 to 2050 as needed for the water demand projections. The consultants produced high, medium, and low forecasts based on different migration/economic scenarios. The range provided through the various scenarios aims at capturing the degree of uncertainty that exists in population forecasts and also the business cycles that are impossible to predict. Historically recessions or long periods of slow to negative growth are followed by periods of faster growth.

It is important to remember that Colorado and its counties are part of a national and international system. Its future growth needs to be taken into the context of the growth of the nation. International and national forecasts are used to produce Colorado's forecast. The low 2050 scenario produced for Colorado projects Colorado growing at the US's growth for the same period. One has to consider whether it is realistic for Colorado to grow at the same rate as the US since historically it has grown above the US rate. Our evaluation of the 2050 low forecast is that it is indeed low and would imply that Colorado would be less attractive than other states for both job and population growth. It is possible for this scenario to occur but not highly probable. The 2050 high forecast includes some level of oil shale development in the northwest region of the state and would imply much stronger growth in the state. It is certainly possible for this scenario to occur if oil shale development occurs in the state.

It is difficult to evaluate the accuracy of our forecast since we update it annually. Since we update it annually and we produce it for single years, an evaluator could select any number of years in the forecast to evaluate or any "year produced" to evaluate. One could "cherry pick" the year produced or the year of the forecast to demonstrate accuracy or inaccuracy. However, we have spent time this year evaluating our forecasts to identify potential trends. We chose to look at the longest term forecasts since 1985 with years for which we have data. For example 1985 to 2000. In general there are a few findings.

First, during recessions we tend to under forecast in the long run (i.e. our 1989 forecast for 2010 was approximately 10% low) and during periods of growth we tend to over forecast the long run (i.e. our 2000 forecast for 2010 was approximately 1.3% high). We do not forecast booms or busts and assume periods of stronger growth or decline will average out in the long run. Our 1985 forecast for 2000 was approximately 3.6% low for a 15 year time period or about .24 percent per year. Our 1985 forecast for 2010 is approximately 5.6% low or about .22% per year. Less than 1% error per year is very accurate.

The decree of accuracy varies by region in the state, varies by size of the county, and varies by the volatility of the economy. Counties with a smaller population base and with economies highly dependent on single industries tend to have greater errors with forecasts

both above and below the eventually released estimates. Harvey Economics extended our forecasts to 2050 with low, medium and high scenarios in order to provide information on the degree of uncertainty of the economy for a region or county. It provides an important perspective on the certainty of the forecasts.

I hope this letter has clarified any comments or questions that have been asked about the population forecasts the State Demography Office of the Department of Local Affairs produces for the state. Our forecast methodologies can be found on our website at www.dola.state.co.us/dlg/demog/pop_colo_forecasts.html.

Thank you for including us in the production of this important report and we look forward to working with your office and the communities throughout the state.

Sincerely,

Elizabeth Garner
State Demographer
Colorado Department of Local Affairs

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
1	Trout Unlimited (David Nickum)	11/13/2009	Current per-capita use figures are not a suitable metric for projecting future use. Quite simply, new development tends to have a smaller water footprint than older, established communities. This is true for a number of reasons, including: typically smaller lot sizes requiring less outdoor water; more efficient infrastructure that reduces leaks & system losses; and the use of water-saving fixtures/appliances within new construction. In some communities with existing water-intensive industrial users (but who are not self-supplied), the inclusion of those uses in system-wide per capita figures could also inflate future demand estimates based on those per capita figures. I would recommend, instead, that the CWCB use per capita figures from recent developments - not system-wide figures including many older neighborhoods - to more accurately project the likely demands of upcoming developments.	The impact of land use and development patterns were discussed as part of the CWCB sponsored Western States Water Council 2009 Symposium Water & Land Use Planning for a Sustainable Future: Scaling and Integrating (http://www.westgov.org/wswc/symposium%20agd%20091509.html). Consideration of how Colorado grows in the future is being considered in the scenario and portfolio development by the IBCC and CWCB Board. In addition, CWCB will include passive conservation savings that will occur in the future in the revised report, taking that amount off future demands, Active conservation being planned by providers will also be delineated as part of the scenario and portfolio development by the IBCC and CWCB Board.
2	Trout Unlimited (David Nickum)	11/13/2009	Per-capita figures used for many suppliers are out-of-date and do not reflect trends in conservation during the recent drought. In the Appendix provided to us for the metro area, many of the suppliers are listed as still having data based on SWSI I figures. These figures need to be updated.	The draft report updated water usage rates for 149 water providers across the state covering 70 percent of the population in Colorado. Since the draft report was produced several more water providers have provided updated information and this information will be included in the revised report.
3	Trout Unlimited (David Nickum)	11/13/2009	Expected improvements on future conservation should be accounted for in demand projections. Apart from the inherent differences in new development that would lead to a reduction in per capita usage, most water utilities have active conservation programs that will over time lead to further reductions in usage with both existing and new customers. Some of this "baseline" conservation should be identified and incorporated into revised demand projections. I do recognize that more aggressive water conservation programs - changes in landscaping requirements in municipal ordinances, turf buy-back programs, etc. - may be more appropriately considered as "strategies" for addressing the gap, but the expected results of existing conservation programs should be reflected in the demand figures that shape the gap.	In the revised State of Colorado 2050 Municipal and Industrial Water Use Projections report, passive conservation will be included (subtracted) from the baseline demands. Active conservation being planned by providers will also be delineated as part of the IPPs as part of the scenario and portfolio development by the IBCC and CWCB Board.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
4	Trout Unlimited (David Nickum)	11/13/2009	Population projections - and particularly those beyond what the state demographer provides - are very uncertain and, in light of the economic downturn and its effects on growth and in-migration may be overstated. Over time, slight inaccuracies will be compounded. Accordingly, projecting population - and thus water demand - with reasonable reliability is more appropriate looking ahead to 2035 than to 2050.	The CWCB has revised the demands to 2050 population projections based on the latest State Demographer Model from November 2009 which includes consideration of the economic downturn. The CWCB developed demands to 2050 based on advice, input, and close consultation with the State Demographer. The State Demographer has also submitted written comments addressing these issues as detailed in comment numbers 84 to 91 of this document.
5	Trout Unlimited (David Nickum)	11/13/2009	Not all identified processes and projects are created equal. Some of these measures reflect water supplies that have already been secured, but which are not yet being used - for example, Colorado Big Thompson shares owned by municipalities but not currently being used for municipal purposes, or water diversions that are decreed (& projects constructed) but are not yet being fully exercised until demand increases. Such measures should not be recognized as confirmed supplies, and not subjected to the percentage uncertainty estimates that are used in looking at other IP&Ps that require additional permitting or water right filings/changes and therefore have greater uncertainty. Applying an uncertainty factor to water supplies that are not at all uncertain contributes to an over-stated gap. Frankly, different projects facing permits have very different probabilities of success and ought to be weighted differently - but I recognize the practical and political problems that would be raised if the CWCB started to "handicap" such projects. At a minimum, however, supplies that are already secured but not yet in use should be treated differently than other projects that do face uncertainty.	Comment noted and will be considered as CWCB implements BNDSS and gap analysis with updated data indicating how providers are planning on meeting their future needs..
6	Trout Unlimited (David Nickum)	11/13/2009	Rueter-Hess. This project is listed as providing 16,200 AF of yield (with 70,000 more under its expansion). Those figures actually reflect storage capacity of the reservoir, not its yield. As noted in the Denver Post earlier this week, Rueter-Hess has a very uncertain yield given the lack of a substantial water supply to be stored in it. Insofar as this project is included with the identified project and processes database, its yield estimates should reflect the yield it would provide from its current sources of water.	Comment noted and will be considered as CWCB implements BNDSS and gap analysis with updated data from Parker Water & Sanitation District..

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
7	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	CWCB should incorporate existing conservation efforts into the entire report's analysis as a reduction in demand. Reducing demand is fundamentally different than providing additional supply, and it should be addressed in this report. At a bare minimum, CWCB should incorporate Level l conservation into future demands (as was practiced in SWSl l) because this level of conservation is mandated by federal legislation. To be truly accurate, CWCB should incorporate the higher levels of conservation already being implemented by utilities across the state. To do otherwise ignores the impacts that "current" levels of conservation have on future demands and disregards the substantial efforts made by many cities in the past few years. CWCB should also evaluate the impact of a "1% per Year" reduction in demand, and can look to efforts made by WRA for direction on how to approach this concept. Even modest levels of conservation will keep demands from ever rising to the levels described in the report. An alternative approach that maintains truthfulness about future demands-perhaps more cumbersome and confusing-would be for CWCB to caveat every statement based on the current analysis with the words, "without conservation." The highest levels of conservation may be appropriate to include as a "supply option" because their implementation would require additional planning and funding, similar to a new transbasin diversion, and may rightly be addressed in CWCB's water supply strategies report.	In the revised State of Colorado 2050 Municipal and Industrial Water Use Projections report, passive conservation will be included (subtracted) from the baseline demands. Active conservation being planned by providers will also be delineated as part of the scenario and portfolio development by the IBCC and CWCB Board.
8	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	CWCB should employ a consistent, defensible, and easily replicable methodology for determining the most recent water use rates used in estimating future water demands. Currently, CWCB uses gallons per capita per day (gpcd) values from 2000, 2003, 2005, 2006, 2007, and 2008, which are self-reported by utilities, calculated by CWCB consultants, or taken from reports written by various entities. Having such a wide-array of data points and methodology would appear to undermine the accuracy of this analysis. Even a small error in gpcd (applied over a large population) will lead to a large miscalculation in any so called "gap."	CWCB used the best and most recent data available to calculate the demands to 2050. The approach used was utilized in SWSI and was chosen since it could be applied consistently across the state. Through the BNDSS process, the CWCB is working with water providers to gather the best water usage information available to accurately reflect future demands.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
9	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	CWCB should reevaluate the population projections used in the draft report for two reasons: 1) the current economic downturn in Colorado's economy will have a far-reaching impact on future economic and population growth; and 2) the population forecasts used by Harvey Economics to develop 2050 projections were a draft document and have been superseded.	The CWCB has revised the demands to 2050 population projections based on the latest State Demographer Model from November 2009 which includes consideration of the economic downturn. The State Demographer has also submitted written comments addressing these issues as detailed in comment numbers 84 to 91 of this document.
10	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	Population projections are the driver for increased future water demands, Thus it is critical to have accurate and up-to-date projections for planning efforts. Population projections are heavily dependent on the initial rates of population growth, and errors in the first few years are compounded greatly over time.	The CWCB has revised the demands to 2050 population projections based on the latest State Demographer Model from November 2009 which includes the consideration of the economic downturn. The State Demographer has also submitted written comments addressing these issues as detailed in comment numbers 84 to 91 of this document. It is also important to note that the methodology used by the State Demographer and replicated by CWCB is not a simple trend analysis. Because of sophisticated economic model used in forecasting, errors in the first few years are not simply compounded over time.
11	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	Our current economic downturn will play a significant role in reducing estimated future water demands by decreasing population growth rates over the next few years. Future demands will not be as high as currently projected, even if growth continues at the expected rate five or ten years from now, because our growth is held up at this time. Harvey Economics attempts to argue that the current economic downturn is within the normalcy of Colorado's historic, cyclical economic trends. Unfortunately, this is not the case; the data provided illuminate the fact that this recession is the worst Colorado has experienced in the past forty years, with rates of unemployment, foreclosures, and building permits considerably outside the norm. The fact that the economic downturn is nation-wide and world-wide will dramatically slow Colorado's rate of recovery.	The CWCB has revised the demands to 2050 population projections based on the latest State Demographer Model from November 2009 which includes the consideration of the economic downturn. The State Demographer has also submitted written comments addressing these issues as detailed in comment numbers 84 to 91 of this document.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
12	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	The 2009 unemployment rate, at 7.9%, is the highest unemployment rate Colorado has experienced since 1976. The change in employment from 2008 to 2009, at -4.0%, is the largest drop Colorado has experienced by more than a factor of three; in fact, this rate has only ever been negative for 4 of the past 33 years. Building permits are at their lowest level since 1970, and the percent change in building permits from 2008 to 2009 is -61.4%, the worst drop yet. Data for State GDP and personal income is not available for 2008 or 2009, but one can assume that the trends highlighted above will be expressed in these numbers as well. These factors are the drivers for economic and population growth in the state and clearly, this is not "normal" when compared to other cyclical downturns in Colorado's recent history.	The CWCB has revised the demands to 2050 population projections based on the latest State Demographer Model from November 2009 which includes the consideration of the economic downturn. In addition, the state's unemployment rate is less than other states across the country and the state demographer projects that economic development and job growth will continue in the state.
13	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	Secondly, the population forecasts from 2005-2035 used by Harvey Economics were draft in nature, i.e. un-official, and never available to the public. These draft forecasts were provided to Harvey Economics by the Colorado Department of Local Affairs (DOLA) in early 2008, but DOLA has since updated its projections out to 2035, and published this data in November 2008. This more recent data should be used in the water demand projections and should also be used to reevaluate the models Harvey Economics used to project populations at 2050.	The CWCB has revised the demands to 2050 population projections based on the latest State Demographer Model from November 2009 which includes the consideration of the economic downturn.
14	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	There are several errors in the analysis that need to be corrected. The estimates provided for Garfield County in Table 4-5, describing energy development's direct water demands, are in momentous disagreement with the same numbers presented in Table 4-6 summarizing all self-supplied industrial (551) demands; the discrepancy is as great as 250,000 AFY. Because Garfield County is in the oil-shale region of Colorado, it is difficult to determine which estimate is correct.	The final report will include information developed during Phase II of the Energy study that provides more detail on where population and oil will be developed on the west slope.
15	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	The estimated demands for La Plata County are off by 6,000 to 10,000 AF. Calculating demands using the reported gpcd and population numbers are not equivalent to what is graphed in the draft report's accompanying figures (Table 2).	This was an error in the draft report and will be corrected in the final report.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
16	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	Estimates of snowmaking presented in Table 4-3 do not incorporate the impacts of climate change. Although it may be difficult to estimate how snowmaking demands may change in a warmed climate, an acknowledgement or brief discussion of this impact is appropriate.	Water use numbers were provided by Ski Industry representatives. CWCB relies on them to include or not include climate change as part of their forecasts as they deem appropriate.
17	Western Resource Advocates and Colorado Environmental Coalition (Drew Beckwith, Becky Long and Drew Peternell)	10/29/2009	It is unlikely the "Existing Water Use and Systems" region of the summary graphs (e.g. Figure ES-7) actually represents the total available supply capable of being provided by utilities. Many utilities, including Denver Water, are not maxing out their supplies currently, and could provide more water without the need of IPPs. In effect, this would increase the amount of water available and decrease the gap by an equivalent amount. CWCB should acknowledge this lack of data and evaluate its impacts further.	These graphics will not be used in the final report. The gap analysis will occur as part of the final report that CWCB will complete by the end of 2010.
18	Colorado Springs Utilities (Wayne Vanderschuere)	11/12/2009	It appears that the CWCB forecast seems to barely capture the current and recent years' affects of the customers' drought response, economic downturn, economic dislocation, and temporary price elasticity. The combination of these factors are difficult to separate and quantify, but the combined effect would reduce the baseline starting point -30% (our estimate) depending the makeup for each community. This variance in the early years continues into the forecast years. It may be that not all places in Colorado have had the same response to the factors as we have. My impression is that some places have had a substantial change in consumption. Given the dramatic impact of these factors, it may be best to continue reset the forecast. That approach would provide more current forecasts and likely lower. However, the longer term prospects of Colorado's economic potential and vitality are strong, therefore we should not let the current "gloom & doom" sentiment control the longer term outlook for Colorado. Moreover, if history is a guide, we should expect a sharper escalation in demands as impact of these factors diminish and reverse over time.	Our range of population forecasts out to 2050 anticipate an economic recovery in the mid-to-high range. The low range does make some fairly dire economic projections in the long-term. Feedback from the State Demographer indicates that our low projects may be very low and we are more likely to end up in the mid-to-high range. The State Demographer has also submitted written comments addressing these issues as detailed in comment numbers 84 to 91 of this document. In terms of the water use rates our forecasts capture current water use rates. Comment noted that it may be appropriate to revisit current water use rates on a regular basis to capture changes.
19	Colorado Springs Utilities (Wayne Vanderschuere)	11/12/2009	In Fig. 5-29, I consider the high projection unachievable, because it is my understanding it is primarily premised on extensive oil shale development. Using current technologies and techniques, the power demands to reach that water demand for oil shale development is huge and unachievable with current technology and environmental constraints. Moreover, from a national energy policy and State perspective is development of oil shale the best and highest value use of water to achieve long term economic benefit for Colorado? For those reasons, I disregard that portion of the forecast.	The energy demands reported in the draft report will be revised based on results from Phase II of the Energy Study that is currently underway. As part of the scenario and portfolio development by the IBCC and CWCB Board, oil shale development can be turned on or off.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
20	Colorado Springs Utilities (Wayne Vanderschuere)	11/12/2009	On Fig. ES-03 it appears that Arkansas gpcd in 2008 is -190. Given that Colorado Springs and El Paso County is about 80% of Basin's population and economy and our regions number are more around 150. The -190 number looks large.	The numbers included in the demand calculations are systemwide GPCDs. This could explain some of the variation. In addition, CWCB in the process of gathering information for the Basin Needs Decision Support System and including new water use data in the final report.
21	Colorado Springs Utilities (Wayne Vanderschuere)	11/12/2009	On pages ES-7, 5-3, and maybe elsewhere the report talks about existing supplies, "that these supplies may decrease in the future due to climate change." Where is the analysis and back up for that information and decline? Please provide. Does that decline apply to IPPs' too? I thought the Water Supply Availability Study only focused on Colorado River. I understand that climate change projections derived from that work only applied to Colorado River? Are we transferring that work to other basin's hydrology too? I recall reading somewhere in the report, too, that climate change projections are not applied to water demand forecasts, yet we apply them to supply. Consistency? Are climate change projections an uncertainty to be considered along with other uncertainties like more restrictive legislative, regulatory, environmental conditions that will reduce current and future water supply and infrastructure capacity?	These graphics will not be used in the final report. The gap analysis will occur as part of the final report that CWCB will complete by the end of 2010.
22	Colorado Springs Utilities (Wayne Vanderschuere)	11/12/2009	All and all, the report is fine. We need a place to start and this is best we have on the table now. Therefore, regardless of the changes, tinkering, and fine tuning I have suggested and others may propose, there remains a growing and formidable water gap beginning around 2020, which in the water business is immediate. So, given the cost and complexity of water solutions, as well as a good case of denial of growth by some and determined opposition and obstructionism to solutions by others, it is well past time to start endorsing, encouraging, and pursuing solutions.	Comment noted
23	Arkansas Basin Roundtable Verbal Comment	10/14/2009	Canon City not included in SSI and Appendix D does not reference Canon City CC Study	Will correct in final report.
24	Pueblo Board of Water Works (Alan Ward)	11/05/2009	Thermoelectric numbers are high (17,000 in the report, 14,700 actual). They only serve the Comanche Plant - does the report include something else as well. However the CU seemed low (they've calculated 78% and anticipate this rising to 85% with plant modifications to increase water recycling).	CWCB will review these values and correct in the final report if needed.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
25	Gunnison Basin Roundtable Verbal Comment (John McClow)	10/05/2009	Concern that the population projections may be flawed and wants a presentation on the methodology and extrapolation of the projections to 2050.	The State Demographer presented to the Gunnison Roundtable on March 1, 2010 and explained their forecasting methodology and extrapolation of the projections to 2050. The State Demographer has also submitted written comments addressing these issues as detailed in comment numbers 84 to 91 of this document.
26	Gunnison Basin Roundtable Verbal Comment	10/05/2009	Table 3-1: Montrose County is omitted	Will correct in final report.
27	Gunnison Basin Roundtable Verbal Comment	10/05/2009	Mesa County—most of the development (industrial) is located in the Colorado River basin.	Will review assumptions and fix in final report
28	Pitken County (Phil Overeynder)	11/13/2009	I estimated that the permanent population of the Aspen water service area is 7550 persons. I obtained this by taking the ratio of the number of connections (as measured by "Equivalent Capacity Units") within the service area to the number of connections within the municipal boundaries, then applying this ratio to the number you provided below. Total water production for the 2009 water year was 2503.4 acre feet. This figure includes water provided for snowmaking. Subtracting water provided for snowmaking leaves a net water production of 2305.0 acre feet for this time period. Applying the net water use against the above population numbers yields a value of 272.6 gallons/capita/day for permanent residency. As we discussed, permanent population is not really an accurate measurement of the average number of people served. Second home occupants and tourist accommodations significantly increase the average number of people served each day. The Aspen Consolidated Sanitation District (ACSD) maintains estimates of average occupancy throughout the year and uses a figure of approximately 12/000 population for this same time period. Their service area is the same as the Aspen Water service area with only a few homes on wells. Applying ACSD's population figure to net water consumption (after snowmaking) yields a value in the range of 171 gallons/capita/day.	CWCB will include revised water usage rates in final report.
29	Town of Kremmling (Thomas Clark)	11/9/2009	I have compared our sales with the return flows to the San. Dist. 2008 difference is 75 ac-ft (months of May thru Oct). The factor for future growth is 2.5. I have used this figure for future planning and design. Therefore the Town of Kremmling Future Consumptive need is 187 ac-ft	CWCB will include revised water usage rates in final report

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
30	Colorado Basin Roundtable Verbal Comment (Mike Wageck)	10/05/2009	Grand County gpcd too high	CWCB will include any revised water usage rates provided by Grand County in the final report.
31	Colorado Basin Roundtable Verbal Comment	10/05/2009	Check Grand County Snowmaking numbers	CWCB will include any revised water usage in the final report.
32	Colorado Basin Roundtable Verbal Comment	10/05/2009	Section 4 of the draft report describes SSI water use, estimating it for 1) large industry 2) snowmaking, 3) thermo electric and 4) direct energy development and provides a summary table at the end of each subsection (Tables 4-1, 4-3, 4-4, and 4-5). These demands are rolled up into a large summary table of all SSI demands for every county (Table 4-6). There is a large discrepancy between Table 4-5 and Table 4-6 with respect to Garfield County's direct energy development needs. The Table 4-5 high estimate at 2-5- is 251,790 AF, where as Table 4-6 high estimate at 2050 is 1,595 AF. From my analysis of the other counties I think table 4-5 is incorrect, but I'm not sure because Garfield County is in the oil shale region (Drew Beckwith, WRA) <<Cross check all the tables for consistency and verify numbers>>	The final report will include information developed during Phase II of the Energy study that provides more detail on where population and oil may developed on the west slope.
33	Metro Basin Roundtable Verbal Comment	10/14/2009	Break out Metro region in the report, including economics study.	CWCB will break out Metro area from South Platte basin on a county basis for the final report.
34	Metro Basin Roundtable Verbal Comment	10/14/2009	On page 15 of the economics study include a paragraph about the Yampa/White	CWCB will revise this in the final report.
35	Metro Basin Roundtable Verbal Comment	10/14/2009	For each basin summary paragraph include the major population growth drivers	CWCB will include this in the final report.
36	Metro Basin Roundtable Verbal Comment	10/14/2009	On Exhibit 27 of the economics report, include Pitkin County and check to make sure other figures adequately include the appropriate counties.	CWCB will revise in the final report.
37	Metro Basin Roundtable Verbal Comment	10/14/2009	Mark Harding: Wedge diagram shouldn't separate IPPs as separate color since it's all meeting new demands. Doing so seems to indicate the providers are not competent in meeting needs.	These graphics will not be used in the final report. The gap analysis will occur as part of the final report that CWCB will complete by the end of 2010.
38	Rangeview Metro District	10/27/2009	Rangeview Metro District has about 1200 people and provides 159 af/y resulting in 119 gpcd.	CWCB will include revised water usage rates in final report.
39	Metro Basin Roundtable Verbal Comment	10/14/2009	Get upper mountain counties data for wells. This data may be available from the WSRA funded study of the Upper Mt. Counties water needs	If available, CWCB will include updated water usages rate from this study in the final report.

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No.	**Entity**	**Date**	**Comment**	**Response**
40	Colorado Geological Survey (Ralf Topper)	10/15/2009	I am concerned about the updated gallons per capita per day numbers presented in Table 3-1 • The variability from 151 in Douglas County to 390 in Phillips County is too large • The larger values for rural counties on the eastern plains suggests water use for irrigation (lawns and gardens), but these users would typically have irrigation wells also. • Few municipal water suppliers exist in the rural counties and most supply is from wells If the simulations and forecasts use the weighted average value of 177gpcd, which is more consistent with other published literature, then the individual county values are less critical. The State Engineer currently allows for 0.33 acre-feet of annual use for a domestic well. Assuming a 2.5 person household, that equates to 118 gpcd.	The methodology used to establish county wide water usage (gpcd) was a weighted average approach. The weighting process was applied to develop a county average gpcd based upon the portion of the population serviced by each utility to the total county population.
41	Metro Basin Roundtable Verbal Comment	10/14/2009	Check to make sure Arapahoe County doesn't have SSI since they are not on the table.	CWCB will review and update if needed.
42	Metro Basin Roundtable Verbal Comment	10/14/2009	Need SSI table similar to Appendix D to check accuracy.	CWCB will include detail on SSI sources in the final report.
43	North Platte Roundtable (Barbara Vasquez)	10/27/2009	I saw no mention of any oil and gas development (industrial) use of water for the North Platte Basin. In the past 2-2.5years, 5 oil wells have been drilled in the North Platte Basin by EOG and another by Wellstar. My understanding is that each of the EOG wells required over 1M gal of water to drill, and the water was diverted from Ag use, taken from irrigation ditches with agreement from the rancher who is the property owner but not addressed as a formal 'change of use'. Regarding projected industrial use, please note that EOG currently holds 19 well permits, which would require much more water to drill should they be developed. Finally, I believe the mud and produced water from these wells is currently being trucked out of state to evaporation ponds in Wyoming. How is that loss to the watershed accounted for in the projections?	CWCB will work with North Platte Basin Roundtable representatives to assess the long term water needs for oil and gas development and include this in the revised report as appropriate.
44	North Platte Basin Roundtable Verbal Comment	10/27/2009	Walden is only half of the population so extrapolation may not be accurate. For example - how is well use accounted for? A couple small water providers exist (i.e. Eagle's Rock)	CWCB will work with North Platte Roundtable representatives and if additional water use data is available it will be incorporated in the final report.
45	North Platte Basin Roundtable Verbal Comment	10/27/2009	Population numbers do not match draft county populations submitted by State Demographer on January 23, 2009. See letter and 3 tables.	The CWCB is revising the demands to 2050 population projections based on the latest State Demographer Model from November 2009.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
46	Rio Grande Basin Roundtable Verbal Comment	10/13/2009	Alamosa gpcd numbers seem high. Does this include open space, parks, and Adams State?	The water usage data used in the analysis is a system-wide water usage and includes irrigation of parks and Adams State.
47	Rio Grande Basin Roundtable Verbal Comment	10/13/2009	Anticipated increase in SSI due to solar development, though variable depending on technology	CWCB has received water use information on solar development and will include this in the final report.
48	Rio Grande Basin Roundtable Verbal Comment	10/13/2009	Is groundwater use in designated groundwater basins addressed in this report or others?	The groundwater use in the designated basin is not specifically addressed in this report. The Rio Grande Basin Roundtable completed a task order studying the designated groundwater basin during 2007. Agricultural issues with the designated groundwater basin and other areas in the state will be addressed in a different section of the final report that CWCB will complete by the end of 2010.
49	Rio Grande Basin Roundtable Verbal Comment	10/13/2009	State should entertain idea of Mississippi pumpback project.	Comment noted. Strategies and projects to meet states future water needs are not part of Demands to 2050 report.
50	Rio Grande Basin Roundtable Verbal Comment	10/13/2009	Concerned that decrease in ag use due to groundwater issues, subdistricts, etc. is accounted for in SWSI updates. That the basin gets credit for the taking the water and land out of production.	The purpose of the State of Colorado 2050 Municipal and Industrial Water Use Projections report was to estimate municipal and industrial uses of water. The CWCB is currently updating the agricultural demands from SWSI and these will be included in the final report that CWCB will be completing by the end of 2010.
51	Rio Grande Basin Roundtable Verbal Comment	10/13/2009	Projected growth rates seem realistic though on the high side.	Comment noted. The CWCB projected population growth on a low, medium and high basis because of the uncertainty of projecting population 40 years in the future. The State Demographer has also submitted written comments addressing this issue as detailed in comment numbers 84 to 91 of this document.
52	Rio Grande Basin Roundtable (Mike Gibson)	11/30/2009	The data provided in CWCB study, State of Colorado 2050 Municipal and Industrial Water Use Projections, June 2009, for the Rio Grande Basin, has been reviewed. The figures in Table 3-2, M&I Forecast by River Basin, page 3-7, appear reasonable for the Rio Grande Basin. The figures are based on an overall Basin annual population increase of 0.9 to 1.3 %, or from 49,400 in 2005 to a 2050 low of 73,200 and a high of 88,100 (Table 2-2. Population Projections by River Basin, page 2.6).	Comment noted.
53	Rio Grande Basin Roundtable (Mike Gibson)	11/30/2009	We have considered additional analysis of the future municipal use in the Basin, however, we determined that such effort would not significantly change the relative, overall increase in Municipal water demand and shortfall. This is demonstrated by evaluation of the above referenced projected 2050 water demand figures.	Comment noted.

