SWSI 2010 MUNICIPAL AND INDUSTRIAL WATER CONSERVATION STRATEGIES

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EXECUTIVE SUMMARY

Municipal water conservation is an important component of Colorado's strategy to provide a safe, secure, and sustainable water supply for future generations. This document represents the latest effort by the Colorado Water Conservation Board (CWCB) to integrate water conservation into overall water supply planning and to estimate the statewide water conservation potential up to the year 2050.

The CWCB defines water conservation as those measures and programs that provide for measurable and verifiable permanent water savings (CWCB 2010b).[1] This is separate and in addition to the temporary savings that may result from short-term drought restrictions and related programs. In support of the Statewide Water Supply Initiative (SWSI), the Interbasin Compact Committee (IBCC), and other water conservation efforts throughout the state, the CWCB has developed several work products which provide technical detail related to water conservation planning. The purpose of this report is to:

- Incorporate recent water conservation-related efforts into the SWSI 2010 update,
- Update the range of potential future water conservation savings, and
- Provide *water conservation strategies* that may contribute toward meeting the projected 2050 M&I water supply gap[2] and help address Colorado's future municipal and industrial (M&I) water needs[3].

Water conservation is assumed to be one of several water supply strategies that Colorado will need to rely on to meet future M&I water demands. Meeting Colorado's future water supply needs will require a mix of successful identified plans and processes (IPPs), agricultural transfers, reuse, and new water supply projects. The conservation savings forecasts presented here are intended for statewide planning purposes and are *not intended to replace water conservation and water resources planning and projections prepared by local entities*. This report estimates potential future water conservation for three distinct strategies, but has not determined the portion of those savings that could potentially be utilized toward meeting a future water supply gap.

The information in this report was prepared for the CWCB by Aquacraft, Inc. and Headwaters Corporation. The approach and results were presented to and reviewed by the CWCB staff, the CWCB's Water Conservation Technical Advisory Group, and a broad collection of stakeholders.

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[1] Under this definition, water conservation may include measures and programs that are being implemented for political reasons and/or to improve customer satisfaction

[2] The "M&I gap" is defined as the difference between future water demands and identified projects and processes (IPPs) which local water providers are pursuing to help meet their M&I water demands.

[3] Colorado's 2050 M&I water demands include water demands associated with Self Supplied Industrial (SSI) users – large industrial users that have their own water supplies or lease raw water from others. The potential water conservation *savings* provided in this SWSI 2010 update include only savings from the M&I demands associated with a typical municipal system. Potential SSI water *savings* are not estimated.

Three Conservation Strategies: Low, Medium, and High

Methodology

The potential for future conservation by the year 2050 was estimated for three distinct conservation strategy scenarios titled simply: Low, Medium, and High. Water savings in 2050 were forecast for each river basin in Colorado using a conditional demand forecasting methodology that employed a set of efficiency targets, sectoral demand reductions, and assumed implementation rates. Each strategy includes an overview of the conservation measures and programs that could be implemented to achieve a range of efficiency targets (for indoor use) and estimated sectoral conservation savings which were based upon the best available literature and data on demand management. The conservation savings forecasts developed here are conditional and rely on an assumption of implementation at the described levels in order to achieve the overall estimated savings level.

The SWSI 2010 water conservation projections are founded upon the 2050 demand projections prepared under the "Colorado Water Conservation Board State of Colorado 2050 Municipal and Industrial Water Use Projections" report (CWCB 2010c). Using the basin-level per capita current baseline water use data and 2050 population projections, this report disaggregates water demand key water use sectors: residential and non-residential indoor and outdoor uses and utility water loss. Water demands and conservation savings were estimated using a *driver multiplied by rate of use* approach, where the driver is population in each basin and the rate of use is in gallons per capita per day (*gpcd*) in each basin.

The conditional forecasting methodology used for this SWSI 2010 update assumes that the identified strategies will be implemented and does not account for water providers' management decisions, such as storing a portion of the savings for drought planning or using a portion to improve stream flows for environmental or recreational benefits. Management decisions consider legal, temporal, and spatial constraints that must be understood at a local utility level, and should be part of integrated resource planning that considers the specific water rights portfolio, system reliability, drought response, etc.

Conservation Strategies: Implementation Rates and Savings Levels

Table 1 presents a comparison of the Low, Medium, and High conservation strategies. Savings and measures for each water use sector are presented and the key demand reduction modeling assumptions for each sector are shown in bold blue font. The conservation strategy measures that apply to each sector are listed as bullet points beneath each demand reduction assumption. Table 1 includes the implementation/penetration levels and ranges that are assumed to be achieved by 2050 to accomplish the demand reductions.

Broad conservation measures such as education and rates that impact across all customer sectors are presented at the top of Table 1. These broad measures are assumed to support and contribute to the savings levels estimated for each customer sector.

Table 1: Comparison of 2050 implementation and penetration level for three conservation strategies, and demand reductions used in forecasts

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

*Landscape water demand reductions include the anticipated impact of urban densification.

The demand reductions presented in Table 1 represent feasible levels of conservation savings based on an extensive review of the literature on the impacts of conservation measures and programs. Although these savings measures may be technically achievable, they are by no means automatic, and will require significant and sustained effort and investment by the State and local governments, by water providers, and by water customers.

The conservation measures presented in Table 1 are largely based on the recently published *Best Practices Guide for Municipal Water Conservation in Colorado* (CWW 2010). Implementation levels are engineering estimates designed to be achievable and to deliver substantive water savings. Detailed cost-effectiveness analysis was not conducted for this study and should be the subject of future research, however all water saving strategies were based on program measures determined to be cost-effective from the water provider perspective (CWW 2010).

Water Savings in 2050 Under Three Conservation Strategies

The total estimated water savings that may be achieved through implementation of the three conservation strategies are presented in Table 2. In Table 2 the water savings from each SWSI 2010 strategy builds upon the previous strategy starting with the passive savings.

The SWSI Levels analysis of statewide passive water conservation potential showed that by 2050 demands will likely be reduced by 154,000 AF through the natural replacement of toilets, clothes washers, and other standard domestic fixtures (CWCB 2010b). In Table 2 these passive savings are embedded in all three conservation strategies. The SWSI 2010 conservation strategies add savings from active conservation program efforts to the passive savings estimates.

If successfully implemented to the levels described, in 2050 the Low strategy + passive savings results in estimated statewide water savings of 314,200 AF. In 2050 the Medium strategy + passive savings results in estimated statewide water savings of 485,200 AF and the High strategy + passive savings results in estimated statewide water savings of 615,300 AF.

In Table 3 passive and active water savings estimates are presented separately to help ensure double counting of water savings does not occur in the future as these estimates are used.

To provide perspective on how estimates of conservation savings have been adjusted over the past decade a summary of the statewide demand forecasts and total water savings in 2030 and 2050 developed for the SWSI 2010 update are presented in Table 2, along with similar forecasts from the SWSI Phase 1 (2004), SWSI Phase 2 (2007), and the recent SWSI Levels (2010) analysis. This includes passive savings, which is constant in all strategies.

Table 2: Statewide forecast water savings potential from SWSI Phase 1, 2, and SWSI 2010 [a]

Project	Level	2030 Forecast Savings* (AFY)	2050 Forecast Savings* (AFY)
SWSI Phase 1	Level 1 (Passive)	101,900	NA
	Level 2	170,533	
	Level 3	272,852	
	Level 4	443,385	
	Level 5	699,183	
SWSI Phase 2	Low	287,000	NA
	Mid	372,000	
	High	459,000	
SWSI 2010	Passive**	131,000	154,000
	Low	209,000	314,200
	Medium	264,000	485,200
	High	328,100	615,300

Notes:

[a] Total water savings potential included, which does not decipher the portion of the savings that may be available to meet future demands versus other planning uses such as drought reserve.

* Volumes savings estimates are total cumulative and include passive savings (e.g. SWSI Phase 1, Level 3 savings build upon Levels 1 and 2; SWSI 2010, Medium savings build upon Low savings).

**From SWSI Levels analysis (CWCB 2010b).

SWSI 2010 savings are estimated through 2050 rather than 2030, but 2030 savings are available for comparison against SWSI Phase 1 and SWSI Phase 2 estimates. Water savings estimated to be achieved by 2030 from the Low, Medium, and High SWSI 2010 strategies are generally smaller in magnitude than the 2030 savings estimates developed in the SWSI Phase 1 and SWSI Phase 2. The SWSI 2010 savings estimates are smaller because many water providers in Colorado have already reduced demand over the past 10 years particularly in response to the 2002 drought. Overall, statewide gpcd has decreased by 18 percent since the SWSI Phase I report was completed, however the cause and permanency of these savings is uncertain (CWCB 2010c). Changes in system wide 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 data and information account for a significant portion of these observed changes according to the team that developed the baseline demand profiles (CWCB 2010c).

In Table 3, forecasted passive and active conservation savings are compared. The data in Table 3 are the same as in Table 2, only the passive savings are not included for each program level. Data from SWSI Phase 2 have not been included in Table 2 or Table 3 because passive and active savings are not disaggregated in that analysis.

Table 3: Statewide forecast water savings (separating passive and active) potential from SWSI Phase 1 and SWSI 2010 [a]

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

Notes:

[a] Total water savings potential included, which does not decipher the portion of the savings that may be available to meet demands associated with new population versus other planning uses such as drought reserve.

* Volumes savings estimates are total cumulative and include passive savings (e.g. SWSI Phase 1, Level 3 savings build upon Levels 1 and 2; SWSI 2010, Medium savings build upon Low savings).

** From SWSI Levels analysis (CWCB 2010b).

Cost Estimates

The SWSI Phase 2 analysis effort included a weighted utility program implementation cost estimate of $10,600 per AF of water saved for implementing the identified conservation measures. The SWSI 2010 includes similar utility cost estimates, but because of the methodology utilized to develop water savings forecasts that aggregated savings by end use sector, creating a single weighted average of the cost per AF of conservation was not possible. Customer side costs were not included because, as with all other SWSI 2010 supply strategies (i.e. agricultural transfers and new supply projects), only the direct utility costs for implementing conservation were considered. Water users must ultimately bear the costs of all new water supplies, but consideration of the customer side costs for conservation implementation was beyond the scope of this effort. Because the SWSI 2010 conservation strategies rely on codes, ordinances, and the natural replacement of fixtures and appliances (passive savings) to a large extent, it is anticipated that that implementation costs per acre-foot of savings will be significantly lower than what was estimated for SWSI Phase 2 which included substantial rebates and financial incentives to spur savings.

Since cost estimates are necessary for planning purposes, per acre-foot utility-side estimates for the SWSI 2010 Low, Medium, and High conservation strategies were developed using the SWSI 2 weighted average of $10,600 per AF for all active savings and a cost of $0 per AF for all passive savings. This analysis yielded an average utility cost of $5,358 per AF of savings for the Low strategy, $7,296 per AF of savings for the Medium strategy, and $8,183 per AF of savings for the High strategy. For comparison, a recent study prepared by the Western Water Policy Program and the University of Colorado titled, "Relative Costs of New Water Supply Options for Front Range Cities" found an average per acre foot cost for water conservation program implementation of $5,200 per acre-foot of conserved water (Kenney et. al. 2010). Improving understanding of the costs associated with implanting water conservation strategies is an important area for future research and analysis. An incremental cost analysis may be useful toward understanding the break points between costs to implement the Low, Medium, and High savings strategies as costs are likely to increase for the Medium and High strategies.

Assumptions and Limitations

There are important caveats and assumptions regarding the water conservation strategies that should be understood so that the results are not misinterpreted or misapplied.

Conditional Statewide Strategies to Assess Conservation Potential – These three strategies were used to prepare a conditional demand forecast. The savings estimates presented are expected to be achieved *if* the programs and measures described are implemented at the specified level across the entire state. The medium and high strategies in particular will require a significant and sustained effort in order to achieve the forecast water savings. The forecasting assumptions do not reflect differences that exist between individual water providers. Each water provider in Colorado is distinct and it is anticipated that over the next 40 years water conservation will be implemented differentially across the state. In order to prepare statewide forecasts of conservation potential it was assumed that the potential to conserve water may exist irrespective of an individual water provider's need or desire to conserve. In reality, some providers will need little if any conservation savings to meet future demands while others will seek substantial demand reductions.

Permanency of Existing Conservation Efforts – The water savings projections in this report are conditioned on post-drought baseline demands, and assume water conservation savings since the 2002 drought period will be sustained into the future. The permanency of post-drought related reductions in water use is uncertain. Some of this uncertainty may be resolved as additional water utility-level data are obtained and further investigated. Additional and improved data is anticipated through future utility water conservation plans and under data reporting requirements established in Colorado House Bill 10-1051.

Climate Change Not Considered – The impacts of climate change on water demands were not included in this analysis. Time and budgetary limitation did not allow for this complexity to be included. Climate change is an important factor for consideration in conjunction with future water demands and should be included in subsequent forecasting efforts.

The Future is Uncertain and Water Use May Change – It is impossible to predict all of the technological and cultural changes that could occur over the next 40 years which might impact water use. The trends over the past 15 years have been towards greater efficiency and lower use and at this moment in time, there is no indication that these trends will not continue (Coomes, et. al. 2010). However, it is possible that new uses for water could emerge in the future which might increase municipal demand (e.g. increased use of evaporative cooling, increased installation rates of swimming pools, spas and/or multi-headed showering systems). Unanticipated demand increases could counteract some of the savings estimated in this report, even if conservation programs are implemented at the specified levels. Similarly, technology could also serve to reduce future water demands below those estimated here.

Updating the baseline condition and demand forecasts regularly is the best way to incorporate unanticipated future changes.

Uses of Conserved Water Are Not Assumed – No assumptions have been made about the portion of the water savings forecast in this report that could potentially be utilized toward water supply, serving new customers, or meeting the M&I gap. Each water provider must decide how best to apply water garnered from demand reductions within their individual water supply portfolio. Utilities will need to make these decisions based on their integrated water resources planning efforts, consideration of their system's reliability throughout drought periods, impacts of conservation on their return flows and availability of reusable supplies, effectiveness of water rates and impacts to their revenue streams, and other local considerations. Subsequent efforts will be needed to help determine what portion of active conservation savings can be applied to the M&I gap.

Impacts from New Construction – A substantial number of new homes and businesses will be constructed throughout the state between now and 2050. The projections provided for this basin-level planning effort do not distinguish between savings that will be achieved from existing versus new construction. Actual savings may be attributed more to higher efficiency new construction in portions of the state, particularly where more dense development occurs.

INTRODUCTION

Municipal water conservation is an important component of Colorado's strategy to provide a safe, secure, and sustainable water supply for future generations. This document represents the latest effort by the Colorado Water Conservation Board (CWCB) to integrate water conservation into overall water supply planning and to estimate the statewide water conservation potential up to the year 2050.

The CWCB defines water conservation as those measures and programs that provide for measurable and verifiable permanent water savings (CWCB 2010b).[4] This is separate and in addition to the temporary savings that may result from short-term drought restrictions and related programs. In support of the Statewide Water Supply Initiative (SWSI), the Interbasin Compact Committee (IBCC), and other water conservation efforts throughout the state, the CWCB has developed several work products which provide technical detail related to water conservation planning. The purpose of this report is to:

- Incorporate recent water conservation-related efforts into the SWSI 2010 update,
- Update the range of potential future water conservation savings, and
- Provide *water conservation strategies* that may contribute toward meeting the projected 2050 M&I water supply gap[5] and help address Colorado's future municipal and industrial (M&I) water needs[6].

Water conservation is assumed to be one of several water supply strategies that Colorado will need to rely on to meet future M&I water demands. Meeting Colorado's future water supply needs will require a mix of successful identified plans and processes (IPPs), agricultural transfers, reuse, and new water supply projects. The conservation savings forecasts presented here are intended for statewide planning purposes and are *not intended to replace water conservation and water resources planning and projections prepared by local entities*. This report estimates a range of potential future water conservation-related savings, but has not determined the portion of those savings that could potentially be utilized toward meeting a future water supply gap.

The information provided in this report is intended to facilitate discussions between the CWCB Board, IBCC, Basin Roundtables, and others as they consider how M&I water conservation can be utilized to help provide sufficient water for future generation of Coloradoans. Water conservation and demand management are key components of the suite of options under consideration to meet future urban

[4] Under this definition, water conservation may include measures and programs that are being implemented for political reasons and/or to improve customer satisfaction

[5] The "M&I gap" is defined as the difference between future water demands and identified projects and processes (IPPs) which local water providers are pursuing to help meet their M&I water demands.

[6] Colorado's 2050 M&I water demands include water demands associated with Self Supplied Industrial (SSI) users – large industrial users that have their own water supplies or lease raw water form others. The potential water conservation *savings* provided in this SWSI 2010 update include only savings from the M&I demands associated with a typical municipal system. Potential SSI water *savings* are not estimated.

water needs. Building upon past efforts, this update provides additional clarification and validation to incorporate the best currently available data. While the findings show potential for significant savings through water conservation, there is no consideration that water conservation can be the only supply strategy to meet all future statewide demands; combinations of other strategies including agricultural transfers, reuse, and new water supply projects will also be needed.

The information in this report was prepared for the CWCB by Aquacraft, Inc. and Headwaters Corporation. The approach and results were presented to and reviewed by the CWCB staff, the CWCB's Water Conservation Technical Advisory Group, and a broad collection of stakeholders.

Members of the Water Conservation Technical Advisory Group (WCTAG) include:

Greg Baker, Aurora Water
Drew Beckwith, Western Resource Advocates
Tracy Bouvette, Great Western Institute
Beorn Courtney, Headwaters Corporation
Veva Deheza, Colorado Water Conservation Board
Melissa Essex Elliott, Denver Water
Paul Fanning, Pueblo Water Works
Greg Fisher, Denver Water
Christopher Goemans, Colorado State University
Jeff Tejral, Aurora Water and Denver Water
Rick Marsicek, Aurora Water
Peter Mayer, Aquacraft, Inc.
Rebecca Mitchell, Department of Natural Resources
Kevin Reidy, Colorado Water Conservation Board
Jean Van Pelt, Southeastern Colorado Water Conservancy District
Esther Vincent, Northern Water
Scott Winter, Colorado Spring Utilities

This process was invaluable toward improving the technical content and recommendations developed under this effort. The Water Conservation Technical Advisory Group (WCTAG) agreed that the conditional water conservation forecasts and strategies identified in this report are technically achievable, based on information available today and included in this report. The WCTAG stressed the importance of understanding the conditions and the additional research required to further quantify the uncertainties. The CWCB provided multiple opportunities for the WCTAG to comment on this report in all stages of development, but the WCTAG did not reach consensus on the implementation and water savings levels of the three conservation strategies. The CWCB worked to incorporate information and concerns from individual stakeholders throughout this report.

WATER CONSERVATION IN COLORADO: KEY ISSUES

The water conservation strategies presented in this report expand upon and integrate past CWCB water conservation work products, including:

- **Statewide Water Supply Initiative – Phase 1** (CWCB 2004)
- **Colorado's Water Supply Future, Statewide Water Supply Initiative – Phase 2** (CWCB 2007a)
- **State of Colorado 2050 Municipal and Industrial Water Use Projections** (CWCB 2010c)
- **SWSI Water Conservation Levels Analysis** (CWCB 2010b)
- **Guidebook of Best Practices for Municipal Water Conservation in Colorado** (CWW 2010)

This document is organized first by providing an overview of the current status of water conservation in Colorado. Potential savings that could be achieved by the year 2050 are presented, through a water-budget analysis of current and future water uses, followed by a description of conceivable water conservation strategies to achieve savings potentials. Conservation savings estimates disaggregated into conservation strategies to achieve the conditional forecasts. Potential program measures from the 2010 Guidebook of Best Practices for Municipal Water Conservation in Colorado (CWW 2010) are presented, along with an update of the SWSI Phase I conservation matrix.

Purpose

As with previous SWSI planning efforts, the water savings projections presented in this report are intended to:

- Provide a reconnaissance-level forecast for the entire state;
- Establish a consistent empirical approach and methodology;
- Maximize use of currently available data; and
- Derive conditional forecasts, which assume specific actions are taken in order to achieve water savings.

Key Issues

The report utilizes the finalized baseline water use data from the July 2010 report entitled State of Colorado 2050 Municipal and Industrial Water Use Projections (CWCB 2010c), which assumed the savings achieved since the 2002 drought period will be sustained into the future. Conditional water conservation forecasts are made, with strategies that support a Low, Medium, and High water conservation strategy. This approach is intended for statewide planning purposes and is *not intended to replace water conservation and water resources planning and projections prepared by local entities*. As better information and data become available, the potential savings and water conservation strategies presented in this report may be updated, building on the analysis framework provided herein.

Several fundamental concepts are discussed throughout this report:

a. This update is based on projected future demands and potential savings estimates from water conservation measures, programs, rules and regulations to be *sponsored and implemented by water providers, local government, the State of Colorado, and the end users of water across Colorado*. The savings are only achievable to the extent that measures described here are implemented to the levels described within the 40 year planning period. It is important to understand the conditions upon which the forecasts are based.

b. *Demands are characterized by river basin*, capturing the current distribution between water use rates and the projected future changes throughout various regions of the state. The projected water savings provide average basin-wide estimates. These projections cannot be directly applied to all water providers within a given basin, as some may already be at, above, or below the projected level of conservation. Variability in application of water conservation strategies will exist within any given river basin and some individual water users will end up above while others end up below the projected levels of conservation presented.

c. This methodology was applied similarly to all river basins and did not consider the "need" to conserve. Further, it *did not integrate a water supply analysis,* and did not attempt to discern the legal, temporal, or spatial availability of conserved water toward meeting the gap in future water supplies. It is therefore feasible that for certain water providers, the demand scenarios presented in this report are not necessary. These basin-wide estimates provide a planning tool and opportunities to be further considered on a regional or local level.

This report does not determine the portion of the water conservation-related savings that could potentially be utilized toward meeting a future water supply gap. Some Colorado water providers who continue to experience a decrease in demand since the 2002-03 drought are uncertain about the nature, extent, and permanency of any demand reductions. If reductions in demand are validated, water providers may decide to dedicate some of the water supply savings to new uses.

The conditional forecasting methodology used for this SWSI 2010 update assumes that the identified strategies will be implemented and does not account for water providers' management decisions, such as storing a portion of the savings for drought or strategic planning or using a portion to improve stream flows for environmental or recreational benefits. Management decisions consider legal, temporal, economic, social, political, and spatial constraints that must be understood at a local utility level, and should be part of integrated resource planning that considers the specific water rights portfolio, system reliability, drought response, etc. The relationship between water conservation and some of these topics are further explored below.

Water Conservation and Density

While not quantitatively assessed under the updated forecasting methodology described in this report, the future new housing stock in some parts of Colorado is anticipated to be more dense than historical; resulting in less future irrigated acreage per person and consequently lower outdoor water demand on a per capita basis. Densification will impact regions of the state differently (e.g. more densification is likely for the Denver metro area as compared to the west slope). The Denver Regional Council of Governments (DRCOG) has set a policy intended to achieve at least a 10 percent increase in the region's overall density between 2000 and 2035 (DRCOG 2007).

Impacts of land use and development patterns were presented at the Western States Water Council "2009 Symposium, Water & Land Use Planning for a Sustainable Future: Scaling and Integrating" conference held in Denver, Colorado. In 2010, the Center for Systems Integration published a report entitled "Colorado Review: Water Management and Land Use Planning Integration" on behalf of the CWCB and the Colorado Department of Natural Resources (CWCB 2010a), which also describes impacts of land use decisions on water demands. Related to water conservation, density is known to reduce per capita water usage. The 2009 California Water Plan Update has calculated water savings from densification and estimates *"As a rule of thumb, landscaping irrigation accounts for almost half of residential water use. An increase in residential density from 4 units per acre to 5 reduces the landscaping area by 20%, which should cut water usage by roughly 10% compared to the lower density development"* (CWCB 2010a).

However, given that water utilities usually do not control future growth and construction trends, changes in density are not considered to be active water conservation programs; reductions in per capita water use associated with changes in density are also not considered passive savings (CWCB 2010b). The forecasting methodology used in this report assumed the water demand distribution between single family residential and multi-family residential uses remains constant from 2010 to 2050. With expectations for increased densification in parts of Colorado in the future, this assumption could conservatively over-estimate future water demands. The researchers understand this issue and chose to include the potential savings from densification into the outdoor water saving strategies within this report. Under this approach, the effects of densification have been included as one of several avenues to reduce lawn size, but have not been disaggregated from other outdoor water savings.

In the three conservation strategies (Low, Medium, and High) proposed in this report, water savings from densification are included as part of the per capita irrigation reductions assigned to each strategy. It is assumed that the impacts of densification will contribute to reduced irrigation demands in each water saving strategy. Since the reductions are applied equally across all river basins, and it is understood that densification will impact Colorado communities differently, this is an element of the forecasting methodology that could be improved upon in future iterations. With better data and planning information from across the state, it should be possible to more explicitly incorporate forecast densification into future water demand projections. Disaggregating water savings from densification in this forecasting methodology would require careful consideration and analysis at a local level, something that was beyond this scope of this effort, but is being considered as part of future CWCB efforts to examine potential savings from changes in density patterns and other land uses.

Water Conservation and Return Flows

The updated methodology presented in this report, which estimates current and future water demands for various water use categories, allows more explicit characterization of the potential impacts from changes in water demand and efficiency on consumptive use, return flows, and water supply portfolios[7]. Some water providers have stated that water conservation may have unintended and undesirable consequences on municipal water supplies, particularly if the municipality relies on the use/reuse of return flows for part of its water supply. With reusable return flows, a water provider is able to use (directly or by exchange) the non-consumptive portion of water use that returns to the hydrologic system. Also, on a macro level, one users' increased efficiency may reduce the water supply to another downstream user, effectively not closing the overall gap in water demand. The specific measures considered under the water conservation strategies may have varied impacts on this issue.

Changes in landscape plant varieties that result in lower consumption are likely to produce a net gain downstream from the site, yet an increase in irrigation application efficiency may have varying effects. While increasing application efficiency achieves conservation in terms of lower water usage to meet the same consumptive water demand, considering that return flows decrease as the water is used more efficiently, there may be no downstream gain. Particularly with a water rights portfolio that allows return flows to be reused and incorporated into the overall water supply, an increase in water efficiency alone does not necessarily increase the net water supply. In this situation, conserved water may not be available to meet future needs, but it may provide other benefits in certain situations, such as allowing less water to be diverted from the stream system and more water to be maintained in storage, reduce the burden on and need to expand infrastructure, lower energy treatment and delivery costs, and minimize overall impacts on stream flow.

Further complicating the return flow topic, indoor water use is largely non-consumptive. While a reduction in the indoor water use results in a lower water demand, it may have little net effect on the consumptive use. Again, there may be other benefits such as allowing water supply to be maintained in storage or minimizing overall impacts on stream flow. These examples provide insight into the complexity of this topic and the need to more closely examine the potential impacts of water conservation on individual water supply systems through utility-level integrated resource planning processes. Understanding the impacts of using the conserved water (e.g. to increase storage/drought reserve or toward new population growth) on system reliability is also highly dependent on the specific system and should be part of the integrated resource planning.

One of the benefits of this SWSI 2010 updated water conservation methodology is that the potential impacts of various water conservation measures on consumptive use and return flows can be investigated more explicitly, through the disaggregated water demand categories.

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[7] Changes in return flow volumes and patterns may result due to reductions in demand and increases in water use efficiency. Physical impacts to the hydrology and legal impacts to water rights should be evaluated on a case-by-case basis and considered under integrated resource plans, as they can vary widely in different situations.

Water Conservation and Drought Response

For some water professionals, the relationship between water conservation and drought response is framed around the issue of "demand hardening" which some view as a limitation on the use of conserved water to meet new demands and an impediment to increased water conservation in Colorado. Over the past several years, experts have examined this issue and come to some reasonable conclusions about demand hardening and the economics associated with it. A brief summary of recent work on the subject is presented here.

The concept of demand hardening is defined as follows: "By saving water, long term conservation can also reduce the water savings potential for short term demand management strategies during water shortages" (Flory, J. E. , and T. Panella 1994). Howe and Goemans explain demand hardening as, "a result of longer term conservation measures…that make it increasingly difficult for the utility to induce further reductions in water use during a drought" (Howe and Goemans, 2007).

Most experts agree that demand hardening is a real phenomenon. However, the research team could find no documentation in the literature quantifying the impacts or presenting examples of demand hardening ever occurring in Colorado or elsewhere (Mayer and Little 2006).

By definition, demand hardening is typically only a consideration in a water shortage and if a significant portion of conserved water has been used to serve new customers. Customers who have reduced their demand through technological changes or who join a system as efficient users (such as new customers) can still achieve behavioral reductions during a shortage. Since conservation savings are achieved by existing customers, it is important that the supply reliability for these customers not be negatively impacted as new customers are added to a system (Mayer and Little 2006).

Several factors can mitigate the potential impact of demand hardening. First, for many water providers in Colorado with available storage capacity, conservation in excess of new demands will allow more water to be kept in storage, thereby reducing the risk and potential impacts of drought (DeOreo 2006). Since demand hardening is primarily a concern during a shortage, reducing the recurrence of water shortages reduces the likelihood of demand hardening impacting a provider. Second, the technologies and economics of water-use efficiency are constantly changing. Any expansion of conservation potential beyond what it is today can help mitigate future demand hardening. New, more efficient technologies are coming on to the market, and the price of those that are already on the market is dropping, thereby continuing to expand the cost-effective conservation savings potential of existing and new customers (Pacific Institute 2007). Third, since demand hardening is typically only an issue during a water shortage, a well-thought-out drought and water shortage mitigation plan can help reduce the potential impacts of demand hardening. Finally, increased storage can mitigate demand hardening provided there is available water (either from conservation or new supplies) to store.

What does demand hardening mean for a water utility? Howe and Goemans conclude that, "the existence of demand hardening…does not imply that a utility should 'oversize' its systems and ignore wasteful water use by its clients just so it will be easier to cut back when a drought comes along. System capacity decisions and linked supply reliability should be based on long-term, net-benefit criteria. This means quantifying the tradeoff between reduced system capacity and operating costs through conservation and additional drought-period utility and customer costs when drought requires further water use cutbacks" (Howe and Goemans 2007).

Based on the current state of knowledge, concerns about demand hardening are not a sound argument against implementing long-term water conservation programs. However, as conservation levels increase, so does the potential for demand hardening if any excess conserved water has not been stored as a drought or strategic reserve. Mitigation strategies, developed at the local utility level, may be needed, such as reserving a portion of conserved water in storage for drought periods, implementation of drought tolerant landscaping, and building additional storage if conserved water is relied on as a future water supply. Proper drought planning and preparedness, along with integrated water resources planning, is probably the single best preventative measure that a water utility can take to guard against the potential impacts of demand hardening.

REVIEW OF CONSERVATION PLANNING AND FORECASTS

A substantial amount of water conservation planning and implementation has occurred in Colorado throughout the past decade. The following section provides a brief overview of these efforts, and key pieces of information that were used to develop the M&I water conservation savings and strategies presented in subsequent sections of this update.

SWSI Terminology and Previous Water Conservation Methods

The SWSI water conservation-related efforts have been based on several pieces of information:

1) Current and forecasted population,
2) Current water use rates, to estimate current and forecasted water demands[8],
3) Estimated future water savings from conservation-related activities.

Population Data and Baseline Water Demand Estimates

Throughout the various efforts supporting SWSI, multiple levels of future water conservation activities have been considered and updated "baseline" water demand projections have been developed. For this project, the word "baseline" represents current water demand that has been estimated using "current" water use rates. It should be understood that the current water use rate (or baseline demand) includes the impacts of passive and active conservation and drought response efforts that have been undertaken. In Colorado there appears to have been an 18% reduction in per capita use since SWSI Phase 1 (CWCB 2010c). The forecasting methodology and demand reduction estimates have been adjusted to try and account for past conservation achievements while still recognizing the ongoing potential to conserve in the future, and the improvements in conservation technology achieved in recent years. With this method, a baseline demand does not include impacts of potential future active water conservation (beyond the increasing effects of passive conservation already factored into the analysis) nor does it account for other factors which may affect demand in the short-term, such as economic and climatic factors. The nature and permanency of demand reductions achieved since 2000 may become more apparent in the coming years as additional and better data on demands are available. Estimates of future conservation potential should be updated regularly to account for on-going changes in baseline water use and the uncertainty associated with long range demand projections.

For SWSI Phase 1, year 2000 reconnaissance-level M&I water use rates[9] were multiplied by year 2000 county population data to develop a year 2000 baseline water demand for each county:

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[8] Water demands have been estimated using a driver multiplied by rate of use approach, where the driver is population and the rate of use is in gallons per capita per day (gpcd).

[9] A sample of water providers throughout the state provided information that was utilized in estimating *year 2000 per capita water use rates* for each county. It is important to recognize that the per capita water use rates represent total water use throughout the system divided by census population data, and therefore include M&I uses from transient populations such as tourism, but only divide the total use by permanent population. Further,

$$\text{Baseline Demand}_{2000} = \text{Population}_{2000} \text{ X GPCD}_{2000}$$

Year 2030 baseline water demands were forecasted using the same year 2000 water use rates multiplied by projected 2030 population forecasts for each county:

$$\text{Baseline Demand}_{2030} = \text{Population}_{2030} \text{ X GPCD}_{2000}$$

The baseline 2000 and 2030 demand forecasts reflected a water conservation level (both passive and active) that was captured in the year 2000 water use rate data. The 2030 demand forecast did not "embed" potential additional future passive or active water conservation; rather, 2030 demand projections were based on 2000 water use rates, and effects of various levels of water conservation were characterized as water "savings" off of the 2030 baseline projection:

$$\text{Conservation Demand}_{2030} = (\text{Population}_{2030} \text{ X GPCD}_{2000}) \text{ X } (1 - \%\text{ Savings}_{2030})$$

As noted in SWSI Phase 1, tourism, commercial, and light industrial uses represented in the water use data but not in census population data result in increased per capita demand data. As a result of these factors, climate, and other influences, it is not appropriate to directly compare *gpcd* values between counties and basins.

SWSI Phase 1 Findings

SWSI Phase 1 projected future water use (demands) throughout Colorado in the year 2030. A water needs assessment was performed, through evaluating water providers' plans for future water supply projects (i.e. Identified Projects and Processes or IPPs). The availability of existing water supplies was considered, and options for meeting the gap in future water supply were outlined. Water conservation, specifically "active" M&I conservation, was identified as one of the "family of options" for consideration (along with agricultural transfers, reservoir storage, conjunctive use of groundwater, water reuse, and control of non-native phreatophytes). The SWSI Phase 1 baseline demand forecast was reflective of both passive and active water conservation that existed as of year 2000.

SWSI Phase 1 developed a five-level system for categorizing water conservation measures. Each level included examples of water conservation programs that a utility or water provider might implement at the given level of water conservation effort. Estimated percent reduction in total M&I demand that might result from each level of conservation was provided, as well as a generalized cost of the water savings at each level (Table 8-1, CWCB 2004).

Level 1 was defined as water savings that result from the impacts of plumbing codes, ordinances, and standards that improve the efficiency of water use, particularly the National Energy Policy Act of 1992[10].

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they may not represent the total demand to the extent that some of the uses are supplied by non-municipal sources such as private wells or ditch rights.

[10] The National Energy Policy Act of 1992 set manufacturing standards that became effective in 1994, for improved water efficiency in toilets, urinals, showerheads, and faucets.

These conservation savings were termed “passive” savings and require no action on the part of water providers. Level 1 conservation was estimated from five existing studies throughout other states, and was included in the SWSI Phase 1 baseline water demand forecast. Without active water conservation, the SWSI Phase 1 concluded that water demands would increase from 1,194,900 acre-feet per year (AFY) in 2000 to 1,926,800 AFY in 2030, based on population projections and 2000-level per capita water use rates. As shown in Figure , the statewide reduction in total M&I per capita water use from Level 1 was projected to be about 101,900 acre-feet per year (about 5%), by the end of the 30-year planning period (Figure ES-4, CWCB 2004). This savings projection came from the combination of new and existing construction.

In contrast to the passive savings (Level 1), the SWSI Phase 1 referred to water conservation savings resulting from utility-sponsored water conservation programs as “active” savings. Thus Level 2 through 5 were outlined with corresponding measures and estimated savings as shown in Table 4, including measures such as: metering and leak detection; increasing water rate pricing; rebates for efficient water appliances; incentives for reducing high water use landscaping; and restrictions on lawn area (Table 8-1, CWCB 2004). The report showed potential for over 40% reduction in future demands, if all levels of conservation were pursued[11]. It was noted that “emergency” conservation programs and short-term drought response restrictions were not included among the long-term active water conservation programs. During the “2002” statewide drought, it was reported that mandatory restrictions enacted to mitigate for drought impacts resulted in short-term water demand reductions of 20% to 30% (page 8-3, CWCB 2004). However, the SWSI Phase 1 recognized that permanent savings can also result from droughts to the extent that water users retrofit indoor plumbing with more efficient water savings devices or reduce/eliminate high water use landscaping in response to the drought.

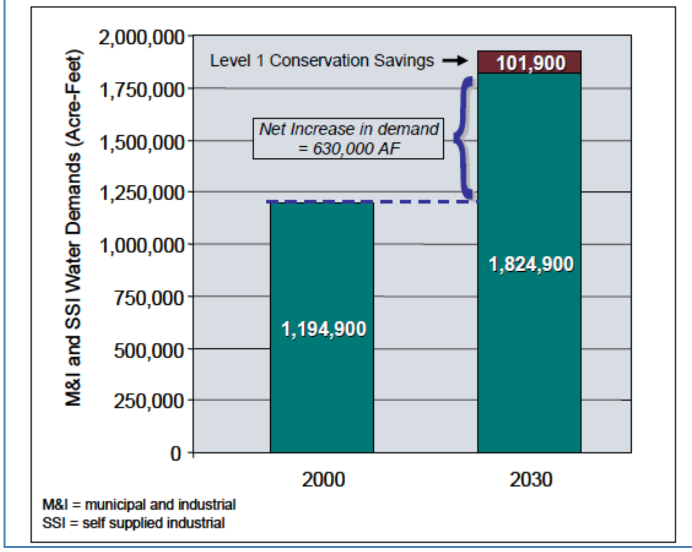

Figure 1: SWSI Phase 1 water demands and Level 1 conservation savings (Figure ES-4, CWCB 2004).

[11] The SWSI Phase 1 baseline county gpcd water use values were based on year 2000 data and implicitly included the “current” level of conservation at that time. The *reductions in water demand* percentages presented in Table 8-1 (CWCB 2004) could not be applied directly to a demand number without further understanding the existing level of water conservation represented in that demand number.

Table 4: SWSI Phase 1 active conservation matrix (Table8-1, CWCB 2004).

Level	Types of Programs	Percent Reduction in Future M&I Demand				Cost $ per AF
		2000	2010	2020	2030	
1	Plumbing codes	n/a*	2.5%	4.5%	6%	$0
	Fixture standards from National Energy Policy Act					
2	Metering	n/a*	4%	4%	4%	$100
	Leak detection		(6.5%)	(8.5%)	(10%)	
3	All of the above (Level 2)	n/a*	5%	8%	10%	$500
	Education		(7.5%)	(12.5%)	(16%)	
	Rebates for toilets and washers					
	Audits: residential and commercial					
	Landscape audits					
	Increasing rate structure					
4	All of the above (Level 3)	n/a*	10%	15%	20%	$1,000
	Steep pricing rate and surcharges		(12.5%)	(19.5%)	(26%)	
	Rebate for landscape changes					
	Turf replacement & restrictions					
	Rebates for irrigation sensors & controllers					
	Sub-metering of master-meter properties					
	Fixture retrofit upon sale of property					
	Ordinance eliminating single-pass cooling					
5	All of the above (Level 4)	n/a*	15%	25%	35%	$2,000
	Replacement of all inefficient water fixtures & appliances		(17.5%)	(29.5%)	(41%)	
	Eliminate leakage by all customers					
	Eliminate high-water using landscape					
	Install non-water using urinals by non-residential customers					

n/a* The 2000 level of water use implicit in the county gpcd values includes "current" conservation savings.
The percent reduction indicated for Levels 2 through 5 is "above and beyond" the Level 1 reduction; the cumulative percent reduction is shown in parentheses.

SWSI Phase 1 described implementation of *Level 2* conservation as the "least a water provider should do to promote water conservation amongst its customers" and *Level 3* conservation as being equivalent to implementing the nine[12] water conservation measures recommended by the CWCB (as of 2004) for consideration in developing a water conservation plan. While Level 3 was also described as similar to the program the Denver Water Board had already implemented as of the year 2000, it was noted that continued implementation of Level 3 programs would further increase the market saturation and enhance program savings. *Level 5* conservation was compared to the approaches described in two reports: "Smart Water: A comparative Study of Urban Water Use Efficiency Across the Southwest" (WRA 2003) and "Waste Not, Want Not: The Potential for Urban Water conservation in California" (Pacific Institute, 2003). SWSI Phase 1 characterized the reduction in water demand in all but Level 5 to assume a "reasonable" level of program participation. Level 5 assumed total participation by all customers when in reality the level of participation was influenced by water conservation budgets, education programs and advertising, water pricing, the local "conservation ethic", and emergency drought conditions. Using data provided in the SWSI Phase 1 report Appendix E[13], the water conservation Levels 2 through 5 were projected to achieve between 170,533 AFY to 699,183 AFY by 2030 (these total savings include 101,900

[12] As of July 1, 2005, the minimum water conservation plan elements defined in §37-60-126(4) C.R.S. were updated and expanded (cwcb.state.co.us/Conservation/Conservation/WaterConservationPlanning/).

[13] Level 2 through 5 total savings estimates were derived from the statewide totals provided in Appendix E of the SWSI 2007 report and compare to the values cited on page 2-10 of the SWSI 2007 report.

AFY from passive conservation; the active portion of Levels 2 through 5 ranged from 68,633 AFY to 597,283 AFY). This effort characterized the total potential water savings through conservation but did not attempt to discern commitment from individual water providers nor the extent to which these savings could be relied on as a future water supply.

Many of the water providers' IPPs[14] included savings that would result from their existing active water conservation programs, beyond Level 1; any additional water conservation would be achieved through implementing additional water conservation programs. To approximate the current level of active conservation effort within each basin, the year 2000 level of water conservation was identified for each county, through a review of existing available water conservation plans and a 1994 survey from the Colorado Municipal League. SWSI Phase 1 estimated that if fully implemented, the IPPs were capable of meeting 80% of the state's projected M&I water needs through 2030 (i.e. about 511,800 AFY of the 630,000 AFY gap in supply) and that the passive and current active water conservation programs could result in water savings of about 231,000 acre-feet per year (AFY) by 2030 (ranging from 3 to 14 percent by basin), if the current level of effort were sustained over the entire period[15]. These water savings from the current conservation programs were presumably already factored into the IPPs by many water providers, but it was unknown to what extent.

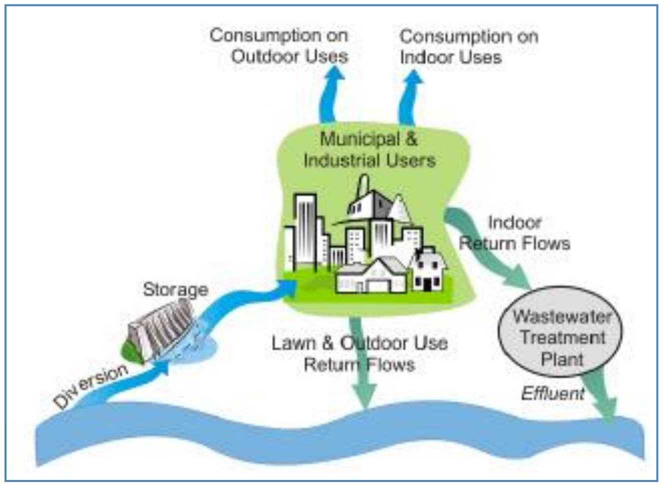

Figure 2: Return flows from M&I Use of surface water (Figure 8-2, CWCB 2004).