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No.	**Entity**	**Date**	**Comment**	**Response**
54	Rio Grande Basin Roundtable (Mike Gibson)	11/30/2009	The 2050 High figure of a municipal water demand of 34,000 AF, or an increase from 2008 of 14,100 AF, by 2050, (34,000 – 19,900), is less than 10% of the current shortfall in agricultural water demands, as shown above. This shows that the projected future municipal demand in the Basin by 2050 is overshadowed by the shortfall in the agricultural sector.	Comment noted.
55	Rio Grande Basin Roundtable (Mike Gibson)	11/30/2009	It is unclear from the June 2009 Study if the figures relate to the water supplied, “in the pipes” for domestic or municipal use or if they are based on consumptive use. If they are figures for “water in the pipes”, then they are high, as the consumptive use with a central sewage system is about 5 % and with septic tanks and leach fields some 10%. These figures do not take into consideration the consumptive use of lawns, gardens, parks, golf courses, etc.	The demand projections are based on the water "in the pipes". The water usage rates are based on system-wide usage such as watering of lawns, parks, and golf courses.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
56	Rio Grande Basin Roundtable (Mike Gibson)	11/30/2009	The SWSI 1 Study of 2005 and the above referenced June 2009 Study, do not show any increase in Industrial demand in the Rio Grande Basin by the year 2050. In recent years the San Luis Valley has been characterized as having a high potential for production of electricity by solar means. The Rio Grande Roundtable and water community became concerned that some of the technologies being considered included water-cooled concentrated solar electrical generation that had a relatively high water need of 1 AF of consumptive use per megawatt of output. An example of this would be a 200 MW water cooled concentrated solar plant needing 2,000 AF of water. While this is not a lot of water when considered against the consumptive use of a sprinkler irrigated 120 acre circle of crops of 240 AF, it is the inherent administrative and logistics of providing this amount of surface water at a specific location. These issues include, but are not limited to, water right ownership, ditch companies' restrictions, and future need for augmentation of wells. In recent months, Xcel Energy has indicated it will not be considering acquiring power from solar facilities using technology with this relative high water demand. Kent Scholl, Senior Resource Planning Analyst, Xcel Energy, recently stated that the company is considering a San Luis Valley located solar facility with 200 MW capacity that has a water consumptive demand of 300 AF. Future solar power generation in the San Luis Valley will be limited because of transmission line capacity to export the power from the area. A new, proposed power line having a capacity of 700 to 750 MW is planned to be constructed in the next 3 to 4 years. The proposed a line will have the capacity to export power from similar sized facilities as the one under consideration. Additional solar generating facilities may be installed over the next 5 to 10 years, utilizing this additional transmission line capacity. If it is assumed there will be additional line capacity built over time, an assumption can be made that between now and 2050 a total of possibly four (4) or five (5) solar facilities of 200 MW might be operating, with a total water demand of 1,200 to 1,500 AF of consumptive use. If an allowance is made in for other solar plant demands using different technologies then a figure of 2,000 AF of additional consumptive use by 2050 might be appropriate. Again, such a figure is small in comparison to the shortfall of the agricultural sector of 160,000 AF.	CWCB will work with the Rio Grande Roundtable and Xcel to incorporate these SSI values into the final report.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
57	Rio Grande Basin Roundtable (Mike Gibson)	11/30/2009	In recent years, there have been instances when the public land agencies have considered putting parcels of land up for bid for oil and gas development. For one reason or another, these parcels have subsequently been withdrawn from such action. There have been instances where oil and gas exploration has been proposed on land where the mineral interest is not owned by the federal government. It is not possible to determine with any accuracy the overall potential for oil and gas development by 2050 in the Rio Grande Basin, and currently there are areas of the state that have a much higher potential. Based on this, and reviewing areas where development might occur (e.g. Routt County), the water demands are again small in comparison with the water shortfall in the agricultural sector of the Rio Grande Basin.	CWCB will work with the Rio Grande Roundtable to incorporate these SSI values into the final report if appropriate.
58	City of Greeley (Sean Cronin)	11/10/2009	Our Conservation Plan, that includes demand projections, is located on the web. This serves as the latest and greatest "public" document and you can find it. .. http://www.greeleygov.comlWater/Documents/CONSERVATION PLAN FINAL 3-9-09.pdf Specifically, the planning gpcd and demand projections are located on p15 and 16 respectively. This document will also provide you some insight on drought planning and firm yield (P11) and the proposed water projects (Le. Seaman enlargement per Harold's request) to bridge Greeley's "gap" (P20). Unfortunately the demand projections go just out to 2030. As Greeley's 2050 demands are pre-decisional by the Corps of Engineers (COE), they are not public yet.	CWCB will include this information in the final report.
59	South Platte Basin Roundtable Verbal Comment	10/13/2009	Figure ES-7 and ES-8 should indicate which IPPs have been implemented (e.g. ag dry up, conservation) since year 2000. Since the 2002 drought, gpcd has decreased but the demand curve does not indicate this. Specify what demand numbers were used to generate this graph (2000 or 2008 demands).	These graphics will not be used in the final report. The gap analysis will occur as part of the final report that CWCB will complete by the end of 2010.
60	South Platte Basin Roundtable Verbal Comment	10/13/2009	In the M & I report, it lists Fort St. Vrain Station as a coal-fired facility and it is actually a gas-fired plant.	CWCB will revise in final report.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
61	Pagosa Area Water and Sanitation District and San Juan Water Conservancy District (Karen A. Wessels and Ernie Amos)	11/11/2009	In 2050, we have projected the total Equivalent Units (EUs) served to be 36,042 requiring 11,397 Acre-Feet (AF) of water. In 2055, the planning horizon recently endorsed by the Colorado Supreme Court in its second "Pagosa" opinion, we have projected the total Equivalent Units (EUs) served to be 43,640 requiring 13,610 Acre-Feet (AF) of water. These projections represent a 3.9% average annual growth rate in EUs in our service area and do not include the one year of water storage safety supply margin also recently endorsed by the Colorado Supreme Court in its second "Pagosa" opinion. These numbers are based on providing water to 7227 Equivalent Units (EUs) at the end of 2008 with an average treated water demand of260 gallons per EU per day (the average water demand since 2002) and additional legal obligations to provide 900 Acre Feet per year of untreated water. Please note that the 260 gallons per EU per day demand figure reflects both water conservation and drought response factors. To reiterate our position as expressed in our correspondence last April, we use Equivalent Units (EUs), or single family equivalents, when projecting future water demand in our service area. Like many communities throughout the state, our community has significant tourism and second home ownership components. Because EUs more accurately measure the water use of second home and transient populations and their associated commercial services than permanent population, and because our projections use the actual average annual historic EU growth rate in our service area for the last ten years as opposed to estimates of permanent population by the State Demographer's Office (SDO)for the entire county, we strongly feel that our method is most accurate for our planning needs. In deference to statewide consistency of projection methods, our 3.9% growth rate does incorporate an average of SDO estimates for the past ten years; however, as noted in our April 2009 letter and supported by the CWCB (July 2009) in its draft report, "[methods used] for the purpose of general statewide planning [should not] replace demand projections prepared by local entities for project-specific purposes" (p. ES-l).	Comment noted. The methodology used by CWCB is based on population multiplied by a water use rate. As such, the water use rate incorporates site-specific system characteristics. For example, resort and second home communities will naturally have higher water use rates. To project water demands consistently across the state for the statewide analysis, resident population is the only consistent dataset available. Also, the CWCB facilitated meetings and presentations between the State Demographer and local entities in the Southwest Basin and the Southwest Roundtable. The State Demographer incorporates local data into their forecasts. The State Demographer has also submitted written comments detailed in comment numbers 84 to 91 of this document.

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No.	**Entity**	**Date**	**Comment**	**Response**
62	Pagosa Area Water and Sanitation District (Carrie Weiss)	4/20/2009	This letter is to comment on the recently completed Harvey Economics Report (Harvey Report) which extrapolated the future population for the State of Colorado and counties from the year 2035 to 2050. Though this methodology may be appropriate for general population estimates and for some counties, the Pagosa Area Water and Sanitation District (PAWSD) and San Juan Water Conservancy District (SJWCD) do not believe the Harvey Report will accurately forecast future water use within our community, which has significant second homes and a transient population. Also, we are concerned that the projections in the Harvey Report may be used by some people and entities to attempt to dictate to local entities what should be used for future water demand. In previous discussions with CWCB and Camp Dresser and McKee staff during SWSI Phase I, similar concern was expressed with discrepancies between permanent and transient populations. While they recognized the problem, for consistency, permanent population was the chosen basis for projections. We appreciate this reasoning but believe it is an important detail to point out because of the significant difference and effects the resulting numbers have on adequate planning for water projects. Both PAWSD and SJWCD completed a thorough evaluation of their 2055 water demand this past February. Growth estimates were based primarily on equivalent units which the PAWSD tracks on a monthly basis and has very good records for the past 15 years. We also incorporated the State Demographer's (SDO) projection and ended with an average of the average (3.9%) of both sets of numbers. Our analysis of past State Demographer (SDO) future population estimates have indicated significant differences between projections and actual population; for instance, the SDO estimate in 1994 for the 2004 Archuleta County population was 43% low. Permanent population projections underestimate future water demand in our type of community. PAWSD and SJWCD recommend the CWCB develop a disclaimer that the projections by the CWCB and specifically the Harvey Report are prepared for the purpose of general SWSI planning and that future water demand projections prepared by local entities take precedent over estimates in the Harvey Report.	Comment noted. The draft report explains the methodology and describes the purpose: “the objectives were to develop a reconnaissance-level water use forecast … The methods utilized in this approach are for the purpose of general statewide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes.” CWCB will repeat this explanation in a more prominent location in the final report.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
63	Dolores Water Conservancy District (Mike Preston)	11/18/2009	There was a long and intense discussion at the November Roundtable meeting regarding how the estimates in the Report have been and may be used for unintended purposes. Roundtable members expressed strong concerns about the risks of such unintended use. There were a variety of ideas about how to address these risks. DWCD is among those that suggest that the Report include a very prominent disclaimer statement, rather than a sentence buried within the body of the Report. A separate page near the front of the Report would be helpful to highlight the purpose of the Report and describe the boundaries of how the data should be used.	Comment noted. Also see response to comments No. 61 and 62.
64	Dolores Water Conservancy District (Mike Preston)	11/18/2009	DWCD is also among those that believe that data is needed to show the reliability of the model used to estimate the future population projections such as: (a) a comparison to actual population growth over the past 40 or 50 years, statewide and by county; and (b) evaluations by the State Demographer's Office on how accurate their population forecast model has been during its period in use. No one with experience in responding to fluctuating community growth expects such a model to be perfect. What would be useful is an understanding of the strengths and limitations of this model relative to specific communities.	Comment noted. Also see response to comments No. 61 and 62.
65	Dolores Water Conservancy District (Mike Preston)	11/18/2009	The Montezuma and Dolores Counties per capita uses of 250 and 242 seem a little high but DWCD does not have any data to suggest they should be changed. Additional description in the Report of how those were derived would be helpful to verify the amounts.	CWCB will work with water providers in these areas to see if there is more updated information and if so will include in the final report.
66	Pagosa Area Water and Sanitation District and San Juan Water Conservancy District (Karen A. Wessels and Ernie Amos)	11/19/2009	There was a lengthy discussion at the November 11th Roundtable meeting regarding how the estimates for growth and water demand in the Report have been and may be used for unintended purposes. The Districts are very concerned about this and though the Report on page ES-l and on page 3-1 clearly states the general planning purpose, the Report has already been used for an unintended purpose in the Pagosa II Colorado Supreme Court Decision. There are also similar concerns with use of the non-consumptive use information for unintended purposes. A stronger, stand alone disclaimer statement on a separate page following the Table of Contents might be helpful to more prominently state the purpose of the Report and describe boundaries of how the data should be used. An example of the disclaimer page is attached for your consideration.	The draft report explains the methodology and describes the purpose: “the objectives were to develop a reconnaissance-level water use forecast … The methods utilized in this approach are for the purpose of general statewide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes.” CWCB will repeat this explanation in the final report and make it more prominent.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
67	Pagosa Area Water and Sanitation District and San Juan Water Conservancy District (Karen A. Wessels and Ernie Amos)	11/19/2009	A comparison of State and County population projections should be compared to actual historic growth. The only comparison is on page 6 of the Harvey Economics Report (HE) where the statewide growth rate of2.2% from 1969 to 2009 is compared to the HE average estimate of 1.5% for the next 40 years. The reasons to use a significantly smaller growth rate are not well documented. Similar comparisons should have been made for each County to assess the historic growth rate with the Report estimates; the Report population estimates may be far more accurate on a State level than a County level.	Comment noted. The State Demographer has presented comparisons of forecasts to actual growth to different roundtables and the IBCC. The State Demographer has also submitted written comments addressing these issues as detailed in comment numbers 83 to 90 of this document.
68	Pagosa Area Water and Sanitation District and San Juan Water Conservancy District (Karen A. Wessels and Ernie Amos)	11/19/2009	The methodology included in the HE Report to prepare the population projections is recommended to be included in the main body of the Report in addition to the HE Report.	CWCB will modify the final report to include this information in the main body of the report.
69	Pagosa Area Water and Sanitation District and San Juan Water Conservancy District (Karen A. Wessels and Ernie Amos)	11/19/2009	An evaluation of the past population projections by the State Demographers Office (SDO) was not included. For instance, what did the SDO model predict in 1990 the population would be in 2000 (US Census data available to verify the results)? How do we know the SDO model has produced reliable results in the past? The evaluation should include how well the SDO model has historically performed statewide and for each county.	Comment noted. See response to No. 67.
70	Pagosa Area Water and Sanitation District and San Juan Water Conservancy District (Karen A. Wessels and Ernie Amos)	11/19/2009	The future water demand amounts provided by local entities should be included in the Report in some manner. For instance, the Districts provided their estimate of the 2055 water demand which should be included in the Report as alternate estimates. This would seem possible without distracting from the purpose of the Report.	Comment noted and will be considered as CWCB implements BNDSS and gap analysis.
71	Pagosa Area Water and Sanitation District and San Juan Water Conservancy District (Karen A. Wessels and Ernie Amos)	11/19/2009	Based on analysis of future water estimates for Archuleta County in Table 3.1, the 2050 water demand estimate is not adequate. The Districts understand that the CWCB wants to use a consistent methodology for population estimates, but this comment is to reiterate the 2050 and 2055 estimates by the Districts. In 2050, the Districts project the total Equivalent Units (EUs) served to be 36,042 requiring 11,397 Acre-Feet (AP) of water. In 2055, the planning horizon recently endorsed by the Colorado Supreme Court in its second "Pagosa" opinion, we have projected the total EUs served to be 43,640 requiring 13,610 AF of water. These amounts include 900 AF of raw water the Districts are contractually required to deliver for golf course and open space irrigation.	Comment noted.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
72	Pine River Irrigation District (Hal Pierce)	11/19/2009	The discussion at the Roundtable meeting regarding how this information may be used for unintended purposes is a concern to PRID as it was to most of the other Roundtable members. Though it is impossible to stop the unintended use of the information, a more prominent statement of the purpose and limitations would be appropriate.	Comment noted. See response to No. 61.
73	Pine River Irrigation District (Hal Pierce)	11/19/2009	Actual past population growth patterns are as good as we have to calibrate future projections. There is nearly no comparison of the projections in the Report with past growth patterns. There is one comparison is on page 6 of the Harvey Economics Report (HE) where the Statewide growth rate of 2.2% from 1969 to 2009 is compared to the HE average estimate of 1.5% for the next 40 years. Similar comparisons should have been made for each County estimate to assess the historic to estimated variation in growth around the state.	Comment noted. See response to No. 67.
74	Pine River Irrigation District (Hal Pierce)	11/19/2009	Similarly, the Report should either include or refer to an evaluation of the historic accuracy of State Demographers Office (SDO) population forecast model. An evaluation of how well the SDO model has performed in the past, statewide and for each county, would very helpful in trusting the population projections included in the Report.	Comment noted. See response to No. 67.
75	Pine River Irrigation District (Hal Pierce)	11/19/2009	The La Plata County (LPC) per capita water usage of 167 gallons seems low but may reflect the large number of homes on wells that use less than that amount to balance the homes on central systems that use more. Also LPC requires new development to prove they have 350 gallons per home per day whether full time or part time residences; the number of persons per home is not known to compare the 350 gallons per home to the 167 gallons per capita per day.	Comment noted.
76	Southwest Basin Roundtable Verbal Comment	11/11/2009	This report and others may need some sort of legal disclaimer to prevent misuse of the information (even if this requires policy or legislative changes).	Comment noted. See response to No. 61.
77	Southwest Basin Roundtable Verbal Comment	11/11/2009	Should the 2050 Demands Report (especially Table 3-1) be subject to a required roundtable approval process similar to the NCNA process?	Comment noted.
78	Southwest Basin Roundtable Verbal Comment	11/11/2009	Report is good for broad state planning but not appropriate or accurate for local application	Comment noted. See response to No. 61.
79	Southwest Basin Roundtable Verbal Comment	11/11/2009	How is groundwater use accounted for in water use estimations?	If a water provider's source is groundwater and they provided water use information, then this information was used for water use estimation.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
80	Southwest Basin Roundtable Verbal Comment	11/11/2009	Due to service area boundaries, it is impossible for county level data to incorporate appropriate growth rates and locations.	The consistent methodology used by the report that incorporates county level data and water use rates is intended for broad state and regional planning as discussed in comment No. 66.
81	Southwest Basin Roundtable Verbal Comment	11/11/2009	Where is the nonconsumptive counterpart to this report?	The CWCB produced two reports in June 2009: Non-Consumptive Needs Assessment (NCNA) Priorities Mapping and Watershed Flow Evaluation Tool (WFET) Pilot Study for Roaring Fork and Fountain Creek Watersheds and Site-Specific Quantification Pilot Study for Roaring Fork Watershed. These are available at: http://cwcb.state.co.us/IWMD/COsWaterSupplyFuture/
82	Yampa-White Basin Roundtable Verbal Comment	10/21/2009	SSI power needs in Moffat County, even at the low end are probably too high. They don't expect that even if they need more power it will result from a local power plant.	The energy demands reported in the draft report will be revised based on results from Phase II of the Energy Study that is currently underway.
83	Colorado State Demographer, Elizabeth Garner	4/23/2010	I am writing this letter to answer and clarify some of the comments that were submitted in response to the Draft Colorado Water Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections published in June 2009.	Comment noted.
84	Colorado State Demographer, Elizabeth Garner	4/23/2010	The State Demography Office produces and updates its population forecasts on an annual basis taking into account current and projected economic conditions. The population projections for the CWCB report have been revised since the June 2009 draft using the most current data available and taking into account the current economic downturn. The revision in the current forecast to account for the current recession has a larger impact in the next 5 to 10 years than it does in the next 30. Overall our 2035 forecast was revised down by approximately 200,000 people or by approximately 2%.	Comment noted.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
85	Colorado State Demographer, Elizabeth Garner	4/23/2010	Our population forecasts are long term forecasts and therefore you will not see the cyclic nature of growth in the forecasts. We realize booms and busts exist but it is impossible to predict them. The goal of the long term forecasts is to have the booms and busts average out in the long run. Recent history has shown that is possible. In 1985 we produced forecasts for 2000. During that time period we had the bust of the late 1980s and the booms of the 1990s. The forecast produced in 1985 did not include either the boom or the bust but the resulting forecast was impressively close to the results from Census 2000.	Comment noted.
86	Colorado State Demographer, Elizabeth Garner	4/23/2010	The relationship between population and the economy tends to be lagged, meaning that you will not necessarily see an immediate change in population when there is a change in jobs (increase or decrease). Migration data for July 2008 - July 2009 using IRS filings showed a net migration to the state of 48,000 even though the state had lost around 130,000 jobs during that same time period. Similarly, historical data shows when we have seen increases in jobs it will take 6 to 12 months for the migration to begin to increase due to the excess supply of workers.	Comment noted.
87	Colorado State Demographer, Elizabeth Garner	4/23/2010	Colorado population forecasts produced by the State Demography Office are subject to uncertainty. There is uncertainty related to birth and death rates as well as to migration rates (impacted by the economy). The CWCB contracted with a consultant to extend our forecasts from 2035 to 2050 as needed for the water demand projections. The consultants produced high, medium, and low forecasts based on different migration/economic scenarios. The range provided through the various scenarios aims at capturing the degree of uncertainty that exists in population forecasts and also the business cycles that are impossible to predict. Historically recessions or long periods of slow to negative growth are followed by periods of faster growth.	Comment noted.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
88	Colorado State Demographer, Elizabeth Garner	4/23/2010	It is important to remember that Colorado and its counties are part of a national and international system. Its future growth needs to be taken into the context of the growth of the nation. International and national forecasts are used to produce Colorado's forecast. The low 2050 scenario produced for Colorado projects Colorado growing at the US's growth for the same period. One has to consider whether it is realistic for Colorado to grow at the same rate as the US since historically it has grown above the US rate. Our evaluation of the 2050 low forecast is that it is indeed low and would imply that Colorado would be less attractive than other states for both job and population growth. It is possible for this scenario to occur but not highly probable. The 2050 high forecast includes some level of oil shale development in the northwest region of the state and would imply much stronger growth in the state. It is certainly possible for this scenario to occur if oil shale development occurs in the state.	Comment noted.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
89	Colorado State Demographer, Elizabeth Garner	4/23/2010	It is difficult to evaluate the accuracy of our forecast since we update it annually. Since we update it annually and we produce it for single years, an evaluator could select any number of years in the forecast to evaluate or any "year produced" to evaluate. One could "cherry pick" the year produced or the year of the forecast to demonstrate accuracy or inaccuracy. However, we have spent time this year evaluating our forecasts to identify potential trends. We chose to look at the longest term forecasts since 1985 with years for which we have data. For example 1985 to 2000. In general there are a few findings. First, during recessions we tend to under forecast in the long run (i.e. our 1989 forecast for 2010 was approximately 10% low) and during periods of growth we tend to over forecast the long run (i.e. our 2000 forecast for 2010 was approximately 1.3% high). We do not forecast booms or busts and assume periods of stronger growth or decline will average out in the long run. Our 1985 forecast for 2000 was approximately 3.6% low for a 15 year time period or about .24 percent per year. Our 1985 forecast for 2010 is approximately 5.6% low or about .22% per year. Less than 1% error per year is very accurate. The degree of accuracy varies by region in the state, varies by size of the county, and varies by the volatility of the economy. Counties with a smaller population base and with economies highly dependent on single industries tend to have greater errors with forecasts both above and below the eventually released estimates. Harvey Economics extended our forecasts to 2050 with low, medium and high scenarios in order to provide information on the degree of uncertainty of the economy for a region or county. It provides an important perspective on the certainty of the forecasts.	Comment noted.
90	Colorado State Demographer, Elizabeth Garner	4/23/2010	I hope this letter has clarified any comments or questions that have been asked about the population forecasts the State Demography Office of the Department of Local Affairs produces for the state. Our forecast methodologies can be found on our website at www.dola.state.co.us/dlg/demog/pop_colo_forecasts.html.	Comment noted.

Responsiveness Summary – CWCB Draft Colorado Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections				
No.	**Entity**	**Date**	**Comment**	**Response**
91	Southwest Basins Roundtable Comment Letter	5/3/2010	The Roundtable is very appreciative of the work the CWCB has performed for this study. This type of planning will allow the State to discuss "big picture" issues of overall water supplies for municipal and industrial water use. To this end, the first page of the draft Report states that, "The methods utilized in this approach are for the purpose of general statewide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes." It is the feeling of the Roundtable that regardless of this statement, the potential still exists for the Report to be used for the unintended purpose of guiding water court decisions regarding local project-specific planning efforts, both for consumptive and non-consumptive use projects. Therefore, the Roundtable wishes to recommend a stronger, stand alone disclaimer statement on a separate page following the Table of Contents that might be helpful to more prominently state the purpose of the Report and describe the boundaries of how the data should be used.	A clear statement of "Study Objectives" will be included in a more prominent location the final report. The language will read as follows: "The objectives of this study were to develop a reconnaissance-level water use forecast that employs consistency in data collection and forecast methodology across the state and maximizes available data. The methods utilized in this approach are for the purpose of general statewide and basin-wide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes."
92	Southwest Basins Roundtable Comment Letter	5/3/2010	The Roundtable understands that the CWCB wants to use a methodology for population estimates consistent with that used for the SWSI I Report. This methodology used permanent population figures for projecting future growth and water demand and consequent gaps in supply. The Roundtable encourages the CWCB to incorporate a factor for water demand by transient populations into its future growth and demand projection calculations. By "transient" we mean the population of water users comprised of tourists and second homeowners. The transient population has a large impact to the water systems of small mountain communities. The Roundtable wants to make sure that water demand by transient populations is carefully considered by CWCB to avoid underestimating future demand, and therefore supply gaps, in areas of the state predominantly dependent upon tourism and second-home ownership for their economic vitality.	Comment noted. Also see response to comments No. 61 and 62.

Appendix B
2050 Population Projections for the State of Colorado Municipal and Industrial Water Use Projections

FINAL REPORT

April 2010

2050 Population Projections for the State of Colorado Municipal and Industrial Water Use Projections

Prepared for

Colorado Water Conservation Board

Prepared by

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April 2010

Harvey Economics

Introduction

One of the primary mandates of the Inter-basin Compact Process is for the Basin Roundtables to develop a water needs assessment. Part of this needs assessment is to compare water supplies with projected water demand to identify future needs which must be met throughout the State. This report addresses one part of those water demand projections, namely future economic and demographic activity, which serves as a foundation for the municipal, industrial and sectoral water demand projections. This report presents population projections for the year 2050 for the State of Colorado, each county and each river basin, along with year 2050 employment projections for the State and for each river basin. These projections, when applied to assumptions about water use patterns and conservation, will result in water demand projections. Separate reports or technical appendices are provided for water use patterns, conservation and water demand projections.

This water demand forecasting effort follows the initial Statewide Water Supply Initiative (SWSI) water demand projections, which adopted a forecast horizon of year 2030. Completed in the year 2004, these projections were based upon population projections from the Colorado State Demographer's Office (SDO) and water use patterns estimated largely from a CDM survey of Colorado water providers, further adjusted for retrofit and conservation.

The Colorado Water Conservation Board (CWCB) determined that the forecast horizon for the water demand projections needed to be extended to the year 2050 to better represent the very long-term water needs which the State will face. Infrastructure investments and commitment of water supplies require a very long term view into the future. This report responds to that requirement. This report was prepared by Harvey Economics (HE) under subcontract to CDM and is part of CDM's work with the CWCB and its constituents. The projections were prepared in April 2010.

2050 Population Projections in Context of Long-term Economic Cycles

As described in this report, the future population of Colorado is largely dependent on the availability of jobs and growth of future employment opportunities. The projections included in this report rely upon assumptions about the economic conditions in Colorado and the U.S, as well as internationally. More than ever before, international and U.S. economic and demographic conditions will affect the number and type of jobs available in Colorado. The projections in this report are also based on the assumption that, over the long-term, Colorado will experience an overall secular growth trend that includes both periods of slower and faster economic growth. Evidence to support this assumption is provided below through an examination of historical population growth and economic trends and comparisons of historical population growth to projected growth.

Historic and current economic downturns. Colorado has experienced several periods of economic downturn or recession in the last 40 years; these periods are outlined briefly below:

1) The 1970's were characterized by two recessionary periods, one between 1973 and1975 and a second in the 1979-80 period.[1] The first was driven by an oil embargo and the second by rampant inflation.

2) The 1980's saw two economic downturns as well. The first, a recession in the 1981-82 period, was triggered by the second "energy crisis". The second downturn (not an official recession), which occurred during the 1986-87 period, was related to savings and loan failures along with financial and housing market dysfunction.

3) Except for a recession between mid 1990 and early 1991, the 1990's were mostly prosperous for Colorado, but the 2001-02 period produced a sharp downturn for the State as technology and telecommunication sectors almost collapsed in Colorado as well as the U.S.

4) The Colorado, U.S and global economies are currently experiencing the effects of a recessionary period that began in late 2007.[2] The current recession began in the financial sector, resulting from large numbers of sub-prime home loan defaults, and eventually spread to other major sectors of the economy, including the insurance, auto and manufacturing industries. This period has been categorized by large declines in stock values, tighter credit availability, relatively high unemployment rates, widespread home foreclosures and decreased home values, as well as a drop in consumer confidence.

These downturns were evidenced clearly by the population, employment and other economic data portrayed in Table 1. During those time frames, State gross domestic product (GDP) flattened or turned down. Building permit activity dropped sharply during these times. Personal income growth flattened or declined. Unemployment rates jumped up.

Historical population and employment changes, as indicated in Table 1, also reflect much slower growth or even declines during these recessionary periods. Between 1969 to 2009, population growth slowed to less than one percent per year in the late 1980's and was below two percent in 17 of those 40 years. Employment declines occurred in four of those forty years. Employment growth of less than one percent occurred in another four of those years, while less than two percent growth occurred in still another six of those years.

Cyclical upturns. However, it is important to note that the past forty years has also been characterized by periods of rapid growth. State GDP grew by more than five percent in eleven out of the past forty years. Personal income also grew by more than five percent in eleven out of the past forty years. Building permits have increased by more than twenty percent in seven out of forty years.

Similarly, annual population and employment growth has been substantially above average for some years during the 1969 to 2009 period. For seven out of the forty years, the Colorado

[1] National Bureau of Economic Research, US Business Cycle Expansions and Contractions, www.nber.org/cycles/cyclesmain.html.
[2] The National Bureau of Economic Research identified December 2007 as the beginning of the current recession.

population grew by more than three percent. State employment growth was also four percent or higher in seven out of the past forty years. One can conclude that the current recession lies within the state's historical experience of economic cycles.

Colorado's economic cycles. As shown in Table 1, Colorado has seen periods of relatively low annual population growth and high unemployment followed by periods of faster growth and lower unemployment. These data confirm that periods of rapid population and employment growth and periods of slower growth are both parts of long term average growth rates.