SWSI Phase 1 identified potential benefits and issues related to using each *member of the family of options* to address the future water supply gap. It was recognized that water use can be considered in terms of both gross water demand delivered to the user and consumptive use, with the difference being return flows to the river as shown in Figure (Figure 8-2, CWCB 2004). SWSI Phase 1 determined that an average M&I consumptive use factor of 35% was appropriate in reconnaissance efforts for evaluating the new supply from M&I water conservation. Potential issues with depending on water savings from additional active water conservation to meet the water supply gap were identified, including (CWCB 2004):

- Potential water rights limitations – conserving and decreasing demand for direct flow water rights may not create a reliable supply and loss of return flow credits may limit the net "savings" from conservation;

[14] Water providers' plans for future water supply projects (i.e. Identified Projects and Processes).

[15] This estimate was based on the benchmark year of 2000 and included Level 1 passive water conservation as well as any additional active water conservation that was included in the water provider-reported IPPs. Based on review of existing efforts, a maximum Level 3 conservation effort was identified at the time.

- ‘Demand hardening’ and decreased supply reliability (if conserved water is not stored and instead is used for new growth and demand reductions are needed during droughts);
- Customers potentially being unwilling to accept mandated conservation measures;
- Impacts on utility revenues as a result of reduced demand;
- Some urban water suppliers may already be at a high level of conservation.

Benefits were also identified, including (CWCB 2004):

- Reduced implementation costs in comparison to developing new water supply;
- No new river diversions or permits required to implement;
- Implementation is within control of the water provider and does not require approval of other entities;
- Existing supplies can be stretched to supply demands of new growth;
- Lesser environmental impacts than new storage; and
- Reduction in water and wastewater treatment, distribution, and collection capital, operations, and maintenance costs.

SWSI Phase 1 identified two important findings regarding water conservation and efficiency (CWCB 2004).

1) Conservation is an important component of most municipal water providers' future plans to meet the water supply needs of their customers.
2) While conservation will be an important solution for meeting some of the future water needs, conservation alone cannot meet all future water needs and significant water conservation had already occurred in many areas.

Under the SWSI Phase 1, “most providers indicated that they would be more likely to acquire additional agricultural water rights than to implement aggressive levels of conservation.” Reasons cited included urban quality of life associated with irrigated turfgrass, low customer acceptance of permanent irrigation restrictions, and that lawn watering can in effect serve as a water supply reserve produced by restrictions during drought periods.

One of the key observations made during the SWSI Phase 1 process was that data sources on M&I demand were difficult to access. Interpretation of the data was also difficult because this reporting is not routinely provided and is not available in a standardized format.

SWSI Phase 2 Findings

Recognizing the importance of water conservation and wise water use, the CWCB formed a Technical Roundtable (TRT) during the SWSI Phase 2 process, to further explore the opportunities, challenges, and limitations associated with the implementation of agricultural and M&I water conservation measures at the local and regional level. Membership in the Water Conservation and Efficiency TRT represented a broad range of water users who were interested in this issue and/or had professional expertise in the area of agricultural and M&I water conservation and efficiency; members were also included to provide for broad river basin and interest group representation.

As its mission, the Water Conservation and Efficiency TRT set out to "Develop a deeper understanding and greater consensus on conservation and efficiency for municipal, industrial, and agricultural water uses." The focus of the M&I Water Conservation TRT was to explore the role that agricultural and M&I conservation and efficiency can play in meeting future water needs and provide recommendations that encourage Colorado to move to more effective conservation and efficiency programs, while at the same time respecting local planning and protection of water right and private property. It did this by identifying the potential long-term savings from M&I conservation measures, water system reliability concerns, and opportunities, challenges, and limitations associated with implementation of M&I water conservation at the local and regional level (CWCB, 2007). A matrix of potential water conservation savings from various M&I water conservation measures was developed, and implementation and penetration rates were estimated. Financial, institutional, and legal considerations were identified.

The TRT made significant advances that forward our understanding of the important role of water conservation and efficiency in municipal water planning. Consensus was reached on some topics while varying opinions remained on others. Successes were identified and documented to include (CWCB 2007):

- Reaching consensus on how M&I conservation may affect system reliability under various scenarios;
- Quantification of potential long-term savings available from M&I conservation measures (an attempt to refine SWSI level savings potentials);
- Development of a range of potential water conservation savings from select measures that were in a comparable range to potential M&I water conservation savings identified in the SWSI Phase 1 report.

Utilizing existing studies at the time, the TRT developed a list of M&I water conservation measures (programs and policies) and projected long-term water savings (Table 2-1, CWCB 2007a), often referred to as the 'SWSI 2 Matrix' (provided in Appendix A). If successfully implemented at the assumed implementation and penetration rates[16], these measures identified in SWSI Phase 2 could potentially reduce the 2030 demand by 287,000 AFY to 459,000 AFY, with a mid-point estimate of 372,000 AFY. The average cost of conservation programs to achieve these savings was estimated to be around $10,600 per acre-foot, with the less expensive measures costing as little as $1,000 to $2,000 per acre-foot. However, SWSI Phase 2 also found that it would be inaccurate to apply statewide conservation savings to the gap areas as this would assume that saved water in one geographic area can or would be delivered to gap areas.

[16] The SWSI 2 Matrix (Table 2-1, CWCB 2007a) provides estimated implementation/penetration levels by 2030 that were assumed in developing the potential water savings estimates. This table is reprinted as an appendix to this report.

SWSI Phase 2 concluded that while most water providers have implemented significant conservation, there are opportunities to achieve even greater conservation savings. The penetration level, or extent to which a conservation measure is implemented, was identified as one of the most sensitive variables that affects the amount of reduction in water demand estimates. SWSI Phase 2 further concluded that if conservation is to be used successfully to meet growing demands in Colorado, it must be fully integrated into the water resources planning process. Finally, SWSI Phase 2 reached the following conclusions about the role of water conservation in meeting the M&I gap. A portion of conserved water can be used for new growth, but it is unlikely that water providers would be willing to perpetually allocate saved water to other water providers. Rather, it is more likely that conserved water would be used first to increase system reliability and then any additional savings might be allocated on a temporary basis to other providers or uses.

Historical Demand Projections

Reflecting on historical demand projections and conservation outlooks provides a valuable perspective on the effort to forecast demands 40 years into the future. Only since the late 1990's have detailed end-use level consumption data been available which has quantified the impacts of conservation and demand management efforts. While water conservation-related data have advanced more rapidly in recent years, water conservation measures and programs have been incorporated to some extent in municipal water supply planning throughout history.

A study completed in 1977 analyzed water supply management and development alternatives for the South Platte River basin for the period of 1970 through 2020 (USACOE 1977). According to this study, the South Platte basin-wide per capita water use was around 220 gpcd in 1970. Many years before metering was mandated, the report identified that, "With metering, pricing could be an effective tool to bring the per capita water usage to any amount desired." This indicates that progressive water conservation strategies were being considered in Colorado well in advance of widely implemented metering and technology. The 1977 study projected per capita demands in the year 2010 could range from a low level of 145 gpcd to an intermediate level of 179 gpcd, all the way up to the 1970 level of 220 gpcd. Current South Platte basin demands are around 188 gpcd and metro basin demands are at 155 gpcd (CWCB 2010c), falling in the range of the intermediate demand levels predicted under this study over thirty years ago.

A 1988 study completed as part of the proposed Two Forks project forecasted metro area water demands at around 206 gpcd by the year 2010, assuming the continuance of existing water conservation programs and the natural replacement of toilets and showerheads (USACOE 1988). Current metro basin demands are around 155 gpcd (CWCB 2010c, 2010), much lower than anticipated and demonstrating the impact of federal plumbing codes and success in water conservation over the previous three decades. While the metro area population is higher today than it was projected to be in the 1980's (around 2.6 million as compared to the 1980's projection of around 2.26 million), the total demand is lower (around 437,000 AFY as compared to the 522,000 AFY projected back in the 1980's) (USACOE 1988, CWCB 2010c). This suggests that decreases in gpcd have outpaced the increased rate of population growth.

This brief look back on historical demand projections shows variability in forecasting demands, population, and water use rates and the inherent uncertainty involved in forecasting. It is only in the past several decades that metering and new technology have allowed data to be collected, tracked, and interpreted temporally and spatially to the extent needed to begin understanding effects from conservation programs and measures.

Current and Future Demands – 2050 M&I Water Use Projections

To better represent the long-term statewide water needs, the CWCB recently updated the SWSI Phase 1 M&I demand projections to estimate M&I demands in the year 2050 (CWCB 2010c). Similar to SWSI Phase 1, the 2050 M&I Water Use Projections report used the approach of multiplying population by *gpcd* to estimate demands. Whereas in SWSI Phase 1 the State Demographer's Office (SDO) population projections were available through year 2030, under the 2050 M&I Water Use Projections effort, the population projections were now available through the year 2035. Population projections from 2035 to 2050 were estimated by extending and adjusting the SDO forecasting models. Low, medium, and high scenarios were developed for the 2050 demand projections because of uncertainty in projecting so far into the future, particularly for economic conditions and unemployment. The report projected that from 2005 to 2050, Colorado's population will nearly double from approximately 5.1 million in 2008 to between 8.6 and 10.5 million people in 2050 as shown in Figure (Figure ES-2, CWCB 2010c). 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, however the West Slope of Colorado will grow at the fastest rate of any areas in Colorado between now and 2050 (CWCB 2010c).

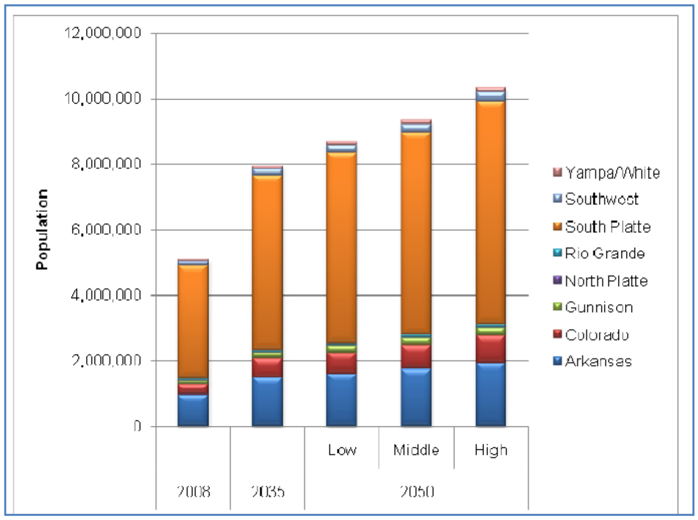

Figure 3: Relative population projections for Colorado's river basins (Figure ES-2, CWCB 2010c).

Expanding upon the data collected in SWSI Phase 1, updated service area population and total water deliveries were collected from 214 water providers covering 87 percent of the Colorado population (CWCB 2010c). The data sources included water providers' water conservation plans on file with the CWCB, master plans, water provider websites and independent studies that included water use information, the 2007 Colorado Drought and Water Supply Update (2007b), and interviews and communication with water providers (CWCB 2010c). To develop the current baseline water use projections, the 2008 *gpcd* values (which represent usage by individual water providers) were weighted by the respective population to develop a county- average *gpcd*[17]. County demand forecasts were developed and then aggregated to a basin total.

Statewide M&I water use has decreased since the SWSI Phase 1 efforts from an average 210 to 172 gpcd, an 18 percent reduction in per person daily water use statewide (CWCB 2010c). For most all basins except the North Platte and Yampa-White, system-wide gpcd water use has decreased. The report notes that these decreases in water use may be due to a combination of permanent savings from conservation efforts, lingering effects of 2002 drought-related behavioral changes, driven by socio-economic factors, and/or a result of better data. The updated data represent the addition of 83 water providers' data that was not available for SWSI Phase 1 and some of the planning numbers used in SWSI Phase 1 have been replaced with treated water delivery data (CWCB 2010c). Concern about the reliability of water savings is an issue for some water providers. Many utilities have not determined how they will utilize water savings reflected in the current baseline gpcd values, and therefore the current baseline and projected demands are lower than utility planning numbers in some cases. In addition to being uncertain about the reliability of the baseline gpcd values due to the unknown nature and permanency of savings reflected in them, many water providers have not determined whether or how they will utilize possible savings. The report also notes that while system wide water usage rates are appropriate for statewide planning purposes, they should not be used for comparisons between basins. Because the major driver for water use is population growth, the M&I water use is expected to nearly double by 2050, as shown in Figure (Figure 5-2, CWCB 2010c).

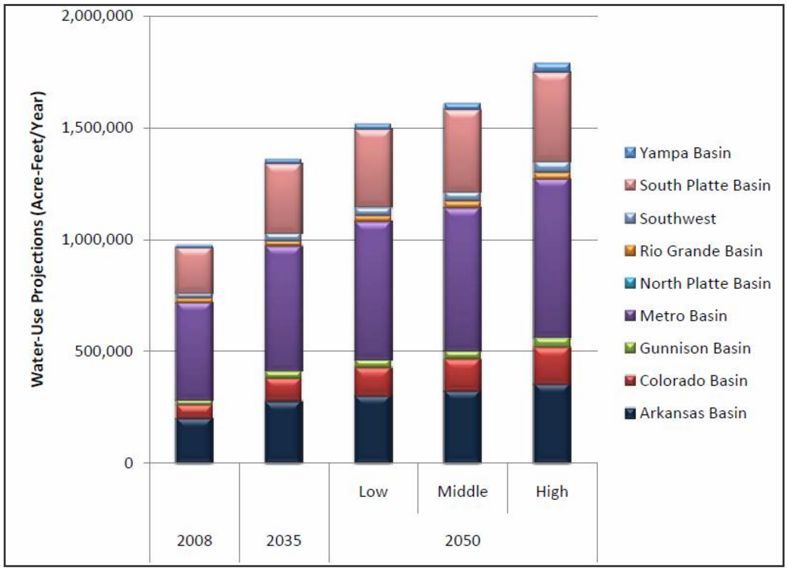

Figure 4: M&I and SSI Demands for Baseline and with Passive Conservation (Figure 5-2, CWCB 2010c)

These current water use estimates reflect the best data available representing recent existing uses[18], including any passive or active conservation practices. Active conservation savings beyond what was

[17] The method assumes that on average, all residences, businesses, and industries throughout a county use water at the same rate as the provider-supplied residences, businesses, and industries represented in the sample database.

[18] Data were based on surveys requesting water providers to provide the most "representative" recent data, often based on annual metered water treatment plant data. CWCB reviewed the data and verified that the most recent data summarized in the new information were correct, particularly where data varied significantly from the SWSI Phase 1 data. The data used to represent the year 2008 are based on a range of reported years which include a mix of data from SWSI Phase 1 and updates from a general range of 2005 through 2008.

included in the baseline is not embedded in the future demand projections. The 2050 M&I Water Use Projections Report incorporated passive savings to reflect information in the recent *SWSI Conservation Levels Analysis* report, as described further in sections below. The 2050 Low, Middle, and High county-level demand projections include the upper range of the passive savings (33 gpcd) projected to continue as a result of retrofitting housing stock and businesses that exist prior to 2016 (CWCB 2010c). Care was taken to ensure that passive savings were not double counted. The three reasons for using the high passive savings, as documented in the *SWSI Conservation Levels Analysis* report include: 1) high efficiency fixtures and appliances will become more efficient as customers strive to reduce water and energy related costs; 2) potential for substantial permanent savings if appropriate regulations and ordinances are adopted to address water use in existing and new construction; and 3) the impact of commercial retrofits is not well captured in the passive savings estimates (CWCB 2010c).

Recent CWCB Studies in Water Conservation

Several recently completed projects and ongoing efforts being conducted by the CWCB contribute to providing an updated, scientifically valid foundation for assessing urban water conservation potential in Colorado. The CWCB anticipates these efforts will assist in defining water conservation's role in local and state water resource management and in assessing the impact of water conservation on the future water supply gap. These ongoing efforts may also assist in local water conservation efforts in terms of prioritization and effectiveness. Limitations in availability and transparency of water use data continue to be one of the biggest challenges in advancing water conservation information. As described in subsequent sections of this report, recent state and federal initiatives demonstrate support toward making it simpler for water users to practice water conservation and toward encouraging data collection that will assist in advancing information. The following sections describe the recently completed and ongoing efforts.

Colorado Statewide Water Conservation Best Practices Guidebook

The Colorado Statewide Water Conservation Best Practices Guidebook was developed under a grant awarded to Colorado WaterWise, through the CWCB's Water Efficiency Grant Program. The guidebook will assist urban water providers with the selection and implementation of effective water conservation programs and measures. A Project Advisory Committee and stakeholder group, consisting of water professionals and water conservation experts from around the state, including many members of the CWCB's Water Conservation Technical Advisory Group, was formed to guide the process and review the technical work products. Fourteen best practices were selected for inclusion (Table 5 below), and the guidebook was completed in August 2010 with technical workshops offered to water providers across the state. The guidebook was utilized for the SWSI 2010 water conservation update, as described in subsequent sections.

Table 5: Colorado's Statewide Water Conservation Best Practices (CWW 2010).

NO	BEST PRACTICE	CATEGORY
1	Metering, conservation oriented rates and tap fees, customer categorization within billing system	Water System Utility
2	Integrated resources planning, goal setting, and demand monitoring	
3	System water loss control	
4	Conservation coordinator	
5	Water waste ordinance	
6	Public information and education	
7	Landscape water budgets, information, and customer feedback	Outdoor Landscape and Irrigation
8	Rules and regulations for landscape design and installation and certification of landscape professionals	
9	Water efficient design, installation, and maintenance practices for new and existing landscapes	
10	Irrigation efficiency evaluations	
11a	Rules for new construction	Indoor Residential
12a	High-efficiency fixture and appliance replacement for residential sector	
13	Residential water surveys and evaluations, targeted at high demand customers	
11b	Rules for new construction	Indoor Non -Residential
12b	High-efficiency fixture and appliance replacement for non-residential sector	
14	Specialized non-residential surveys, audits, and equipment efficiency improvements	

SWSI Conservation Levels Analysis

The CWCB recently conducted research into the advances that have been made in the science of water conservation at all levels – regional, national, and international (CWCB 2010b). This effort was used to reassess the water conservation classification levels developed under SWSI Phase 1, and to quantify potential future water demand reductions associated with the "passive" water conservation predicted in SWSI Phase 1. The CWCB analyzed the results of the 2004 and 2007 Drought and Water Supply Assessment (DWSA) surveys, the SWSI Phase 1 and 2 reports, and relevant CWCB-approved water conservation plans submitted after July 2006. By examining these varied data sets spanning the last five years, the CWCB gained insight into current water conservation efforts of participating utilities, the consistency of and the discrepancies between self-reported conservation efforts, and the best approach to updating projections of plausible water savings through varying water conservation strategies and integrating water conservation into the SWSI assessment tool.

In Colorado, water providers delivering 2,000 acre-feet or more annually on a retail basis (known as "covered entities"[19]) are required to adopt and implement a water conservation plan[20]. A recent survey

[19] Per Section 37-60-126(1)(b), Colorado Revised Statutes (C.R.S.), "Covered entity" means each municipality, agency, utility, including any privately owned utility, or other publicly owned entity with a legal obligation to supply, distribute, or otherwise provide water at retail to domestic, commercial, industrial, or public facility customers, and that has a total demand for such customers of two thousand acre-feet or more.

by the CWCB identified approximately 100 covered entities in Colorado. Following the impacts of the 2002 drought, the Colorado General Assembly amended the statutes pertaining to water conservation planning requirements in the state in 2004 (House Bill 04-1365). It added the language to include requirements of covered entities seeking financial assistance from the State[21] to estimate and report the water savings from water conservation programs and measures and define water conservation goals (in terms of quantifiable savings). The CWCB added policies between 2004 and 2006 to further define the reporting requirements for covered entities and now requires that an implementation plan be included the water conservation plan submitted for approval.

Table 6: Water providers who have an approved CWCB conservation plan on file

Providers with an Approved CWCB Conservation Plan	
Arapahoe County Water & Wastewater Authority	Ft. Collins-Loveland
Alamosa	Glenwood Springs
Aurora	Greeley
Boulder	Lafayette
Brighton	Lamar
Castle Pine Metro	Left Hand Water Dist.
Castle Pines North Metro Dist.	Longmont
Castle Rock	Northglenn
Centennial W&S Dist.	North Weld County
Cherokee Metro Dist.	North Table Mountain
CO Springs Utilities	Parker
Denver Water	Pagosa Area W&S Dist.
East Larimer County Water Dist.	Pinery
Erie	Rifle
Evans	Salida
Firestone	Sterling
Ft. Lupton	Thornton
Ft. Morgan	Tri County Water Cons. Dist.
Fountain	Widefield W&W
Ft. Collins	Windsor

Recognizing that SWSI Phase 1 only had the pre-2006 water conservation plans to draw from, and that SWSI Phase 2 had roughly half a dozen post-2006 plans available, the CWCB conducted a thorough analysis of over 30 approved water conservation plans on file (listed in Table 6) as of January 2010 (CWCB 2010b). Each conservation plan was fully evaluated for information about the water conservation

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[20] Each covered entity shall, subject to §37-60-127 C.R.S., develop, adopt, make publicly available, and implement a plan pursuant to which such covered entity shall encourage its domestic, commercial, industrial, and public facility customers to use water more efficiently. Any state or local governmental entity that is not a covered entity may develop, adopt, make publicly available, and implement such a plan. (§37-60-126(2)(a) C.R.S.)

[21] On and after July 1, 2006, a covered entity that seeks financial assistance from either the board or the Colorado water resources and power development authority shall submit to the board a new or revised plan to meet water conservation goals adopted by the covered entity, in accordance with this section, for the board's approval prior to the release of new loan proceeds. (§37-60-126(2)(c) C.R.S.)

measures to be implemented, levels of anticipated penetration rates into the utility's customer base, estimated savings associated with those measures, as well as utility water conservation goals. Specifically, the following questions were explored:

- Do water utilities and special districts have meaningful conservation plans?
- What are the best water conservation programs for each utility that water providers can implement?
- What are the costs for these measures and programs?
- What was the influence of the 2002 drought on customer water demand?
- What is the potential for water demand reductions through utility sponsored water conservation programs?