Table 1.
Historical Population, Employment and Other Economic Data for Colorado, 1969 to 2009

Year	Population	Annual Growth Rate	Employment	% Change	Unemployment Rate	Building Permits	% Change	State GDP (M)	% Change	Personal Income (M)	% Change
1969	2,166,000	NA				NA		$62,013		$52,261	
1970	2,209,596	2.01%				28,839	NA	$63,330	2.12%	$54,773	4.81%
1971	2,303,524	4.25%				53,180	84.40%	$70,016	10.56%	$59,426	8.50%
1972	2,404,619	4.39%				63,430	19.27%	$78,118	11.57%	$65,292	9.87%
1973	2,495,868	3.79%				44,779	-29.40%	$85,408	9.33%	$70,060	7.30%
1974	2,541,406	1.82%				19,724	-55.95%	$84,482	-1.08%	$71,058	1.42%
1975	2,586,192	1.76%				17,467	-11.44%	$85,765	1.52%	$71,031	-0.04%
1976	2,632,306	1.78%	1,171,613		6.0%	23,859	36.60%	$89,404	4.24%	$74,500	4.88%
1977	2,696,140	2.43%	1,219,529	4.09%	6.5%	36,234	51.87%	$95,218	6.50%	$77,077	3.46%
1978	2,766,748	2.62%	1,285,477	5.41%	5.4%	42,701	17.85%	$101,114	6.19%	$81,358	5.55%
1979	2,849,234	2.98%	1,369,768	6.56%	4.6%	37,712	-11.68%	$101,041	-0.07%	$81,264	-0.11%
1980	2,889,733	1.42%	1,413,339	3.18%	5.9%	30,129	-20.11%	$102,143	1.09%	$83,691	2.99%
1981	2,977,898	3.05%	1,461,092	3.38%	5.5%	29,391	-2.45%	$105,397	3.19%	$86,961	3.91%
1982	3,061,564	2.81%	1,485,571	1.68%	7.8%	31,788	8.16%	$104,673	-0.69%	$87,543	0.67%
1983	3,133,630	2.35%	1,544,124	3.94%	7.3%	51,290	61.35%	$105,363	0.66%	$89,039	1.71%
1984	3,169,992	1.16%	1,614,511	4.56%	5.4%	44,329	-13.57%	$112,597	6.87%	$94,277	5.88%
1985	3,214,448	1.40%	1,610,800	-0.23%	6.0%	32,824	-25.95%	$116,152	3.16%	$97,086	2.98%
1986	3,243,803	0.91%	1,592,585	-1.13%	7.5%	30,961	-5.68%	$116,828	0.58%	$99,422	2.41%
1987	3,263,354	0.60%	1,585,706	-0.43%	7.5%	17,988	-41.90%	$119,109	1.95%	$100,524	1.11%
1988	3,271,448	0.25%	1,600,162	0.91%	6.4%	12,864	-28.49%	$122,333	2.71%	$103,168	2.63%
1989	3,284,537	0.40%	1,623,887	1.48%	5.6%	11,131	-13.47%	$126,192	3.15%	$109,940	6.56%
1990	3,294,393	0.30%	1,678,229	3.35%	5.1%	11,897	6.88%	$128,834	2.09%	$112,413	2.25%
1991	3,380,951	2.63%	1,704,522	1.57%	5.4%	14,071	18.27%	$131,397	1.99%	$114,114	1.51%
1992	3,489,832	3.22%	1,744,235	2.33%	6.0%	23,484	66.90%	$137,105	4.34%	$118,877	4.17%
1993	3,605,038	3.30%	1,831,489	5.00%	5.3%	29,913	27.38%	$143,037	4.33%	$123,186	3.62%
1994	3,712,062	2.97%	1,953,111	6.64%	4.3%	37,229	24.46%	$148,670	3.94%	$126,817	2.95%
1995	3,811,074	2.67%	2,041,652	4.53%	4.0%	38,622	3.74%	$153,337	3.14%	$131,567	3.75%
1996	3,902,448	2.40%	2,083,740	2.06%	4.2%	41,135	6.51%	$159,100	3.76%	$137,421	4.45%
1997	3,995,923	2.40%	2,154,294	3.39%	3.4%	43,053	4.66%	$176,421	NA	$143,219	4.22%
1998	4,102,491	2.67%	2,226,296	3.34%	3.5%	51,156	18.82%	$185,607	5.21%	$153,626	7.27%
1999	4,215,984	2.77%	2,269,668	1.95%	3.0%	49,313	-3.60%	$196,906	6.09%	$162,353	5.68%
2000	4,301,261	2.02%	2,300,192	1.34%	2.7%	54,596	10.71%	$208,281	5.78%	$174,992	7.79%
2001	4,457,665	3.64%	2,303,494	0.14%	3.8%	55,007	0.75%	$206,173	-1.01%	$176,790	1.03%
2002	4,531,539	1.66%	2,304,109	0.03%	5.7%	47,871	-12.97%	$206,898	0.35%	$173,859	-1.66%
2003	4,595,814	1.42%	2,339,532	1.54%	6.1%	39,569	-17.34%	$210,574	1.78%	$173,978	0.07%
2004	4,664,062	1.49%	2,392,952	2.28%	5.6%	46,387	17.23%	$221,497	5.19%	$183,790	5.64%
2005	4,731,799	1.45%	2,448,150	2.31%	5.1%	45,891	-1.07%	$234,561	5.90%	$193,227	5.13%
2006	4,827,387	2.02%	2,526,986	3.22%	4.4%	38,343	-16.45%	$240,232	2.42%	$199,840	3.42%
2007	4,919,884	1.92%	2,582,486	2.20%	3.9%	29,454	-23.18%	$245,535	2.21%	$207,258	3.71%
2008	5,010,395	1.84%	2,596,309	0.54%	4.9%	19,086	-35.20%	NA	NA	$209,321	1.00%
2009	N/A	N/A	2,492,562	-4.00%	7.9%	7,362	-61.43%				
Average Annual Population Growth 1969 to 2009:				2.17%							

Notes: (1) The 2009 population data is a projection from the State Demographer's Office.

(2) 2009 employment and unemployment rate data reflect March 2009 conditions.

(3) 2009 building permits are an annual estimate based on the number of permits authorized in January and February 2009.

(4) Industry definitions changed in 1997 causing a discontinuity in state GDP estimates between 1996 and 1997. Therefore, the percent change in GDP between 1996 and 1997 is not applicable.

(5) Historical retail sales data was unavailable prior to 1993.

(6) All data in this table was adjusted for inflation and is show in constant 2008 dollars.

Sources: Colorado Department of Local Affairs, State Demographer's Office; Bureau of Labor Statistics; Census Bureau; Center for Business and Economic Forecasting; Harvey Economics, 2009, Bureau of Economic Analysis, Colorado Department of Revenue, Harvey Economics, 2009.

Comparison of historic and projected population growth. The state's long-term historical average annual population growth rate over the 40 year period from 1969 and 2009 was 2.2 percent. The projected average annual growth rate for the 40 year period between 1995 and 2035, which includes both a historical period and the Colorado State Demographer's projections through 2035, is 1.8 percent. Projected population growth over the 40 year period between 2010 and 2050 reflects an average annual growth rate of about 1.4 percent, under HE's middle growth scenario. Declining long-term annual growth rates over time are common as both metropolitan and rural areas become more populated and some areas approach build-out conditions. As with the 1969 to 2009 historical period, population growth and economic conditions in Colorado will likely vary from year to year in the future depending on statewide, national and global conditions. The average annual population growth rates projected for the state through 2050 incorporate these potential variations.

Overview of Approach

HE's first step in the development of the year 2050 population projections was to determine if other suitable forecasts for the year 2050 economic or demographic activity had previously been prepared and might be useful in this endeavor. We found that local, regional, State and Federal forecasting agencies generally avoid making projections 40 years or more into the future. The U.S. Social Security Administration was one of the few agencies which prepared population projections for the U.S. for 2050; there was an actuarial interest in the solvency of the Social Security Trust Fund, which led to those projections. The U. S. Census has also prepared population projections to 2050 at the national level.

With this fact in mind, HE searched for a population forecasting methodology that could meet the needs of the 2050 water demand projections. To be suitable, the water demand projections would need to satisfy the following criteria:

- The forecasting methodology must be valid and widely acceptable, both by users of the results and demographic forecasting practitioners.

- The forecasting approach must be transparent and understandable to the extent possible.

- The projections must be replicable.

- In keeping with state-of-the-art practice, the projections must be economically based and then linked to demographic factors in an integrated manner.

- The projections must be able to produce population forecasts for each county to the year 2050 under high, medium and low economic development assumptions.

HE determined that the forecasting process and models utilized by the SDO, in conjunction with its consultant, the Center for Business and Economic Forecasting (CBEF), met all of those criteria and therefore adopted the SDO forecasting process for the 2050 effort.

As of 2010 the SDO/CBEF projections are only available through the year 2035. HE determined that the forecasting models, equations and algorithms could largely be extended or adjusted as needed from 2035 to 2050. HE obtained the State models, developed a familiarity with them, and modified certain elements as needed to extend the SDO/CBEF models to the year 2050. The next step was to prepare national and international assumptions which would help determine the driving forces behind Colorado's basic economic sectors.

Basic economic sectors include those activities which bring money and economic stimulus into a geographic area. HE projected employment for each of Colorado's basic economic sectors on the basis of the assumptions for the driving forces behind those basic sectors. With projections of basic employment, HE applied industry-specific employment multipliers to arrive at total Colorado jobs. Those Colorado job projections served as inputs to HE's 2050 version of the SDO and CBEF economic/demographic models, the methodology of which is outlined in Exhibit 1.

Because of the uncertainty in projecting economic conditions and employment levels in 2050, HE developed low, middle and high employment scenarios for each key employment sector, leading to low, middle and high population projections. Each of the scenarios reflects unique assumptions for the economy and for each employment sector.

Once HE produced statewide employment and population projections, these projections were allocated to each region of the State based upon that region's economic base, and then to each county, based upon its proportion to that region, subject to build-out limitations. HE surveyed regional and local planning agencies throughout the State to ascertain build-out assumptions. Finally, with the county population projections, HE aggregated counties to river basins to complete this component of the 2050 water demand forecasting effort.

SDO/CBEF forecasting model. The Center for Business and Economic Forecasting and the State Demographer's Office have together created a forecasting model used to project employment and population for the State, each of 14 planning regions and each of Colorado's 64 counties. This model currently combines both employment projections and assumptions of various demographic factors into estimates of population through the year 2035. The CBEF/ SDO model is updated annually and provides the official population projection data for the State of Colorado. The projections in this report are based on a CBEF/ SDO model last updated in October 2009 and modified in early April 2010 to reflect interim revisions of

employment and population data for a small number of counties. The April 2010 model modifications came about as the result of review and consultation between CBEF/SDO and HE. These revisions were incorporated into the SDO/ CBEF model by HE prior to the work done to estimate the 2050 population. Therefore, the SDO's official population projections, as of November 2009, are slightly different than the revised model's projections. Together, CBEF's employment projections and SDO's population assumptions create estimates of migration and commuting and ultimately result in population projections for the State, regions and counties.

HE 2050 extension of model. Exhibit 2 depicts HE's extension and modification of the CBEF/ SDO model to produce 2050 population projections. Steps A through M show how HE used the model to project population, beginning with projections of traditional and household basic jobs, as more fully described below. Essentially, assumptions of various employment and demographic factors are applied to projected basic jobs, ultimately resulting in population estimates.

In general, HE applied model algorithms from the 2020 through 2035 time period to 2050. For example, HE held military jobs constant at the 2035 level since no data sources were able to provide information on military actions or trends that far into the future. For several demographic assumptions, such as the unemployment rate and the labor force participation rate, HE used half the difference between the 2030 and 2035 rates for projecting 2050 rates.

An Overview of Colorado's Basic Economic Sectors

Basic economic sectors are those activities that bring money into a particular economy, be it a state, a region, a county or a community. The demand for goods and services is determined outside that geographic area, i.e., demand for oil is determined outside of Colorado, and the money which oil development brings into an area is circulated around that economy. This circulation process is often referred to as "the multiplier effect". The basic economic activity is therefore a crucial starting point in projecting future economic or demographic activity in a particular area.

Colorado has two types of basic sectors, traditional basic and household basic. Traditional basic sectors are those such as agriculture, mining or manufacturing for whom demand is determined outside the State, but whose activity brings money into the State, stimulating the economy. Less well recognized, but of equal importance, are the household basic sectors, which result from individuals in the State, because of their demographic circumstance, representing a source of money and expenditures coming into Colorado. For example, retirees receive Social Security and pension support. Welfare recipients receive public assistance from governmental entities outside their local area. A listing of the traditional and household basic sectors is provided in Exhibit 3.

National and International Assumptions

Basic industry projections and the driving forces which affect changes in those basic sectors are underpinned by future conditions which will exist internationally and across the entire United States. These international and national assumptions are the framework or foundation

for assumptions about changes in the basic economic sectors. For example, economic growth rates in the developing world will help determine purchasing power for much of the world's population. If that purchasing power increases, demand for food and commodities will increase, causing upward pressure in real prices and increasing food demand worldwide. Agricultural prices and thus demand will increase, and this will result in upward trends in Colorado agriculture, for example.

Exhibit 4 indicates the primary U.S. and international assumptions which HE adopted for year 2050 conditions. The key factors are listed and HE's assumptions for low, middle and high scenarios are provided. HE performed considerable research into each of these factors as the basis for adopting the assumptions set forth in Exhibit 4. The bibliography behind this research is offered at the end of this report.

HE's assumptions for international economic conditions are of paramount importance because, more than ever, Colorado's economic development will depend upon international conditions. Generally, economic growth is expected to continue in the developing world at a rate faster than that expected for developed or mature economies. Exchange rates are also important because they reflect not only a balance of trade between countries, but a competitive export advantage between countries. The U.S. growth rates and economic aggregates reflect the historical range and projections HE ascertained from various publications. The bibliography at the end of this report indicates the data sources for these projections.

Exhibit 5 describes our assumptions for the demand for oil and natural gas under low, middle and high scenario assumptions. Demand for oil will be a function of transportation assumptions, such as alternative vehicles, alternative fuels, technological recovery improvement, economic growth rates and per capita utilization. National and international oil and natural gas demand will affect the mining sector and other sectors with rely on these fuels.

Projections for Traditional Basic Employment Sectors

Traditional basic employment sectors include Agriculture; Government; Manufacturing; Mining; Regional and National Services; and Tourism. The structural basis for the projections is described below, followed by a summary of each sectoral projection.

Driving influences and assumptions. Driving influences are those factors which affect the growth of employment, production and sales in a given sector. A thorough and comprehensive research effort was undertaken to determine the driving influences for each traditional basic sector and to identify sector specific trends or programs that will influence future employment. Based on this research, assumptions were then developed for each driving influence for the low, middle and high scenarios of each sector. The mining sector was further broken down to reflect assumptions related to the mining of specific products.

Reports, studies and data were gathered from numerous state and national agencies and government departments. Information was also obtained from various local and regional sources as well as from universities and other organizations. Interviews and data gathered

from local and regional planners and other local sources provided information on which sectors are important to the economy in specific regions of Colorado. Gathered information was reviewed and synthesized to provide the basis for development of each driving influence and to create assumptions for the low, middle and high employment scenarios. Specific data sources used for making 2050 basic sector employment projections are provided in the bibliography at the end of this report.

Agriculture. Colorado's basic agriculture sector is composed of agricultural production, including crops and livestock; the manufacture and provision of agricultural inputs, such as equipment, feed or fertilizer; and agricultural processing, such as dog food, sugar from beets, or ethanol. HE determined through its research that the driving influences that will determine future agricultural activities in Colorado are numerous:

- World food demand;
- The acceptance and success of genetic modification for seeds and livestock;
- Economics of Colorado agriculture;
- The conversion of agricultural lands to urban or other uses;
- The subdivision of ranches to ranchettes;
- The acreage devoted to biofuel production;
- Climate change;
- Land productivity; and
- Federal farm subsidies and net cash returns per acre.

Each of these driving influences and our assumptions under the low, middle and high growth scenarios, are set forth in Exhibit 6. HE performed considerable research into each of these driving forces, as indicated in the bibliography provided at the end of this report. Overall, the increase in world food demand, under the middle and high scenarios, will tend to improve agricultural prospects.

HE projections of the basic agricultural sector are provided in Exhibit 7. The State employment projections, as developed by CBEF, through the year 2035 indicate an annual increase Statewide of about one percent per year. Under the HE scenarios, basic agricultural employment would increase between 0.3 percent and 1.2 percent per year, between 2035 and 2050, under the low and high scenarios, respectively.

Government. Colorado's basic government employment includes military personnel, Federal personnel and a portion of state and local employment which is determined by out-of-state influences such as Federal support. Military and other Federal support make up the bulk of this basic government sector.

The driving influences behind changes in basic government employment for the year 2050 are indicated in Exhibit 8. The constraint in governmental budgets due to the demands for entitlement funding, such as Social Security and Medicare, will tend to reduce Federal budget growth and defense spending over the long term, based on HE research. Colorado's share of the Federal dollars is not expected to change under the middle scenario.

Exhibit 9 offers the State's projected annual employment change through the year 2035 and the low, middle and high HE scenarios of annual employment change for the basic government sector between 2035 and 2050. HE projects very modest growth under the low and middle scenarios, somewhat less than that projected through the year 2035.

Mining. The basic Colorado mining sector includes oil and gas extraction, mining, except oil and gas, and mining support. Oil and gas extraction would include oil shale. Mining support would include exploration and drilling. Given the importance of Colorado's mining sectors to different parts of the State, HE examined driving influences separately for oil, natural gas, oil shale, coal, uranium, molybdenum, and other mining related sectors. These driving influences for each segment of the mining industry are described in Exhibit 10.

The prospects of each segment of the mining industry are starkly different. Long term, oil production is on the decline because Colorado oil fields are mostly mature. On the other hand, exploration for natural gas is expanding with sizeable future drilling opportunities to develop and considerable growth in the number of gas wells is projected, compared with 2007. The oil shale industry exhibits the greatest level of uncertainty in terms of what is reasonably likely to occur. HE assumes that no oil shale will be developed by 2050 under the low scenario, whereas 550,000 barrels per day (bpd) will be developed under the high scenario by that year. The middle and high scenario oil shale development assumptions will result in considerable employment and growth in northwestern Colorado over the very long term under the middle and especially the high scenarios. Coal production will increase under each scenario, largely due to the demand for electric generation in Colorado and elsewhere. Off a very low base, uranium production is expected to increase considerably, due to demands for nuclear power generation. Molybdenum and other mining sectors reflect a small portion of the total mining industry and that will continue over the long term.

Exhibit 11 indicates the projected growth rate for Colorado's basic mining sector, including all its segments. State projections reflect a relatively flat to downward trading industry through the year 2035. HE assumes substantial annual growth in mining employment under the middle and high scenarios over the long term.

Manufacturing. Basic manufacturing includes fabrication activities for products which are sold outside the State of Colorado, such as computer manufacturers or breweries. The driving influences which will determine basic manufacturing employment for the year 2050 are enumerated in Exhibit 12, which also provides our low, middle and high scenario assumptions for year 2050 conditions in Colorado. U.S. economic conditions, the growth of international markets, and the foreign exchange rates are particularly important factors.

Exhibit 13 offers the manufacturing employment projections from the year 2000 through the year 2050. State projections through 2035 suggest a flat to slightly diminishing

manufacturing sector in Colorado. HE projections for the manufacturing sector are slightly more optimistic because of renewable and biofuel energy production and the growth in U.S. defense and aerospace spending.

Regional and national services. Colorado's basic regional and national services economic sector includes those companies that sell their services outside the State. For example, cable and telecommunications businesses, which are headquartered in Colorado, sell their services throughout the U.S. and the world. Professional service providers, such as engineers and lawyers, would also be a part of this sector.

The driving influences behind future changes to the regional and national services sector in Colorado are listed and described in Exhibit 14. This economic sector, which has grown considerably in recent years, will fluctuate largely on the growth in key service sectors, such as telecommunications, healthcare, construction, technology, etc. as a portion of the U.S. economy. In addition, the growth in mining, renewable fuels, or high-tech will also stimulate growth in the professional services sector in Colorado.

Exhibit 15 offers the employment projections for Colorado's regional and national services sector through the year 2050. Growth is projected by the State to continue at a healthy pace, and HE projects this growth to continue from 2035 to 2050.

Tourism. Colorado's basic tourism sector includes all tourist related employment, such as resorts, tourist activities, tourist related transportation, as well as second home construction and related real estate.

The driving influences behind changes in Colorado's tourism industry are listed in Exhibit 16. The tourism sector is susceptible to many influences, including overall U.S. economic conditions and foreign exchange rates. Labor shortage issues and the ability of Colorado's resort communities to manage those labor shortages will also have an effect on long term tourism growth. Climate change over the very long term will also have an influence, which might be positive for summer tourism in the mountains, but negative for winter mountain recreation activities. Colorado tourism, as in the past, will continue to be significantly affected by the national and international perceptions of Colorado as a tourist destination. For example, the pine beetle infestation and the potential for subsequent fires could be an issue.

Exhibit 17 provides the State of Colorado employment forecast for tourism through 2035 and the HE employment projections under the low, middle and high scenarios, through the year 2050. The range in growth between 2035 and 2050 exhibits the highly uncertain influences and susceptibility of tourism to a myriad of outside influences.

Household Basic Sectors

Household basic sectors focus on those population groups that, by their nature, result in an influx of money and once that money is expended, these household sectors produce jobs in the State of Colorado. The low, middle and high assumptions behind each of the four household basic sectors (retirees, wealth and income, public assistance and commuting employment) are set forth in Exhibit 18. Retirees are a household basic sector because

pensions and social security monies from outside the State tend to support these groups, and as these groups expend money, they create jobs. Less obvious, but of equal importance, are the number of jobs created by individuals under the age of 65 which, through the receipt of dividends, interest, rent and royalties, expend monies and support jobs in Colorado. Public assistance includes expenditures generated from individuals who receive government support. The last group, commuting jobs, are supported by expenditures of people who earn income outside their county of residence but spend those monies at home.

Household basic employment projections. Several inputs provide the basis for household sector employment projections. First, HE developed projections of income by source for 2050 based on an analysis of historical income data, CBEF's income projections through 2035 and the Social Security Administration's assumptions of changes in earnings and the real-wage differential through the year 2082.[3] HE then made estimates of the age distribution of the population in 2050 by applying age and gender specific birth rates and death rates to the SDO's 2035 population projections.[4] HE also made projections of the ratio of income to generated jobs for each household sector based on historical job and income data and CBEF projections through 2035. These three components, in combination with the assumptions made for the low, middle and high scenarios formed the basis of the 2050 household employment projections

State level household sector employment (Retiree; Wealth and Income; and Public Assistance) was distributed by region based on the ratio of region to state employment in that sector in 2035. Regional employment was distributed by county based on the ratio of county to region employment for each sector. Commuter jobs were held constant at the state, regional and county levels.

Exhibits 19 – 22 provide the employment projections through 2050 related to retirees, public assistance recipients, investment and wealth income recipients and commuters, respectively. Given demographic changes anticipated through the year 2050, these employment growth estimates are substantial.

Employment Projections

Year 2050 employment projections were made for each traditional and household basic industry based on the assumptions for each industry described previously in this report. Employment multipliers were then applied to basic employment projections to derive total employment.[5] Statewide employment projections were allocated to regions and then to counties as described more fully below. Additionally, regions largely dependent upon agriculture, mineral production, or tourism were projected independently, but projections were still based on assumptions for those industries developed at the Statewide level.

[3] CBEF income projections are obtained from Moody's Economy.com.
[4] This analysis changed the 2035 population through births and deaths, but does not account for any net migration.
[5] The difference between basic employment and total employment is local resident service jobs. These are all jobs in fields other than the traditional and household basic sectors described in this report,

Stepping down from the State to specific regions in Colorado, HE initially projected employment by the State's planning and management regions, since those were the focus of the SDO/CBEF models. In most instances, HE stepped down from each of the 14 State planning regions to counties within each region based upon that county's 2035 proportion of the regional population or employment for that region. A Colorado map delineating the Colorado State planning and management regions is provided in Exhibit 23.

Once HE developed the individual county employment projections for 2050, the employment estimates for each of Colorado's river basins could be compiled. HE aggregated the county employment for each basin, splitting counties which shared multiple river basins using the same algorithms as applied in the initial SWSI water demand studies completed in 2004. A Colorado map showing the State's river basins is provided in Exhibit 24.

The regional and county employment projection process is illustrated in Exhibit 25, which also includes an illustration of how the employment projections are used, along with other model inputs, to create population projections. Population projections for river basins and the State are discussed in the final section of this report.

Total State and river basin employment projections. Exhibit 26 shows year 2050 employment projections for each river basin and for the State, by industry. These employment projections are based on the industry assumptions developed for the middle scenario. Employment projections based on the low and high scenarios can be found in the Appendix to this report. Exhibit 25 also includes year 2007 employment data by industry for each river basin and the State. A comparison of 2007 and 2050 employment by industry can provide information about projected changes in the relative importance of each industry in each basin. A summary of key findings and observations is below:

- Statewide, in 2050 slightly more than half of total jobs (52 percent) are projected to be in traditional basic industries and household basic sectors and slightly less than half (48 percent) are projected to be resident service jobs. Agriculture, mining, manufacturing and government sector jobs are projected to increase through 2050, but the percentage of jobs in these sectors as a portion of total jobs will decrease compared to 2007 levels. The major drivers of growth in the State will be household basic jobs (those jobs created through the spending of retirees, public assistance recipients, investment income recipients and commuters) and regional and national service jobs. Household basic jobs will experience a large amount of growth mainly due to the aging of the population; of the household basic sectors, jobs based on retiree spending will grow by the largest number and the fastest rate. Regional and national service jobs will be a leading sector of growth in the State due to the assumption of moderate economic growth in the U.S., the growth of Colorado service sectors (healthcare, technology, construction, technology) as a result of U.S. economic growth and the development of mining, renewable fuels and other high technology sectors. Tourism is also anticipated to grow in importance in Colorado by 2050, due to moderate growth of the U.S. economy, international economic expansion, and the identity of Colorado as a tourist destination.

- Patterns of employment growth in the Arkansas Basin are similar to those seen at the Statewide level. Regional and national service jobs, along with household basic jobs, made up the majority of basic sector employment in 2007. Household basic jobs, tourism jobs and regional and national service jobs will be the drivers of growth in the Basin by 2050. Employment in these sectors is anticipated to grow by 193 percent, 131 percent and 117 percent, respectively, between 2007 and 2050. In comparison, employment in other basic sectors (agriculture, mining, manufacturing and government) will increase by 40 percent or less over the same period.

- In the Colorado Basin, tourism jobs comprised the largest portion of basic sector employment in 2007, followed by regional and national service jobs and household basic jobs. Household basic jobs are expected to grow at the fastest rate of any sector between 2007 and 2050, but tourism will remain the Basin's largest base of employment. Mining is the only sector in the Basin that is expected to experience decreased employment by 2050.

- In the Gunnison Basin, household basic jobs made up the largest portion of basic sector employment in 2007. These jobs will grow at the fastest rate of any basic sector and will remain the largest source of employment in 2050, followed by tourism and regional and national services. Other sectors will grow at slower rates, with decreased employment anticipated in the mining sector by 2050.

- Agriculture was the largest basic employment sector in the North Platte Basin in 2007 and is anticipated to remain the most important sector by 2050. Household basic jobs will remain the second most important sector in the Basin, with a decreasing share of total jobs. Regional and national service jobs will grow at the fastest rate of any sector between 2007 and 2050, increasing in share of total jobs.

- Agriculture was the largest basic employment sector in the Rio Grande Basin in 2007, but is expected to be slightly behind household basic sectors by 2050. The portion of mining jobs compared to total jobs in the Basin is expected to increase by 2050; the same pattern is anticipated in regional and national service jobs and tourism jobs.

- The South Platte Basin has the largest employment of all Basins, totaling over 2 million jobs in 2007 and over 3.4 million job opportunities are expected by 2050. Regional and national service jobs led employment in 2007 and will remain the largest source of employment in the Basin in 2050. Household basic sector employment is anticipated to grow more rapidly than other basic sectors, about 174 percent between 2007 and 2050. Tourism jobs are expected to grow by about 83 percent and other basic sector employment will grow by 35 percent or less over the same period.

- Tourism was the most important basic sector in the Southwest Basin in 2007, followed by household basic jobs and regional and national service jobs. Similar to the Colorado Basin, household basic jobs are expected to grow at the fastest rate of any sector between 2007 and 2050, but tourism will remain the Southwest Basin's

largest source of employment, increasing in its share of total employment. By 2050, mining jobs in the Basin will have decreased compared to 2007 mining employment.

- In the Yampa Basin, tourism was the leading sector in 2007, followed by regional and national services; however, by 2050 regional and national service are expected to be the leading sector, with both mining and tourism about equal for second place. Mining jobs in the Basin are expected to grow by over 400 percent between 2007 and 2050.

Population Projections

With the completion of the employment projections, the population projection process relies upon the SDO/CBEF models prepared by the State and modified and extrapolated by HE as described previously.[6] As with the employment projections, once HE developed the individual county population projections for 2050, the population estimates for each of Colorado's river basins could be compiled. HE aggregated the county population for each basin, splitting counties which shared multiple river basins.

Total State and river basin population projections. Exhibit 27 depicts the key results of the study, namely population projections for the State and for each river basin through the year 2050, under low, middle and high economic development assumptions. Between the year 2005 and 2050, the State of Colorado is projected to grow from approximately 4.8 million people to more than 9.1 million people, or slightly less than a doubling of the population under middle economic development assumptions. Under low economic development assumptions, State population would be projected to grow to about 8.4 million people, or by about 76 percent. Under high economic development assumptions, including a 550,000 barrel per day oil shale industry, the State's population is projected to grow to just over 10.0 million people, or by 109 percent, as compared to the year 2005. On average, Statewide population projections from 2005 forward indicate an increase of about 1.4 million people every 15 years, similar to the increase which occurred from 1990 to 2005.

Population projection by river basin. Population projections for each river basin from 1990 through the year 2050, and counties within those river basins, are provided in Exhibits 28 through 34. These exhibits illustrate population changes from 1990 to 2005, SDO/CBEF projections of population to 2035 and HE projections under low, middle and high economic development assumptions through the year 2050. Summary results for individual basins follow:

- Arkansas River Basin population is projected to increase by about 86 percent between 2005 and 2050 under middle economic development assumptions; El Paso county will account for much of the growth and will remain the largest population center in that basin.

[6] Total employment is used to estimate migration in and out of the State.

- The Colorado River Basin is expected to grow by 2.53 times between the year 2005 and 2050 with considerable growth projected by all counties in that basin, especially Garfield and Mesa Counties.

- The Southwest Basin is projected to grow by about 2.24 times between the year 2005 and 2050 under middle economic development assumptions. La Plata County will remain the most populous county in that basin and will continue to experience growth.

- The Gunnison River Basin is projected to grow by about 2.23 times between 2005 and 2050, under the middle scenario, with Mesa and Montrose Counties being the most populous in that region.

- The North Platte River Basin, which consists of only Jackson County, is projected to grow from about 1,565 people in 2005 to about 2,200 people by the year 2050; an increase of about 40 percent.

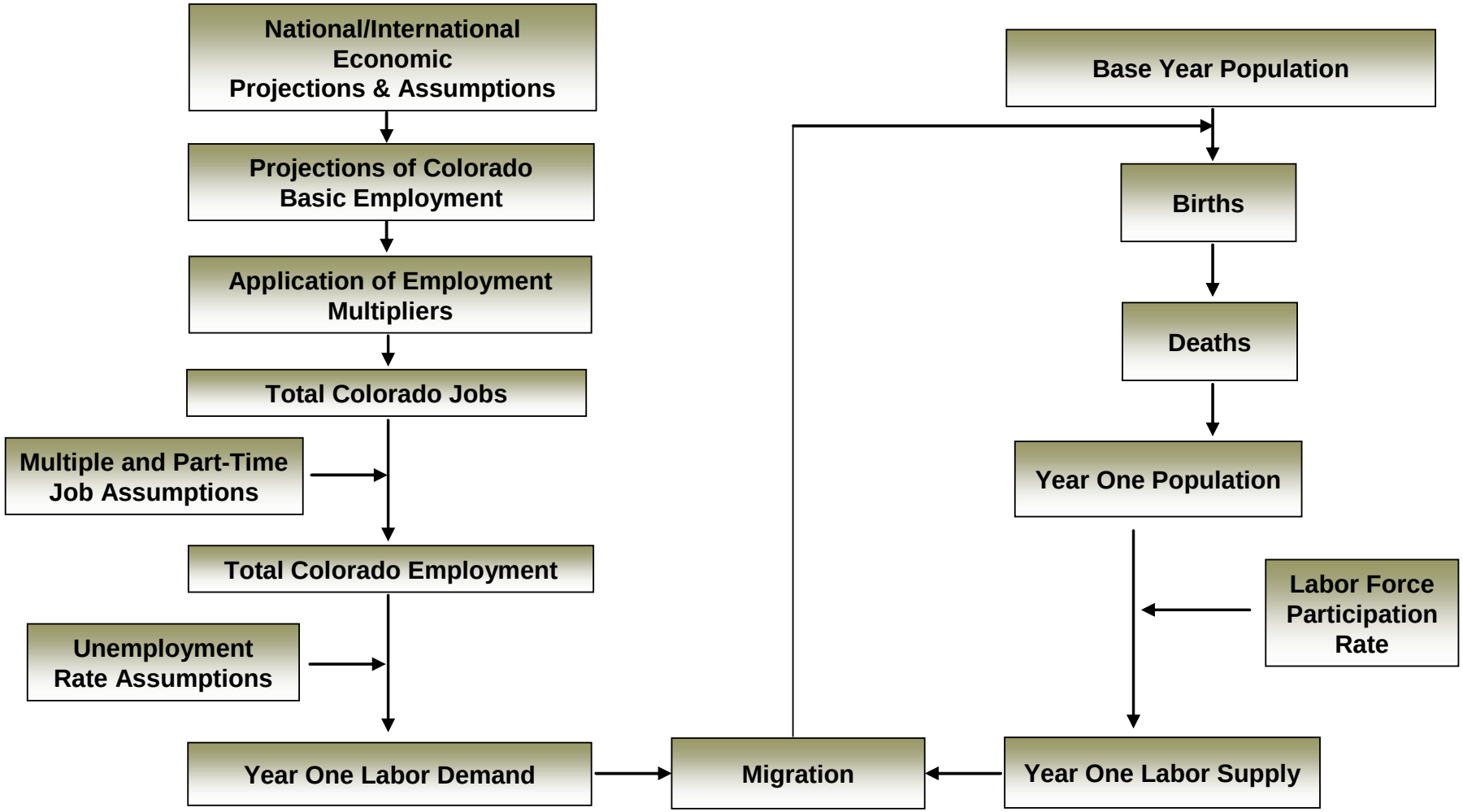
- The Rio Grande River Basin is projected to increase from approximately 50,000 people in the year 2005 to 80,000 people by the year 2050; an increase of about 60 percent.