Of the 30 plans on file at the time of this analysis, average demands measured prior to and since the 2002 statewide drought indicate an average 22% drop in system wide per capita water use due to demand reductions related to the 2002-03 drought, with every planning entity observing a decrease in per capita water use between 2000 and 2003. A 7% increase in per capita water use since 2003 has been observed (Figure 3, CWCB 2010b).

The permanency of these changes will likely vary. Overall, demand levels have not rebounded to pre-drought levels, even in locations without ongoing water conservation programs, and it is anticipated that impacts of the drought will persist at some level for years to decades. The Denver Water Department indicates a 20% decrease in customer demand associated with drought-related demand reductions, and an estimated permanent per capita reduction of about 5%[22] to be maintained through implementation of their selected water conservation measures and programs. Colorado Springs Utilities observed a 17% decrease in water demand largely attributed to drought response and plans to implement water conservation measures and programs to offset post-drought increases in per capita demand.

The SWSI Conservation Levels Analysis found that the *extent* of meaningful water conservation occurring in Colorado is unclear. Many existing conservation plans are not on file with the CWCB, do not include specifics regarding water conservation measures and programs, do not indicate that tracking data are collected to characterize the effectiveness of implemented water conservation measures and programs, nor do the majority of providers appear to have budgets specified for implementation of their water conservation (CWCB 2010b). The report notes that while water utilities and special districts were created to provide safe and reliable potable water, it is only recently that rigorous cost-benefit analyses have become available to help evaluate the value of water conservation with respect to budgetary issues. The report states: *"The state of the science of water conservation in Colorado and the United States has greatly improved in the past three to five years, such that more meaningful planning can now occur at the utility and district level – better than at any time before"* (CWCB 2010b).

[22] Based on other utilities' experience through the 1980's drought.

From the review of the 30 water conservation plans on file with the CWCB, a total cumulative water savings of about 68,500 acre-feet by the end of 2017 was expected which amounts to an average water demand reduction of 11.3% over 10 years (CWCB 2010b).[23] While this information is valuable, it is inappropriate to generalize and extrapolate demand reductions from these proposed savings to other utilities and beyond the ten year projections upon which they are based. Further, the conservation plans do not specify the portion of the water savings that are available for new growth, or how the saved water will be used otherwise. Also, from the water conservation plan review, water providers report the cost to implement water conservation over the next ten years averages around $6,327 per acre-foot (with a range of $245 to $37,387 per acre-foot) of expected demand reduction. It was noted that these costs include combinations of measures and programs that water providers have selected to implement, including public education and information efforts. The reported average cost indicates that water providers are targeting the lower-cost options first, with the range of program costs being over five times that of the average.

The Levels Analysis updated the SWSI Phase 1 estimates of passive water savings. As compared to the SWSI Phase 1 passive savings, this updated analysis includes water savings related to retrofitting homes and businesses with high efficiency fixtures and appliances subject to not only the 1992 National Energy Policy Act, but also due to other relevant regulations and market influences not actively funded or implemented by water utilities[24], including retrofitting housing stock and businesses that exist prior to 2016. No attempt was made to predict the effect of potential future local, state, or federal regulations or customer behavioral changes, and the analysis was limited to household fixtures that are not influenced by behavior[25]: high-efficiency toilets, clothes washers, and dishwashers. Using the 2000 water use baseline from SWSI Phase 1, a range of future passive savings for each year starting in 2000 and continuing until 2050 were estimated, using the “middle” population projections from the 2050 M&I Water Use Projection report. Based on the analyses, passive savings are expected to reduce system wide daily per capita use by 19 to 33 gpcd by 2050. The passive savings considered for this current report, and in the 2050 M&I Water Use Projections report, shows a statewide passive savings of 154,000 AF will be achieved between 2010 and 2050.[26]

Several other key findings from this analysis include:

- A volume (e.g. acre-foot) of water savings is a better metric to support planning efforts than a percentage savings – volume does not vary by time, per capita use, changes in future population estimates (after current projections for the years 2010 through 2015), or by lasting impact of

[23] Seventy percent of the ten-year water savings are associated with Denver Water and Colorado Springs Utilities programs.

[24] Legislative acts in California and through the US Department of Energy as well as the EPA WaterSense program were identified as having influenced the rate and type of fixtures and appliances being replaced.

[25] For example, savings from low-flow shower heads may be offset by longer shower times.

[26] The SWSI Water Conservation Levels Analysis report used a 2000 baseline to project passive savings in the year 2030. These data were adjusted for incorporation into the 2050 Municipal & Industrial Water Use Projections report, which utilized a current baseline to project passive savings in year 2035.

drought on future M&I water demands. This is because under the methodology used for the SWSI Levels Analysis, total acre feet of passive savings are only a function of per capita water use caused by the impact of retrofits and/or fixture replacement and the county populations in years 1994, 2005, and 2015. Projected population changes for the years after 2015 did not change the total acre feet of passive savings estimated using the methodologies presented in this report.

- New ordinances, codes, and/or regulations that affect new construction have considerable potential to further reduce demands. As compared to 2010, there will be a 40% increase in new homes by 2030 and a 75% increase by 2050 (CWCB 2010b). Stated differently, approximately 40% of the homes will be new in 2050.

The report indicates that actual passive savings over the coming decades are expected to trend toward the maximum end of the range of estimated savings, because water and energy savings will become increasingly important as fuel costs rise; substantial permanent demand reductions are possible if future regulations and ordinances are developed to address water use in existing and new construction; and because the impact of commercial retrofits is not well captured in the current analyses.

The report also proposed a framework for characterizing "meaningful water conservation" at the water utility level in four categories:

- Foundational
- Ongoing Water Use Programs
- Ordinances and Regulations
- Education

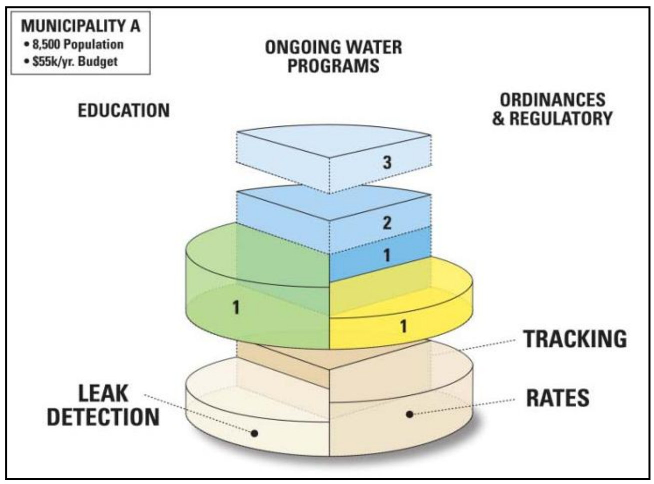


Figure 5: Visual representation of water conservation levels from the SWSI Conservation Levels Analysis Report (CWCB 2010b).

Building from concepts provided in the Colorado Statewide Water Conservation Best Practices Guidebook, "foundational" conservation measures and programs include metering and billing (including water rate structures), leak detection, and water use tracking and should be in place before a utility considers additional conservation efforts (CWCB 2010b). The SWSI Conservation Levels Analysis Report states that only after the foundational measures and programs are in place can a water utility, "… begin to support demand reductions based on business decisions that improve their own and their customer's water use efficiency" (CWCB 2010b).

The Levels Analysis report provides a method of rating the "level" at which a utility has implemented the various water conservation programs. A cylindrical chart, like the one shown in Figure 5, is used to provide a visual image of how coverage and gaps in individual water conservation programs can be identified through the proposed new framework. Utilizing this framework to review the water conservation plans on file with the CWCB, it was noted that most plans had not fully developed the foundational measures and many have gaps between the programs being implemented and the data being collected to verify and monitor the water savings (CWCB 2010b).

Ongoing CWCB Water Conservation Research

Ultimately, the following two questions and need for answers will serve as a guide for further in-depth analysis of the urban water conservation potential in Colorado:

1) What amounts of water can M&I conservation provide to meet our 2050 water needs?

2) What is the best array of conservation measures to achieve these demand reductions?

The CWCB is continuing efforts to improve the water use data upon which the SWSI-related planning efforts rely. In 2010, the Colorado legislature adopted Senate Bill 10-025, extending the CWCB's Water Efficiency Grant Program until 2020 (previously schedule to sunset in 2012). This program assists water providers and other eligible entities in planning and implementing water conservation activities. House Bill 10-1051 was also adopted, creating new annual water use and conservation data reporting requirements for all covered entities starting no later than June 30, 2014. This data will be utilized for statewide water conservation planning and the CWCB anticipates the new data will serve to better define future water conservation potential. The CWCB, with assistance from its Water Conservation Technical Advisory Group, is in the process of developing Guidelines for covered entities regarding reporting of water use and conservation data, which will be adopted by the CWCB no later than February 1, 2012. Pursuant to the legislation, the guidelines will include clear descriptions of categories of customers, uses, and measurements, how the Guidelines will be implemented, and how date will be reported to the Board.

The CWCB is also conducting a water conservation permanency and penetration rates feasibility study. The purpose of this project is to assist in identifying the feasibility of future research into the permanency and penetration rates of past and current water conservation savings and measures. This project seeks to develop partnerships with Colorado urban water providers who may inform the feasibility of this study through data sharing. Through this effort, the CWCB will be able to assist water providers in identifying what challenges and opportunities exist at the provider level in order to carry out future water conservation savings permanency and penetration rates research. This research will help better define the water conservation potential out to 2050. Deliverables from this project will include a needs assessment matrix for conservation partners and CWCB and recommendations of a feasibility study approach and timeline for future research into water conservation potential to 2050 in Colorado.

Other State and Federal Water Conservation Initiatives

Several recent state and federal initiatives show momentum in the field of water conservation, and are expected to improve information and implementation of water conservation on a broader levels.

The U.S. Environmental Protection Agency's (EPA) WaterSense® program is a "partnership program that seeks to protect the future of our nation's water supply by promoting water efficiency and enhancing the market for water-efficient products, programs, and practices." With the volume of new housing stock penetrating the market, the EPA has an opportunity to "promote water efficiency in the new housing sector while creating livable communities that help families save resources for the future." On December 9, 2009, the EPA released a new *WaterSense® Single-Family New Home Specification*, which establishes criteria for water-efficient new homes under the EPA's WaterSense® program. EPA's goal is that WaterSense labeled new homes will use approximately 20 percent less water than a standard new home.

In addition to House Bill 10-1051 previously described, the Colorado legislature also adopted two new bills in 2010 related to new housing stock. House Bill 10-1358, concerning a requirement for new home builders to offer home buyers water efficient options. Effective January 1, 2011, builders must offer every buyer of a new single-family detached residence the opportunity to select one or more water-smart home options described further in the bill, which include water-efficient fixtures and landscaping. House Bill 10-1204 adds the word "conservation" to the Colorado state plumbing code. This allows Colorado's plumbing board to now be able to consider water conservation and efficiency standards when recommending changes to the states' plumbing code.

In 2008, recognizing the importance of integrating water conservation into water supply planning, Colorado adopted House Bill 08-1141. The bill stated "land use and development approval decisions are matters of local concern, but to ensure adequacy of water for new developments is a statewide concern and necessary for preservation of public health, safety, welfare, and the environment of Colorado". The new statute requires all development permit applications, with the support of a water supply experts, include information about the proposed development's water supply requirements, physical source, yield under various hydrologic conditions, conservation measures, and demand management.

These changes emphasize the momentum that water conservation has gained over the past decade, and point toward conservation increasingly becoming integrated in water supply and demand management planning.

WATER CONSERVATION STRATEGIES AND METHODS

One of the goals of the SWSI 2010 update is to utilize scientifically valid and current data and methodologies to fully examine potential conservation savings that may be achieved by 2050, and to identify the types of conservation practices (strategies) that can be utilized to accomplish the savings. The impacts of the implementation of water conservation measures on the reliability of water systems should be examined locally based on the potential uses of the conserved water, such as new growth, instream flows, drought reserve, or lease or sale to other entities. The use of a portion of conserved water for new growth or drought reserve by the conserving utility appears possible under most circumstances without impacting reliability.

The reliability of demand forecasts will likely continue to improve as additional and more accurate water demand data are collected. The updated water conservation methodology presented in this section will further assist in addressing this issue, with system-wide water demand being distributed between water use sectors. This initial approach is based on readily available water conservation planning data and assumptions described in this report, and more accurate distributions between water use sectors may be developed in the future as more and better data become available.

Water Savings Forecasting Methodology

The approach utilized in this SWSI 2010 water conservation update incorporates information from many of the previous CWCB efforts. Demand forecasting for this project and the previous SWSI efforts relied upon somewhat similar data inputs and methods. All SWSI water conservation-related forecasting efforts have been based on several pieces of information:

1) Current and forecasted population,
2) Current water use rates, used to estimate current and forecasted water demands,
3) Estimated future water savings from conservation-related activities.

Water demands have been estimated using a *driver multiplied by rate of use* approach, where the driver is population and the rate of use is in gallons per capita per day (*gpcd*). Multiple levels of future water conservation activities have been considered.

Different "baseline" water demand projections have been developed by the CWCB throughout the various efforts supporting SWSI. Under the SWSI process, the word "baseline" represents either a current or forecasted water demand that has been estimated using "current" water use rates. For the current SWSI 2010 update, current and forecasted population and water use rates were prepared by CWCB staff and the Camp Dresser & McKee Inc. (CDM) consulting team and then provided to the Aquacraft/Headwaters team (CWCB 2010c). Per capita water use estimates were prepared for each county in Colorado using available demand and population data. County estimates were aggregated up to the basin level by assigning each county to a river basin. For counties that straddle more than one basin, demands were split based on the population from the county in each basin.

CWCB's baseline demand forecast for 2050, shown in Figure 4, already include passive water conservation savings from the natural replacement of fixtures and appliances such as toilets and clothes washers. This SWSI 2010 conservation strategies analysis developed active conservation savings estimates that could be achieved from the implementation of three distinct water conservation strategies (Low, Medium, and High).

To forecast water savings under the three scenarios outlined above, the Aquacraft/Headwaters team first disaggregated basin-level baseline per capita demand estimates into the following six demand categories:

- Residential (Single-Family and Multi-Family) Indoor Use
- Non-Residential Indoor Use
- Single-Family Residential Outdoor Use
- Multi-Family Residential Outdoor Use
- Non-Residential Outdoor Use
- Utility Water Loss

Data from the 40 water conservation plans submitted and approved by the CWCB as of July 2010 were used to estimate the percent of water use in each of the categories described above. All approved plans include at least a simple breakdown of demands by customer category. Conservation plan data from at least one plan were available for every river basin in Colorado except the North Platte Basin, which accounts for only 0.1% of total municipal water use in the State. Disaggregated demands for the North Platte Basin were estimated from other plans. These disaggregated demand percentages are presented in Table 7.

The general split between seasonal and non-seasonal (non-irrigation season) demands for each basin were assigned based on available data from conservation plans. When reported, the seasonal (irrigation season) demand split was found to be quite similar for utilities across the state with 46.0% for non-seasonal (indoor) and 54.0% for seasonal (outdoor) demands. These values were applied across all river basins. Irrigation water use can vary greatly depending on climate, lot size, plant type, soil conditions, and irrigation system setup and maintenance, among other things. US Census data on the percent of households living in single-family (SF) and multi-family housing (MF) were obtained for each county in Colorado and these data were used to help disaggregate single-family and multi-family use.

Utility water loss rates were fairly consistent across the state with reported losses below 8% in nearly all regions. The exception of the Southwest Basin which had a reported water loss rate of 29.4% based on only a single water conservation plan. The statewide average for water loss was 7.9%. The per capita water loss levels presented for each conservation strategy scenario are intended to be real, physical losses of water, not apparent losses. Some utilities have already achieved a level of real losses well below the level identified even in the High savings strategies. For example, Aurora reports their real losses are between 3 and 4 gpcd. As more utilities adopt the AWWA Water Loss Control methodology, which includes a consistent data collection and reporting methodology, understanding of water loss in Colorado should improve.

Table 7: Demand percentages by customer and end use category used to disaggregate per capita use

Basin	INDOOR			OUTDOOR			% Water Loss	TOTAL %
	%SF Res	%MF Res	% Non Res	%SF Res	%MF Res	% Non Res		
Arkansas Basin	20.0%	9.2%	28.5%	23.5%	2.3%	8.7%	7.8%	100.0%
Colorado Basin	13.6%	16.1%	23.0%	16.0%	4.0%	21.2%	6.0%	100.0%
Gunnison Basin	28.5%	8.0%	17.4%	33.5%	2.0%	4.4%	6.3%	100.0%
Metro Basin	16.4%	11.8%	24.2%	19.3%	2.9%	18.4%	7.1%	100.0%
North Platte Basin	22.0%	1.5%	33.8%	25.9%	0.4%	8.4%	8.0%	100.0%
Rio Grande Basin	21.5%	3.9%	34.5%	25.2%	1.0%	8.6%	5.4%	100.0%
Southwest	16.2%	5.4%	12.4%	19.1%	1.3%	16.2%	29.4%	100.0%
South Platte Basin	21.8%	10.2%	20.9%	25.6%	2.5%	11.0%	8.0%	100.0%
Yampa Basin	18.7%	11.4%	28.5%	22.0%	2.9%	8.7%	7.8%	100.0%

Next, the disaggregated demand percentages shown in Table 7 were applied to the baseline per capita demands for each river basin prepared by the CWCB and CDM consulting team. The results are shown in Table 8 below which shows some of the differences in water demands by sector across Colorado. Per capita use is meaningful in the indoor residential context, but is less useful when examining disaggregated demand sectors such as outdoor use or water loss because these categories of demand are typically evaluated through different metrics. Outdoor irrigation for example is often evaluated based on the gallons per square foot of area per year. Because the 2050 projections are based on population increases, the use of per capita demands was the only viable option. Per capita volume does provide the best currently available basis for comparing demands between basins, but future studies and forecasting efforts may seek to use a different approach. In particular, future forecasting efforts may find alternative metrics that could be employed for forecasting outdoor demands and utility water loss, but there are complications with nearly all broad-based demand measures.

Water savings for each of the three conservation scenarios was forecast by applying reduction factors to each demand category in Table 8 and then multiplying the revised per capita demand by the forecast basin population in 2050. This simple but effective forecasting method allowed for adjustments to be made at the basin level while still producing clear and understandable state-wide demand projections under different conservation scenarios.

The 2050 Municipal and Industrial Water Use Projections Report presents a mid-population projection of 9.1 million people in Colorado by 2050, a 74% increase over the 5.2 million people estimated to live in the state in 2010 (CWCB 2010c). The population projections used for this analysis are shown in Table 9 and were developed on a county-by-county basis from data provided by the state demographer to the CWCB and the CDM consulting team. Three population forecasts were developed – low, mid, and high. The mid level projection was determined to be the most likely scenario given current knowledge and understanding of growth patterns, so this was the population estimate used for all forecasting calculations in this report.

Table 8: Disaggregated baseline per capita water use by river basin.

Basin	BASELINE - PER CAPITA WATER USE (gpcd)						
	INDOOR		OUTDOOR			Water Loss	TOTAL*
	Res. (SF & MF)	Non Res.	SF Res.	MF Res.	Non Res.		
Arkansas Basin	54.1	52.7	43.4	4.3	16.1	14.4	185
Colorado Basin	54.2	41.9	29.1	7.3	38.5	10.9	182
Gunnison Basin	63.5	30.3	58.3	3.5	7.6	10.9	174
Metro Basin	43.7	37.5	29.8	4.6	28.4	10.9	155
North Platte Basin	73.0	104.7	80.2	1.2	26.2	24.8	310
Rio Grande Basin	79.6	108.3	79.1	3.1	27.1	17.0	314
Southwest	39.5	22.7	34.9	2.5	29.6	53.8	183
South Platte Basin	60.1	39.2	48.2	4.8	20.7	15.0	188
Yampa Basin	69.4	65.5	50.6	6.6	20.0	17.9	230
Statewide	50.7	41.3	37.6	4.6	24.6	13.5	172

*From CWCB 2010c

Table 9: Population projections used for demand forecasts with conservation

Basin	POPULATION PROJECTIONS*						
	2010	2015	2020	2025	2030	2035	2050 (mid level)
Arkansas Basin	977,000	1,067,000	1,161,000	1,258,000	1,355,000	1,451,000	**1,688,000**
Colorado Basin	323,000	366,000	421,000	466,000	511,000	558,000	**725,000**
Gunnison Basin	110,000	125,000	141,000	157,000	171,000	184,000	**220,000**
Metro Basin	2,602,000	2,846,000	3,058,000	3,267,000	3,451,000	3,622,000	**4,144,000**
North Platte Basin	1,500	1,600	1,700	1,700	1,800	1,800	**2,200**
Rio Grande Basin	50,000	54,000	58,000	62,000	65,000	68,000	**80,000**
Southwest	109,000	123,000	138,000	154,000	170,000	185,000	**224,000**
South Platte Basin	1,009,000	1,118,000	1,236,000	1,369,000	1,497,000	1,622,000	**1,902,000**
Yampa Basin	47,000	53,000	61,000	68,000	75,000	81,000	**117,000**
TOTAL	5,228,500	5,753,600	6,275,700	6,802,700	7,296,800	7,772,800	**9,102,200**

*From CWCB 2010c

Some of the benefit from describing water demands and conservation potential by water demand category can be better understood through the following example. Previous SWSI reports and others have identified issues related to representing water demands by developing water use rates as the *total treated water volume* divided by *permanent population*, because it does not explicitly represent effects of fluctuating tourism and commercial-related population in areas such as headwaters communities. This methodology is considered appropriate for statewide planning purposes, and is consistent with the approach to account for water use by transient populations, commercial, and light industry (CWCB

2010c). The Northwest Colorado Council of Governments Water Quality/Quantity Committee recommended an approach to adjust the SWSI Phase 1 estimate of 327 gpcd for Summit County down to a 'more realistic' 113 gpcd, to represent the demand of the permanent population (NCOG 2009). Some of this issue has likely been addressed with the updated water demand data provided under the 2050 M&I Water Use Projections report. The updated SWSI 2010 methodology further assists with this issue by separating demands and conservation strategies between the residential permanent population and other sectors more influenced by transient populations, commercial uses, etc.