- The Yampa River Basin population is projected to increase by about 2.8 times between 2005 and 2050, under middle economic development assumptions, increasing from about 42,000 to about 117,000 residents during that period. This increase is mainly due to assumptions about increased mining activity in the area.

- As the most populous river basin in the State, the South Platte, which includes Denver metro area counties, is projected to grow from approximately 3.3 million people in the year 2005 to 6.0 million people by the year 2050, under the middle economic development assumptions. This amounts to an increase of about 2.7 million people, or about 81 percent, during that time frame. About 69 percent of all Colorado residents resided in the South Platte Basin in the year 2005; by the year 2050 that proportion will decrease only slightly to about two-thirds.

Exhibit 35 provides a tabular form of the population projections by river basin and by county from 2005 to the year 2050, with average annual changes under each scenario for that period. The State's population is projected to grow by 1.44 percent on an annual average basis through the year 2050, under middle economic growth assumptions.

Exhibit 1
SDO – CBEF POPULATION FORECASTING METHODOLOGY



Note: CBEF uses employment commuting pattern assumptions and historical growth capture rates to allocate job growth from the state to regions and counties.

Exhibit 2
SDO – CBEF POPULATION FORECASTING METHODOLOGY

A. Direct basic jobs – Harvey Economics projected independently by sector

Times

B. Non-basic resident service job ratio – HE applied one-half difference in 2030 and 2035 ratio

Equals

C. Total jobs – sum of basic and non-basic jobs

Plus

D. Military jobs – Harvey Economics held constant from 2035 to 2050

Plus or Minus

E. Number of commuters – Weighted average of years 2020 to 2035

Times

F. Multiple job holding rate – 2035 rates held constant to 2050

Equals

G. Total Employment – Sum of C,D,E and F above

Exhibit 2 (cont).
EXTENDING THE CBEF/SDO MODEL TO 2050

G. Total Employment – Sum of C,D,E and F above

Times

H. Unemployment rate – Half the difference in 2030 and 2035 rates

Equals

I. Civilian labor force – Employment plus unemployment

Times

J. Labor force participation rate – Applied half the difference between 2030 and 2035 to produce 2040, 2045 and 2050 rates

Equals

K. Non-institutional working age population – working population and those who could work

Times

L. Ratio of working age population to total population – Half difference of 2030 and 2035 ratio to estimate 2040, 2045, 2050 rates

Equals

M. Total population – Census based and modified for under/over counts

Exhibit 3.
COLORADO'S BASIC EMPLOYMENT SECTORS

Traditional Basic Sectors	Household Basic Sectors
Agriculture → production, inputs, processing	**Retirees** → jobs support by expenditures of persons 65 years and older
Government → military, other federal, state and local	**Wealth & Income** → jobs supported by expenditures of the non-wage income of persons under 65 years
Mining → oil & gas, mining exc. oil & gas, mining support	**Public Assistance** → jobs supported by expenditures from those on public assistance
Manufacturing → that portion which sells products outside county	**Commuting/Employment** → jobs supported by expenditures of those who earn their income outside the county of residence
Regional and National Services → services provided to out-of-county customers	
Tourism → resorts, recreational, tourism, related services, tourist related transportation, second home construction and real estate	

Exhibit 4.
U.S. AND INTERNATIONAL ASSUMPTIONS FOR 2050 CONDITIONS

Factor	Low	Middle	High
Conditions in developing world	➢ Economic growth rates slow to developed world growth rates ➢ Population growth rate slows to half of current developing world rates	➢ Economic growth rates slow to twice recent developed world growth rates ➢ Population growth rates slow to twice developed growth rates	➢ Economic growth slows to half recent developing world rates ➢ Population growth slows to rate of developed world
Relative value of dollar	➢ Will return to late 1980's level (i.e., $1.00 per euro)	➢ Will return to late 1990's level (i.e., $1.20 per euro)	➢ Will remain at present levels (i.e., $1.50 per euro)
U.S. population	➢ 0.5% per year growth	➢ 1.0% per year growth	➢ 1.5% per year growth
U.S. personal income	➢ 1.5% per year growth	➢ 2.0% per year growth	➢ 3.0% per year growth
U.S. personal consumption expenditures	➢ 1.5% per year growth	➢ 2.0% per year growth	➢ 3.0% per year growth
U.S. GDP	➢ 1.5% per year growth	➢ 2.0% per year growth	➢ 3.0% per year growth
U.S. Federal budget	➢ 1.0% annual growth	➢ 2.0% annual growth	➢ 2.5% annual growth

Exhibit 5.
INTERNATIONAL AND U.S. OIL AND NATURAL GAS DEMAND ASSUMPTIONS FOR 2050 CONDITIONS

Factor	Low	Middle	High
Demand for oil (bbl)	➢ Consumer moves to transportation substitutes	➢ Consumer substitution is incomplete	➢ Petroleum-based transportation continues
	➢ Alternative fuels become prevalent (biofuel, electric, hydrogen)	➢ Alternative fuels meet portion of demand	➢ Marginal contribution from alternative fuels
	➢ Same per capita rate	➢ Total demand increases at half current per capita rate	➢ Per capita demand reductions in developed world more than offset by per capita increases in developing world
	➢ Important technological improvement in recovery	➢ Periodic technological improvements	➢ Marginal technological improvements
	➢ Economic growth rate in developing world slows considerably	➢ Economic growth in developing world slows somewhat	➢ Economic growth in developing world continues at rapid pace
Demand for natural gas	➢ Large portion of gas comes from Alaska, LNG	➢ Portion of supplies come from Alaska, LNG	➢ Portion of supplies from Alaska, no LNG supplies
	➢ Increasing pace of technological improvement	➢ Modest technological improvement	➢ Minimal technological improvement
	➢ Demand per capita slows from current pace; coal or nuclear fuel used for power generation	➢ Demand per capita stays at present levels; coal or coal gasification used for some power generation	➢ Demand per capita increases, no substitute for NG identified

Exhibit 6.
AGRICULTURAL ASSUMPTIONS FOR 2050 CONDITIONS

Driving Influences	Low	Middle	High
World food demand	➢ Economic growth rates slow to developed world growth rates ➢ Population growth rate slows to half of current developing world rates ➢ Food demand stabilizes	➢ Economic growth rates slow to twice recent developed world growth rates ➢ Population growth rates slow to twice developed growth rates ➢ Food demand increases moderately	➢ Economic growth slows to half recent developing world rates ➢ Population growth slows to rate of developed world ➢ Food demand increases substantially
Economics of Colorado Agriculture	➢ Real prices relatively stable ➢ Operating costs relatively stable	➢ Real prices fluctuate up ➢ Operating costs rise with prices	➢ Real prices fluctuate up ➢ Operating costs rise less than prices
Genetic modification	➢ Acceptance remains same ➢ No significant changes in seeds	➢ Modest sporadic increases in acceptance ➢ Continued improvement in seed capability	➢ Full acceptance of GM produce ➢ Breakthroughs in yield gains
Conversion of agriculture lands	➢ High Colorado population growth scenario, lower density development, no further zoning restrictions	➢ Middle Colorado population growth scenario, continue same density development, same current effort to preserve ag lands	➢ Low Colorado population growth scenario, higher density development, stricter zoning to preserve ag lands
Subdivision of ranches to ranchettes	➢ Stricter zoning diminishes subdivision, Demographic shifts post-baby boom reduce demand for ranchettes	➢ Subdivision of ranches continues at current pace	➢ Subdivision of ranches increases, Reverse migration to rural areas evident
Acreage devoted to Biofuel production	➢ Ag production devoted to Biofuel does not Increase, Biofuel subsidies removed	➢ New Biofuels developed, Colorado a marginal participant	➢ New Biofuels developed, Colorado ag a marginal participant

Exhibit 6 (continued).
AGRICULTURAL ASSUMPTIONS FOR 2050 CONDITIONS

Driving Influences	Low	Middle	High
Climate change	➢ Variable growing seasons at lower elevations, longer growing seasons at higher elevations, unexpected challenges, lower ag output from climate change	➢ Variable growing seasons at lower elevations, longer growing seasons at higher elevations, modestly lower ag output from climate change	➢ Variable growing seasons at lower elevations, longer growing seasons at higher elevations, no net change in ag output from climate
Land productivity, technological innovation	➢ Important improvements, increased yield per acre with stabilized labor requirements per acre	➢ Continued incremental improvements in productivity, labor requirements per acre increase modestly	➢ Limited improvements in productivity, labor requirements per acre increase seeking high yield per acre
Federal Farm Program and Subsidies	➢ Continues current status	➢ Continues current status	➢ Continues current status

Exhibit 7.
BASIC SECTOR EMPLOYMENT – AGRICULTURE

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	-0.3%	-1,399
	2005-2020	0.7%	11,800
	2020-2035	0.6%	10,500
	2025-2035	0.6%	7,500
HE Scenarios			
Low	2035-2050	0.3%	6,100
Middle	2035-2050	0.7%	12,700
High	2035-2050	1.2%	24,600

Exhibit 8.
GOVERNMENT ASSUMPTIONS FOR 2050 CONDITIONS

Driving Influence	Low	Middle	High
U.S. Population	➢ 0.5 % per year growth	➢ 1.0 % per year growth	➢ 1.5 % per year growth
U.S. Federal Budget	➢ 1.0 % per year growth	➢ 2.0 % per year growth	➢ 2.5 % per year growth
Fiscal constraint at Federal, state and local government level	➢ Austere due to entitlements, no relief to constraint on budgets	➢ Modest revenue increases, entitlement adjustments, delayed retirements relieve fiscal constraint somewhat	➢ Public sector revenues and terms of Entitlements adjusted into balance
Share of Federal role performed in Colorado	➢ Decreases slightly	➢ Stays the same	➢ Increases slightly
U.S. Defense Spending	➢ Annual average growth of 0.5%	➢ Long term average growth of 1% per year	➢ Annual growth of 1.5% per year
Share of Defense role performed in Colorado	➢ Less than present share	➢ Equal to present share	➢ Greater than present share
Shifting of public sector responsibilities to state and local governments	➢ No further shift	➢ Moderate additional shift	➢ Considerable shift in responsibility

Exhibit 9.
BASIC SECTOR EMPLOYMENT – GOVERNMENT

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	0.8%	7,565
	2005-2020	1.6%	50,200
	2020-2035	0.0%	1,600
	2025-2035	0.0%	1,200
HE Scenarios			
Low	2035-2050	0.3%	10,800
Middle	2035-2050	0.5%	18,300
High	2035-2050	0.8%	29,900

Exhibit 10.
MINING ASSUMPTIONS FOR 2050 CONDITONS

Driving Influences	Low	Middle	High
Oil	➢ Recovery techniques same, well costs rise	➢ Recovery techniques improve modestly, well costs stay same	➢ Enhanced recovery techniques, lower well costs
	➢ Exploration activity 70% less that 2007	➢ Exploration activit y 35% less than 2007	➢ Exploration activity 20% less than 2007
	➢ Production and number of wells to decline by 40% from 2007	➢ Oil production and number of wells to decline by 20%	➢ Oil production, number of wells slowly declines
	➢ Field and well maintenance 40% less than 2007	➢ Field and well maintenance 20% less than 2007	➢ Field and Well Maintenance 10% less than 2007
	➢ Net end of year reserves decline rapidly	➢ Net end of year reserves decline steadily	➢ Net end of year reserves decline slowly
Natural Gas	➢ Enhanced recovery techniques, lower well costs	➢ Recovery techniques improve modestly, well costs stay same	➢ Slight improvement in recovery techniques, same well costs
	➢ Exploration activity average of 2000-2007	➢ Exploration activity continues at 2007 pace	➢ Exploration activity 33% more than 2007
	➢ Gas production, number of wells increase moderately	➢ Gas production and number of wells doubles from 2007	➢ Gas production, number of wells increases four-fold from 2007
	➢ Field and well maintenance increases moderately	➢ Field and well maintenance doubles from 2007	➢ Field and well maintenance four -fold more than 2007
	➢ Net annual reserves stays same	➢ Net annual reserves declines modestly	➢ Net annual reserves declines steadily
Oil Shale	➢ No Oil shale industry	➢ 150,000 Bb l per day industry	➢ 550,000 Bbl per day industry
	➢ Development challenges not overcome	➢ Development challenges overcome by 2040	➢ Development challenges overcome by 2030

Exhibit 10 (continued).
MINING ASSUMPTIONS FOR 2050 CONDITIONS

Sectors	Low	Middle	High
Coal	➢ Production increases 50% over 2007 ➢ Productivity continues to improve modestly ➢ Employment remains same as 2007 ➢ No improvement in clean coal technologies ➢ Large decrease in coal's share of electric generation fuel.	➢ Production increases by 75% over 2007 ➢ Productivity continues to improve modestly ➢ Employment doubles over 2007 ➢ Moderate improvement in clean coal technologies ➢ Moderate decrease in coal's share of electric generation fuel	➢ Production doubles over 2007 ➢ No further improvement in productivity ➢ Substantial improvement in clean coal technologies ➢ Coal maintains same share of electric generation fuel
Uranium	➢ Uranium mining at twice 2007 levels ➢ Price drops modestly ➢ Modest increase in Nuclear Power Generation	➢ Uranium mining three times 2007 levels ➢ Price remains at 2007 levels ➢ Moderate increase in Nuclear Power Generation	➢ Uranium mining five times 2007 levels ➢ Price increases at half recent rate ➢ Substantial increase in Nuclear Power Generation
Molybdenum	➢ Existing mines play out ➢ No new recoverable reserves identified ➢ Environmental issues for new developments preclude development of known deposits ➢ Steel demand slows	➢ One mine remains in Colorado ➢ Moderate amount of new recoverable reserves identified ➢ Environmental issues for new developments overcome ➢ Steel demand continues at current pace	➢ Two mines operating in Colorado ➢ Doubling of 2007 recoverable reserves ➢ Environmental issues for new developments overcome ➢ Steel demand continues to grow
Other mining and related sectors	➢ Gold, Sand and Gravel, other mining activities diminish ➢ Electric Generation employment diminishes	➢ Gold, Sand and Gravel, other mining activities remain same size ➢ Electric Generation employment remain same size	➢ Gold, Sand and Gravel, other mining activities grow in line with Colorado employment ➢ Electric Generation employment grows modestly

Exhibit 11.
BASIC SECTOR EMPLOYMENT – MINING

		Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data		2000-2005	8.2%	6,112
		2005-2020	1.8%	5,700
		2020-2035	-1.3%	-4,500
		2025-2035	-1.9%	-4,300
HE Scenarios				
	Low	2035-2050	1.3%	4,100
	Middle	2035-2050	3.9%	15,400
	High	2035-2050	6.5%	31,500

Exhibit 12.
MANUFACTURING ASSUMPTIONS FOR 2050 CONDITIONS

Driving Influence	Low	Middle	High
U.S. GDP	➢ Slow Growth—1.0% per year	➢ Moderate Growth—2% per year	➢ Recent Historical Growth—3% per year
International markets	➢ Modest growth in developing world; flat demand from G7 countries	➢ Developing world markets growing moderately; modest growth from G7 countries	➢ Developing world market grow at half recent pace; moderate growth from G7 countries
Relative value of dollar	➢ Will return to late 1980's levels	➢ Will return to historical 10 year average	➢ Will remain at present levels
High tech	➢ Remaining at 2007 levels ➢ 2007 technology continues	➢ Moderate gains resume ➢ Technology evolves	➢ Sizeable gains for Colorado ➢ Breakthroughs in high tech
U.S. Defense and Aerospace Spending	➢ Annual average growth of 0.5%	➢ Long term average growth of 1% per year	➢ Annual growth of 1.5 % per year
Productivity and technological innovation	➢ Rapid gains resulting in less labor demand	➢ Moderate gains, downward pressure on employment	➢ Minimal gains, no effect on employment demand
Outsourcing	➢ Continues rapid pace	➢ Moderate pace	➢ Slows to modest level
Renewable, Biofuel Energy production	➢ Infancy of industry, Colorado production facilities small role	➢ Colorado becomes a player in a growing industry	➢ Renewable industry takes off, Colorado plays an important role

Exhibit 13.
BASIC SECTOR EMPLOYMENT – MANUFACTURING

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	-4.9%	-29,625
	2005-2020	0.4%	6,600
	2020-2035	1.0%	17,300
	2025-2035	1.2%	14,100
HE Scenarios			
Low	2035-2050	0.0%	0
Middle	2035-2050	0.4%	6,900
High	2035-2050	0.6%	12,000

Exhibit 14.
REGIONAL AND NATIONAL SERVICES ASSUMPTIONS FOR 2050 CONDITIONS

Driving Influences	Low	Middle	High
U.S. GDP	➢ Slow Growth—1.5% per year	➢ Moderate Growth—2% per year	➢ Recent Historical Growth—3% per year
Growth in key service sectors as a portion of U.S. economy	➢ Health care, business services, construction and technology will grow modestly as a portion of U.S.	➢ Health care, business services, construction and technology will grow moderately as a portion of U.S.	➢ Health care, business services, construction and technology will grow significantly as a portion of U.S.
Professional services	➢ Changes with mining, manufacturing, defense, high tech	➢ Changes with mining, manufacturing, defense, high tech	➢ Changes with mining, manufacturing, defense, high tech
Colorado's market share of these sectors	➢ Colorado will lose market share to other states	➢ Colorado will maintain its market share	➢ Colorado will gain market share
Technological innovation	➢ Minimal technological innovation	➢ Moderate technological innovation	➢ Substantial technological innovation
Extent of outsourcing for business services	➢ Organizations reduce percentage of outsourcing	➢ Organizations maintain current percentage of outsourcing	➢ Organizations increase percentage of outsourcing

Exhibit 15.
BASIC SECTOR EMPLOYMENT – REGIONAL & NATIONAL SERVICES

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	1.5%	34,102
	2005-2020	1.9%	149,700
	2020-2035	1.6%	167,500
	2025-2035	1.6%	115,500
HE Scenarios			
Low	2035-2050	0.8%	99,600
Middle	2035-2050	1.2%	153,700
High	2035-2050	2.0%	271,400

Exhibit 16
TOURISM ASSUMPTIONS FOR 2050 CONDITIONS

Driving Influences	Low	Middle	High
U.S. Economic Conditions (change in GDP)	➢ 1.5% per year growth	➢ 2% per year growth	➢ 3% per year growth
Relative value of dollar	➢ Will return to late 1980's level	➢ Will return to late 1990's level	➢ Will remain at present levels
Fuel Demand	➢ High	➢ Medium	➢ Low
Demographic Patterns (percent of population aged 18-65)	➢ Lower proportion of traveling population	➢ Lower proportion of traveling population	➢ Lower proportion of traveling population
Colorado Population Growth	➢ Slow growth	➢ Moderate growth	➢ High growth
Labor shortage	➢ No improvement in housing shortage ➢ No labor shortage solutions found	➢ Moderate improvements in worker housing ➢ Isolated success with alternative labor supply	➢ Worker housing constraint overcome ➢ Alternative labor supplies widely used
Second homes	➢ Market saturated ➢ 2007 use patterns remain	➢ Limited growth in new units ➢ Modestly higher utilization	➢ Continued growth in units ➢ Usage increases
Climate change	➢ No adaptive actions to mitigate effects ➢ 3 week loss from ski season ➢ Snow conditions deteriorate ➢ Early rapid run-off disrupts stream-based recreation	➢ Moderate adaptive actions to mitigate effects ➢ 1.5 week loss from ski season ➢ Snow conditions deteriorate somewhat ➢ Early rapid run-off disrupts stream-based recreation somewhat, market adapts somewhat ➢ Refuge from global warming marketed to some effect	➢ Major adaptive actions to mitigate effects ➢ No loss from ski season ➢ Reduced snow conditions managed well ➢ Stream-based recreation market adjusts to early rapid run-off ➢ Summer season in mountains big as a refuge from global warming
National, International perception of Colorado	➢ Mountain pine beetle decimates most lodgepole pines and climate change causes increased vulnerability of forests to infestations. ➢ Increased frequency and magnitude of fires ➢ Second home market near recreation areas suffers ➢ Poor snow conditions recognized, loss of tourism market share ➢ Press coverage of forest loss, reduced aesthetics results in negative perceptions, loss of tourism market share	➢ Mountain pine beetle decimates most lodgepole pines and climate change causes some increased vulnerability of forests to infestations. ➢ Good management of more numerous fires ➢ Demand for second homes diminishes somewhat ➢ Poor snow conditions managed somewha no loss of tourism market share ➢ Limited press coverage of forest loss, reduced aesthetics results in no loss of tourism market share	➢ Mountain pine beetle decimates many lodgepole pines, but some forests survive and vulnerability of forests to infestations is unchanged. ➢ Pro-active efforts reduce number and magnitude of fires ➢ Second home market remains unaffected ➢ Snow conditions managed better in Colorado, gain of tourism market share ➢ Press coverage recognizes Colorado's relative ability to meet challenges, gain of tourism market share

Exhibit 17.
BASIC SECTOR EMPLOYMENT – TOURISM

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	0.0%	410
	2005-2020	1.7%	54,600
	2020-2035	1.7%	72,800
	2025-2035	1.7%	49,000
HE Scenarios			
Low	2035-2050	0.5%	24,500
Middle	2035-2050	1.5%	79,500
High	2035-2050	2.5%	143,700

Exhibit 18.
KEY 2050 ASSUMPTIONS FOR HOUSEHOLD BASIC SECTORS

Sector	Low	Middle	High
Commuting Employment	➢ No change in overall commuting jobs	➢ No change in overall commuting jobs	➢ No change in overall commuting jobs
Retiree Generated Employment	➢ Annual increases in total property income remain constant at the 2030-2035 average rate, 2.0 percent per year	➢ Annual increases in total property income remain constant at 2030-2035 average rate, 2.0 percent per year	➢ Total property income increases at 3.1 percent per year, reflecting increase during the period 2020 to 2035
	➢ Proportion of property income earned by persons aged 65+ increases with its increasing proportion of the total population by 2050	➢ Proportion of property income earned by persons aged 65+ increases with its increasing proportion of the total population by 2050	➢ Proportion of property income earned by persons aged 65+ increases with its increasing proportion of the total population by 2050
	➢ Social Security payments increased between 3.1 and 3.5 percent per year between 2035 and 2050	➢ Social Security payments increased between 3.1 and 3.5 percent per year between 2035 and 2050	➢ Social Security payments increased between 3.1 and 3.5 percent per year between 2035 and 2050
	➢ Ratio of retiree income to retiree generated jobs increases between 2.3 and 2.5 percent per year	➢ Ratio of retiree income to retiree generated jobs increases between 1.9 and 2.2 percent per year	➢ Ratio of retiree income to retiree generated jobs increases between 1.9 and 2.2 percent per year
Public Assistance (PA) Generated Employment	➢ Transfer payments increase from 2.4 to 3.0 percent per year between 2035 and 2050	➢ Transfer payments increase from 2.1 to 3.0 percent per year between 2035 and 2050	➢ Transfer payments increase at average 2030- 2035 rate - 3.5 percent per year between 2035 and 2050
	➢ Ratio of PA income to generated jobs increases between 1.7 and 2.2 percent per year	➢ Ratio of PA income to generated jobs increases between 0.7 and 1.7 percent per year	➢ Ratio of PA income to generated jobs increases between 0.7 and 1.7 percent per year
Wealth and Income (W&I) Generated Employment	➢ Annual increases in total property income remain constant at the 2030-2035 average rate, 2.0 percent per year	➢ Annual increases in total property income remain constant at 2030-2035 average rate, 2.0 percent per year	➢ Total property income increases at 5.1 percent per year, reflecting the increase between 2020 to 2035
	➢ Proportion of property income earned by persons under age 65 decreases with its decreasing proportion to total population by 2050	➢ Proportion of property income earned by persons under age 65 decreases with its decreasing proportion to total population by 2050	➢ Proportion of property income earned by persons under age 65 decreases with its decreasing proportion to total population by 2050
	➢ Ratio of property income to W&I generated jobs increases between 0.6 and 1.0 percent per year	➢ Ratio of property income to W&I generated jobs increases between 0.5 and 0.8 to percent per year	➢ Ratio of property income W&I to generated jobs increases between 0.5 and 0.8 percent per year

Exhibit 19.
HH BASIC SECTOR EMPLOYMENT – RETIREES

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	1.2%	6,801
	2005-2020	4.7%	115,000
	2020-2035	3.0%	131,200
	2025-2035	2.3%	74,500
HE Scenarios			
Low	2035-2050	0.9%	53,400
Middle	2035-2050	1.0%	58,400
High	2035-2050	1.3%	78,500

Exhibit 20.
HH BASIC SECTOR EMPLOYMENT – PUBLIC ASSISTANCE

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	3.6%	8,125
	2005-2020	2.1%	18,100
	2020-2035	1.0%	11,600
	2025-2035	1.0%	7,900
HE Scenarios			
Low	2035-2050	1.3%	17,100
Middle	2035-2050	2.9%	42,800
High	2035-2050	3.3%	49,600

Exhibit 21.
HH BASIC SECTOR EMPLOYMENT – INVESTMENT & WEALTH

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	-0.8%	-3,376
	2005-2020	2.9%	41,900
	2020-2035	2.2%	45,400
	2025-2035	1.7%	25,700
HE Scenarios			
Low	2035-2050	1.3%	36,600
Middle	2035-2050	1.4%	39,000
High	2035-2050	2.2%	65,000

Exhibit 22.
HH BASIC SECTOR EMPLOYMENT – COMMUTER GENERATED JOBS

	Time Period	Average Annual Change	Absolute Change (Employees)
CBEF Data	2000-2005	0.0%	0
	2005-2020	-0.4%	-360
	2020-2035	-0.2%	-210
	2025-2035	-0.2%	-140
HE Scenarios			
Low	2035-2050	2.4%	2,700
Middle	2035-2050	2.4%	2,700
High	2035-2050	2.4%	2,700

Exhibit 23.
COLORADO STATE PLANNING AND MANAGEMENT REGIONS

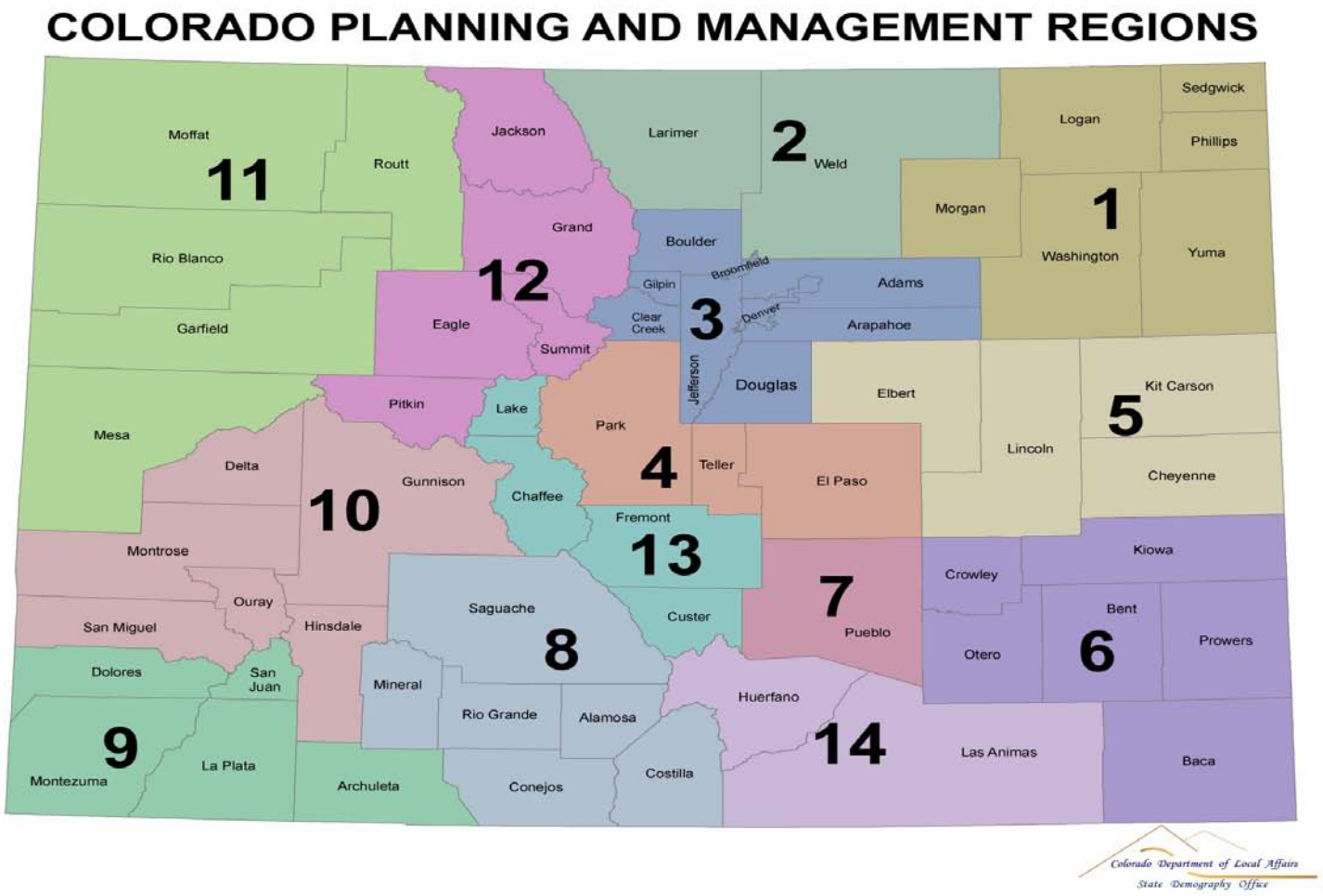
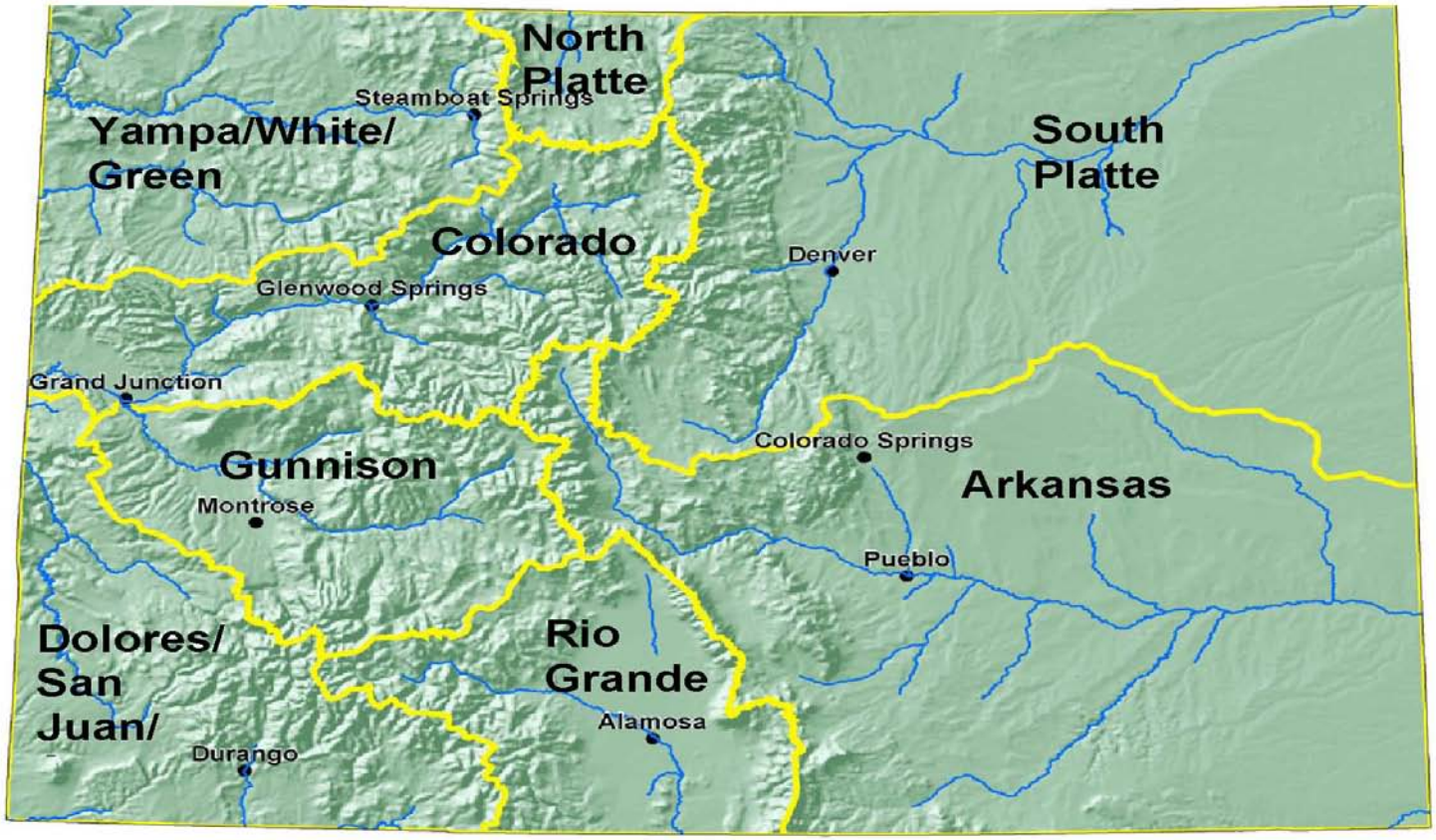


Exhibit 24.
COLORADO RIVER BASINS



Colorado's Eight Major River Basins

Exhibit 25.
2050 EMPLOYMENT PROJECTIONS BY RIVER BASIN, MIDDLE SCENARIO

	River Basins									
	Arkansas		Colorado		Gunnison		North Platte		Rio Grande	
	2007	2050	2007	2050	2007	2050	2007	2050	2007	2050
Agribusiness Jobs	**13,000**	**17,300**	**5,300**	**7,800**	**4,200**	**6,000**	**300**	**400**	**5,400**	**7,700**
% of Total Jobs	2.7%	1.9%	2.6%	1.8%	7.5%	5.8%	33.3%	26.7%	22.9%	20.9%
Total % Growth	NA	33%	NA	47%	NA	43%	NA	33%	NA	43%
Mining Jobs	**900**	**1,000**	**5,400**	**2,900**	**1,600**	**600**	**0**	**0**	**60**	**140**
% of Total Jobs	0.2%	0.1%	2.6%	0.7%	2.9%	0.6%	0.0%	0.0%	0.3%	0.4%
Total % Growth	NA	11%	NA	-46%	NA	-63%	NA	0%	NA	133%
Manufacturing Jobs	**20,100**	**25,300**	**3,300**	**4,200**	**1,400**	**1,900**	**5**	**5**	**190**	**200**
% of Total Jobs	4.2%	2.8%	1.6%	0.9%	2.5%	1.8%	0.6%	0.3%	0.8%	0.5%
Total % Growth	NA	26%	NA	27%	NA	36%	NA	0%	NA	5%
Government Jobs	**59,200**	**82,500**	**8,400**	**11,700**	**2,700**	**3,600**	**60**	**90**	**1,800**	**2,300**
% of Total Jobs	12.3%	9.1%	4.1%	2.6%	4.8%	3.5%	6.7%	6.0%	7.6%	6.2%
Total % Growth	NA	39%	NA	39%	NA	33%	NA	50%	NA	28%
Regl/Natl Services Jobs	**70,200**	**152,100**	**24,300**	**50,200**	**7,000**	**13,000**	**40**	**90**	**2,800**	**4,900**
% of Total Jobs	14.6%	16.8%	11.9%	11.3%	12.5%	12.6%	4.4%	6.0%	11.9%	13.3%
Total % Growth	NA	117%	NA	107%	NA	86%	NA	125%	NA	75%
Tourism Jobs	**23,800**	**55,000**	**51,800**	**106,000**	**6,400**	**13,700**	**100**	**100**	**1,900**	**3,400**
% of Total Jobs	4.9%	6.1%	25.4%	23.9%	11.4%	13.2%	11.1%	6.7%	8.1%	9.2%
Total % Growth	NA	131%	NA	105%	NA	114%	NA	0%	NA	79%
Household Basic Jobs	**60,400**	**176,900**	**20,600**	**74,700**	**9,400**	**25,400**	**270**	**410**	**3,700**	**7,800**
% of Total Jobs	12.6%	19.5%	10.1%	16.8%	16.8%	24.6%	30.0%	27.3%	15.7%	21.1%
Total % Growth	NA	193%	NA	263%	NA	170%	NA	52%	NA	111%
Total Basic Jobs	**247,600**	**510,200**	**119,200**	**257,500**	**32,600**	**64,400**	**700**	**1,100**	**15,900**	**26,500**
% of Total Jobs	51.5%	56.2%	58.4%	58.0%	58.2%	62.3%	77.8%	73.3%	67.4%	71.8%
Total % Growth	NA	106%	NA	116%	NA	98%	NA	57%	NA	67%
Resident Service Jobs	**233,500**	**397,700**	**85,000**	**186,500**	**23,300**	**39,000**	**100**	**400**	**7,800**	**10,500**
% of Total Jobs	48.5%	43.8%	41.6%	42.0%	41.6%	37.7%	11.1%	26.7%	33.1%	28.5%
Total % Growth	NA	70%	NA	119%	NA	67%	NA	300%	NA	35%
Total Jobs	**481,100**	**907,900**	**204,100**	**444,000**	**56,000**	**103,400**	**900**	**1,500**	**23,600**	**36,900**
% of Total Jobs	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total % Growth	NA	89%	NA	118%	NA	85%	NA	67%	NA	56%

Exhibit 25 (continued).
2050 EMPLOYMENT PROJECTIONS BY RIVER BASIN, MIDDLE SCENARIO

	River Basins							
	South Platte		Southwest		Yampa		State of Colorado	
	2007	2050	2007	2050	2007	2050	2007	2050
Agribusiness Jobs	**69,700**	**88,500**	**3,200**	**4,500**	**1,700**	**3,000**	**102,800**	**135,300**
% of Total Jobs	3.3%	2.6%	4.9%	3.6%	5.2%	3.8%	3.5%	2.6%
Total % Growth	NA	27%	NA	41%	NA	76%	NA	32%
Mining Jobs	**15,500**	**18,400**	**1,300**	**1,000**	**2,100**	**11,300**	**26,900**	**35,400**
% of Total Jobs	0.7%	0.5%	2.0%	0.8%	6.4%	14.2%	0.9%	0.7%
Total % Growth	NA	19%	NA	-23%	NA	438%	NA	32%
Manufacturing Jobs	**74,800**	**101,300**	**900**	**1,300**	**250**	**410**	**100,900**	**134,600**
% of Total Jobs	3.6%	2.9%	1.4%	1.0%	0.8%	0.5%	3.4%	2.6%
Total % Growth	NA	35%	NA	44%	NA	64%	NA	33%
Government Jobs	**123,700**	**149,100**	**3,100**	**4,600**	**1,000**	**1,500**	**200,000**	**255,400**
% of Total Jobs	5.9%	4.3%	4.7%	3.7%	3.0%	1.9%	6.8%	5.0%
Total % Growth	NA	21%	NA	48%	NA	50%	NA	28%
Regl/Natl Services Jobs	**384,100**	**694,200**	**6,800**	**10,700**	**5,100**	**13,100**	**500,500**	**938,400**
% of Total Jobs	18.4%	20.2%	10.4%	8.5%	15.5%	16.5%	17.0%	18.3%
Total % Growth	NA	81%	NA	57%	NA	157%	NA	87%
Tourism Jobs	**98,700**	**180,200**	**14,500**	**32,400**	**7,600**	**11,300**	**204,800**	**402,100**
% of Total Jobs	4.7%	5.2%	22.1%	25.9%	23.0%	14.2%	6.9%	7.8%
Total % Growth	NA	83%	NA	123%	NA	49%	NA	96%
Household Basic Jobs	**160,500**	**440,500**	**8,800**	**27,000**	**2,200**	**3,500**	**265,900**	**756,400**
% of Total Jobs	7.7%	12.8%	13.4%	21.5%	6.7%	4.4%	9.0%	14.7%
Total % Growth	NA	174%	NA	207%	NA	59%	NA	184%
Total Basic Jobs	**928,000**	**1,672,200**	**38,500**	**81,500**	**20,200**	**44,200**	**1,402,700**	**2,657,600**
% of Total Jobs	44.5%	48.6%	58.8%	65.0%	61.2%	55.7%	47.6%	51.7%
Total % Growth	NA	80%	NA	112%	NA	119%	NA	89%
Resident Service Jobs	**1,156,300**	**1,767,100**	**27,000**	**43,800**	**12,800**	**35,100**	**1,545,800**	**2,480,100**
% of Total Jobs	55.5%	51.4%	41.2%	35.0%	38.8%	44.2%	52.4%	48.3%
Total % Growth	NA	53%	NA	62%	NA	174%	NA	60%
Total Jobs	**2,083,400**	**3,439,300**	**65,500**	**125,300**	**33,000**	**79,400**	**2,947,600**	**5,137,700**
% of Total Jobs	100%	100%	100%	100%	100%	100%	100%	100%
Total % Growth	NA	65%	NA	91%	NA	141%	NA	74%