Three Conservation Strategies

Three potential urban water conservation strategies were developed to assess the conservation-related water savings potential for municipal providers across the entire state. The goal was to develop realistic strategies that offer significant and cost-effective water savings for all customer sectors in all regions. Each strategy incorporates anticipated savings from active programs, new codes and regulations, landscape and irrigation changes, and improved utility water loss control measures. Passive measures are also noted, although water savings from passive measures are already included in the CWCB baseline 2050 forecast (CWCB 2010c). Specific best practice activities and programs associated with each water use category, as identified in the Guidebook of Best Practice for Municipal Water Conservation in Colorado (CWW/CWCB 2010), were used to develop each strategy.

The three conservation strategies are summarized in Table 10 below and explained in more detail later in this report. The Medium strategy includes all elements from the Low strategy and builds and expands upon the measures. The High strategy includes all elements from the Low and Medium strategies and expands upon the measures. Additional details about each strategy, including assumed implementation and penetration rates, are included in the SWSI 2010 matrix presented in Table 22 later in this report.

Table 10: Low, Medium, and High water savings strategy measures

Conservation Measure	Water Saving Strategy		
	Low	**Medium**	**High**
Passive water conservation savings from natural replacement of fixtures and appliances	X	X	X
Public information and education	X	X	X
Reduction in customer side leakage	X	X	X
Conservation-oriented plumbing and building codes	X	X	X
Landscape water use reductions	X	X	X
Improved utility water loss control measures	X	X	X
Conservation-oriented and water budget-based water rates		X	X
Smart metering with leak detection		X	X
Submetering of new multi-family housing		X	X
Targeted utility audits for high demand non-residential and landscape customers		X	X
Irrigation efficiency improvements		X	X
Informational landscape water budgets and customer feedback		X	X
Landscape water budgets tied to the rate structure and customer feedback	X	X	X
Landscape transformation from high water requirement turf to low water requirement		X	X
Improved utility water loss control measures		X	X

The three conservation strategies emphasize measures that achieve long-lasting, cost-effective water savings using existing technology.[27] The conservation strategies presented rely largely on hardware and technology improvements, codes, standards, conservation-oriented water rates, improved irrigation efficiency, reduction in landscape water requirements through replacement of high demand plant materials, and utility water loss reductions. Achieving the estimated water savings from these three conservation strategies should not require intentional changes to any individual's water use behavior in terms of fewer or shorter showers, less toilet flushing, or elimination of irrigation.

Achieving the water savings objectives of these strategies is not a foregone conclusion, particularly for the Medium and High savings strategies. Implementation of these strategies will require substantial and sustained effort and investment by the State and local governments and by water providers and water customers. Water conservation programs, like water supply projects such as reservoirs and pipelines, must be planned, financed, constructed/implemented, operated, and maintained.

Assumptions and Limitations

There are several important caveats and assumptions regarding the water conservation strategies that should be understood so that the results are not misinterpreted or misapplied.

Conditional Statewide Strategies to Assess Conservation Potential – These three strategies were used to prepare a conditional demand forecast. The savings estimates presented are expected to be achieved *if* the programs and measures described are implemented at the specified level across the entire state. The medium and high strategies in particular will require a significant and sustained effort in order to achieve the forecast water savings. The forecasting assumptions do not reflect differences that exist between individual water providers. Each water provider in Colorado is distinct and it is anticipated that over the next 40 years water conservation will be implemented differentially across the state. In order to prepare statewide forecasts of conservation potential it was assumed that the potential to conserve water may exist irrespective of an individual water provider's need or desire to conserve. In reality, some providers will need little if any conservation savings to meet future demands while others will seek substantial demand reductions.

Permanency of Existing Conservation Efforts – The water savings projections in this report are conditioned on post-drought baseline demands, and assume water conservation savings since the 2002 drought period will be sustained into the future. The permanency of post-drought related reductions in water use is uncertain. Some of this uncertainty may be resolved as additional water utility-level data are obtained and further investigated. Additional and improved data is anticipated through future utility water conservation plans and under data reporting requirements established in Colorado House Bill 10-1051.

[27] Detailed cost-effectiveness analysis was not conducted for this study and should be the subject of future research, however all water saving strategies were based on program measures determined to be cost-effective from the water provider perspective (CWW 2010).

Climate Change Not Considered – The impacts of climate change on water demands were not included in this analysis. Time and budgetary limitation did not allow for this complexity to be included. Climate change is an important factor for consideration in conjunction with future water demands and should be included in subsequent forecasting efforts.

The Future is Uncertain and Water Use May Change – It is impossible to predict all of the technological and cultural changes that could occur over the next 40 years which might impact water use. The trends over the past 15 years have been towards greater efficiency and lower use and at this moment in time, there is no indication that these trends will not continue (Coomes, et. al. 2010). However, it is possible that new uses for water could emerge in the future which might increase municipal demand (e.g. increased use of evaporative cooling, increased installation rates of swimming pools, spas and/or multi-headed showering systems). Unanticipated demand increases could counteract some of the savings estimated in this report, even if conservation programs are implemented at the specified levels. Similarly, technology could also serve to reduce future water demands below those estimated here. Updating the baseline condition and demand forecasts regularly is the best way to incorporate unanticipated future changes.

Uses of Conserved Water Are Not Assumed – No assumptions have been made about the portion of the water savings forecast in this report that could potentially be utilized toward water supply, serving new customers, or meeting the M&I gap. Each water provider must decide how best to apply water garnered from demand reductions within their individual water supply portfolio. Utilities will need to make these decisions based on their integrated water resources planning efforts, consideration of their system's reliability throughout drought periods, impacts of conservation on their return flows and availability of reusable supplies, effectiveness of water rates and impacts to their revenue streams, and other local considerations. Subsequent efforts will be needed to help determine what portion of active conservation savings can be applied to the M&I gap.

Impacts from New Construction – A substantial number of new homes and businesses will be constructed throughout the state between now and 2050. The projections provided for this basin-level planning effort do not distinguish between savings that will be achieved from existing versus new construction. Actual savings may be attributed more to higher efficiency new construction in portions of the state, particularly where more dense development occurs.

Conservation Strategies: Implementation Rates and Savings Levels

Table 11 presents a comparison of the Low, Medium, and High conservation strategies. This table presents both the demand reduction modeling assumptions and the implementation/penetration levels and ranges that are assumed by 2050 to accomplish the demand reductions.

Savings and measures for each sector are presented in and Table 11 the key demand reduction modeling assumptions for each sector are shown in bold blue font. The conservation strategy measures that apply to each sector are listed as bullet points beneath each demand reduction assumption. Broad conservation measures such as education and rates that impact across all customer sectors are presented at the top of Table 11. These broad measures are assumed to support and contribute to the savings levels estimated for each customer sector.

The demand reductions presented in Table 11 represent feasible levels of conservation savings based on an extensive review of the literature on the impacts of conservation measures and programs. Although these savings may be technically achievable, they are by no means automatic and will require effort and investment by the State and local governments and by water providers and water customers.

The conservation measures presented in Table 11 are largely based on the recently published *Best Practices Guide for Municipal Water Conservation in Colorado* (CWW 2010). Implementation levels are engineering estimates designed to be achievable and to deliver substantive water savings. As noted in the SWSI Conservation Levels Analysis report Additional detail about the formulation and impact of each conservation strategy is presented in the next section.

Table 11: Comparison of 2050 implementation and penetration level for three conservation strategies, and demand reductions used in forecasts

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

*Landscape water demand reductions include the anticipated impact of urban densification.

Description of Three Water Saving Strategies by Demand Sector

The descriptions below explain how the estimated water savings may be achieved on a sector-by-sector basis for each of the three strategies developed in this project. Demand forecasting requires a series of assumptions. The purpose of the sections below is to describe the supporting research, key assumptions, and theoretical underpinnings of the conservation future forecasts developed for this report. Additionally, the sections below outline the anticipated implementation level and penetration rates associated with each of the three water saving strategies, as presented in Table 11 above.

Residential Indoor Water Savings Assumptions

- **Low Water Saving Strategy** - Indoor per capita use for both single-family and multi-family housing will be reduced statewide to an average of 40 gpcd by 2050.[28]

- **Medium Water Saving Strategy** - Indoor per capita use for both single-family and multi-family housing will be reduced statewide to an average of 35 gpcd by 2050.

- **High Water Saving Strategy** - Indoor per capita use for both single-family and multi-family housing will be reduced statewide to an average of 30 gpcd by 2050.

Table 12 shows how per capita demand is reduced to the target level under each of these scenarios through an analysis of each residential end use. The assumed efficiency level of toilets, clothes washers, showers, faucets, dishwashers, and leakage is presented along the with assumed penetration rate ranges that may be achieved by 2050.

Recent residential end use research has shown that achieving an average residential indoor demand of 40 gpcd is readily possible and many homes equipped with Ultra Low Flush toilets (1.6 gal/flush) and high efficiency clothes washers (24 gal/load) have already reached this level of efficiency (Aquacraft, 2010; Aquacraft, 2006; Aquacraft, 2004; WaterSense 2009; Headwaters Corp. 2009; Kenney & Reidy 2009). It is anticipated that most of the toilets and all of the clothes washers in Colorado will be replaced between now and 2050, since the average useful life of both of these products is less than 40 years (CWCB 2010b). Increased adoption of conservation-oriented water rates and utilization of the WaterSense new home specification helps ensure "built-in" efficiencies in new homes.

[28] In four basins – Gunnison, North Platte, Rio Grande, and Yampa higher per capita targets were set because the baseline residential demands were significantly higher. Because the population in these basins is relatively small, the overall impact of these altered targets on forecasted demand is small.

Table 12: Estimated indoor residential per capita demands, efficiency level, and penetration rate under three conservation scenarios+

End Use	Estimated Current Level			Low Water Saving Strategy			Medium Water Saving Strategy			High Water Saving Strategy		
	gpcd	Efficiency Level	Penetration Rate	gpcd	Efficiency Level	Penetration Rate	gpcd	Efficiency Level	Penetration Rate	gpcd	Efficiency Level	Penetration Rate
Toilet	11.1	2.2 gpf	100%	8.1	1.6 gpf	80-100%	6.5	1.28 gpf	85-100%	5.1	1.0 gpf	85-100%
Clothes Washer	9.8	25 gal/load	100%	7.4	20 gal/load	80-100%	5.6	15 gal/load	85-100%	5.0	13.5 gal/load	85-100%
Shower	10.0	2.2 gpm	100%	8.7	2 gpm	80-100%	7.5	1.75 gpm	85-100%	6.5	1.5 gpm	85-100%
Faucet	9.2	2.1 gpm	100%	8.2	2.0 gpm	80-100%	7.8	1.0 gpm	85-100%	6.3	0.5 gpm	85-100%
Dishwasher	1.0	10 gal/load	100%	0.9	9 gal/load	80-100%	0.8	8 gal/load	85-100%	0.7	7 gal/load	85-100%
Leak*	7.0	NA	NA	4.7	NA	NA	4.4	NA	NA	4.0	NA	NA
Bath	1.2	NA	NA	1.2	NA	NA	1.2	NA	NA	1.2	NA	NA
Other**	1.4	NA	NA	1.2	NA	NA	1.2	NA	NA	1.2	NA	NA
TOTAL	**50.7**			**40.4**			**35.0**			**30.0**		

Notes:

*Leakage is reduced through toilet replacement, repairs, and improved metering and monitoring by water providers using the capabilities of automatic meter infrastructure.

**Small reductions in the "Other" category come from technological improvements in evaporative cooling and water softeners and reverse osmosis units.

+The SWSI Levels Analysis (CWCB, 2010) considered only toilets, clothes washers, and dishwasher replacement in the passive savings analysis.

Sources:

Aquacraft, Inc. 2000. Seattle Home Water Conservation Study. Aquacraft, Inc. Boulder, CO.
Aquacraft, Inc. 2003. Residential Indoor Water Conservation Study. Aquacraft, Inc. Boulder, CO
Aquacraft, Inc. 2004. Tampa Water Department Residential Water Conservation Study. Aquacraft, Inc. Boulder, CO
Aquacraft, Inc. 2010. Draft Report: Water Efficiency Benchmarks For New Single-Family Homes. Aquacraft, Inc., Boulder, CO
DeOreo, W.B., P.W. Mayer, et. al. 2010. California Residential End Use Study. Aquacraft, Inc. Water Engineering and Management. Boulder, CO.
Mayer, P. et. al. 1999. *Residential End Uses of Water*. American Water Works Association. Denver, CO.

Non-Residential Indoor Water Savings Assumptions

- **Low Water Saving Strategy** – Non-residential per capita indoor water use is reduced in all basins by 15% by 2050.
- **Medium Water Saving Strategy** – Non-residential per capita indoor water use is reduced in all basins by 25% by 2050.
- **High Water Saving Strategy** – Non-residential per capita indoor water use is reduced in all basins by 30% by 2050.

In Colorado in 2050, this analysis found that more than 90% of the non-residential water use and water savings are expected to come from four river basins: Metro basin, South Platte basin, Arkansas basin, and Colorado basin. One of the assumptions in this forecast is that non-residential demands grow proportionally with population and in the same location.

In addition to the passive savings from natural replacement of toilets and faucets, non-residential indoor savings will also come from natural replacement of urinals with 0.5 gpf fixtures (Low) or 0.25 gpf and waterless fixtures and various Commercial, Institutional, and Industrial (CII) equipment and fixtures including clothes washers, water cooled ice machines, other once through cooling, pre-rinse spray valves, etc.

While much of the indoor water savings in the residential sector are anticipated to be achieved through passive measures such as plumbing codes and natural replacement of fixtures and appliances, water savings in the non-residential sector will likely require more effort. Achieving a 15% reduction in non-residential indoor use (Low scenario) could likely be accomplished through widespread adoption of efficiency plumbing fixtures and appliances through programs such as the WaterSense commercial buildings program and will be further enhanced by broader adoption of conservation-oriented water rates designed specifically for non-residential users (Dziegielewski, et. al. 2000, EBMUD 2008). The 25% and 30% estimates of non-residential indoor savings (Medium and High scenarios) will require additional regulation and expenditures. In particular, conservation-oriented pricing mechanisms including water budgets, targeted utility audits of high demand customers with follow-up efforts, and the establishment of tap fees based on anticipated demand will be necessary to achieve this significant level of water savings (Colorado WaterWise 2010).

As the cost of water rises over the next 40 years, non-residential customers (who are often concerned about utility costs and the bottom line) are likely to pay more attention to their water use patterns both indoors and outdoors. Engaging non-residential customers as partners in the effort to reduce water demand will be essential to achieve 25% and 30% reductions. Utility conservation programs must increasingly focus on outdoor use and non-residential customers. A utility billing database system that can be queried for the purpose of identifying customers with unusually high demands will be an important demand management tool in the years to come. A utility tap fee structure that rewards water efficient buildings with reduced service connection costs (such as the tap fee structure used in Broomfield and in Westminster) provides real incentive to include water efficient fixtures and equipment in new buildings. The WaterSense CII program currently under development may also help improve efficiency at non-residential sites. It is anticipated that WaterSense will begin labeling non-residential equipment that is at least 20% more efficient than standard models. Additionally, a WaterSense program that labels and certifies new non-residential construction is also under consideration. A concerted effort to reduce and eliminate single-pass water cooling statewide through state legislation, regulation, and utility programs can also result in substantial water savings.

Improvements in water consuming equipment and technology used by the non-residential sector will also provide water saving opportunities. The 2008 EBMUD Watersmart Guidebook addresses most of the significant categories of non-residential demand including hospitality, medical facilities, car washes, manufacturing, etc. (EBMUD 2008). The potential savings identified through that guidebook are sufficient to achieve the Low and Medium water saving strategies. The High Water Saving Strategy will likely require additional efficiency improvements, but given the advances in the past 5 years, it appears likely that additional water savings may be achieved as new equipment is installed. Utilities can facilitate these savings if they wish by establishing non-residential efficiency benchmarks and offering rebates and incentives to high demand customers.

Outdoor (SF, MF, and Non-Residential) Water Savings Assumptions

- **Low Water Saving Strategy**:
  - **SF Residential Outdoor –** 15% reduction in per capita outdoor use by 2050.
  - **MF Residential Outdoor –** 15% reduction in per capita outdoor use by 2050.
  - **Non-Residential Outdoor –** 15% reduction in per capita outdoor use by 2050.

- **Medium Water Saving Strategy**:
  - **SF Residential Outdoor –** 22% reduction in per capita outdoor use by 2050.
  - **MF Residential Outdoor –** 25% reduction in per capita outdoor use by 2050.
  - **Non-Residential Outdoor** - 25% reduction in per capita outdoor use by 2050.

- **High Water Saving Strategy**:
  - **SF Residential Outdoor –** 27% reduction in per capita outdoor use by 2050.
  - **MF Residential Outdoor –** 35% reduction in per capita outdoor use by 2050.
  - **Non-Residential Outdoor –** 35% reduction in per capita outdoor use by 2050.

In this analysis it was assumed that multi-family and non-residential irrigators have a somewhat higher water conservation potential than single-family residential customers in the medium and high scenarios. This is based on research and irrigation audits conducted in Colorado over the past 10 years that indicates a greater level of over-irrigation at non-residential sites (Aquacraft 2010, 2009, 2007, 2006, 2004).

Outdoor landscape water savings in all three sectors under the Low, Medium, and High scenarios can be accomplished through a combination of the following measures and programs.

- Densification of urban areas and reduction in average lot size.
- General irrigation efficiency and technological improvements.

- Regulations governing landscape design and installation.
- Certification of landscape professionals.
- Replacement of up to 40% of high water requirement turf with lower water requirement plantings including alternative turf grasses.
- Public information and education campaign focused on outdoor water use.

The Medium and High scenarios may be achieved through the following additional measures and programs:

- Expanded use of smart controllers and soil moisture sensors.
- Improved water efficient design, installation, and maintenance practices for new and existing landscapes.
- Targeted irrigation efficiency evaluations with follow-up to ensure implementation of recommendations.
- Informational landscape water budgets and customer feedback (Medium).
- Conservation-oriented (Low) and water budget-based water rates (Medium) with sharp increases in higher tiers (High).

Outdoor water use for irrigation in Colorado occurs primarily during growing season months and was assumed to account for 54% of total residential water use based on data from conservation plans submitted to the CWCB (Denver Water 2007, Aurora 2007). Irrigation water use can vary greatly depending on climate, lot size, plant type, soil conditions, and irrigation system setup and maintenance, among other things.

Landscape preferences in the Colorado Front Range have evolved over the past 10 years. From what was originally largely turf landscapes have emerged beds of moderate and low water demand plants, flowers, and shrubs nestled in mulch, rocks, and ground cover. Originally called "Xeriscape" by Denver Water in the 1980s, "waterwise" landscape designs, like the landscape pictured here, have gained broad acceptance across Colorado. This transformation of landscapes has been an important contributor to the decrease in water demands measured across all major Colorado water providers (and across the United States) since 2002 (Coomes 2010, Aquacraft 2007).

Metro Water Conservation, Inc. of Denver and the U.S. Bureau of Reclamation, in partnership with nine water utilities completed a study (YARDX, 2004) for the 1997 through 2002 period comparing outdoor water use for traditional (pre-existing) and waterwise landscaping along Colorado's Front Range. The study found that water efficient plots could consistently obtain water savings of 30%, and up to 50%, over more traditional landscaping. The savings noted above were achieved by installing waterwise landscaping which was defined as including approximately 25% low water use plants, 25% more moderate water use plants and up to 50% traditional turf. The report notes that savings could likely have been increased with less turf area. The study also found that participants were extremely satisfied with the more waterwise landscaping and said they would recommend it to others.

Another driver for outdoor conservation in the densification of building that is forecast for Colorado's urban areas. The 2009 California Water Plan Update has calculated water savings from densification and estimates *"As a rule of thumb, landscaping irrigation accounts for almost half of residential water use. An increase in residential density from 4 units per acre to 5 reduces the landscaping area by 20%, which should cut water usage by roughly 10% compared to the lower density development"* (CWCB 2010a). It should be understood that the landscape demand reductions forecast in this document include the impacts of densification.

Many communities have found landscape regulations are an effective method for reducing irrigation water demands both through improved irrigation efficiency, reduced runoff, and replacement of high water demand plants. Table 13 presents a summary of a number of regulatory requirements in Colorado and other western states (Headwaters 2010). A 2002 study of three landscape tracts located in northeastern Colorado Springs compared water use between a traditional landscape and two landscapes developed using the principles of xeriscape. The study found water savings ranging from 22% to 63% over that of a traditional turfgrass landscape after implementing the rules and regulations set forth in the 1998 Colorado Springs Landscape Code and Design Manual. The tract developed prior to implementation of the 1998 manual applied 170% of the theoretical irrigation requirement (based on evapotranspiration) to the landscape. The landscape manual was developed by following the main principles of good xeriscape design, installation, maintenance and "regulations set forth by the city, requiring additional [soil] amendments, inspections, and the submittal of landscape professional's credentials" (Schneider 2008).

Table 13: Summary of existing outdoor program and regulatory requirements (Headwaters 2010).