Exhibit 26.
REGIONAL AND COUNTY PROJECTIONS

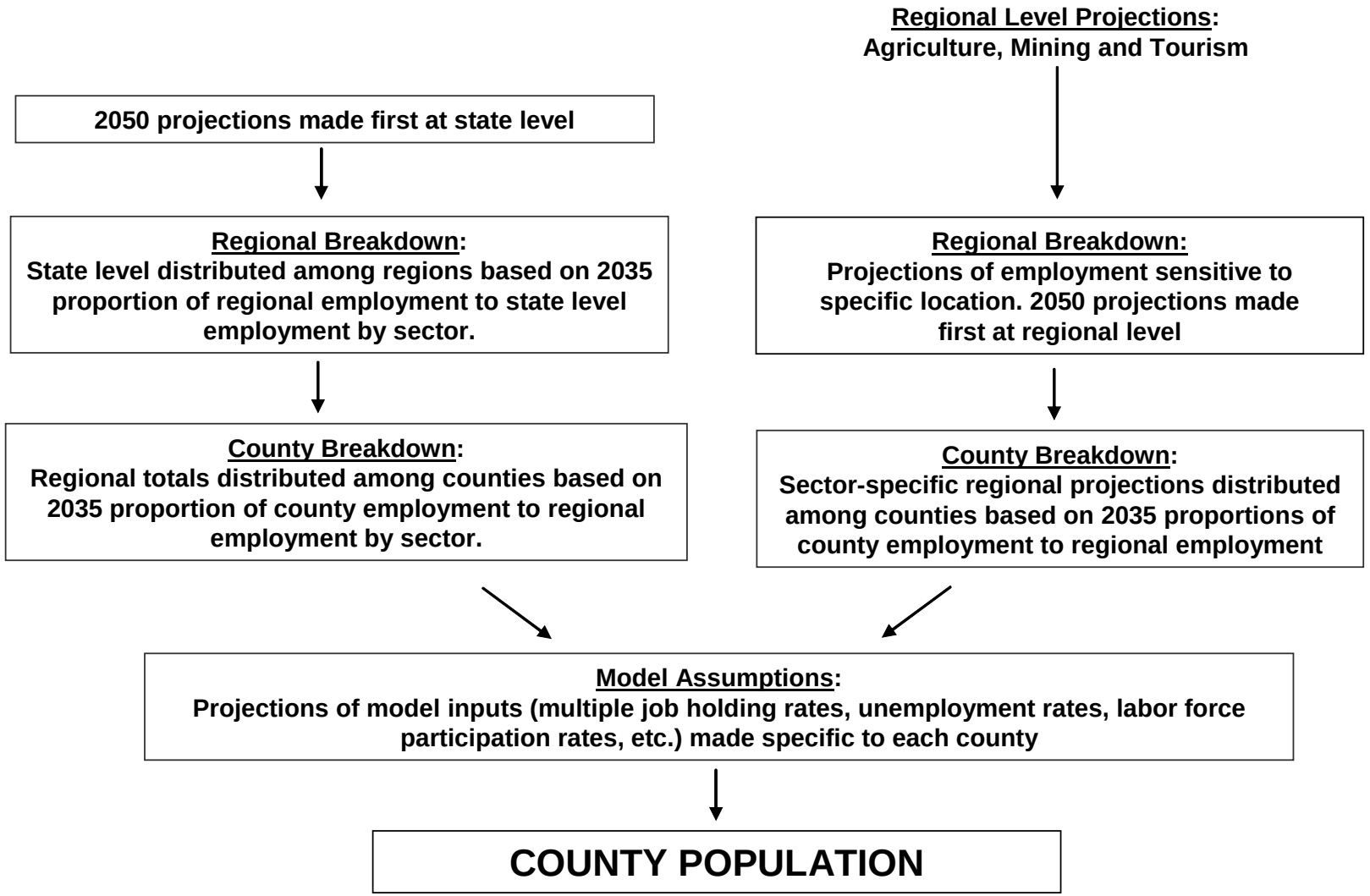


Exhibit 27.
COLORADO POPULATION PROJECTIONS BY BASIN

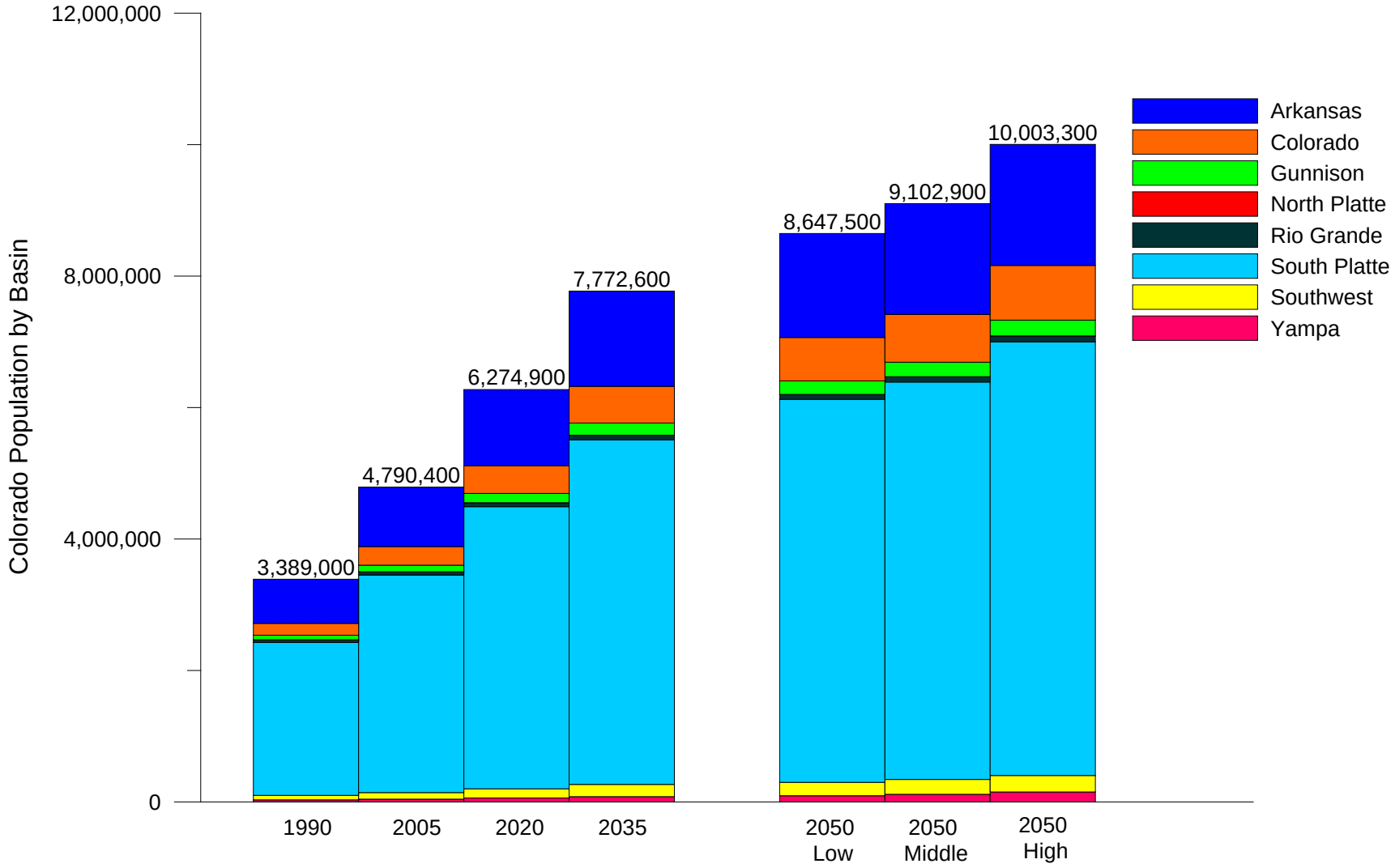


Exhibit 28.
ARKANSAS BASIN – PROJECTIONS TO 2050

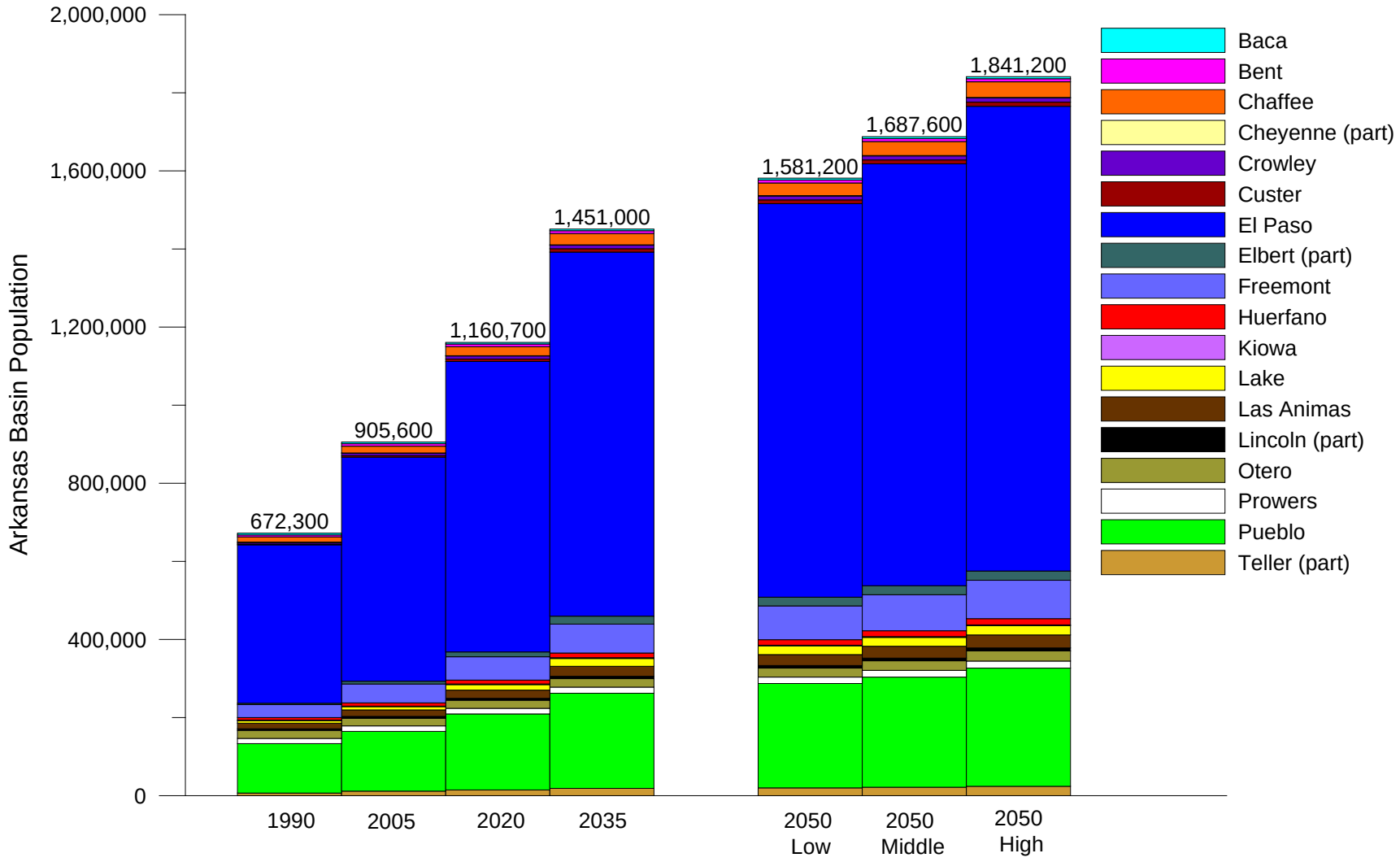


Exhibit 29.
COLORADO BASIN – PROJECTIONS TO 2050

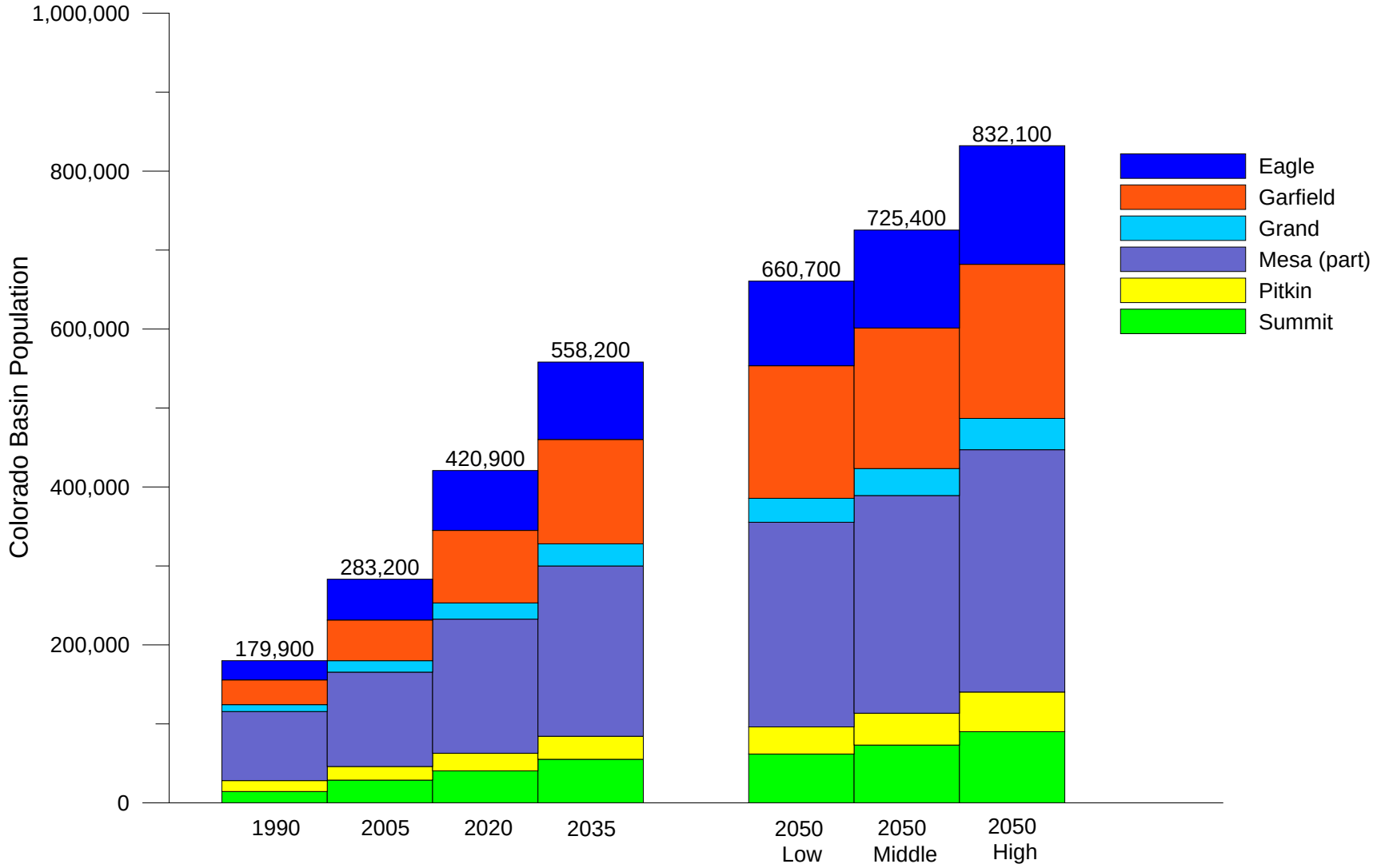


Exhibit 30.
GUNNISON BASIN – PROJECTIONS TO 2050

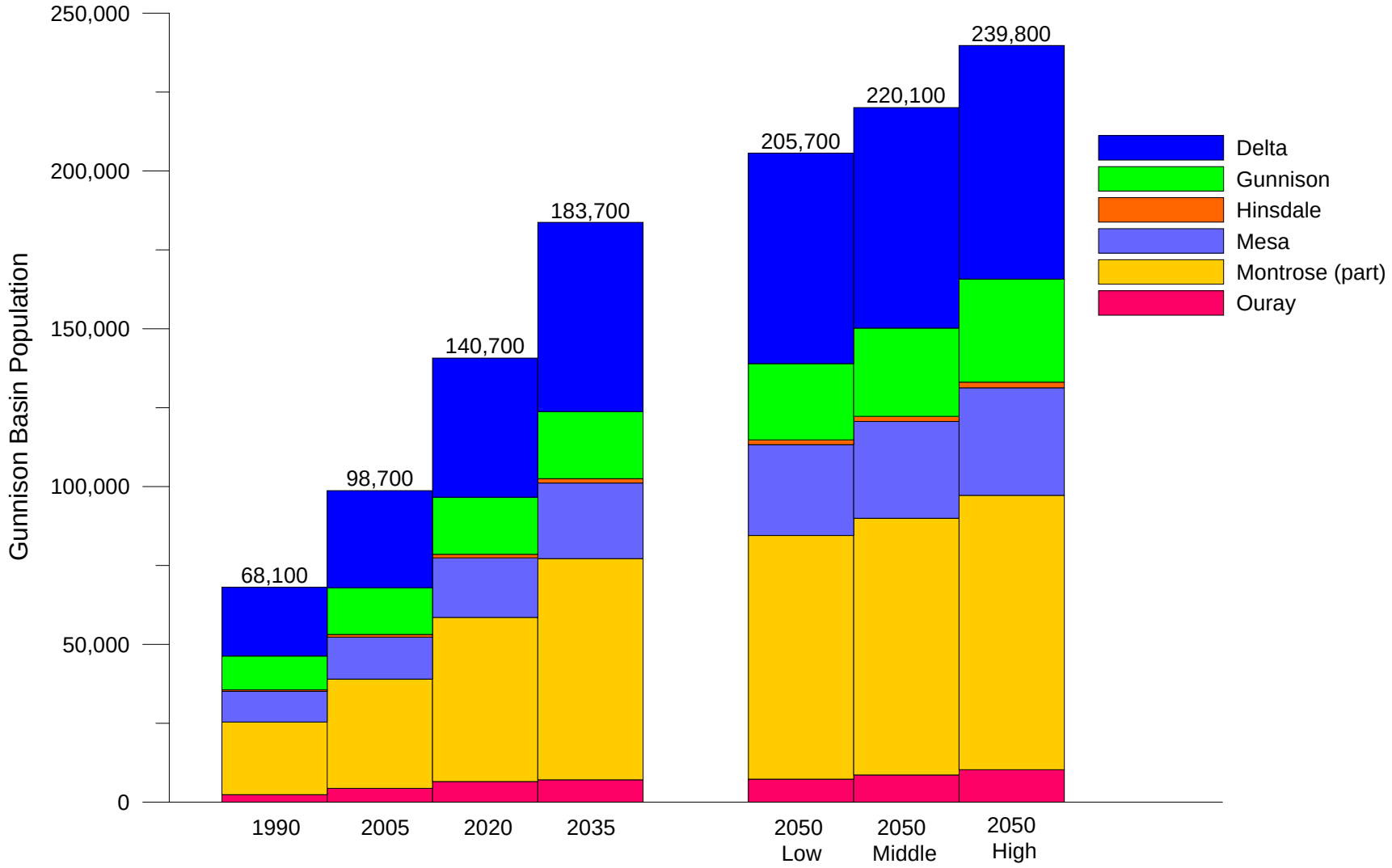


Exhibit 31.
NORTH PLATTE BASIN – PROJECTIONS TO 2050

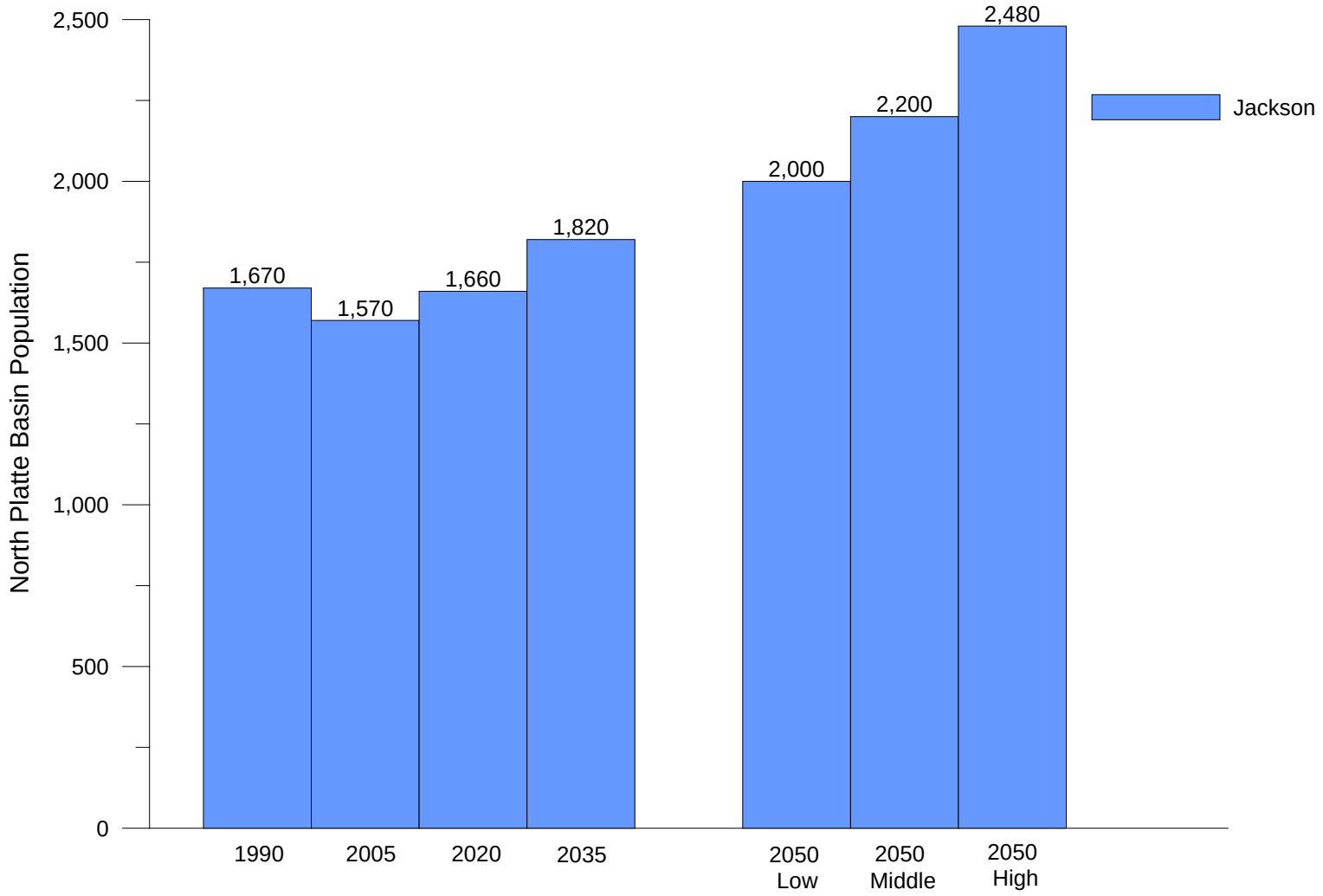


Exhibit 32.
RIO GRANDE BASIN – PROJECTIONS TO 2050

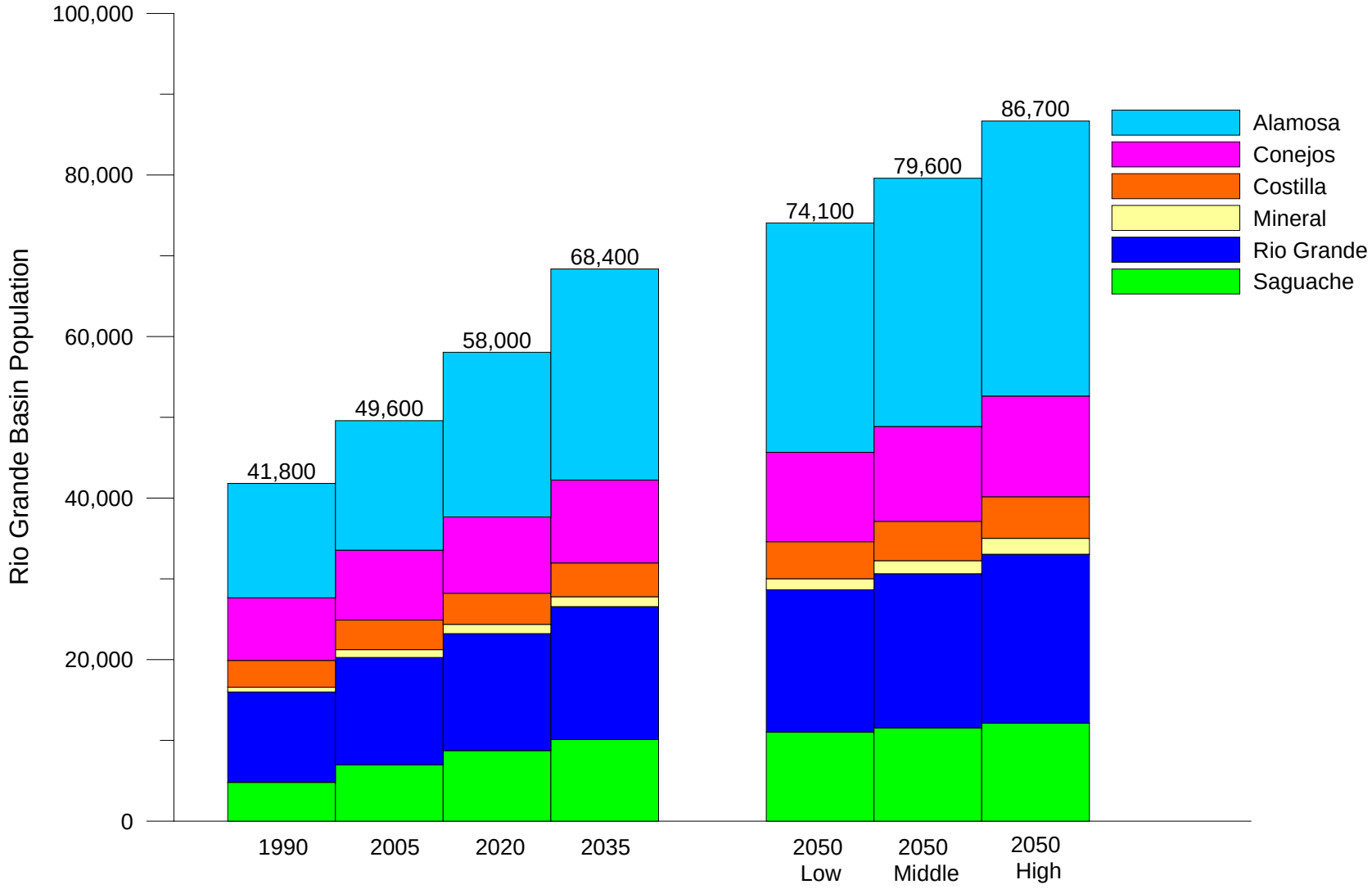


Exhibit 33.
SOUTH PLATTE BASIN – PROJECTIONS TO 2050

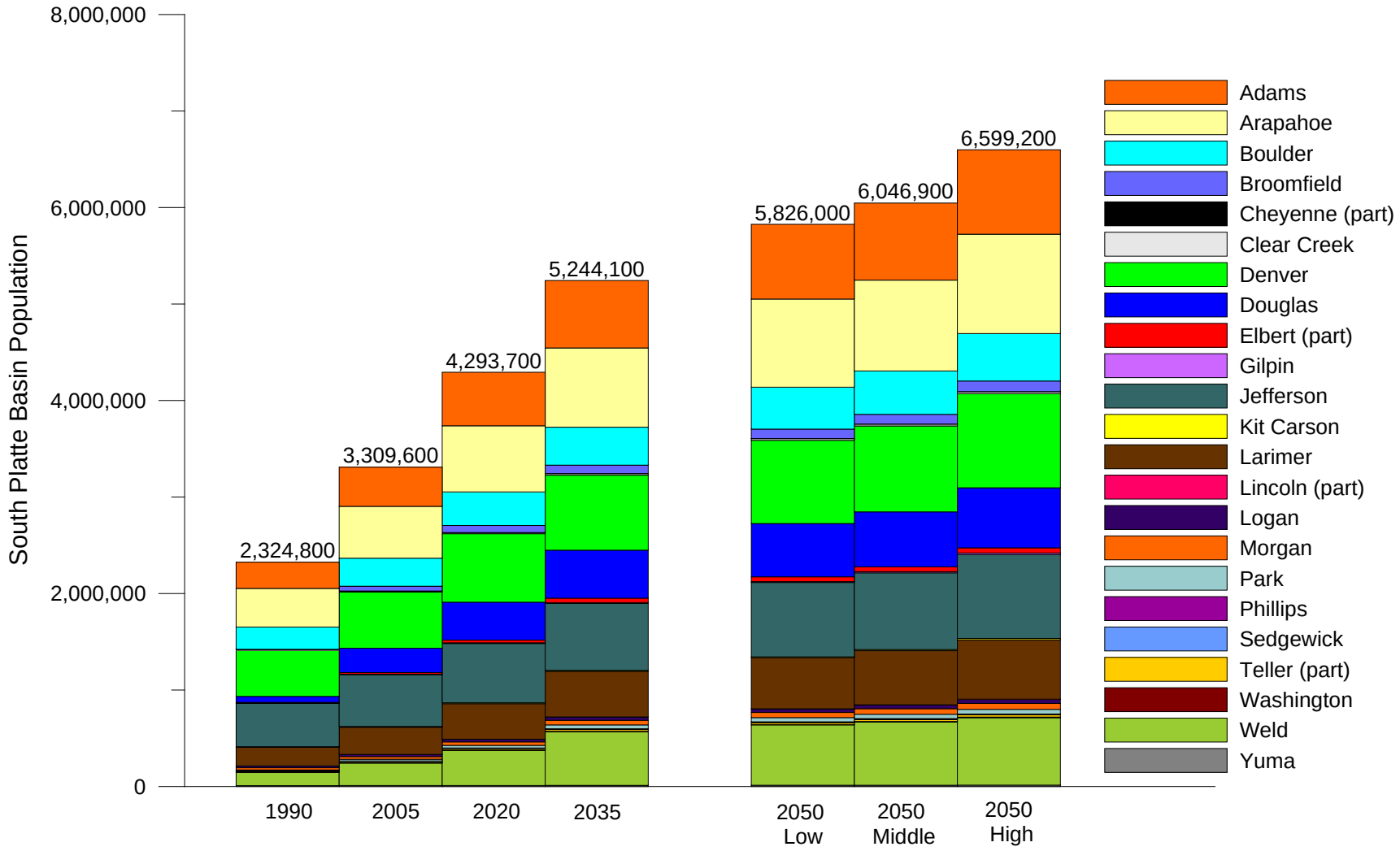


Exhibit 34.
SOUTHWEST BASIN – PROJECTIONS TO 2050

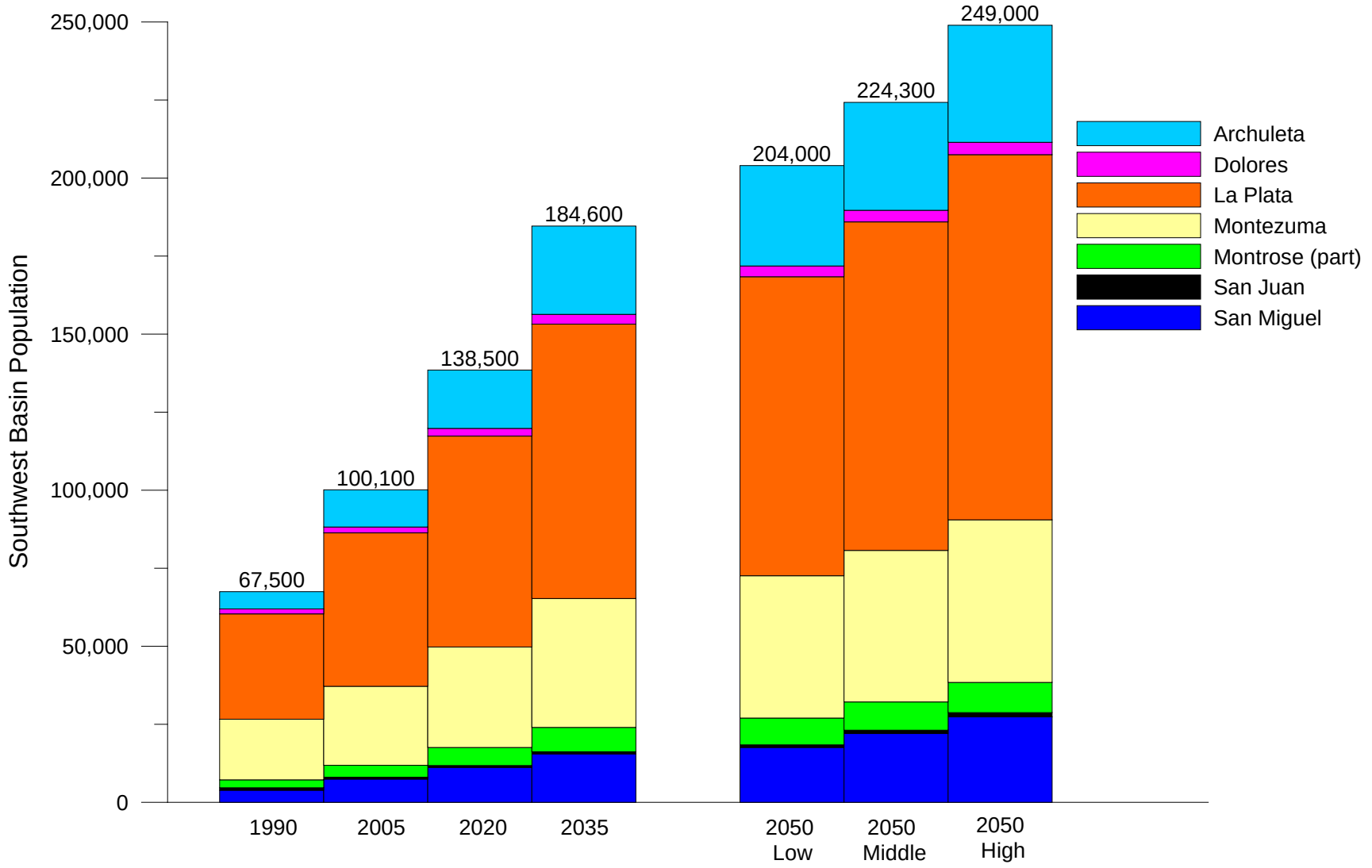


Exhibit 35.
YAMPA-WHITE BASIN – PROJECTIONS TO 2050

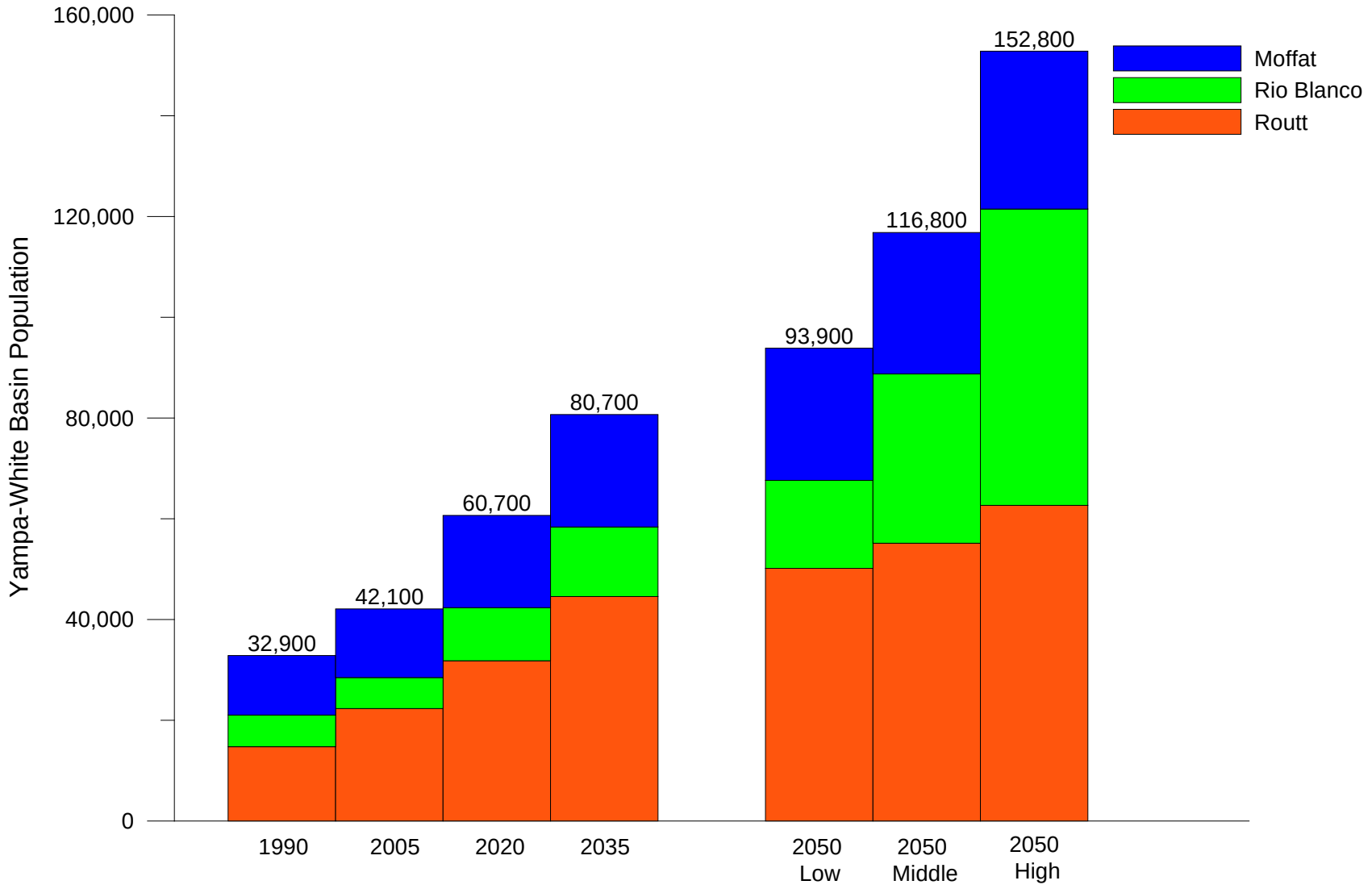


Exhibit 36.
2050 POPULATION PROJECTIONS BY COLORADO COUNTY AND RIVER BASIN

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
Arkansas Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Baca County	4,282	4,200	4,200	4,200	4,200	4,300	4,300	4,600	4,900	5,300	0.15%	0.28%	0.46%
Bent County	6,406	6,300	6,600	6,800	6,900	6,900	6,900	7,500	7,700	8,000	0.34%	0.42%	0.51%
Chaffee County	17,215	17,800	20,000	23,100	25,700	27,700	29,100	32,400	35,600	40,000	1.42%	1.63%	1.89%
Cheyenne County*	815	800	800	900	900	900	900	1,000	1,100	1,200	0.40%	0.64%	0.90%
Crowley County	5,921	7,000	7,400	7,800	8,200	8,600	9,000	10,100	10,300	10,600	1.19%	1.25%	1.30%
Custer County	4,054	4,400	5,300	6,100	7,000	7,900	8,700	9,700	10,200	10,800	1.95%	2.06%	2.21%
El Paso County	573,822	629,300	686,100	743,800	806,200	869,000	932,400	1,007,600	1,080,200	1,189,800	1.26%	1.42%	1.63%
Elbert County*	7,103	7,400	9,300	12,600	15,500	18,000	20,200	22,200	22,800	23,700	2.56%	2.62%	2.71%
Fremont County	48,406	49,700	54,600	59,400	64,500	69,300	74,000	86,700	92,400	98,400	1.30%	1.45%	1.59%
Huerfano County	8,130	8,400	9,400	10,300	11,200	11,700	12,200	14,000	14,900	16,000	1.22%	1.36%	1.52%
Kiowa County	1,544	1,500	1,500	1,600	1,600	1,700	1,700	1,800	1,900	2,100	0.39%	0.52%	0.68%
Lake County	8,175	9,300	11,600	13,900	16,200	18,800	20,300	22,200	22,800	23,700	2.24%	2.30%	2.40%
Las Animas County	16,559	17,400	19,200	21,000	22,700	24,200	25,600	28,200	30,300	33,100	1.19%	1.35%	1.55%
Lincoln County*	4,802	4,600	4,900	5,100	5,300	5,600	5,900	6,600	7,200	7,800	0.71%	0.90%	1.08%
Otero County	19,675	19,200	20,100	20,700	21,200	21,400	21,700	23,100	24,400	25,800	0.36%	0.48%	0.61%
Prowers County	14,039	13,500	14,100	14,400	14,800	15,200	15,600	16,200	17,100	18,300	0.32%	0.44%	0.59%
Pueblo County	153,071	164,400	179,000	194,500	210,100	226,600	243,900	267,400	282,000	302,500	1.25%	1.37%	1.53%
Teller County*	11,565	11,900	13,300	14,700	16,100	17,300	18,500	19,900	21,800	24,000	1.21%	1.42%	1.64%
BASIN TOTAL	**905,582**	**977,000**	**1,067,400**	**1,160,700**	**1,258,500**	**1,355,300**	**1,451,000**	**1,581,200**	**1,687,600**	**1,841,200**	**1.25%**	**1.39%**	**1.59%**

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
Colorado Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Eagle County	51,616	59,000	67,900	75,800	80,800	88,500	98,000	107,200	124,000	150,200	1.64%	1.97%	2.40%
Garfield County	51,621	61,100	72,500	91,900	106,300	118,800	132,300	167,900	178,000	195,100	2.65%	2.79%	3.00%
Grand County	14,392	15,500	17,600	20,400	23,100	25,600	28,000	30,300	34,200	39,800	1.67%	1.94%	2.29%
Mesa County*	119,578	137,900	152,300	169,900	185,300	200,500	215,600	259,200	275,800	306,700	1.73%	1.87%	2.12%
Pitkin County	17,092	18,100	20,200	22,300	24,600	26,900	29,200	34,300	40,300	50,200	1.56%	1.93%	2.42%
Summit County	28,884	31,300	35,500	40,500	45,700	50,600	55,100	61,800	73,100	90,200	1.71%	2.09%	2.56%
BASIN TOTAL	**283,183**	**322,900**	**366,000**	**420,900**	**465,800**	**511,000**	**558,200**	**660,700**	**725,400**	**832,100**	**1.90%**	**2.11%**	**2.42%**

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
Gunnison Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Delta County	30,776	33,300	38,400	44,100	50,300	55,600	59,900	66,700	69,900	74,000	1.73%	1.84%	1.97%
Gunnison County	14,826	15,600	16,800	18,100	19,300	20,300	21,300	24,200	28,000	32,700	1.09%	1.42%	1.77%
Hinsdale County	841	900	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,800	1.30%	1.48%	1.68%
Mesa County*	13,286	15,300	16,900	18,900	20,600	22,300	24,000	28,800	30,600	34,100	1.73%	1.87%	2.12%
Montrose County*	34,643	39,600	45,700	52,000	58,600	64,900	70,100	77,200	81,300	86,900	1.80%	1.91%	2.07%
Ouray County	4,354	5,000	5,900	6,600	6,800	6,900	7,100	7,300	8,600	10,300	1.15%	1.54%	1.93%
BASIN TOTAL	**98,726**	**109,700**	**124,800**	**140,700**	**156,800**	**171,400**	**183,700**	**205,700**	**220,100**	**239,800**	**1.64%**	**1.80%**	**1.99%**

* Indicates that only the portion of the total county population within that particular river basin is included.

Exhibit 36 (continued).
2050 POPULATION PROJECTIONS BY COLORADO COUNTY AND RIVER BASIN

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
Metro Basin**								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Adams County	405,150	451,300	506,600	555,000	606,400	652,800	698,200	774,500	799,000	874,600	1.45%	1.52%	1.72%
Arapahoe County	538,163	583,100	638,000	684,800	733,600	779,300	822,300	912,200	941,000	1,030,000	1.18%	1.25%	1.45%
Broomfield County	49,021	59,100	66,600	73,300	80,300	84,500	86,800	96,300	99,400	108,800	1.51%	1.58%	1.79%
Denver	582,417	636,900	687,400	708,400	728,400	750,200	777,700	862,700	890,000	974,200	0.88%	0.95%	1.15%
Douglas	251,464	298,400	341,100	393,300	435,800	468,500	497,600	551,900	569,400	623,300	1.76%	1.83%	2.04%
Jefferson	537,482	556,300	585,300	615,200	648,000	675,200	694,700	770,600	795,000	870,200	0.80%	0.87%	1.08%
Elbert County*	15,810	16,500	20,700	27,900	34,500	40,000	45,000	49,400	50,700	52,700	2.56%	2.62%	2.71%
BASIN TOTAL	**2,379,508**	**2,601,600**	**2,845,700**	**3,058,000**	**3,266,900**	**3,450,500**	**3,622,200**	**4,017,700**	**4,144,500**	**4,533,800**	**1.17%**	**1.24%**	**1.44%**

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
North Platte Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Jackson County	1,565	1,500	1,600	1,700	1,700	1,800	1,800 0	2,000	2,200	2,500	0.55%	0.75%	1.03%

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
Rio Grande Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Alamosa County	16,038	16,800	18,700	20,400	22,200	24,100	26,100	28,400	30,700	34,000	1.28%	1.46%	1.69%
Conejos County	8,650	8,600	9,100	9,400	9,800	10,000	10,300	11,100	11,700	12,500	0.55%	0.68%	0.82%
Costilla County	3,675	3,600	3,700	3,800	4,000	4,100	4,200	4,600	4,900	5,200	0.49%	0.63%	0.76%
Mineral County	959	1,000	1,100	1,200	1,200	1,200	1,200	1,400	1,600	2,000	0.80%	1.17%	1.60%
Rio Grande County	13,303	12,800	13,600	14,500	15,200	15,900	16,500	17,600	19,100	20,900	0.63%	0.81%	1.01%
Saguache County	6,965	7,400	8,100	8,700	9,300	9,700	10,100	11,000	11,500	12,100	1.03%	1.13%	1.24%
BASIN TOTAL	**49,591**	**50,200**	**54,400**	**58,000**	**61,700**	**65,100**	**68,400**	**74,100**	**79,600**	**86,700**	**0.90%**	**1.06%**	**1.25%**

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
South Platte Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Boulder County	290,846	307,700	330,400	348,000	366,600	381,000	392,900	435,800	449,600	492,100	0.90%	0.97%	1.18%
Cheyenne County*	1,330	1,300	1,300	1,400	1,500	1,500	1,500	1,600	1,800	2,000	0.40%	0.64%	0.90%
Clear Creek County	9,767	9,800	10,800	11,900	13,000	14,100	15,200	17,200	18,800	21,100	1.27%	1.47%	1.72%
Gilpin County	5,166	5,500	6,100	6,600	7,200	7,800	8,400	10,100	12,700	15,800	1.49%	2.01%	2.52%
Kit Carson County	8,308	8,500	8,800	9,000	9,300	9,400	9,600	10,600	11,500	12,500	0.55%	0.73%	0.92%
Larimer County	280,699	304,600	334,900	367,700	404,700	439,300	472,800	527,600	561,800	616,900	1.41%	1.55%	1.77%
Lincoln County*	1,126	1,100	1,100	1,200	1,300	1,300	1,400	1,500	1,700	1,800	0.71%	0.90%	1.08%
Logan County	21,758	22,100	24,400	27,000	29,600	31,600	33,500	36,100	38,500	42,200	1.13%	1.27%	1.48%
Morgan County	28,713	29,200	32,100	35,800	39,800	43,800	48,100	53,600	56,600	61,000	1.40%	1.52%	1.69%
Park County	16,841	18,000	22,000	27,600	33,500	38,100	40,200	43,100	45,200	47,700	2.11%	2.22%	2.34%
Phillips County	4,648	4,600	4,800	4,800	4,900	5,000	5,000	5,200	5,600	6,100	0.26%	0.40%	0.60%
Sedgewick County	2,690	2,600	2,700	2,800	2,900	3,000	3,100	3,400	3,500	3,700	0.50%	0.58%	0.73%
Teller County*	11,111	11,400	12,800	14,100	15,500	16,700	17,800	19,100	20,900	23,100	1.21%	1.42%	1.64%
Washington County	4,955	4,800	4,900	4,900	5,000	5,000	5,000	5,300	5,600	6,100	0.15%	0.27%	0.45%
Weld County	232,102	267,900	310,600	361,800	422,800	487,800	555,600	625,300	655,000	698,300	2.23%	2.33%	2.48%
Yuma County	10,025	10,100	10,600	11,000	11,400	11,700	12,000	12,700	13,600	15,100	0.53%	0.69%	0.91%
BASIN TOTAL	**930,084**	**1,009,000**	**1,118,300**	**1,235,700**	**1,368,700**	**1,497,100**	**1,621,900**	**1,808,300**	**1,902,500**	**2,065,400**	**1.49%**	**1.60%**	**1.79%**

* Indicates that only the portion of the total county population within that particular river basin is included.
** Metro Basin counties are a part of the South Platte River Basin.

Exhibit 36 (continued).
2050 POPULATION PROJECTIONS BY COLORADO COUNTY AND RIVER BASIN

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
Southwest Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Archuleta County	11,913	13,500	16,000	18,700	21,800	25,100	28,300	32,200	34,600	37,500	2.23%	2.40%	2.58%
Dolores County	1,871	2,100	2,300	2,500	2,700	2,900	3,100	3,500	3,700	4,000	1.37%	1.52%	1.69%
La Plata County	49,147	53,000	60,100	67,600	74,800	81,500	87,900	95,800	105,300	117,000	1.49%	1.71%	1.95%
Montezuma County	25,290	26,700	29,400	32,200	35,300	38,400	41,300	45,600	48,500	52,100	1.32%	1.46%	1.62%
Montrose County*	3,849	4,400	5,100	5,800	6,500	7,200	7,800	8,600	9,000	9,700	1.80%	1.91%	2.07%
San Juan County	585	600	600	600	700	700	700	800	1,100	1,400	0.78%	1.41%	1.95%
San Miguel County	7,450	8,300	9,800	11,200	12,700	14,100	15,500	17,600	22,000	27,400	1.93%	2.44%	2.93%
BASIN TOTAL	**100,105**	**108,600**	**123,200**	**138,500**	**154,500**	**169,900**	**184,600**	**204,000**	**224,300**	**249,000**	**1.59%**	**1.81%**	**2.05%**

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
Yampa Basin								**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
Mofffat County	13,628	15,300	16,400	18,300	20,500	21,500	22,300	26,200	28,100	31,300	1.47%	1.62%	1.87%
Rio Blanco County	6,140	7,100	8,700	10,500	11,600	12,700	13,800	17,500	33,600	58,800	2.35%	3.85%	5.15%
Routt County	22,328	24,700	28,100	31,800	36,000	40,300	44,600	50,200	55,100	62,700	1.81%	2.03%	2.32%
BASIN TOTAL	**42,095**	**47,200**	**53,200**	**60,700**	**68,100**	**74,500**	**80,700**	**93,900**	**116,800**	**152,800**	**1.80%**	**2.29%**	**2.91%**

	2005	2010	2015	2020	2025	2030	2035	2050			Average Annual Change		
								Low	**Middle**	**High**	**Low**	**Middle**	**High**
TOTAL ALL BASINS	**4,790,440**	**5,227,700**	**5,754,600**	**6,274,900**	**6,802,700**	**7,296,700**	**7,772,600**	**8,647,500**	**9,102,900**	**10,003,300**	**1.32%**	**1.44%**	**1.65%**

* Indicates that only the portion of the total county population within that particular river basin is included.