	EPA WaterSense Single-Family Home Specs	Southern Nevada Water Smart Home	CO DOLA Model Landscape Ordinance	Castle Rock New Build Regs	Castle Rock Water Wise Model Home	City of Westminster New Build Regs	Denver Water New Build Regs
Landscape							
Water budgets	✓		✓	✓	✓	✓	
Turf restrictions	✓	✓		✓	✓	✓	
Water efficient design and hydrozoning		✓	✓	✓	✓	✓	
Irrigated area restrictions		✓				✓	✓
Ornamental water features restriction	✓	✓	✓		✓		✓
Soil amendment/mulch requirement	✓	✓	✓	✓	✓	✓	✓
Allowable plants list or info		✓		✓	✓	✓	
Irrigation System							
Runoff restrictions	✓	✓	✓	✓	✓	✓	✓
System efficiency requirements	✓		✓	✓	✓	✓	✓
Sprayer requirements/restrictions	✓	✓	✓	✓		✓	✓
Multiple zones			✓	✓	✓	✓	
Drip or subsurface or irrigation requirements	✓	✓	✓	✓	✓	✓	
ET or soil moisture smart controllers	✓			✓	✓	✓	
Rain gage requirement	✓		✓	✓	✓	✓	✓
Controller capability specifications	✓	✓	✓	✓	✓	✓	
Scheduling specifications	✓	✓	✓	✓	✓	✓	✓
Maintenance requirement			✓	✓	✓	✓	✓
Professional Certification Requirements							
Certified Irrigation Designer	✓			✓		✓	
Certified Irrigation Contractor	✓						
Certified Landscape Auditor	✓		✓			✓	
Qualified Water Efficient Landscaper	✓						
Other certification/licensure	✓			✓			

Sources: Headwaters 2010, EPA 2009, SNWA 2007, SNWA 2008, Colorado Department of Local Affairs (DOLA) 2004, Town of Castle Rock 2006, Westminster 2004, Denver 2007

Water Loss Water Savings Assumptions

- **Low Water Saving Strategy** – Real utility water loss in the distribution system is reduced statewide to 7% of total system demand by 2050.

- **Medium Water Saving Strategy** - Real utility water loss in the distribution system is reduced statewide to 6% of total system demand by 2050.

- **High Water Saving Strategy** - Real utility water loss in the distribution system is reduced statewide to 6% of total system demand by 2050.

Reduction in utility water loss represents a significant water savings opportunity across Colorado. Water loss control is the practice of system auditing, loss tracking, infrastructure maintenance, leak detection and leak repair for water utilities. Leak detection and repair are familiar water agency practices, but true water loss control is more pragmatic than simply finding and fixing leaks. The AWWA water loss methodology (detailed in the M36 manual) is considered the industry standard.

Auditing a water distribution system for real and apparent losses and evaluating the costs of those losses is the foundation of water loss control. Real losses are actual physical losses of water due to leaks or other problems with the system. Apparent losses are due to meter inaccuracy, unauthorized consumption, and data handling errors. Cost and benefit considerations drive implementation actions in the recommended methodology, described in detail in the American Water Works Association M36 Manual (2009).

Water loss control represents the efforts of water utilities to provide stewardship and accountability in their operations and sets a positive example for customers. Water auditing and loss control give water utilities the potential to conserve significant volumes of treated water by reducing real losses and to increase revenue by reducing apparent losses (Colorado WaterWise 2010).

Water savings from water loss control under the Low, Medium, and High scenarios could be accomplished through the following utility efforts:

- Implementation of the AWWA M36 water loss accounting methodology by Colorado water providers (Low, Medium, and High).
- Leak detection and repair program (Level of effort increases from Low, Medium to High).
- Improved meter testing and repair program (Medium and High).
- Adoption of water loss control measures (as described in AWWA M36) across Colorado utilities (Low ~ 50% of utilities, Medium >60%, High >90%).

The water savings potential from improved and expanded water loss control is significant, but will require substantial effort and investment in data collection, listening equipment, and infrastructure improvement by water utilities to achieve. The first step is to implement the AWWA M36 water loss accounting methodology and to establish and annual updating procedure so that all water in the utility distribution network can be accounted for. It is recommended that water providers start with the "top down" audit which can often be completed quickly using data available in annual reports. However, the top down approach contains numerous estimates and it is essential that over time utilities adopt the "bottom up" approach for water loss accounting which requires physical measurements, meter testing and more rigorous evaluation. Both approaches are described in the 2009 report, "Utility Water Loss Control – A Review of Current Practices In Colorado, Requirements in Other States, and New Procedures and Tools" (CWCB 2009).

> "The straight forward, top-down auditing process can be completed by any agency – small, medium, or large – and requires a very small investment of time and resources. Colorado water providers should be encouraged to routinely compile a simple monthly water statistics report showing system input, billed consumption, nonrevenue water, and the number of customer accounts. Once a year, a full water audit and water balance should be compiled using the monthly reports as fundamental input data. For many water providers, an annual top-down audit will be sufficient to determine the economic levels of water loss and to help inform decisions about future water loss control efforts." (CWCB 2009)
>
> "Some water providers, having completed a top-down audit, will wish to embark on the bottom-up audit approach. This will result in improved information and data validity and hence will improve a utilities ability to respond appropriately to the level of real and apparent losses in the water system. Even if a utility only uses the top-down approach, efforts should be made to improve the level of data validity each year." (CWCB 2009)

In order to achieve the water savings from water loss control estimated in this analysis, most water providers in Colorado would need to work toward implementing the bottom up approach.

The 2009 CWCB report included a detailed set of recommendations of actions that could be taken at the state level to improve water loss control in Colorado. In order to achieve the water loss savings projected in this report, the State will need to take a leadership role, provide incentives, and promulgate regulations to ensure that water providers take the necessary steps to reduce real losses in their system. The recommendations from the 2009 CWCB report are re-printed here:

- Educate Colorado water providers about the 2009 M36 manual update, the IWA/AWWA water audit and water balance procedures, and the free AWWA water audit software.
- Encourage (and perhaps provide incentives to) Colorado water providers to immediately begin implementing and to eventually adopt the M36 water audit procedures into their standard practice. Grant funds could be used to help agencies conduct their first IWA/AWWA water audits, but implementing the top down approach is not an expensive procedure and the grants could easily be for less than $10,000 which should be sufficient for a utility with a service area population of 50,000 or less.
- The CWCB should begin collecting water audit results from all covered entities in the state and storing these data so that they can be used to help develop minimum water loss standards. A web-based reporting mechanism could be established for this purpose, or providers could

simply submit their complete water audit accounting spreadsheet (based on the free AWWA software) each year.

- The State should over a 1-3 year period mandate adoption and implementation of the IWA/AWWA water loss accounting procedures for all CWCB covered entities and should also mandate water audit data reporting.
- Following California's lead, Colorado should collect water audit data for a period of 4 to 5 years. After that time, the reported data and level of data validity should be assessed. If sufficient audit data from utilities with a validity score greater than 50 is obtained, then a stakeholder group should be convened for the purpose of determining appropriate minimum water loss standards for Colorado utilities.
- Default values used in the software may not be suitable for Colorado water agencies. Percentages for unbilled, unmetered consumption and unauthorized consumption can be set to default values initially, but as soon as possible should be evaluated through a measurement study (CWCB 2009).

RESULTS

Per Capita Demands in 2050 Under Three Conservation Scenarios

Table 14, Table 15, and Table 16 present the per capita demands under the Low, Medium, and High water saving strategies for each basin. These per capita demand forecasts incorporate the impacts of both passive and active conservation programs. These data are also presented graphically in Figure . Also included in these tables are the demand reduction assumptions for each customer category, which are shown in Table 11 in bold blue type. Baseline statewide water use as of 2010 was 172 gpcd. In 2050, the Low savings strategy would reduce statewide water use to 142 gpcd –a 30 gallon reduction from baseline. In 2050, the Medium savings strategy would reduce statewide water use to 126 gpcd – a 46 gallon reduction from baseline. In 2050, the High savings strategy would reduce statewide water use to 113 gpcd – a 59 gallon reduction from baseline.

Table 14: Disaggregated low water saving strategy per capita water use by river basin

	LOW SAVINGS STRATEGY PER CAPITA WATER USE - 2050						
	INDOOR		OUTDOOR				
Basin	Res. (SF & MF)	Non Res	SF Res	MF Res	Non Res	Water Loss	TOTAL
Arkansas Basin	40.0	44.8	36.9	3.6	13.7	10.5	149
Colorado Basin	40.0	35.6	24.7	6.2	32.7	8.9	148
Gunnison Basin	45.0	25.7	49.5	3.0	6.4	8.6	138
Metro Basin	40.0	31.9	25.4	3.9	24.2	9.4	135
North Platte Basin	55.0	89.0	68.2	1.0	22.2	17.7	253
Rio Grande Basin	55.0	92.0	67.2	2.6	23.0	13.7	254
Southwest	39.5	19.3	29.6	2.1	25.2	8.7	124
South Platte Basin	40.0	33.4	40.9	4.1	17.6	10.2	146
Yampa Basin	45.0	55.6	43.0	5.6	17.0	12.5	179
Statewide	40.3	35.3	32.0	4.0	21.0	9.8	**142**
Reductions from Baseline	40 gpcd*	-15%	-15%	-15%	-15%	7%	

*Basins with high baseline residential indoor demand were assigned a higher gpcd target.

Table 15: Disaggregated medium water saving strategy per capita water use by basin.

Basin	MEDIUM SAVINGS STRATEGY PER CAPITA WATER USE - 2050						
	INDOOR		OUTDOOR				
	Res. (SF & MF)	Non Res	SF Res	MF Res	Non Res	Water Loss	TOTAL
Arkansas Basin	35.0	39.5	33.9	3.2	12.1	7.9	132
Colorado Basin	35.0	31.4	22.7	5.5	28.9	7.9	131
Gunnison Basin	40.0	22.7	45.4	2.6	5.7	7.4	124
Metro Basin	35.0	28.1	23.3	3.4	21.3	7.1	118
North Platte Basin	50.0	78.5	62.6	0.9	19.6	13.5	225
Rio Grande Basin	50.0	81.2	61.7	2.3	20.3	12.3	228
Southwest	35.0	17.0	27.2	1.8	22.2	6.6	110
South Platte Basin	35.0	29.4	37.6	3.6	15.5	7.7	129
Yampa Basin	40.0	49.1	39.5	4.9	15.0	9.5	158
Statewide	35.3	31.1	29.4	3.5	18.6	7.5	**126**
Reductions from Baseline	35 gpcd*	-25%	-22%	-25%	-25%	6%	

*Basins with high baseline residential indoor demand were assigned a higher gpcd target.

Table 16: Disaggregated high water saving strategy per capita water use by basin.

Basin	HIGH SAVINGS STRATEGY PER CAPITA WATER USE - 2050						
	INDOOR		OUTDOOR				
	Res. (SF & MF)	Non Res	SF Res	MF Res	Non Res	Water Loss	TOTAL
Arkansas Basin	30.0	36.9	31.7	2.8	10.5	7.1	119
Colorado Basin	30.0	29.4	21.2	4.8	25.0	7.0	117
Gunnison Basin	35.0	21.2	42.5	2.3	4.9	6.8	113
Metro Basin	30.0	26.3	21.8	3.0	18.5	6.4	106
North Platte Basin	45.0	73.3	58.5	0.8	17.0	12.4	207
Rio Grande Basin	45.0	75.8	57.7	2.0	17.6	11.3	209
Southwest	30.0	15.9	25.5	1.6	19.3	5.9	98
South Platte Basin	30.0	27.5	35.2	3.1	13.5	7.0	116
Yampa Basin	35.0	45.8	36.9	4.3	13.0	8.6	144
Statewide	30.3	29.1	27.5	3.1	16.1	6.8	**113**
Reductions from Baseline	30 gpcd*	-30%	-27%	-35%	-35%	6%	

*Basins with high baseline residential indoor demand were assigned a higher gpcd target.

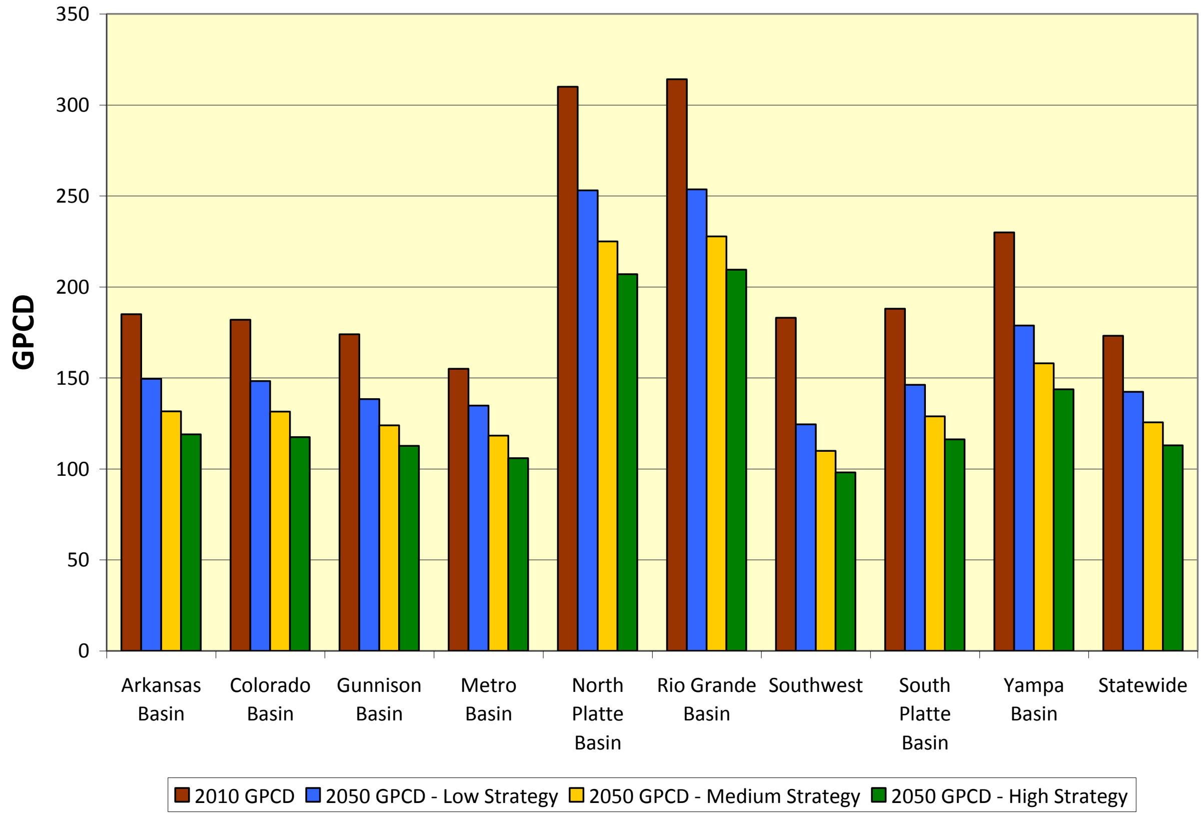


Figure 6: Water use (GPCD) in 2010 and in 2050 under three conservation strategy scenarios by basin and statewide.

Water Savings in 2050 Under Three Conservation Strategies

The total estimated water savings that may be achieved through implementation of the three conservation strategies are presented in Table 17. In Table 17 the water savings from each SWSI 2010 strategy builds upon the previous strategy starting with the passive savings.

The SWSI Levels analysis of statewide passive water conservation potential showed that between 2010 and 2050 demands will likely be reduced by 154,000 AF through the natural replacement of toilets, clothes washers, and other standard domestic fixtures (CWCB 2010b). These passive savings are distinct from the three active strategies developed in this document. Passive and active savings have been added together in Table 17 to present the full estimated impact of water conservation in Colorado by 2050.

If successfully implemented to the levels described, in 2050 the Low strategy + passive savings results in estimated statewide water savings of 314,200 AF. In 2050 the Medium strategy + passive savings results in estimated statewide water savings of 485,200 AF and the High strategy + passive savings results in estimated statewide water savings of 615,300 AF.

To provide perspective on how estimates of conservation savings have been adjusted over the past decade, a summary of the statewide total water savings in 2030 and 2050 developed for the SWSI 2010 update are presented in Table 17, along with similar forecasts from SWSI Phase 1 and the recent SWSI Levels (2010) analysis. This includes passive savings.

Table 17: Statewide forecast water savings potential from SWSI Phase 1, Phase 2, and SWSI 2010 [a]

Project	Level	2030 Forecast Savings* (AFY)	2050 Forecast Savings* (AFY)
SWSI Phase 1	Level 1 (Passive)	101,900	NA
	Level 2	170,533	
	Level 3	272,852	
	Level 4	443,385	
	Level 5	699,183	
SWSI Phase 2	Low	287,000	NA
	Mid	372,000	
	High	459,000	
SWSI 2010	Passive**	131,000	154,000
	Low	209,000	314,200
	Medium	264,000	485,200
	High	328,100	615,300

Notes:

[a] Total water savings potential included, which does not decipher the portion of the savings that may be available to meet future demands versus other planning uses such as drought reserve.

* Volumes savings estimates are total cumulative and include passive savings (e.g. SWSI Phase 1, Level 3 savings build upon Levels 1 and 2; SWSI 2010, Medium savings build upon Low savings).

** From SWSI Levels analysis (CWCB 2010b).

SWSI 2010 savings are estimated through 2050 rather than 2030, but 2030 savings are available for comparison against SWSI Phase 1 estimates. Water savings estimated to be achieved by 2030 from the Low, Medium, and High SWSI 2010 strategies are generally smaller in magnitude that the 2030 savings estimates developed in the SWSI Phase 1. The SWSI 2010 savings estimates are smaller because many water providers in Colorado have already reduced demand substantially over the past 10 years particularly in response to the 2002 drought. Overall, statewide gpcd has decreased and estimated 18% since the SWSI Phase I report was completed, however the causes and permanency of these savings is uncertain. (CWCB 2010c). Changes in system wide 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 data and information account for a significant portion of these observed changes according to the team that developed the baseline demand profiles (CWCB 2010c).

In Table 18, forecasted passive and active conservation savings are compared. The data in Table 18 are the same as in Table 17, only the passive savings are not included for each program level. Data from SWSI Phase 2 have not been included in Table 17 or Table 18 because passive and active savings are not disaggregated in that analysis.

Table 18: Statewide forecast water savings (separating passive and active) potential from SWSI Phase 1 and SWSI 2010 [a]

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

Notes:

[a] Total water savings potential included, which does not decipher the portion of the savings that may be available to meet demands associated with new population versus other planning uses such as drought reserve.

* Volumes savings estimates are total cumulative and include passive savings (e.g. SWSI Phase 1, Level 3 savings build upon Levels 1 and 2; SWSI 2010, Medium savings build upon Low savings).

** From SWSI Levels analysis (CWCB 2010b).

Conservation Strategy Impact Summary

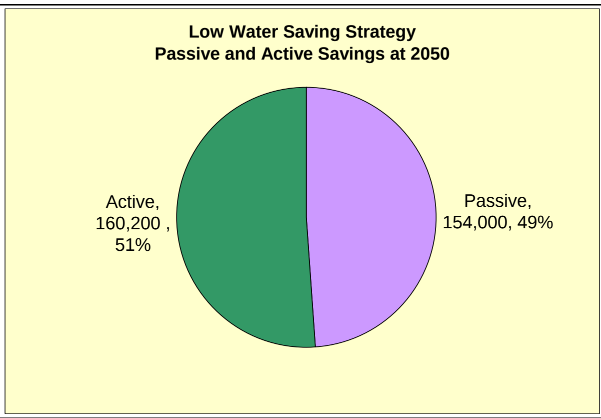
For the following summary impact pie charts, whereas in the earlier sections of the report, water loss was represented in relation to total savings (active and passive), the following pie charts represent water loss reductions as a percent of active savings only.

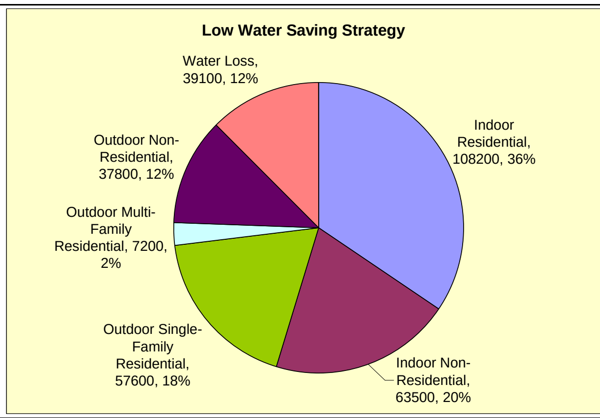
Low Strategy

The Low conservation strategy offers water savings that are divided almost equally between passive and active savings. Relatively low implementation rates of program measures are anticipated under this strategy, but it's success does rely on an on-going commitment to and investment in water conservation information and education in Colorado, universal adoption of conservation-oriented water rates, expanded green building efforts, replacement of some turf areas by less than 20% of the population, improved irrigation efficiency, utility programs directed at non-residential customers, and utility water loss prevention. Table 19 summarizes the impacts of the Low conservation strategy.

Table 19: Low conservation strategy impact summary

Low Conservation Strategy Impact Summary
Total estimated water savings by 2050 = 314,200 AFY • Estimated 2050 passive savings component = 154,000 AFY (49% of total)[29] • Estimated 2050 active savings component = 160,200 AFY (51% of total)





Medium Strategy

The Medium conservation strategy offers water savings that are approximately one third passive and two thirds active savings. Significant implementation rates of program measures are anticipated under this strategy and its success relies on an on-going commitment to and investment in water conservation information and education in Colorado, universal adoption of conservation-oriented water rates, water budget based rates implemented by less than 30% of utilities, expanded green building efforts,

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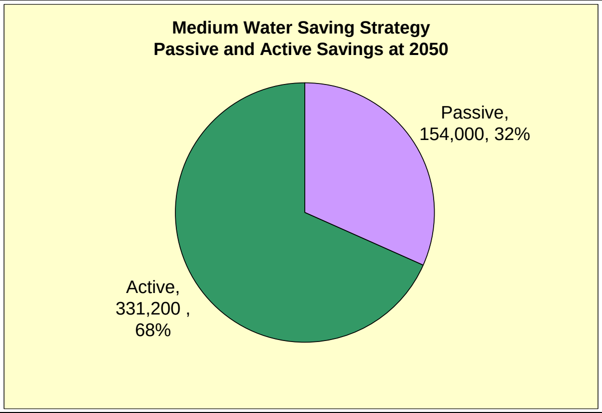
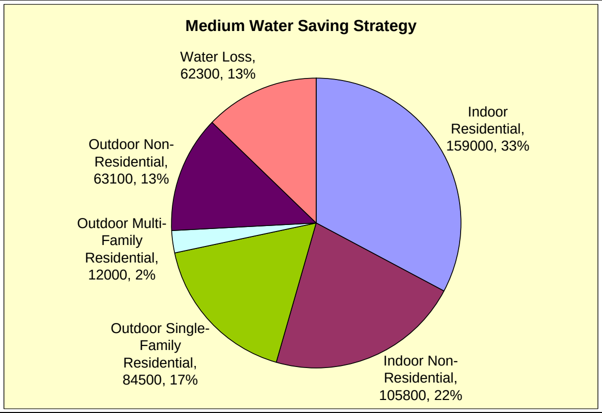
[29] Passive savings estimates at 2050 = 154,000 AFY which are the high scenario passive savings achieved from 2010 – 2050 from the SWSI Levels Analysis (CWCB 2010b). Passive savings for this analysis are less than the total high passive savings (212,000 AFY) reported by Bouvette, because for this analysis only savings starting in 2010 were considered.

submetering in 50% of new multi-family buildings, replacement of some turf areas by 20-40% of the population, improved irrigation efficiency, utility programs directed at non-residential customers, and utility water loss prevention. Table 20 summarizes the impacts of the Medium conservation strategy.

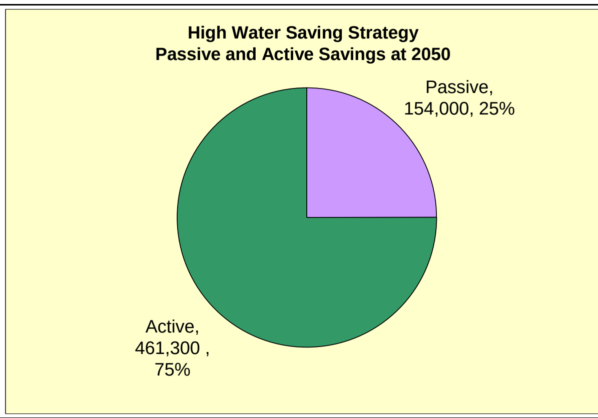
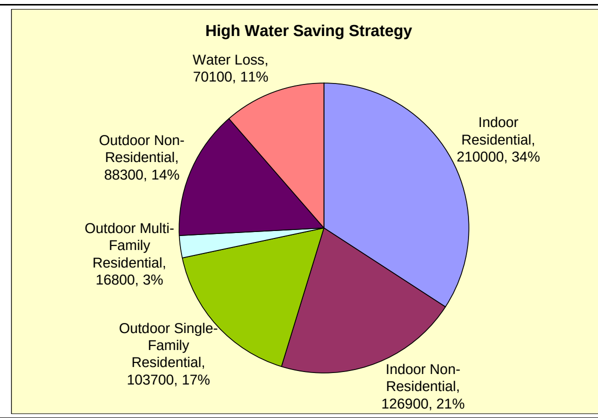
Table 20: Medium conservation strategy impact summary

Medium Conservation Strategy Impact Summary	
Total estimated water savings by 2050 = 485,200 AFY • Estimated 2050 passive savings component = 154,000 AFY (32% of total) • Estimated 2050 active savings component = 331,200 AFY (68% of total)	
	

High Strategy

The high conservation strategy offers water savings that are approximately one quarter passive and three quarters active savings. Aggressive implementation of program measures are required under this strategy and its success relies on a substantial on-going commitment to and investment in water conservation information and education in Colorado, universal adoption of conservation-oriented water rates, water budget based rates implemented by 30-50% of utilities, mandatory green building regulations, submetering in 100% of new multi-family buildings, smart metering for 50-100% of the population, replacement of some turf areas by 40-50% of the population, improved irrigation efficiency, utility programs directed at non-residential customers, and utility water loss prevention. Table 21 summarizes the impacts of the High conservation strategy.

Table 21: High conservation strategy impact summary

High Conservation Strategy Impact Summary	
Total estimated water savings by 2050 = 615,300 AFY • Estimated 2050 passive savings component = 154,000 AFY (25% of total) • Estimated 2050 active savings component = 461,300 AFY (75% of total)	
	

SWSI 2010 Conservation Matrix

As part of the SWSI Phase 2 process, the Water Conservation Technical Round Table (TRT) developed an estimate of the conservation potential in Colorado. Utilizing existing studies at the time, the TRT developed a list of M&I water conservation measures (programs and policies) and projected long-term water savings (Table 2-1, CWCB 2007a), often referred to as the 'SWSI 2 Matrix'. If fully and successfully implemented, it was estimated that these measures could potentially reduce the 2030 demand by 287,000 AFY to 459,000 AFY, with a mid-point estimate of 372,000 AFY. The average cost to achieve these measures was estimated to be around $10,600 per acre-foot, with the less expensive measures costing as little as $1,000 to $2,000 per acre-foot.

As part of the SWSI 2010 update, a revised water conservation matrix was developed to estimate where water savings may be achieved. The SWSI 2010 matrix is presented in Table 22 and the SWSI Phase 2 matrix is provided in Appendix A.

The methodology used to develop the SWSI Phase 2 and SWSI 2010 matrices was significantly different and since the SWSI Phase 2 matrix has been used extensively over the past five years, it is worthwhile to explore the differences. The consulting team that developed the SWSI 2010 matrix was also directly involved in preparing the SWSI Phase 2 matrix.[30] The SWSI Phase 2 matrix was used to develop statewide conservation savings estimates by taking individual customer level conservation savings volumes (from available research) and up-scaling these savings to the state level using census data as the multiplier.

[30] Peter Mayer, P.E. of Aquacraft, lead author of the SWSI 2010 conservation strategies report, was a member of the SWSI 2 TRT and the chief architect of the SWSI 2 matrix.

In contrast, the SWSI 2010 matrix started with the statewide water savings estimates described above. Using the 2010 Colorado Best Practices Guidebook for Water Conservation as a guide (CWW 2010), the estimated SWSI 2010 water savings were disaggregated among the various best practices using available information from CWCB conservation plans, research on conservation effectiveness, the SWSI 2010 Levels Analysis (CWCB 2010b), and engineering estimates. The total savings shown in the SWSI 2010 matrix are intentionally matched to the statewide estimates discussed earlier in this report. In the SWSI 2010 matrix, water savings are grouped into functional categories including: Water loss control, outdoor and landscape, indoor residential, and indoor non-residential. Key efforts such as metering, conservation-oriented rates, and tap fees are not assigned water savings, but instead are considered supporting factors to spur water savings assigned to other categories. This is a simplification introduced to avoid double counting water savings and to reduce reliance on engineering estimates used in the SWSI Phase 2 matrix.

For comparison, the SWSI Phase 2 matrix was used to estimate potential water savings ranging from 287,000 AFY to 459,000 AFY by 2030 while the SWSI 2010 matrix was used to disaggregate potential water savings ranging from 314,200 AFY and 615,300 AFY by 2050. A comparison of the 2030 demand estimated in the SWSI 2010 effort is shown in Table 17 earlier in this report.

The SWSI Phase 2 matrix included a weighted utility program implementation cost estimate of $10,600 per AF of water saved for implementing the identified conservation measures. The SWSI 2010 matrix includes similar utility cost estimates, but because of the methodology utilized to develop water savings forecasts that aggregated savings by end use sector, creating a single weighted average of the cost per AF of conservation was not possible. Customer side costs were not included because, as with all other SWSI 2010 supply strategies (i.e. agricultural transfers and new supply projects), only the direct utility costs for implementing conservation were considered. Water users must ultimately bear the costs of all new water supplies, but consideration of the customer side costs for conservation implementaion was beyond the scope of this effort. Because the SWSI 2010 conservation strategies rely on codes, ordinances, and the natural replacement of fixtures and appliances (passive savings) to a large extent, it is anticipated that that implementation costs per acre-foot of savings will be significantly lower than what was estimated for SWSI Phase 2 which included substantial rebates and financial incentives to spur savings.

Since cost estimates are necessary for planning purposes, per acre-foot utility-side estimates for the SWSI 2010 Low, Medium, and High conservation strategies were developed using the SWSI 2 weighted average of $10,600 per AF for all active savings and a cost of $0 per AF for all passive savings. This analysis yielded an average utility cost of $5,358 per AF of savings for the Low strategy, $7,296 per AF of savings for the Medium strategy, and $8,183 per AF of savings for the High strategy. For comparison, a recent study prepared by the Western Water Policy Program and the University of Colorado titled, “Relative Costs of New Water Supply Options for Front Range Cities” found an average per acre foot cost for water conservation program implementation of $5,200 per acre-foot of conserved water (Kenney et. al. 2010). Improving understanding of the costs associated with implanting water conservation strategies is an important area for future research and analysis. An incremental cost analysis may be useful toward understanding the break points between costs to implement the Low, Medium, and High savings strategies as costs are likely to increase for the Medium and High strategies.

Table 22: Matrix of water conservation measures and savings based on Colorado Statewide Water Conservation Best Practices Guidebook and State Water Supply Initiative savings estimates

#	Measure	CWW Best Practice?	Sector Impacted	Estimated Implementation or Penetration Level by 2050	Low Water Saving Strategy Savings (AFY)	Medium Water Saving Strategy Water (AFY)	High Water Saving Strategy Water (AFY)	Estimated Utility Cost Range of Program per AFY of Savings ($/AFY)	Expected Durability of Savings	Sources and Documentation
1	Full metering	BP 1	All	100%	Contributing factor to savings listed in other sectors.	Contributing factor to savings listed in other sectors.	Contributing factor to savings listed in other sectors.	NA	NA	NA
2	Conservation-oriented rates	BP 1	All	~100%				$1,000 - $8,000	No deterioration	AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers
3	Conservation-oriented tap fees	BP 1	All	Low 0-5%, Medium 5-10%, High 10-50%%				$500 - $2,000	Dependent on Utility or Governing Board Decisions.	2010 Colorado Best Practices Guidebook, City of Westminster, City of Broomfield
4	Integrated resources planning, goal setting, monitoring	BP 2	Utility	~100%				NA	NA	NA
5	Water loss control	BP 3	Utility	Low <=7% real losses; Medium, High <=6% real losses	39,100	62,300	70,100	$2,000 to $7,000	No deterioration as program is on-going.	AWWA M36, 2009 CWCB, 2010 Best Practices Guidebook
6	Conservation coordinator	BP 4	All	100%	Contributing factor to savings listed in other sectors.	Contributing factor to savings listed in other sectors.	Contributing factor to savings listed in other sectors.	NA	NA	NA
7	Water waste ordinance	BP 5	All	100%				NA	NA	NA
8	Public information and education	BP 6	All	100%				NA	NA	NA
9	Landscape water budgets	BP 7	Outdoor irrigation	Low 0-10%, Medium 10-30%, High 30-50%	102,600	159,600	208,800	$2,500 - $5,000	Limited deterioration if budgets are set fairly.	2007 Water Budgets and Rate Structures, 2009 EPA WaterSense, 2008 GreenCO
10	Rules and regs. for landscape design and installation	BP 8	Outdoor irrigation	Low 50-65%, Medium 65-80%, High 80-100%				$500 - $1,500	Limited deterioration.	2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association
11	Certification of landscape professionals	BP 8	Outdoor irrigation	100%				Little or no cost.	Limited deterioration.	2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association, EPA

#	Measure	CWW Best Practice?	Sector Impacted	Estimated Implementation or Penetration Level by 2050	Low Water Saving Strategy Savings (AFY)	Medium Water Saving Strategy Water (AFY)	High Water Saving Strategy Water (AFY)	Estimated Utility Cost Range of Program per AFY of Savings ($/AFY)	Expected Durability of Savings	Sources and Documentation
										WaterSense
12	Water efficient design, installation, and maintenance practices for new and existing landscapes	BP 9	Outdoor irrigation	Low 50-65%, Medium 65-80%, High 80-100%				Customer bears cost, except for inspection - $500 - $2,000	Limited deterioration.	2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association, 2001 Amy Vickers
13	Irrigation efficiency evaluations	BP 10	Outdoor irrigation	Low 30-50%, Medium 50-75%, High 75-100%				$2,000 to $8,000 (assuming utility pays $200 - 500 per audit and customer pays system repair costs)	Same as if no audits are conducted -i.e. standard irrigation system on-going maintenance issues.	2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association, 2001 Amy Vickers
14	Rules for new residential construction	BP 11	Res.	Low 30-50%, Medium 50-75%, High 75-100%	107,000	158,000	209,000	Customer bears cost, except for inspection - $500 - $2,000	No deterioration if new fixture/appliance standards implemented and old units disposed	2010 Best Practices Guidebook, EPA WaterSense, 2008 WaterSmart Guidebook
15	High efficiency fixtures and appliances - Residential	BP 12	Res.	Passive / 100%				$0 - assumes all savings are passive	No deterioration if new fixture/appliance standards implemented and old units disposed	2010 Best Practices Guidebook, EPA WaterSense, 2010, 2007, 2004 Aquacraft, 2001 Amy Vickers
16	Residential water surveys and evaluations, targeted at high demand customers	BP 13	Res.	Low 10-40%, Medium 40-70%, High 70-90%				$2,000 to $7,000 (assuming utility pays $100 per audit and customer pays system repair costs)	Limited deterioration.	2010 Best Practices Guidebook, EPA WaterSense, 2010, 2007, 2004 Aquacraft, 2001 Amy Vickers
17	Submetering of new multi-family res.		Res.	Low 0%, Medium 50%, High 100%				Variable ($0 to $4,000) depending upon who pays for the metering.	No deterioration	2004. National Submetering and Allocation Billing Program Study

#	Measure	CWW Best Practice?	Sector Impacted	Estimated Implementation or Penetration Level by 2050	Low Water Saving Strategy Savings (AFY)	Medium Water Saving Strategy Water (AFY)	High Water Saving Strategy Water (AFY)	Estimated Utility Cost Range of Program per AFY of Savings ($/AFY)	Expected Durability of Savings	Sources and Documentation
18	High efficiency fixtures and appliances - Non-Residential	BP 12	CII	Passive / 100%	63,500	105,800	126,900	$0 - assumes all savings are passive	No deterioration if new fixture/appliance standards implemented and old units disposed	2010 Best Practices Guidebook, 2008 WaterSmart Guidebook, 2001 Amy Vickers, 2000 Commercial and Institutional End Uses of Water
19	Specialized non-residential surveys, audits, and equipment efficiency improvements	BP 14	CII	Low 0-10%, Medium 10-50%, High 50-80%				$3,300 to $16,300 (assuming utility pays $500 per audit and customer pays any repair costs)	Limited deterioration.	2010 Best Practices Guidebook, 2008 WaterSmart Guidebook, 2001 Amy Vickers, 2000 Commercial and Institutional End Uses of Water
20	Rules for new non-residential construction	BP 11	CII	Low 30-50%, Medium 50-70%, High 70-100%				Customer bears cost, except for inspection - $500 - $2,000	No deterioration if new fixture/appliance standards implemented and old units disposed	2010 Best Practices Guidebook, EPA WaterSense, 2008 WaterSmart Guidebook
	TOTAL PASSIVE SAVINGS				**154,000**	**154,000**	**154,000**			
	TOTAL ACTIVE SAVINGS				**160,200**	**331,200**	**461,300**			
	TOTAL				**314,200**	**485,200**	**615,300**			

CONCLUSIONS AND RECOMMENDATIONS

This document represents the latest effort by the CWCB to integrate water conservation into statewide water supply planning and to estimate the water conservation potential that exists in the State up to the year 2050. Through the research, analysis, and writing efforts of the consulting team and the careful review of the WCTAG members and other stakeholders, the CWCB has a water conservation document that incorporates previous water conservation-related efforts into the SWSI resources; updates water conservation savings forecasts; and develops a set of clear water conservation strategies that may contribute toward meeting the projected 2050 water supply gap along with other water supply strategies being investigated.

Key Findings and Conclusions

The following conclusions are drawn from the work completed for this report.

This study provides reconnaissance-level *estimates* of the statewide conservation potential as a building block for future efforts. It provides information regarding technical potential for water savings but does not determine how the saved water may be used, which is determined at a local level through integrated water resources planning, including system reliability and drought mitigation planning. As with previous SWSI planning efforts and other SWSI strategies, the water savings projections presented in this report are intended to provide a reconnaissance-level forecast and methodology that maximizes use of currently available data and uses consistent methods to estimate the conservation potential of the entire state. This approach is intended for statewide planning purposes and to support discussions about water supply strategy options. This approach is not intended to replace water conservation or water resources planning and projections prepared by local entities or to be relied upon in legal proceedings as evidence. These are *conditional* forecasts, in which conservation savings will only be achieved if the identified strategy is fully implemented to the levels described through a significant and sustained effort. As better information and data become available, the potential savings and water conservation strategies presented in this report may be updated, building on the analysis framework provided. However, it should be noted that water conservation planning on a forty year horizon is very challenging. Most utilities plan toward a ten year period, considering that many conservation programs take multiple years to implement while water efficient technology is continuously improving.

Neither climate change nor the "need" to conserve was considered in this analysis. The demand estimates in this study did not consider the potential impacts of climate change or unforeseen behavior changes or new technologies that could increase water use. Future research should strive to incorporate climate change into water supply and demand forecasts for Colorado. The methodology used in this study was applied similarly to all river basins and did not consider the "need" to conserve. Further, it did not integrate a water supply analysis, and did not attempt to discern the portion of new supply that may originate from M&I water conservation savings. It is therefore feasible that for certain water providers, the demand scenarios presented in this report are not necessary, fully achievable, or might not result in a direct net water savings.

Significant potential to conserve water exists in Colorado. Through the water saving strategies developed, it is believed that water savings ranging from 314,000 – 615,000 AFY could be achieved by 2050 using technologies and methods available today if the strategies identified are fully enacted to the levels described. While these strategies are based on sound science showing the potential savings volumes, they do not include all details about *how* Colorado will get there or whether Colorado *wants to* get there. Local water providers will have to consider their own specific water supply situation, customer base, conservation potential and other factors. Furthermore, this analysis makes no assumptions about the portion of the forecast water savings forecast that could potentially be utilized toward water supply, serving new customers, or meeting the gap. Each water provider must decide how best to apply water garnered from demand reductions within their water supply portfolio.

Conservation potential varies across Colorado, but the capacity to reduce demands exists in all regions. Some Colorado communities have mature conservation programs and have observed substantial demand reductions in recent years. Others have made little or no effort to reduce water demands. The potential to conserve differs from system to system. Yet even in the Denver metropolitan area, which has experienced a reported double digit decline in demand since 2002, additional conservation potential exists through the measures and programs outlined in this report.

SWSI Phase 1, SWSI Phase 2, and SWSI 2010 conservation forecasts yielded comparable results. SWSI Phase 1 and SWSI Phase 2 forecasted water savings through the year 2030 and included passive savings in a similar manner to the SWSI 2010. The SWSI Phase 1 forecast 2030 savings ranging from 101,900 to 699,183 AFY. The SWSI Phase 2 forecast 2030 savings ranging from 287,000 to 459,00 AFY. This SWSI 2010 update forecast 2030 water savings ranging from 209,000 to 328,000 AFY. Each SWSI project used a different methodology to forecast water savings over the next 20 years. The SWSI 2010 forecasts at 2030 are lower than comparable SWSI Phase 1 and SWSI Phase 2 forecasts. This is in part because the SWSI 2010 forecasts incorporated reduced baseline demands and a slower population growth rate. While not conclusive of anything, similarities in the forecasts suggest that there is general agreement on the range of feasible statewide water savings.

Achieving water savings from conservation will require sustained, substantive effort and action at the State, local, and customer level. The water savings described in this report are technically possible, but are not assured. Rather, they must be achieved through real effort and investment. If water conservation is to be part of Colorado's future water supply portfolio, it must be supported and funded like other supply initiatives. To obtain the savings forecast in this report, the strategies described must be rigorously implemented at the state, regional, local, and customer level. Water is saved by municipal customers, but customers can be aided in the effort. State polices that promote conservation-oriented rates, water loss control measures, water efficient landscape and building standards, improved plumbing codes, and education and outreach set the stage for regional and local conservation program measures that target high demand customers and ensure new customers join the water system at a high level of efficiency. Consideration may be needed to address the impact of landscape retrofit costs, particularly for lower income customers.

Passive savings are significant: 25-50% of the water savings outlined in the Low, Medium and High strategies are brought about by the anticipated natural replacement of indoor hardware such as toilets and clothes washers over the next 40 years. The "SWSI Levels Analysis" report (CWCB 2010b) determined that substantial passive water savings are likely to be achieved in Colorado. Passive reductions include water savings related to the installation of high efficiency fixtures and appliances that will naturally occur as a result of national plumbing codes and efficiency standards. In this report, 25% – 50% of the water savings occur naturally as fixtures and appliances are replaced and are largely independent of the conservation policies or programs implemented. None of the savings measures included in the three scenarios rely on behavioral changes such as reduced showering or the total elimination of landscape irrigation. Passive savings can be ensured and accelerated through, building codes, education and information programs as well as active utility conservation programs.

Outdoor water use represents the largest demand sector to be targeted for improved efficiency. Analysis of data provided in water conservation plans and from end use research shows that the largest end use of water in Colorado's cities and towns is the irrigation of landscapes accounting for 30% – 50% of total urban demands. Increasing the efficiency of landscape water use in Colorado will probably be the greatest challenge to achieving the water savings forecast in this study. Savings from densification in urban areas and higher efficient landscaping installed in new homes are included in the outdoor savings forecasts and other landscaping savings are accomplished from improving irrigation efficiency and changing plant materials in a manner consistent with recent patterns in Colorado.

Ordinances offer opportunities for landscape demand reductions. The CWW Best Practices Guidebook describes a programmatic shift in water conservation from incentives to ordinances. Many ordinances would be better enacted on the State rather than local level, including those mandating training and certification for landscape professionals, landscape design and installation standards, and design regulations for new construction. If broad landscape savings are to be achieved through ordinances, it is expected that the State would need take a leadership role.