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APPENDIX

Exhibit 1.
2050 Employment Projections by River Basin, Low Scenario

	River Basins									
	Arkansas		Colorado		Gunnison		North Platte		Rio Grande	
	2007	2050	2007	2050	2007	2050	2007	2050	2007	2050
Agribusiness Jobs	**13,000**	**16,500**	**5,300**	**7,300**	**4,200**	**5,700**	**300**	**400**	**5,400**	**7,300**
% of Total Jobs	2.7%	1.9%	2.6%	1.8%	7.5%	6.0%	33.3%	26.7%	22.9%	21.2%
Total % Growth	NA	27%	NA	38%	NA	36%	NA	33%	NA	35%
Mining Jobs	**900**	**600**	**5,400**	**1,800**	**1,600**	**500**	**0**	**0**	**60**	**40**
% of Total Jobs	0.2%	0.1%	2.6%	0.4%	2.9%	0.5%	0.0%	0.0%	0.3%	0.1%
Total % Growth	NA	-33%	NA	-67%	NA	-69%	NA	0%	NA	-33%
Manufacturing Jobs	**20,100**	**24,000**	**3,300**	**4,000**	**1,400**	**1,800**	**5**	**5**	**200**	**200**
% of Total Jobs	4.2%	2.8%	1.6%	1.0%	2.5%	1.9%	0.6%	0.3%	0.8%	0.6%
Total % Growth	NA	19%	NA	21%	NA	29%	NA	0%	NA	0%
Government Jobs	**59,200**	**80,100**	**8,400**	**11,300**	**2,700**	**3,500**	**60**	**80**	**1,800**	**2,200**
% of Total Jobs	12.3%	9.4%	4.1%	2.8%	4.8%	3.7%	6.7%	5.3%	7.6%	6.4%
Total % Growth	NA	35%	NA	35%	NA	30%	NA	33%	NA	22%
Reg/Natl Services Jobs	**70,200**	**143,300**	**24,300**	**47,300**	**7,000**	**12,300**	**40**	**90**	**2,800**	**4,600**
% of Total Jobs	14.6%	16.8%	11.9%	11.6%	12.5%	12.9%	4.4%	6.0%	11.9%	13.4%
Total % Growth	NA	104%	NA	95%	NA	76%	NA	125%	NA	64%
Tourism Jobs	**23,800**	**47,400**	**51,800**	**92,300**	**6,400**	**11,500**	**60**	**90**	**1,900**	**3,000**
% of Total Jobs	4.9%	5.5%	25.4%	22.6%	11.4%	12.0%	6.7%	6.0%	8.1%	8.7%
Total % Growth	NA	99%	NA	78%	NA	80%	NA	50%	NA	58%
Household Basic Jobs	**60,400**	**168,000**	**20,600**	**72,400**	**9,400**	**24,100**	**300**	**400**	**3,700**	**7,300**
% of Total Jobs	12.6%	19.7%	10.1%	17.7%	16.8%	25.2%	33.3%	26.7%	15.7%	21.2%
Total % Growth	NA	178%	NA	251%	NA	156%	NA	33%	NA	97%
Total Basic Jobs	**247,600**	**480,000**	**119,200**	**236,500**	**32,600**	**59,500**	**700**	**1,100**	**15,900**	**24,700**
% of Total Jobs	51.5%	56.2%	58.4%	57.9%	58.2%	62.2%	77.8%	73.3%	67.4%	71.8%
Total % Growth	NA	94%	NA	98%	NA	83%	NA	57%	NA	55%
Resident Service Jobs	**233,500**	**374,300**	**85,000**	**171,900**	**23,300**	**36,200**	**100**	**400**	**7,800**	**9,800**
% of Total Jobs	48.5%	43.8%	41.6%	42.1%	41.6%	37.8%	11.1%	26.7%	33.1%	28.5%
Total % Growth	NA	60%	NA	102%	NA	55%	NA	300%	NA	26%
Total Jobs	**481,100**	**854,300**	**204,100**	**408,400**	**56,000**	**95,700**	**900**	**1,500**	**23,600**	**34,400**
% of Total Jobs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total % Growth	NA	78%	NA	100%	NA	71%	NA	67%	NA	46%

Note: All employment numbers have been rounded to the nearest hundred, except when less than 100. Employment numbers between 10 and 100 have been rounded to the nearest ten; employment numbers less than 10 have not been rounded.

Exhibit 1 (continued).
2050 Employment Projections by River Basin, Low Scenario

	River Basins							
	South Platte		Southwest		Yampa		State of Colorado	
	2007	2050	2007	2050	2007	2050	2007	2050
Agribusiness Jobs	**69,700**	**84,300**	**3,200**	**4,300**	**1,700**	**2,800**	**102,800**	**128,700**
% of Total Jobs	3.3%	2.6%	4.9%	3.8%	5.2%	4.2%	3.5%	2.7%
Total % Growth	NA	21%	NA	34%	NA	65%	NA	25%
Mining Jobs	**15,500**	**13,600**	**1,300**	**600**	**2,100**	**6,900**	**26,900**	**24,100**
% of Total Jobs	0.7%	0.4%	2.0%	0.5%	6.4%	10.4%	0.9%	0.5%
Total % Growth	NA	-12%	NA	-54%	NA	229%	NA	-10%
Manufacturing Jobs	**74,800**	**96,100**	**900**	**1,300**	**300**	**400**	**100,900**	**127,700**
% of Total Jobs	3.6%	3.0%	1.4%	1.1%	0.9%	0.6%	3.4%	2.7%
Total % Growth	NA	28%	NA	44%	NA	33%	NA	27%
Government Jobs	**123,700**	**144,800**	**3,100**	**4,400**	**1,000**	**1,400**	**200,000**	**247,900**
% of Total Jobs	5.9%	4.5%	4.7%	3.9%	3.0%	2.1%	6.8%	5.2%
Total % Growth	NA	17%	NA	42%	NA	40%	NA	24%
Reg/Natl Services Jobs	**384,100**	**654,200**	**6,800**	**10,000**	**5,100**	**12,400**	**500,500**	**884,200**
% of Total Jobs	18.4%	20.3%	10.4%	8.8%	15.5%	18.7%	17.0%	18.4%
Total % Growth	NA	70%	NA	47%	NA	143%	NA	77%
Tourism Jobs	**98,700**	**155,300**	**14,500**	**27,500**	**7,600**	**10,000**	**204,800**	**347,100**
% of Total Jobs	4.7%	4.8%	22.1%	24.1%	23.0%	15.1%	6.9%	7.2%
Total % Growth	NA	57%	NA	90%	NA	32%	NA	69%
Household Basic Jobs	**160,500**	**421,900**	**8,800**	**25,900**	**2,200**	**3,200**	**265,900**	**723,300**
% of Total Jobs	7.7%	13.1%	13.4%	22.7%	6.7%	4.8%	9.0%	15.1%
Total % Growth	NA	163%	NA	194%	NA	45%	NA	172%
Total Basic Jobs	**928,000**	**1,570,200**	**38,500**	**74,000**	**20,200**	**37,100**	**1,402,700**	**2,483,100**
% of Total Jobs	44.5%	48.6%	58.8%	65.0%	61.2%	56.0%	47.6%	51.7%
Total % Growth	NA	69%	NA	92%	NA	84%	NA	77%
Resident Service Jobs	**1,156,300**	**1,659,900**	**27,000**	**39,900**	**12,800**	**29,200**	**1,545,800**	**2,321,600**
% of Total Jobs	55.5%	51.4%	41.2%	35.0%	38.8%	44.0%	52.4%	48.3%
Total % Growth	NA	44%	NA	48%	NA	128%	NA	50%
Total Jobs	**2,083,400**	**3,230,100**	**65,500**	**113,900**	**33,000**	**66,300**	**2,947,600**	**4,804,700**
% of Total Jobs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total % Growth	NA	55%	NA	74%	NA	101%	NA	63%

Note: All employment numbers have been rounded to the nearest hundred, except when less than 100. Employment numbers between 10 and 100 have been rounded to the nearest ten; employment numbers less than 10 have not been rounded.

Exhibit 2.
2050 Employment Projections by River Basin, High Scenario

	River Basins									
	Arkansas		Colorado		Gunnison		North Platte		Rio Grande	
	2007	2050	2007	2050	2007	2050	2007	2050	2007	2050
Agribusiness Jobs	**13,000**	**18,500**	**5,300**	**8,500**	**4,200**	**6,500**	**300**	**500**	**5,400**	**8,200**
% of Total Jobs	2.7%	1.9%	2.6%	1.7%	7.5%	5.7%	33.3%	29.4%	22.9%	20.4%
Total % Growth	NA	42%	NA	60%	NA	55%	NA	67%	NA	52%
Mining Jobs	**900**	**1,700**	**5,400**	**4,700**	**1,600**	**700**	**0**	**0**	**60**	**200**
% of Total Jobs	0.2%	0.2%	2.6%	0.9%	2.9%	0.6%	0.0%	0.0%	0.3%	0.5%
Total % Growth	NA	89%	NA	-13%	NA	-56%	NA	0%	NA	233%
Manufacturing Jobs	**20,100**	**26,200**	**3,300**	**4,400**	**1,400**	**2,000**	**5**	**5**	**200**	**200**
% of Total Jobs	4.2%	2.7%	1.6%	0.9%	2.5%	1.8%	0.6%	0.3%	0.8%	0.5%
Total % Growth	NA	30%	NA	33%	NA	43%	NA	0%	NA	0%
Government Jobs	**59,200**	**86,200**	**8,400**	**12,200**	**2,700**	**3,800**	**60**	**90**	**1,800**	**2,400**
% of Total Jobs	12.3%	8.7%	4.1%	2.4%	4.8%	3.3%	6.7%	5.3%	7.6%	6.0%
Total % Growth	NA	46%	NA	45%	NA	41%	NA	50%	NA	33%
Reg/Natl Services Jobs	**70,200**	**171,200**	**24,300**	**56,500**	**7,000**	**14,700**	**40**	**100**	**2,800**	**5,500**
% of Total Jobs	14.6%	17.4%	11.9%	11.2%	12.5%	12.9%	4.4%	5.9%	11.9%	13.7%
Total % Growth	NA	144%	NA	133%	NA	110%	NA	150%	NA	96%
Tourism Jobs	**23,800**	**62,900**	**51,800**	**124,000**	**6,400**	**16,100**	**60**	**100**	**1,900**	**4,000**
% of Total Jobs	4.9%	6.4%	25.4%	24.7%	11.4%	14.1%	6.7%	5.9%	8.1%	10.0%
Total % Growth	NA	164%	NA	139%	NA	152%	NA	67%	NA	111%
Household Basic Jobs	**60,400**	**187,600**	**20,600**	**81,700**	**9,400**	**27,100**	**300**	**400**	**3,700**	**8,200**
% of Total Jobs	12.6%	19.0%	10.1%	16.3%	16.8%	23.8%	33.3%	23.5%	15.7%	20.4%
Total % Growth	NA	211%	NA	297%	NA	188%	NA	33%	NA	122%
Total Basic Jobs	**247,600**	**554,200**	**119,200**	**291,900**	**32,600**	**70,800**	**700**	**1,200**	**15,900**	**28,700**
% of Total Jobs	51.5%	56.2%	58.4%	58.1%	58.2%	62.2%	77.8%	70.6%	67.4%	71.6%
Total % Growth	NA	124%	NA	145%	NA	117%	NA	71%	NA	81%
Resident Service Jobs	**233,500**	**432,000**	**85,000**	**210,800**	**23,300**	**43,000**	**100**	**500**	**7,800**	**11,400**
% of Total Jobs	48.5%	43.8%	41.6%	41.9%	41.6%	37.8%	11.1%	29.4%	33.1%	28.4%
Total % Growth	NA	85%	NA	148%	NA	85%	NA	400%	NA	46%
Total Jobs	**481,100**	**986,200**	**204,100**	**502,700**	**56,000**	**113,800**	**900**	**1,700**	**23,600**	**40,100**
% of Total Jobs	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total % Growth	NA	105%	NA	146%	NA	103%	NA	89%	NA	70%

Note: All employment numbers have been rounded to the nearest hundred, except when less than 100. Employment numbers between 10 and 100 have been rounded to the nearest ten; employment numbers less than 10 have not been rounded.

Exhibit 2 (continued).
2050 Employment Projections by River Basin, High Scenario

	River Basins							
	South Platte		Southwest		Yampa		State of Colorado	
	2007	2050	2007	2050	2007	2050	2007	2050
Agribusiness Jobs	**69,700**	**97,000**	**3,200**	**4,900**	**1,700**	**3,300**	**102,800**	**147,200**
% of Total Jobs	3.3%	2.6%	4.9%	3.5%	5.2%	3.3%	3.5%	2.6%
Total % Growth	NA	39%	NA	53%	NA	94%	NA	43%
Mining Jobs	**15,500**	**24,900**	**1,300**	**1,400**	**2,100**	**18,000**	**26,900**	**51,500**
% of Total Jobs	0.7%	0.7%	2.0%	1.0%	6.4%	18.0%	0.9%	0.9%
Total % Growth	NA	61%	NA	8%	NA	757%	NA	91%
Manufacturing Jobs	**74,800**	**105,100**	**900**	**1,400**	**300**	**400**	**100,900**	**139,700**
% of Total Jobs	3.6%	2.8%	1.4%	1.0%	0.9%	0.4%	3.4%	2.5%
Total % Growth	NA	41%	NA	56%	NA	33%	NA	38%
Government Jobs	**123,700**	**156,000**	**3,100**	**4,800**	**1,000**	**1,500**	**200,000**	**267,000**
% of Total Jobs	5.9%	4.1%	4.7%	3.4%	3.0%	1.5%	6.8%	4.7%
Total % Growth	NA	26%	NA	55%	NA	50%	NA	34%
Reg/Natl Services Jobs	**384,100**	**781,200**	**6,800**	**12,000**	**5,100**	**14,800**	**500,500**	**1,056,000**
% of Total Jobs	18.4%	20.6%	10.4%	8.6%	15.5%	14.8%	17.0%	18.6%
Total % Growth	NA	103%	NA	76%	NA	190%	NA	111%
Tourism Jobs	**98,700**	**209,000**	**14,500**	**37,300**	**7,600**	**13,000**	**204,800**	**466,300**
% of Total Jobs	4.7%	5.5%	22.1%	26.8%	23.0%	13.0%	6.9%	8.2%
Total % Growth	NA	112%	NA	157%	NA	71%	NA	128%
Household Basic Jobs	**160,500**	**471,000**	**8,800**	**29,000**	**2,200**	**4,300**	**265,900**	**809,300**
% of Total Jobs	7.7%	12.4%	13.4%	20.8%	6.7%	4.3%	9.0%	14.3%
Total % Growth	NA	193%	NA	230%	NA	95%	NA	204%
Total Basic Jobs	**928,000**	**1,844,200**	**38,500**	**90,600**	**20,200**	**55,300**	**1,402,700**	**2,937,000**
% of Total Jobs	44.5%	48.6%	58.8%	65.0%	61.2%	55.4%	47.6%	51.7%
Total % Growth	NA	99%	NA	135%	NA	174%	NA	109%
Resident Service Jobs	**1,156,300**	**1,949,700**	**27,000**	**48,600**	**12,800**	**44,500**	**1,545,800**	**2,740,500**
% of Total Jobs	55.5%	51.4%	41.2%	34.9%	38.8%	44.6%	52.4%	48.3%
Total % Growth	NA	69%	NA	80%	NA	248%	NA	77%
Total Jobs	**2,083,400**	**3,794,000**	**65,500**	**139,300**	**33,000**	**99,800**	**2,947,600**	**5,677,500**
% of Total Jobs	100%	100%	100%	100%	100%	100%	100%	100%
Total % Growth	NA	82%	NA	113%	NA	202%	NA	93%

Note: All employment numbers have been rounded to the nearest hundred, except when less than 100. Employment numbers between 10 and 100 have been rounded to the nearest ten; employment numbers less than 10 have not been rounded.

Appendix C
Water Provider Data Sources

Appendix C Water Provider Data Sources

Provider	Data Source
Academy Water & Sanitation District	SWSI I
Alameda	SWSI I
Aldaroso Ranch & Homeowners Co	SWSI I
Arapahoe County Water and Wastewater Authority	Colorado Drought and Water Supply Update, 2007
Arapahoe Estates	SWSI I
Arvada	CWCB 2010 Provider Interview
Aurora	CWCB 2010 Provider Interview
Avon (Upper Eagle Regional Water Auth)	CWCB 2010 Provider Interview
Avondale Water & Sanitation Di	AVC Study 2010
Bailey Water & Sanitation District	UMC Study 2010
Bancroft-Clover	SWSI I
Basalt	CWCB 2010 Provider Interview
Bear Creek	SWSI I
Beehive Water Assn	AVC Study 2010
Bennett	SWSI I
Bents Fort Water Association	AVC Study 2010
Berkeley	SWSI I
Beulah Water Works District	SWSI I
Black Hawk, City of (full-time residential)	UMC Study 2010
Blue Mountian Water District	UMC Study 2010
Blue Valley Metropolitan District	SWSI I
Board of Water Works of Pueblo	CWCB 2010 Provider Interview
Bon-Vue	SWSI I
Boone, Town of	AVC Study 2010
Bow-Mar	SWSI I
Brook Forest Water District	UMC Study 2010
Brookridge	SWSI I
Buena Vista	Colorado Drought and Water Supply Update, 2007
Buffalo Creek Water District	SWSI I
Canon City	Colorado Drought and Water Supply Update, 2007
Carbondale	CWCB 2010 Provider Interview
Castle Pines Metropolitan Dist	Water Conservation Plan
Castle Rock	CWCB 2010 Provider Interview
Castlewood	SWSI I
Centennial Water & San. Dist.	CWCB 2010 Provider Interview
Central City, City of (full-time residential)	UMC Study 2010
Central Weld County Water District (CWCWD)	Northern Colorado Water Conservancy District, 2006 Phase III Participation and Budget, December 2005

Appendix C Water Provider Data Sources

Provider	Data Source
Charlou Park	SWSI I
Cheraw, Town of	AVC Study 2009
Cherokee Metropolitan District	Colorado Drought and Water Supply Update, 2007
Cherry Creek Valley	SWSI I
Cherry Creek Village	SWSI I
Cherry Hills Farm	SWSI I
Cherry Hills Hts	SWSI I
Cherry Hills North	SWSI I
Cherry Hills Village	SWSI I
Cherrymoor Water	SWSI I
Chipeta Water District	From Gunnison Basin Roundtable Report
City and County of Broomfield	CWCB 2010 Provider Interview
City of Alamosa	CWCB 2010 Provider Interview
City of Aspen	CWCB 2010 Provider Interview
City of Boulder	CWCB 2010 Provider Interview
City of Brighton	CWCB 2010 Provider Interview
City of Brush	Colorado Drought and Water Supply Update, 2007
City of Burlington	Colorado Drought and Water Supply Update, 2007
City of Cortez	CWCB 2010 Provider Interview
City of Craig Public Works Dept	CWCB 2010 Provider Interview
City of Cripple Creek	SWSI I
City of Dacono	Colorado Drought and Water Supply Update, 2007
City of Delta (Project 7 Water Authority)	CWCB 2010 Provider Interview
City of Durango	CWCB Water Efficiency Grant Application, Feb. 2009
City of Englewood	CWCB 2010 Provider Interview
City of Evans	Northern Colorado Water Conservancy District, 2006 Phase III Participation and Budget, December 2005
City of Federal Heights	City of Federal Heights Water Conservation Plan June 2003
City of Florence	Colorado Drought and Water Supply Update, 2007
City of Fort Collins	GPCD from 2009 Annual Report
City of Fort Lupton	City of Fort Lupton Water Conservation Plan August 2007
City of Fort Morgan	Fort Morgan Water Conservation Plan 2008
City of Glendale	Colorado Drought and Water Supply Update, 2007
City of Glenwood Springs	CWCB 2010 Provider Interview
City of Golden, Public Works	Colorado Drought and Water Supply Update, 2007
City of Greeley	Greeley BNDSS survey
City of Holyoke	Colorado Drought and Water Supply Update, 2007
City of Idaho Springs Public Works	Idaho Springs Comprehensive Water Plan
City of La Junta	CWCB 2010 Provider Interview
City of Lafayette	Water Conservation Plan
City of Longmont	CWCB 2010 Provider Interview

Appendix C Water Provider Data Sources

Provider	Data Source
City of Louisville	Colorado Drought and Water Supply Update, 2007
City of Loveland	CWCB 2010 Provider Interview
City of Monte Vista	CWCB 2010 Provider Interview
City of Montrose (Project 7 Water Authority)	CWCB 2010 Provider Interview
City of Northglenn	CWCB 2010 Provider Interview
City of Ouray Public Works	From Gunnison Basin Roundtable Report
City of Rifle	CWCB 2010 Provider Interview
City of Rocky Ford	CWCB 2010 Provider Interview
City of Salida	Colorado Drought and Water Supply Update, 2007
City of Steamboat Springs	CWCB 2010 Provider Interview
City of Sterling	Colorado Drought and Water Supply Update, 2007
City of Thornton	CWCB 2010 Provider Interview
City of Trinidad	Colorado Drought and Water Supply Update, 2007
City of Westminster	CWCB 2010 Provider Interview
City of Wray	Colorado Drought and Water Supply Update, 2007
City of Yuma	Colorado Drought and Water Supply Update, 2007
Clifton	CWCB 2010 Provider Interview
Coalby Domestic Water Company	From Gunnison Basin Roundtable Report
Collbran, Town of	CWCB 2010 Provider Interview
Colorado Springs Utilities	CWCB 2010 Provider Interview
Columbine	SWSI I
Con Mutual	SWSI I
Copper Mountain CMD	CWCB 2010 Provider Interview
Cordillera (Upper Eagle Regional Water Auth)	CWCB 2010 Provider Interview
Crested Butte South Metro. District	SWSI I
Crestview	SWSI I
Crowley County Water System	SWSI I
Cucharas Sanitation & Water Di	SWSI I
Denver Water	CWCB 2010 Provider Interview
Devonshire Heights	SWSI I
Dillon Valley	CWCB 2010 Provider Interview
Donala Water & Sanitation Dist	Colorado Drought and Water Supply Update, 2007
Dukes Mobile Home Park, LLC	UMC Study 2010
Durango West Metro Dist #1	SWSI I
Durango West Metro District #2	SWSI I
E Cherry Hills	SWSI I
Eagle River Water & Sanitation	Colorado Drought and Water Supply Update, 2007
Eagle, Town of	CWCB 2010 Provider Interview
East Alamosa Water & Sanitation	SWSI I

Appendix C Water Provider Data Sources

Provider	Data Source
East Boulder County Water District	SWSI I
East Cherry Creek Valley	Colorado Drought and Water Supply Update, 2007
East Dillon Water District	CWCB 2010 Provider Interview
East End Water Assn.	AVC Study 2009
East Larimer County Water Dist	Water Conservation Plan
East Valley Water and Sanitation District	SWSI I
Edgemont Ranch Metro District	SWSI I
Edgewater	Colorado Drought and Water Supply Update, 2007
Edwards (Upper Eagle Regional Water Auth)	CWCB 2010 Provider Interview
Empire, Town of	UMC Study
Eureka Water Co.	AVC Study 2009
Evergreen Metropolitan Dist.	UMC Study 2010
Fayette Water Assn.	AVC Study 2009
Fehlmann	SWSI I
Fort Collins-Loveland Water District (FCLWD)	Colorado Drought and Water Supply Update, 2007
Fountain Utility	Colorado Drought and Water Supply Update, 2007
Fraser	SWSI I
Fruitland Domestic Water Company	From Gunnison Basin Roundtable Report
Garden Valley Water & San. Dis	SWSI I
Genesee Water & Sanitation District	UMC Study 2010
Georgetown, Town of	UMC Study 2010
Glendale	SWSI I
Granby	CWCB 2010 Provider Interview
Grand Junction, City of	CWCB 2010 Provider Interview
Grant	SWSI I
Green Mtn	SWSI I
Greenwood village	SWSI I
H.I.-Lin	SWSI I
Hancock Water Company	AVC Study 2009
Hasty Water Company	AVC Study 2009
Havana	SWSI I
High View	SWSI I
Hillcrest	SWSI I
Hilltop Water Co.	AVC Study 2009
Holbrook Center Soft Water	AVC Study 2009
Holly Hills	SWSI I
Homestead Improvement Assn.	AVC Study 2009
Homestead Water Company	UMC Study 2010

Appendix C Water Provider Data Sources

Provider	Data Source
Hot Sulphur Springs	SWSI I
Idledale Water & Sanitation District	UMC Study 2010
Ken-Caryl	SWSI I
Lake City	From Gunnison Basin Roundtable Report
Lakehurst	SWSI I
Lakewood	SWSI I
Las Animas	AVC Study 2009
Left Hand Water District	Water conservation Plan July 2008
Left Hand Water District (LHWD)	Northern Colorado Water Conservancy District, 2006 Phase III Participation and Budget, December 2005
Little Thompson Water District (LTWD)	Appendices to the Windy Gap Firming Project: Purpose and Need Report 2005
Littleton	SWSI I
Lochmoor	SWSI I
Lookout Mountain Water District	UMC Study 2010
Loretto Heights	SWSI I
Mansfield	SWSI I
May Valley Water Association	AVC Study 2009
McClave Water Association	AVC Study 2009
Meadowbrook	SWSI I
Menoken Water District	CWCB 2010 Provider Interview
Mesa Cortina	CWCB 2010 Provider Interview
Mesa, Town of	CWCB 2010 Provider Interview
Mid Valley Metropolitan District	CWCB 2010 Provider Interview
Montezuma Water Company	CWCB 2010 Provider Interview
Morgan County Quality Water District (MCQWD)	Northern Colorado Water Conservancy District, 2006 Phase III Participation and Budget, December 2005
Morrison Creek Water&San Dist	SWSI I
Mount Werner Water & San Distr	SWSI I
Mountain View	SWSI I
Mountain Water & Sanitation District	UMC Study 2010
Mt. Crested Butte Water & Sani	SWSI I
Mt. Vernon Country Club	UMC Study 2010
N Lincoln	SWSI I
N Pecos	SWSI I
N Washington	SWSI I
Navajo Western Water District	SWSI I
Newdale-Grand Valley Water Co.	AVC Study 2009
North Carter Lake Water Dist	SWSI I
North Holbrook Water	AVC Study 2009
North Weld County Water District (NWCWD)	TECHNICAL MEMORANDUM HE-5. North Weld County Water District Water Demands

Appendix C Water Provider Data Sources

Provider	Data Source
Northgate	SWSI I
Ordway	SWSI I
Other in Bent Co	SWSI I
Other in Otero Co	SWSI I
Other in Prowers Co	SWSI I
Pagosa Area W&S	CWCB 2010 Provider Interview
Panorama Park	SWSI I
Park Center Water District	SWSI I
Parkdale Water	SWSI I
Parker Water and Sanitation Di	Colorado Drought and Water Supply Update, 2007
Patterson Valley	AVC Study 2009
Penrose Water District	SWSI I
Pine Brook Water District	SWSI I
Pine Drive Water District	SWSI I
Pinewood Springs Water Distric	SWSI I
Pioneer Lookout Water District	SWSI I
Platte Canyon	SWSI I
Pueblo West Metropolitan Distr	Direct contact
Rangeview Metropolitan District	Response to Comments on June 2009 Demands 2050 Report (Appendix A)
Redstone	CWCB 2010 Provider Interview
Ridgewood Water District	SWSI I
Roaring Fork Water & Sanitation District	CWCB 2010 Provider Interview
Round Mountain Water & San. Di	SWSI I
Roxborough Park Metropolitan D	SWSI I
S. Sheridan Water	SWSI I
San Juan River Village Metr Di	SWSI I
San Luis Water & Sanitation Di	Colorado Drought and Water Supply Update, 2007
Security	Colorado Drought and Water Supply Update, 2007
Sheridan	SWSI I
Silt, Town of	CWCB 2010 Provider Interview
Silver Heights Water & San. Di	SWSI I
Silverthorne	CWCB 2010 Provider Interview
South Adams County Water & San	Colorado Drought and Water Supply Update, 2007
South Side Water Assoc. (LaJunta)	AVC Study 2009
South Swink Water Company	AVC Study 2009
South University Pl.	SWSI I
Southeast Englewood	SWSI I
Southgate Water District	SWSI I
Southwest Cherry Hls.	SWSI I
Southwest Metro.	SWSI I

Appendix C Water Provider Data Sources

Provider	Data Source
Southwest Suburban Den.	SWSI I
St. Charles Mesa Water District	AVC Study 2009
St. Mary's Glacier Water & Sanitation District	UMC Study 2010
Stonegate	Draft Final Rueter-Hess Reservoir Purpose and Need Report for the Supplemental Environmental Impact Statement
Stratmoor Hills Water District	SWSI I
Summit Ridge Water District	Colorado Drought and Water Supply Update, 2007
Superior/McCaslin Interchange	SWSI I
Teller County Water & San. Dis	SWSI I
Town of Aguilar	SWSI I
Town of Akron	Colorado Drought and Water Supply Update, 2007
Town of Alma	Colorado Drought and Water Supply Update, 2007
Town of Antonito	Colorado Drought and Water Supply Update, 2007
Town of Bayfield	Colorado Drought and Water Supply Update, 2007
Town of Bennett	SWSI I
Town of Berthoud	Northern Colorado Water Conservancy District, 2006 Phase III Participation and Budget, December 2005
Town of Breckenridge	CWCB 2010 Provider Interview
Town of Brookside	SWSI I
Town of Campo	Colorado Drought and Water Supply Update, 2007
Town of Cedaredge	From Gunnison Basin Roundtable Report
Town of Center	SWSI I
Town of Crawford	From Gunnison Basin Roundtable Report
Town of Creede	SWSI I
Town of Crested Butte	From Gunnison Basin Roundtable Report
Town of Crowley	SWSI I
Town of Del Norte	SWSI I
Town of Dillon Public Works	CWCB 2010 Provider Interview
Town of Dinosaur	Colorado Drought and Water Supply Update, 2007
Town of Dolores	SWSI I
Town of Eads	AVC Study 2009
Town of Eaton	Appendix C Town of Eaton Water Demands
Town of Erie	Erie Water Conservation Plan January 2008
Town of Estes Park	Colorado Drought and Water Supply Update, 2007
Town of Firestone	Town of Firestone Water Conservation Plan June 2007
Town of Flagler	Colorado Drought and Water Supply Update, 2007
Town of Fowler	AVC Study 2009
Town of Frederick	Appendices to the Windy Gap Firming Project: Purpose and Need Report 2005
Town of Frisco	Colorado Drought and Water Supply Update, 2007
Town of Grand lake	SWSI I
Town of Gunnison	From Gunnison Basin Roundtable Report
Town of Hayden	Colorado Drought and Water Supply Update, 2007

Appendix C Water Provider Data Sources

Provider	Data Source
Town of Hotchkiss	From Gunnison Basin Roundtable Report
Town of Hudson	Colorado Drought and Water Supply Update, 2007
Town of Hugo	Colorado Drought and Water Supply Update, 2007
Town of Ignacio	SWSI I
Town of Jamestown	Colorado Drought and Water Supply Update, 2007
Town of Keenesburg	Colorado Drought and Water Supply Update, 2007
Town of Kersey	Colorado Drought and Water Supply Update, 2007
Town of Kiowa	Colorado Drought and Water Supply Update, 2007
Town of Kremmling	Colorado Drought and Water Supply Update, 2007
Town of La Veta	SWSI I
Town of Lamar	AVC Study 2009
Town of Limon	SWSI I
Town of Log Lane Village	Colorado Drought and Water Supply Update, 2007
Town of Lyons	Colorado Drought and Water Supply Update, 2007
Town of Manzanola	Colorado Drought and Water Supply Update, 2007
Town of Meeker	Colorado Drought and Water Supply Update, 2007
Town of Milliken	Colorado Drought and Water Supply Update, 2007
Town of Monument, Water Dept	Colorado Drought and Water Supply Update, 2007
Town of Morrison	Colorado Drought and Water Supply Update, 2007
Town of New Castle	Colorado Drought and Water Supply Update, 2007
Town of Nucla	Colorado Drought and Water Supply Update, 2007
Town of Oak Creek Public Works	Colorado Drought and Water Supply Update, 2007
Town of Olathe (Project 7 Water Authority)	CWCB 2010 Provider Interview
Town of Olney Springs	AVC Study 2009
Town of Orchard City	From Gunnison Basin Roundtable Report
Town of Otis	Colorado Drought and Water Supply Update, 2007
Town of Ovid	Colorado Drought and Water Supply Update, 2007
Town of Palisade	CWCB 2010 Provider Interview
Town of Palmer Lake	Colorado Drought and Water Supply Update, 2007
Town of Paonia	From Gunnison Basin Roundtable Report
Town of Poncha Springs	Colorado Drought and Water Supply Update, 2007
Town of Rangely	CWCB 2010 Provider Interview
Town of Rico	Colorado Drought and Water Supply Update, 2007
Town of Ridgway	Carter-Burgress and Consolidated Consulting Services Report
Town of Sanford	SWSI I
Town of Severance	Northern Colorado Water Conservancy District, 2006 Phase III Participation and Budget, December 2005
Town of Springfield	Colorado Drought and Water Supply Update, 2007
Town of Sugar City	AVC Study 2009
Town of Superior	Appendices to the Windy Gap Firming Project: Purpose and Need Report 2005
Town of Swink	AVC Study 2009

Appendix C Water Provider Data Sources

Provider	Data Source
Town of Telluride	Colorado Drought and Water Supply Update, 2007
Town of Vilas	Colorado Drought and Water Supply Update, 2007
Town of Walden Public Works	CWCB 2010 Provider Interview
Town of Wellington Public Work	Colorado Drought and Water Supply Update, 2007
Town of Wiley	AVC Study 2009
Town of Windsor	Northern Colorado Water Conservancy District, 2006 Phase III Participation and Budget, December 2005
Town of Yampa	Colorado Drought and Water Supply Update, 2007
Tri-County Water Consservation District	CWCB 2010 Provider Interview
Triview Metropolitan District	Colorado Drought and Water Supply Update, 2007
Upper Surface Creek Domestic Water Users Association (USCDWUA)	From Gunnison Basin Roundtable Report
Ute Water Conservancy District	CWCB 2010 Provider Interview
Vail	CWCB 2010 Provider Interview
Valley Water	AVC Study 2009
Vroman	AVC Study 2009
Walsenburg	Colorado Drought and Water Supply Update, 2007
West Fort Collins Water District	SWSI I
West Grand Valley Water Inc.	AVC Study 2009
West Holbrook Water	AVC Study 2009
Westcreek Lakes Water District	SWSI I
Wheat Ridge Water District	SWSI I
Widefield Water And Sanitation	CWCB 2010 Provider Interview
Willow Brook Metropolitan Dist	SWSI I
Willowbrook	SWSI I
Will-O-Wisp Metropolitan District	UMC Study 2010
Willows Water District	SWSI I
Winter Park	CWCB 2010 Provider Interview

Appendix D
County Assignment to River Basin

Appendix D County Assignment to River Basin

Arkansas Basin	Baca County	100%
	Bent County	100%
	Chaffee County	100%
	Cheyenne County—Arkansas Basin Portion	38%
	Crowley County	100%
	Custer County	100%
	El Paso County	100%
	Elbert County—Arkansas Basin Portion	31%
	Freemont County	100%
	Huerfano County	100%
	Kiowa County	100%
	Lake County	100%
	Las Animas County	100%
	Lincoln County—Arkansas Basin Portion	81%
	Otero County	100%
	Prowers County	100%
	Pueblo County	100%
	Teller County—Arkansas Basin Portion	51%
Colorado Basin	Eagle County	100%
	Garfield County	100%
	Grand County	100%
	Mesa County—Colorado Basin Portion	90%
	Pitkin County	100%
	Summit County	100%
Dolores/ San Juan Basin	Archuleta County	100%
	Dolores County	100%
	La Plata County	100%
	Montezuma County	100%
	Montrose County—Dolores/ San Juan Basin Portion	10%
	San Juan County	100%
	San Miguel County	100%
Gunnison Basin	Delta County	100%
	Gunnison County	100%
	Hinsdale County	100%
	Mesa County—Gunnison Basin Portion	10%
	Montrose County—Gunnison Basin Portion	90%
	Ouray County	100%
North Platte Basin	Jackson County	100%
Rio Grande Basin	Alamosa County	100%
	Conejos County	100%
	Costilla County	100%
	Mineral County	100%

Appendix D County Assignment to River Basin

	Rio Grande County	100%
	Saguache County	100%
South Platte Basin	Adams County	100%
	Arapahoe County	100%
	Boulder County	100%
	Broomfield County	100%
	Cheyenne County—South Platte Basin Portion	62%
	Clear Creek County	100%
	Denver	100%
	Douglas	100%
	Elbert County—South Platte Basin Portion	69%
	Gilpin County	100%
	Jefferson	100%
	Kit carson County	100%
	Larimer County	100%
	Lincoln County—South Platte Basin Portion	19%
	Logan County	100%
	Morgan County	100%
	Park County	100%
	Phillips County	100%
	Sedgewick County	100%
	Teller County—South Platte Basin Portion	49%
	Washington County	100%
	Weld County	100%
	Yuma County	100%
Yampa Basin	Mofffat County	100%
	Rio Blanco County	100%
	Routt County	100%

Appendix E
Self-Supplied Industrial Water Use Data Sources

SSI Sector	Industry	Data Source
Snowmaking	Vail	Snowmaking acres from "Vail Ski Resort - Vail Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/vail/profile.html>. Water use from CWCB, Upper Colorado River Basin Information Report, October 2007. ftp://dwrftp.state.co.us/cdss/swm/in/UColoInfo_20070101.pdf
Snowmaking	Sunlight	Snowmaking acres from "Sunlight Mountain Resort Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/sunlight-mountain-resort/profile.html>. "
Snowmaking	Winter Park/Mary Jane	Snowmaking acres from "Winter Park Resort Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/winter-park-resort/profile.html>. Water use from Grand County et al, Upper Colorado River Basin Study (UPCO), Phase II, Final Report, May 2003.
Snowmaking	SolVista (Silver Creek) Basin	Snowmaking acres from "SolVista Golf & Ski Ranch (Silver Creek) Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Web. 26 May 2010. <http://www.onthesnow.com/colorado/solvista-golf-ski-ranch-silver-creek/profile.html>.
Snowmaking	Powderhorn	Snowmaking acres from "Powderhorn Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/powderhorn/profile.html>. "
Snowmaking	Aspin Ski Co (All resorts)	Snowmaking acres from: (1) "Aspen / Snowmass Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Web. 26 May 2010. <http://www.onthesnow.com/aspen/aspen-mountain/profile.html>. (2) "Aspen Highlands Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Web. 26 May 2010. <http://www.onthesnow.com/aspen/aspen-highlands/profile.html>. (3) "Buttermilk Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Web. 26 May 2010. <http://www.onthesnow.com/aspen/buttermilk/profile.html>. (4) "Snowmass Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Web. 26 May 2010. <http://www.onthesnow.com/aspen/snowmass/profile.html>. Water use data from Rocky Mountain News, "Change in the Air: Third in an Occasional Series about High-Altitude Research in Colorado" by Jim Erickson, March 19, 2005.
Snowmaking	Beaver creek	Snowmaking acres from "Beaver Creek Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/beaver-creek/profile.html>.
Snowmaking	Keystone	Snowmaking acres from "Keystone Mountain Stats." Keystone Ski Resort - Colorado Ski Area. Web. 26 May 2010. <http://www.keystoneresort.com/explore-keystone/the-mountain/mountain-statistics.aspx>. Water use from Grand County et al, Upper Colorado River Basin Study (UPCO), Phase II, Final Report, May 2003 and Upper Colorado River Basin Water Resources Planning Model User's Manual (CWCB October 2009).

SSI Sector	Industry	Data Source
Snowmaking	Breckenridge	Snowmaking acres from "Mountain Information - Breckenridge Ski Resort Info." Breckenridge Resort Summer and Winter Activities. Web. 26 May 2010. <http://www.breckenridge.com/mountain/mountain-information.aspx>. Water use from Grand County et al, Upper Colorado River Basin Study (UPCO), Phase II, Final Report, May 2003.
Snowmaking	Copper Mountain	Snowmaking acres from "Copper Mountain Resort Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/copper-mountain-resort/profile.html>. Water use from Grand County et al, Upper Colorado River Basin Study (UPCO), Phase II, Final Report, May 2003 and Upper Colorado River Basin Water Resources Planning Model User's Manual (CWCB October 2009).
Snowmaking	Arapahoe Basin	Snowmaking acres from "Arapahoe Basin Ski Area Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/arapahoe-basin-ski-area/profile.html>. Water use from Grand County et al, Upper Colorado River Basin Study (UPCO), Phase II, Final Report, May 2003.
Snowmaking	Crested Butte	Snowmaking acres from "Mountain Stats." Crested Butte Mountain Resort. Web. 26 May 2010. <http://www.skicb.com/cbmr/mountain/mountain-stats.aspx>. Water use information obtained during the Gunnison Basin Roundtable Needs Assessment.
Snowmaking	Telluride	Snowmaking acres from "Telluride Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/telluride/profile.html>. "
Snowmaking	Durango	Snowmaking acres from "Durango Mountain Resort Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/durango-mountain-resort/profile.html>. "
Snowmaking	Echo Mountain	Snowmaking acres from "Echo Mountain Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/echo-mountain/profile.html>". Water use data from UMC Study, Clear Creek et al 2010.
Snowmaking	Eldora	Snowmaking acres from "Eldora Mountain Resort Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/eldora-mountain-resort/profile.html>.
Snowmaking	Loveland	Snowmaking acres from "Loveland Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. Water use data from UMC Study, Clear Creek et al 2010.
Snowmaking	Steamboat	Snowmaking acres from "Steamboat Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/steamboat/profile.html>. " Water use from the *Yampa River Basin Information Report,* CWCB and Colorado's Decision Support System, 2009.

SSI Sector	Industry	Data Source
Snowmaking	Howelsen Hill	Snowmaking acres from "Howelsen Hill Ski Resort - Overview." Ski & Snow Report, Ski Deals, Skiing Reviews | OnTheSnow.com. Mountain News Corp. Web. 26 May 2010. <http://www.onthesnow.com/colorado/howelsen-hill/profile.html>. "
Thermoelectric	Arapahoe Facility	Data from Xcel Energy, November 2003
Thermoelectric	Cameo Facility	Data from Xcel Energy, November 2003
Thermoelectric	Cherokee Facility	Data from Xcel Energy, November 2003
Thermoelectric	Comanche Facility	Data from Xcel Energy, November 2003
Thermoelectric	Fort St. Vrain Facility	Data from Xcel Energy, November 2003
Thermoelectric	Hayden Facility	Data from Xcel Energy, November 2003
Thermoelectric	Pawnee Facility	Data from Xcel Energy, November 2003
Thermoelectric	Valmont Facility	Data from Xcel Energy, November 2003
Thermoelectric	Zuni Facility	Data from Xcel Energy, November 2003
Thermoelectric	Tri-State G & T Assn., Inc. Facilites	http://www.tristategt.org/
Thermoelectric	Facilites in Moffat and Routt County	BBGC Yampa Study
Thermoelectric	Rawhide Facility	Platte R. Power Authority
Thermoelectric	Rocky Mtn. Energy Facility	SWSI I
Large Industry	Cargill	City of Fort Morgan Water Conservation Plan
Large Industry	Swift Company	City of Greeley demand forecast tech memo by HE
Large Industry	Kodak	City of Greeley demand forecast tech memo by HE
Large Industry	Coors Brewing Co.	SWSI I
Large Industry	Colorado Steel	SWSI I

Appendix F
Energy Water Use Scenarios

DRAFT

Memorandum

To: **Joint Energy Water Needs Subcommittee**
cc:
From: **Ben Harding, Shaden Musleh, Hanna Sloan**
Subject: **Energy Water Use Scenarios**
Date: **June 29, 2010**

This Technical Memorandum documents the development of scenarios of water use as part of Task 2 of the Energy Water Needs Assessment Phase II Study (Study). The Energy Development Water Needs Assessment is being conducted by the Energy Subcommittee of the Colorado, Yampa and White River Basin Roundtables (Subcommittee) as part of the Colorado Water for the 21st Century (HB-1177) water supply planning process.

The objective of Task 2, *Refine Water Demand Estimates*, is to develop estimates of water demand attributable to future energy development and to break those demands down by location to allow a particular water use to be assigned to a particular water supply facility in a water supply scenario. The Study area for the Phase II Study includes all of the Yampa River and White River basins and that portion of the Colorado River basin west of a line running north and south approximately through Edwards.

The scope of Task 2 involves refinement of the water use estimates reported in the Phase I report (URS, 2008). This memo provides information about Sub-task 2.3 *Develop Basin Water Use Scenarios.* The objective of Sub-task 2.3 is to develop a water use scenario for each basin. Subsequent sections of this technical memorandum discuss: an introduction, time frame for scenarios, water use scenarios, and references.

Introduction

Phase I developed estimates of future water required for development of oil shale, coal, natural gas and uranium energy resources. Only estimates of water use attributable to oil shale development have been refined in the Phase II Study; the work in Task 2 has resulted in revised estimates of water use attributable to oil shale that reflect new information about and improved understanding of the future possibilities for an oil shale industry. Water use scenarios depend on the scale of the projected future oil shale industry and on the water use intensity of the industry. Water use intensity is expressed as the amount of water required to produce a unit of production, which is a barrel of oil in the case of oil shale. Revised estimates of the unit water use (in terms of barrels of water per barrel of oil, bbl/bbl) for oil shale development and production activities were reported in project task memorandum *Oil Shale Direct Water Use Estimates*, April 13, 2010. Estimates of unit water use for the population changes caused by oil shale development and production were reported in project task memorandum, *Oil Shale Indirect Water Use Estimates*, June 16, 2010. Validation of Phase I estimates of the projected scale of an oil shale industry were reported in project technical memorandum *Oil Shale Production Scenarios*, June 16, 2010. This technical memorandum provides

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comprehensive estimates of water use by all four energy sectors. Water use for oil shale depends on the production methodology, and there is considerable uncertainty regarding which methodologies ultimately will be used for production. To reflect this uncertainty, water use estimates for oil shale are provided for low, medium and high water use scenarios.

Time frame for scenarios

There are two conceptual time frames that can be used for estimating future water use: estimates at a specific point in time or range of times in the future or estimates at "build-out" that represent the level of water use by a mature, fully–developed industry.

Selection of the conceptual scenario for estimating future water use, and selecting the specific future time frame or time frames at which estimates of water use might be developed is a policy decision that depends on how the water use estimates will be employed. The Subcommittee has determined that a build-out time frame will be used. Accordingly, water use estimates presented in this memo are based on estimates of build-out conditions.

Water Use Scenarios

Coal

Table 1 shows the development scenarios for the coal industry in the study area adopted by the Phase 1 Study.

Table 1. Phase I Assumptions Supporting Coal Production Scenarios

Planning Horizon	Production Scenarios – Coal		
	Low	Medium	High
Near-Term (2007–2017)	Red Cliff mine begins producing 2.5 million tpy by 2011. Total production holds steady at 20.5 million tpy.	No change from low/near-term production scenario.	No change from low/near-term production scenario.
Mid-Term (2018–2035)	Production rate holds steady at 20.5 million tpy.	Red Cliff mine begins producing 8 million tpy by 2018. Total production holds steady at 26 million tpy.	No Change from Medium/Mid-Term production scenario.
Long-Term (2036–2050)	Production rate holds steady at 20.5 million tpy.	No change from medium/mid-term production scenario.	Add 1 coal gasification or liquefaction plant in northwest Colorado processing approximately 4 million tons of coal per year. Total coal production of 30 million tpy.

Table 2. Phase I Total Direct Water Demands for Coal Production (af/year)

Planning Horizon	Production Scenarios – Coal		
	Low	Medium	High
Near-Term (2007–2017)	1,213	1,213	1,213
Mid-Term (2018–2035)	1,213	1,538	1,538
Long-Term (2036–2050)	1,213	1,538	5,063

Natural Gas

Table 3 shows the development scenarios for the natural gas industry in the study area adopted by the Phase 1 Study.

Table 3. Phase I Assumptions Supporting Natural Gas Production Scenarios

Planning Horizon	Production Scenarios – Coal		
	Low	Medium	High
Near-Term (2007–2017)	Average drilling rate ≈ 1,800 wells/year.	Average drilling rate ≈ 1,900 wells/year.	Average drilling rate ≈ 2,000 wells/year.
Mid-Term (2018–2035)	Average drilling rate ≈ 1,700 wells/year. Drilling rate slowly declines in Garfield County and shifts to Rio Blanco County..	Average drilling rate ≈ 2,125 wells/year to account for additional activity in the northern Piceance Basin. Approx. 65,000 operational wells by 2035.	Average drilling rate ≈ 2,300 wells/year to provide thermoelectric power to the oil shale industry for start-up
Long-Term (2036–2050)	Drilling activity slowly declines to ~1,100 well/year by 2050.	Drilling activity slowly declines to ~1,500 well/year by 2050.	Drilling activity slowly declines to ~1,700 well/year by 2050.

Table 4. Phase I Total Direct Water Demands for Natural Gas Production (af/year)

Planning Horizon	Production Scenarios – Coal		
	Low	Medium	High
Near-Term (2007–2017)	2007: 2,965 2017: 4,292	2007: 3,133 2017: 4,880	2007: 3,165 2017: 5,230
Mid-Term (2018–2035)	2018: 4,168 2035: 3,975	2018: 5,044 2035: 4,874	2018: 5,437 2035: 5,276
Long-Term (2036–2050)	2036: 3,869 2050: 2,834	2036: 4,769 2050: 3,285	2036: 5,171 2050: 3,686

Uranium

Table 5 shows the development scenarios for the uranium industry in the study area adopted by the Phase 1 Study.

Table 5. Phase I Assumptions Supporting Uranium Production Scenarios

Planning Horizon	Production Scenarios – Coal		
	Low	Medium	High
Near-Term (2007–2017)	No uranium mining within project area.	No uranium mining within project area.	1 underground uranium mine.
Mid-Term (2018–2035)	No uranium mining within project area.	1 underground uranium mine.	1 underground uranium mine.
Long-Term (2036–2050)	No uranium mining within project area.	1 underground uranium mine.	2 underground uranium mines: 1 in Mesa County and one in Moffat County.

Table 6. Phase I Total Direct Water Demands for Uranium Production (af/year)

Planning Horizon	Production Scenarios – Coal		
	Low	Medium	High
Near-Term (2007–2017)	No uranium mining within project area.	No uranium mining within project area.	62
Mid-Term (2018–2035)	No uranium mining within project area.	62	62
Long-Term (2036–2050)	No uranium mining within project area.	62	124

Oil Shale

Development scenarios for oil shale are discussed in project technical memo *Oil Shale Production Scenarios*, June 16, 2010. Table 7 shows the development scenarios for the oil shale industry in the study area adopted by the Phase 1 Study.

Table 7. Phase I Assumptions Supporting Oil Shale Production Scenarios

Planning Horizon	Production Scenarios – Oil Shale		
	Low	Medium	High
Near-Term (2007–2017)	No Commercial Production RD&D Leases Only	No Commercial Production RD&D Leases Only	No Commercial Production RD&D Leases Only
Mid-Term (2018–2035)	No Commercial Production RD&D Leases Only	Underground mine/surface retort facility with 50,000 bpd production. Additional 25,000 bpd of in-situ production	Underground mine/surface retort facility with 50,000 bpd production. Additional 500,000 bpd of in-situ production
Long-Term (2036–2050)	No Commercial Production RD&D Leases Only	Underground mine/surface retort facility with 50,000 bpd production. Additional 150,000 bpd of in-situ production	Underground mine/surface retort facility with 50,000 bpd production. Additional 1.5 million bpd of in-situ production

The Subcommittee adopted the Phase 1 "Long-term/High" scenario to represent the level of development expected at the build-out time frame. That scenario projects an oil shale industry with 1.5 million bbl/day production from in situ processes (located in the Piceance Basin) and 50,000 bbl/day production from above-ground retorting (located at outcrops along the southern extent of the Piceance Basin, in the Colorado River Basin). Estimates of unit water use for direct use and indirect use for oil shale are provided in project technical memoranda *Oil Shale Direct Water Use Estimates*, April 13, 2010 and, *Oil Shale Indirect Water Use Estimates*, June 16, 2010. Table 8 shows the indirect unit water use and Table 9 shows the direct unit water uses for oil shale production processes.

Table 8. Estimates of Indirect Water Use for Oil Shale (bbl/bbl)

Water Use Category	In situ Retorting	Above-Ground Retorting
Electrical Energy Workforce	0.007	0.002
Production Workforce	0.11	0.42

Table 9. Estimates of Direct Water Use for Oil Shale (bbl/bbl)

	In situ Retorting		Above-Ground Retorting	
Water Use Category	**Low**	**High**	**Low**	**High**
Construction/Pre-production	0.02	0.16	0.01	0.07
Electrical Energy	0.41	1.00	0.17	0.26
Production			0.47	0.47
Reclamation	0.45	0.54	0.02	0.17
Spent Shale Disposal			0.80	1.60
Upgrading	0.57	1.60	0.60	1.60

Table 10 shows the unit amount of water produced as a byproduct of shale oil production. Only one estimate of the rate of water production was obtained for each of in situ and above-ground retorting; therefore no quantitative information can be provided regarding the uncertainty of this estimate. Because of the nature of the processes, methods using combustion heating can be expected to produce more byproduct water than methods using electrical heating or solvents.

Table 10. Estimates of Water Co-Produced When Retorting Oil Shale (bbl/bbl)

In situ Retorting	Above-Ground Retorting
0.80	0.30

Because both unit water use rates and the configuration of a future oil shale industry are uncertain, a range of water use estimates must be developed with the view that the actual future level of water use will be contained between a low and high estimate to a reasonable degree of certainty. In developing a range of water use estimates a variety of assumptions can be made about the mix of production and upgrading technologies that will make up the future oil shale industry, and about the water use intensity of those

individual technologies. Tables 11 and 12 present total (direct and indirect) unit water use estimates for plausible industry configurations.

Table 11. In Situ Industry Configurations and Total Unit Water Use

In Situ Scenario	Scenario Description	Unit Use (bbl/bbl)	Comments
IS-1	Down-hole combustion heating off-site upgrading. Low estimates.	-0.22	Without energy direct use or use by energy workforce; no upgrading use.
IS-2	Down-hole combustion heating, off-site upgrading. High estimates.	0.01	Without energy direct use or use by energy workforce.
IS-3	Shell in situ conversion process (ICP), off-site upgrading. Low estimates.	0.20	Without energy direct use or use by energy workforce; no upgrading use.
IS-4	Shell ICP, on-site upgrading. Low estimates.	0.77	Based on low estimates of electricity use and other process water uses. ICP will likely require less intensive upgrading.
IS-5	Shell ICP, off-site upgrading. High estimates.	1.02	Based on high estimates of electricity use and other process water uses.
IS-6	Down-hole combustion heating on-site upgrading. High estimates.	1.61	Based on high estimates of process water uses. No electrical heating. Combustion-based processes are more likely to require more upgrading. Highest combustion value.
IS-7	Shell ICP, on-site upgrading. High process, low upgrading.	1.59	Uses low estimate of upgrading, as ICP process is more likely to require less upgrading. Otherwise uses high estimates. Highest ICP value.

In situ scenarios 1,4 and 7 were selected to represent the low, medium and high levels of water use. Scenario 1 assumes an industry that uses combustion heating to heat formations to recover oil, and that upgrades kerogen products outside the study area. The use of combustion heating eliminates the direct and indirect water use required for electrical generation for electric heating. Combustion heating is likely to produce more byproduct water than electrical heating or solvent recovery. A solvent-recovery scenario has not been included. Like Scenario 1 it would not require water to support electrical generation, but it would also not produce much, if any, byproduct water. Accordingly, it would be a low water use scenario, but would not be expected to have lower water use than Scenario 1. Scenario 7 assumes an industry that uses the Shell in situ conversion process. This process uses electrical heating and therefore requires water to supply the direct and indirect water needs of generation. Scenario 7 assumes that the kerogen product would require upgrading in the study area, but assumes a lower unit water use for this process to reflect the reported ability of the Shell process to produce a more refined product. Scenarios 6 and 7 are equivalent in terms of water use estimates based on the information available to the Study. However, because the Shell process is likely to produce less byproduct water, the actual water use of Scenario 7 may be greater than shown in Table 11. However, at this time sufficient information is not available to refine

the estimate of water use further. Scenario 4 is similar to Scenario 7 except that low estimates for water use intensity are used.

Table 12. Above-Ground Industry Configurations and Total Unit Water Use

Above-Ground Scenario	Scenario Description	Unit Use (bbl/bbl)	Comments
AG-1	Off-site electricity, off-site upgrading. Low estimates	1.41	Seems a likely possibility, if above-ground product is compatible with down-hole in situ product; small electricity demands can be met from grid. Use with down-hole in-situ.
AG-2	Off-site electricity, on-site upgrading. Low estimates	2.01	Likely that above-ground retort product will require more intensive upgrading, so this estimate may be low. Use with ICP.
AG-3	On-site electricity, on-site upgrading. Low estimates	2.18	Use co-produced gas for on-site combined cycle gas turbine (CCGT). Likely that above-ground retort product will require more intensive upgrading, so this estimate may be low. Use with ICP.
AG-4	Off-site electricity, off-site upgrading. High estimates	2.43	Seems a likely possibility, if Above-Ground product is compatible with down-hole in situ; small electricity demands can be from grid. Use with down-hole in situ method.
AG-5	Off-site electricity, on-site upgrading. High estimates	4.03	Seems a likely possibility with ICP in situ, since the small above-ground production might require on-site upgrading; small electricity demands can be from grid. Use with ICP.
AG-6	On-site electricity, on-site upgrading High estimates,	4.29	Use co-produced gas for on-site CCGT. Use with ICP.

Above-ground Scenarios 1, 3 and 6 were selected to represent the low, medium and high levels of water use. Scenario 1 assumes that electricity is taken from the grid, that upgrading is done outside the study area, and that lower levels of water use intensity will occur. Scenario 6 assumes that electricity is generated on site, that upgrading takes place in the study area, and that higher levels of water use intensity occur. Scenario 3 assumes that electricity is generated on site, that upgrading takes place in the study area, but that lower levels of water us intensity occur.

Table 13 provides estimates of the total, industry-wide water use for the build-out industry scenario (1.5 million bbl/day in situ production and 50,000 bbl/day above-ground production) for low, medium and high water use scenarios. Industry-wide water use estimates are presented to a precision of no more than two significant figures to reflect the uncertainty in those estimates.

Table 13. Total Water Use for Selected Scenarios

Scenario	Unit Use (bbl/bbl)	Industry Water Use, acre-feet/year		
		Low	Medium	High
IS-1	-0.22	-16,000		
IS-4	0.77		54,000	
IS-7	1.59			110,000
AG-1	1.41	3,300		
AG-3	2.18		5,100	
AG-6	4.29			10,000
Total		-13,000	59,000	120,000

Uncertainties in the estimates provided in Table 13 arise from, among other things, estimates and judgments about the following factors: the size of the future oil shale industry, the split between in situ and above-ground retorting, the water intensity of individual industrial processes, the mix of in situ retorting processes, the source of electrical energy for formation heating, the rate at which byproduct water is produced and the degree to which byproduct water will be re-used for process purposes. These factors, in turn, will be influenced by the economic, political, regulatory and social conditions that exist at the time a commercial oil shale industry develops decades in the future.

The factor that has the most significant effect on water use is the size of the industry, including the possibility that no oil shale industry will develop at all. Aside from the scale of the industry, the two factors with the most influence over the estimate of total industry water use are the source of electrical energy for formation heating and the amount of byproduct water and its usability for in situ process needs. If electricity is generated by coal-fired thermal generation within the study area, rather than combined cycle gas turbines, total water use for the *high* scenario would increase by approximately 170,000 af/year. Population will also increase, because coal-fired thermal generation is more labor-intensive than the combined cycle gas turbines. If byproduct water from in situ production is not used to satisfy process needs, total water use for the *high* scenario will increase by an additional 60,000 af/year.

In addition, the estimate of 50,000 bbl/day production from above-ground retorting used in this analysis may understate the future value. For every 50,000 bbl/day increase in production from above-ground retorting total, industry-wide water use for the *high* scenario will increase by about 10,000 af/year. This increase in water use will occur predominantly in the Colorado River basin, along with a related increase in population.

References

URS Corporation, Energy Development Water Needs Assessment (Phase I Report), prepared for Colorado, Yampa, and White River Basin Roundtabes Energy Subcommittee. September, 2008.