Reducing utility water loss (real losses) presents an important opportunity for Colorado providers. Reduction in utility water loss represents a significant water savings opportunity across Colorado. Water loss control is the practice of system auditing, loss tracking, infrastructure maintenance, leak detection and leak repair for water utilities. Leak detection and repair are familiar water agency practices, but true water loss control is more pragmatic than simply finding and fixing leaks.

Improving water loss control in Colorado may require State leadership. The 2009 report, "Utility Water Loss Control – A Review of Current Practices In Colorado, Requirements in Other States, and New Procedures and Tools" (CWCB 2009) included a detailed set of recommendations of actions that could be taken at the state level to improve water loss control in Colorado. In order to achieve the water loss savings projected in this report, the State must take a leadership role to provide incentives and promulgate regulations ensuring that water providers take the necessary steps to reduce real losses in their system.

Water conservation may have a variety of impacts on return flows and overall water supply availability throughout the state. Changes in return flow volumes and patterns may result due to reductions in demand and increases in efficiency – in some situations return flows may increase while in others, return flows may decrease. The net effect is a function of multiple variables, including the specific conservation measures and their associated level of consumption, the change in demand associated with population, the source of water supply used to meet the current and future demands, among other factors. Physical impacts to the hydrology can be better understood through integrated resource plans and local, regional, and statewide planning. The methodology presented in this report allows more explicit characterization of the potential impacts from changes in water demand and efficiency on consumptive use, return flows, and water supply portfolios.

Demand hardening should be studied, but is not a sound argument against implementing long-term water conservation. By definition, demand hardening is typically only a consideration in a water shortage and if a significant portion of conserved water has been used to serve new customers, and the water use patterns of the post conservation customer base leaves no potential for short term demand reductions in response to droughts. There are no documented cases yet in the literature of demand hardening adversely impacting a community during a water shortage. Customers who have reduced their demand through technological changes or who join a system as efficient users (such as new customers) can still achieve behavioral reductions during a shortage such as reduced toilet flushing, clothes washing or lawn watering. Since conservation savings are achieved by existing customers, it is important that the supply reliability for these customers not be negatively impacted as new customers are added to a system. Based on the current state of knowledge, concerns about demand hardening are not a sound argument against implementing long-term water conservation programs. However, as conservation levels increase, so does the potential for demand hardening if any excess conserved water has not been stored as a drought or strategic reserve. Mitigation strategies, developed at the local utility level, may be needed, such as reserving a portion of conserved water in storage for drought periods, implementation of drought tolerant landscaping, and building additional storage if conserved water is relied on as a future water supply. Proper drought planning and preparedness, along with integrated water resources planning, is probably the single best preventative measure that a water utility can take to guard against the potential impacts of demand hardening.

Local planning is essential. Local water providers are responsible for making decisions about how to best utilize water savings from conservation for their particular system. Water planners are strongly encouraged to analyze safe yield and develop reliability criteria for their systems. Water providers should evaluate the actual impacts of conservation on system yields and reliability through model runs and reasonable assumptions about technological and behavior savings that may be expected from customers during droughts before and after the implementation of conservation measures. The impacts of the implementation of water conservation measures on the reliability of water systems should be examined based on treating conserved water as any other new water supply. Any new water supply, including conserved water, can be used to serve new growth, provide in-stream flows, contribute to a drought reserve, or lease or sale to other entities. The use of a portion of conserved water for any of these uses by the conserving utility is a matter to be determined as part of the local integrated resources plan, and one can not generalize as to correct approach a priori. The use of a portion of conserved water for environmental flows also is feasible, especially if the water is subject to a pull back by the utility during drought or other water shortages. Some conserved water, such as from in-basin direct flow rights, may have limitations if transferred to an environmental flow (CWCB 2007a).

Recommendations for Future Research

The following topics are recommended for future research to improve understanding of water demand patterns, customer behavior, demand hardening, and future conservation potential:

Regional analysis of future supply needs and conservation potential and water tracking infrastructure. This SWSI 2010 update aggregated demands to the river basin level. Future research must incorporate more local data and in particular the need to conserve and the existing conservation potential. Factors such as climate change and local drought strategies impact attitudes about water conservation and decisions about how to use water saved through conservation. Some communities in Colorado have sufficient and resilient water supplies that are forecast to meet build-out demands even if no additional conservation savings are obtained. Other communities are actively seeking new water supplies and plan to rely on future conservation savings. To better understand Colorado's future water supply needs and options, more local information must be incorporated into demand forecasts. Database tools could be developed to track demands, evaluate supply needs, and identify conservation potential. Datasets and forecasting models should be preserved over time so that future SWSI efforts can utilize these work products once again. Colorado's new water use data reporting statute (HB 1051) presents a unique opportunity to improve on future planning efforts. Through this effort, a better understanding of Colorado's water use and supply needs can be established.

Improving water demand data. The methodology used in this report depends on user-reported water demand data and distributions between the water demand categories and seasons. Additional and improved data will not only improve this methodology, but will also assist in further understanding issues such as water conservation impacts on depletion patterns, demand hardening, impacts of drought shadow, durability of lower water use and penetration rates. Additional confidence in water savings projections can be gained as the permanency of post-drought water savings are better understood. Implementation of Colorado House Bill 10-1051 data reporting is anticipated to aid this effort.

Penetration rate of efficient fixtures and appliances. How quickly are Colorado residents adopting high efficiency toilets, clothes washers, and other appliances and how permanent are savings? Currently water planners must estimate adoption rates, but feasibility research by Colorado State University currently being funded by the CWCB could shed light on this fundamental water planning question.

Colorado landscape transformation. Water use has dropped all along the Front Range, and turf by itself may no longer be a preferred landscape design. What landscape changes are occurring in Colorado? How fast and wide-spread are waterwise principles being implemented? What impact has lawn abandonment had on the lower water use data being seen by many water utilities? What are the typical efficiency rates of irrigation systems? Do landscape ET calculators overestimate water demands and if so, why and can an adjustment be made to improve use of these tools in planning and irrigation scheduling? What is the cost to retrofit landscaping and what incentives would be needed for households to make changes (e.g. conservation-oriented rate structures)? A landscape transformation is occurring before our eyes. Water utilities, planners, and conservation professionals need to better understand what is going on and how it will impact our water supply future.

Technical assistance to improve water loss control. A fundamental condition of the forecasted savings identified in this report is that water loss will be substantially reduced in Colorado. In order for this to occur it is expected that the State will take a leadership role in providing incentives, technical assistance, and in promulgating regulations to ensure that water providers take the necessary steps to reduce real losses in their system.

Non-residential baseline end use study. While water demand patterns in the residential sector are fairly well understood at this time, non-residential demand and what constitutes efficient use in the non-residential sector is not understood as well. A better understanding of demand patterns and the establishment of baseline efficiency benchmarks for key categories of non-residential customers (schools, restaurants, hotels/motels, office buildings, supermarkets, retail stores, hospitals, public facilities, vehicle washes, etc.) will help water providers establish effective programs to target conservation at the customers who have real potential to reduce demand.

Economics of water conservation and water supply. More information regarding the economics of water conservation, particularly as compared to other alternatives for developing new water supplies, would assist local, regional, and statewide planning efforts. Many economic evaluations of conservation neglect to include all of the potential benefits and costs associated with reducing future demand. Incorporating triple bottom line economic analysis and other full cost accounting methods into the evaluation of conservation and new supply alternatives is an important future goal. For example, customer side costs (e.g. new indoor fixtures and more efficient landscaping) are not included in the cost estimates and without that contribution, these savings cannot occur. Similarly, benefits such as customers' lower water bills and reduced water treatment plant costs are also excluded.

Regional analysis of future supply needs and conservation potential and water tracking infrastructure. This SWSI 2010 update aggregated demands to the river basin level. Future research must incorporate more local data and in particular the need to conserve and the existing conservation potential. Factors such as climate change and local drought strategies impact attitudes about water conservation and decisions about how to use water saved through conservation. Some communities in Colorado have sufficient and resilient water supplies that are forecast to meet build-out demands even if no additional conservation savings are obtained. Other communities are actively seeking new water supplies and plan to rely on future conservation savings. The potential impact of water conservation on return flows and overall water availability can be further defined through a combination of local and regional analyses, including integration in the State's Decision Support System modeling tools. To better understand Colorado's future water supply needs and options, more local information must be incorporated into demand forecasts. Database tools could be developed to track demands, evaluate supply needs, and identify conservation potential. Datasets and forecasting models should be preserved over time so that future SWSI efforts can utilize these work products once again. Colorado's new water use data reporting statute (HB 1051) presents a unique opportunity to improve on future planning efforts. Through this effort, a better understanding of Colorado's water use and supply needs can be established.

Understanding the relationship between long term conservation and drought response. For some water professionals, the relationship between water conservation and drought response is framed around the issue of demand hardening. The concept and analytics of demand hardening are simple, but the task of determining to what extent demand hardening may impact Colorado providers is complex. Colorado water providers need to know to what extent conserved water can be used to serve new customers and to what extent that water should be stored for use during a future supply shortage. Demand hardening is an important topic for future research in Colorado and beyond. The Alliance for Water Efficiency is considering funding a demand hardening study that may answer some of the lingering questions.

APPENDIX A – SWSI PHASE 2 CONSERVATION MATRIX

The conservation matrix developed for the SWSI Phase 2 project is reprinted here for comparison.

Measure	Estimated Implementation or Penetration Level by 2030	Potential Water Savings Range - Per Customer (thousand gals/year)	Potential Water Savings Range - Entire Program (thousand gals/year)	Potential Water Savings Range - Entire Program (AFY)	Estimated Cost Range of Program per AF of Savings ($/AF)	Expected Durability of Savings	Updated Potential Water Savings Range from CWCB Conservation Plans – Per Customer (thousand gals/year)	Sources/Documentation
Turf replacement	25 percent of single family (SF) residents with no more than 60 percent turf	30 to 60	41,000,000 to 69,000,000	125,800 to 211,700	$7,000 to $25,000 depending on level of rebates offered	Limited deterioration anticipated.	No conservation plans had savings outside of the range developed in SWSI Phase 2	2005. Xeriscape Conversion Study results; Southern Nevada Water Authority (SNWA) 2004 "Cash for Grass - A Cost Effective Method to Conserve Landscape Water"; UC- Riverside; Sylvan Addink, Ph.D. 1996. Watering Established Lawns in Western Colorado: Cool-season Grasses (Kentucky bluegrass, turf-type dwarf tall fescue and perennial ryegrass); Colorado State University Cooperative Extension; Curtis E. Swift, Ph.D.
Utility water loss reduction programs	90 percent of public water suppliers	3 to 5 percent of total system demand	16,952,000 to 28,264,200	52,000 to 86,700	$2,000 to $7,000	Relies on continued utility leak detection program.	2% (Source: City of Northglenn)	Harold Evans, City of Greeley, American Water Works Assoc. (AWWA) Water Loss Control Committee
Toilet rebates	80 percent by 2030	14.6 per household based on 2.6 SF residents	18,192,000	55,800 in 2030	$7,230 @ $150 rebate per toilet (avg 2 per unit)	Deteriorization as flappers wear. Requires ongoing education or flapperless toilets	9 to 19 per household (Source: Firestone and Castle Pines, respectively)	Amy Vickers and Associates, Pacific Institute, California Urban Water Conservation Council (CUWCC), Westminster
Conservation oriented water rates - increasing block rates, water budgets, excess use surcharges, information oriented billing	100 percent of municipal customers	Varies by customer class, current rate structure, and other variables	10,000,000	30,675	$6,000 (assuming an implementation cost of $180 per customer)	Dependent on Utility/Governing Board Decisions.	3% to 7% decrease from conservation pricing (Source: Castle Pines and Alamosa, respectively)	Experience of various TRT members

Measure	Estimated Implementation or Penetration Level by 2030	Potential Water Savings Range - Per Customer (thousand gals/year)	Potential Water Savings Range - Entire Program (thousand gals/year)	Potential Water Savings Range - Entire Program (AFY)	Estimated Cost Range of Program per AF of Savings ($/AF)	Expected Durability of Savings	Updated Potential Water Savings Range from CWCB Conservation Plans – Per Customer (thousand gals/year)	Sources/Documentation
Washer rebates	80 percent by 2030	3.6 to 8.5 per household based on age of unit and density	5,550,150 to 13,104,500	17,000 to 40,200 by 2030	$4,000 to $28,000; rebate range $100-$300	No deterioration if new appliance standards implemented and old units disposed	9.4 l (Source: East Larimer)	Amy Vickers and Associates, Pacific Institute, CUWCC
Cooling Towers increased cycle concentration	50 percent by 2030	Not Applicable	1,000,000 to 8,000,000	3,100 to 24,500	$1,000 to $5,000	10 percent deterioration possible	No conservation plans had savings outside of the range developed in SWSI Phase 2	1995 U.S. Geological Survey (USGS) Com./Ind. Use & Denver Water internal estimates
Rebates for landscape retrofits other than turf replacement	2.0 to 2.5 percent of residential customers	15 to 20 percent of irrigation or 11 to 36	1,000,000 to 6,000,000	3,100 to 18,400	$2,439 to $10,678	Permanent	30% savings for ET Controllers (Source: Castle Pines) Savings range 1.4 Rain Sensors to 17.9 for ET Controller (Source: Pagosa and Longmont, respectively)	Evaluation of Water Conservation Program, Maddaus Water Management, July 2003 coupled with Customer Information System (CIS) Data and Internal Analysis and Assumptions
Residential landscape audits (includes irrigation system upgrades, shutoff devices, weather-based controllers, other new technology)	25 percent of all residential customers - targeted at high users	5 to 15	1,250,000 to 3,750,000 by 2030	3,800 to 11,500 by 2030	$2,000 to $7,000 (assuming utility pays $100 per audit and customer pays system repair costs)	Same as if no audits are conducted -i.e., standard irrigation system on-going maintenance issues.	2.6 (Source: Pagosa)	1999. Residential End Uses of Water. AWWA, Amy Vickers, Aquacraft landscape irrigation studies, engineering estimates.
Residential Indoor Audits	25 percent of all residential customers - targeted at high users	3 to 9	750,000 to 2,250,000	2,300 to 6,900	$3,600 to $11,000 (assuming utility pays $100 per audit and customer pays any repair costs)	Limited deterioration anticipated.	No conservation plans had savings outside of the range developed in SWSI Phase 2	1999. Residential End Uses of Water. AWWA, Amy Vickers, Aquacraft landscape engineering estimates.

Measure	Estimated Implementation or Penetration Level by 2030	Potential Water Savings Range - Per Customer (thousand gals/year)	Potential Water Savings Range - Entire Program (thousand gals/year)	Potential Water Savings Range - Entire Program (AFY)	Estimated Cost Range of Program per AF of Savings ($/AF)	Expected Durability of Savings	Updated Potential Water Savings Range from CWCB Conservation Plans – Per Customer (thousand gals/year)	Sources/Documentation
Submetering in multi-family housing	20 percent of multi-family (MF) housing by 2030	6 to 17/apartment unit/year	600,000 to 1,700,000 by 2030	1,800 to 5,200 by 2030	Variable ($0 to $4,000) depending upon who pays for the metering.	No deterioration.	No conservation plans had savings outside of the range developed in SWSI Phase 2	2004. National Submetering and Allocation Billing Program Study
Commercial landscape audits (includes irrigation system upgrades, shutoff devices, weather-based controllers, other new technology)	25 percent of all commercial irrigators - targeted at high users	20 to 75	500,000 to 1,875,000 by 2030	1,500 to 5,800 by 2030	$2,000 to $8,000 (assuming utility pays $500 per audit and customer pays system repair costs)	Same as if no audits are conducted -i.e. standard irrigation system on-going maintenance issues.	109.6 (Source: Left Hand)	2000. Commercial and Institutional End Uses of Water. AWWA, Aquacraft landscape irrigation studies, Amy Vickers, engineering estimates.
Commercial Indoor Audits	25 percent of commercial customers - targeted at high users	10 to 50	250,000 to 1,250,000	800 to 3,800	$3,300 to $16,300 (assuming utility pays $500 per audit and customer pays any repair costs)	Limited deterioration anticipated.	110 (Source: Firestone)	2000. Commercial and Institutional End Uses of Water. AWWA, Amy Vickers, engineering estimates.
Metering of all utility customers	Very few customers in Colorado were not metered as of 2005						Review of conservation plans suggests that most communities across the state are metered	
TOTAL (not including duplicates)			**93,543,300 to 149,509,600**	**286,900 to 458,600**	**$10,600 (weighted avg/AF)**			

APPENDIX B – LANDSCAPE DEMAND REDUCTION EXAMPLES

Landscape water savings represent between 32% and 34% of all water savings forecast at 2050 in the three water saving strategies analyzed. Landscape water savings may be achieved through a variety of methods including:

- Improved irrigation efficiency that reduces excess water application, overspray, and runoff.
- Replacement of irrigated landscape area with non-irrigated area.
- Replacement of high water demand plantings with lower water demand plantings.
- Soil improvement, mulching, hydrozoning.
- Improved maintenance practices.

To illustrate how landscape water use reductions in the range of 15 – 40% could be accomplished, a series of illustrative examples were developed. The purpose of these examples is to show the type of landscape changes that are required to achieve or exceed the percent reductions in outdoor water use included in the Low, Medium and High saving strategies. These are examples only and were not used to estimate the conservation savings potential and are not intended to fully or accurately represent a specific demand reduction strategy.

Figure presents a simple landscape design and theoretical water requirement for a traditional (baseline) residential home alongside the same property with landscape modifications to accomplish a 15% annual reduction in outdoor use. Illustrative photographs are also included. The water budgets in these examples were developed using the EPA WaterSense Water Budget Calculator spreadsheet tool available for free download from www.epa.gov/watersense. The residential examples shown in Figure and Figure are based on a 10,000 square foot (sq-ft) lot and use an annual reference evapotranspiration (ET) requirement of 33.4 inches per year (from the EPA calculator) which is based on the historic average in the Denver metro area. Denver metro area demand estimates from the ET calculator were utilized as a simplification throughout these examples, and are not intended to be representative statewide. For example, the 2009 annual reference ET was 33.0 inches in north Fort Collins; 40.0 inches in Fort Lupton; 38.9 in Ovid; 42.9 Delta County; 27.4 in Vail; 43.7 in the Grand Valley, Mesa County. The examples assume 15 inches of average annual precipitation. Irrigation efficiency was assumed to be 70% for turf areas and 90% for all other areas.[31] The calculated water savings are not dependent on the lot size or the reference ET and similar changes in landscape on smaller or larger lots with lower or higher ET rates can accomplish the same percent water reductions.

Figure presents theoretical landscape design and theoretical water requirements for the same 10,000 sq-ft property. The annual theoretical water requirement for the 10,000 sq-ft property represents a 30% reduction[32] from the baseline shown in Figure . These examples show but one way in which the

[31] These efficiency rates are likely higher than what can be found in most irrigation systems in Colorado today.
[32] The percentage savings was calculated using the methodology previously described. The landscape ET calculator and photos were provided subsequently, as examples of how the savings could be achieved and the visual effect.

water saving strategy reductions could be achieved. In practice, there are many options available for reducing outdoor demands. Comparable water savings could be achieved through irrigation efficiency improvements rather than landscape changes or simply by halting irrigation on part of a landscape. The purpose of these examples is to show that the demand reductions proposed in the water saving strategies are realistic and will not result in the "end of turf" or of Colorado landscaping as we know it. In fact, many citizens across Colorado have self-embraced native and waterwise landscaping practices and the changes to landscapes across the state are likely part of the explanation why utilities have continued to experience reduced demands since 2002.

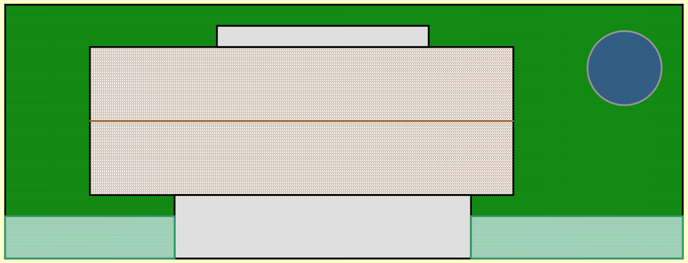
Figure , Figure , and Figure present theoretical landscape designs and water budgets for a non-residential landscape. In these examples, a hypothetical 25,000 SF landscape is created and the theoretical water requirement is calculated using the EPA WaterSense Landscape Water Budget Calculator. The non-residential examples use an annual reference ET requirement of 33.4 inches per year (from the EPA calculator) which is based on the historic average in the Denver metro area. The examples assume 15 inches of average annual precipitation. Irrigation efficiency was assumed to be 75% for turf areas and 90% for all other areas.

In the High Water Saving Strategy, a 35% reduction in non-residential landscape demand is projected. To better explain how this reduction might be accomplished, three different High strategy examples (a, b, and c) were developed and are presented in Figure and Figure . Multiple examples are provided because there are numerous ways in which landscapes can be designed to use less water.

One of the options not presented in any of these examples is to avoid turf grass with a high water demand (such as Kentucky Bluegrass) and instead use another lower demand turf such as tall fescue, dwarf fescue, blue gramma, buffalo grass, or other varieties that can be successful in Colorado. Researchers and sod growers in Colorado and elsewhere are currently working to develop new varieties of turf grasses that have lower water requirements. It appears quite likely that over coming years it will be possible to have attractive largely turf landscapes that require significantly less water than today's turf. Given the rapid pace of urban landscape transformation across Colorado over the past decade, it is not unrealistic to envision landscapes with significantly lower water demands over the next forty years. The effect of densification in new housing stock is anticipated to further reduce the amount of turf in new development.

The information in this section and Figures 7 through 11 are hypothetical examples provided to show some of the variety of landscaping options available for achieving or exceeding the estimated demand reductions in each water conservation strategy. These examples show both how existing landscape could be retrofit and how new landscapes could be designed to meet water budget targets. Illustrative photos were included to provide an idea of how each landscape might appear, but it is not known if the water use at the sites depicted is similar to the estimates provided. While these photographs represent the potential appearance of the landscapes under each scenario, the water demands from each site depicted were not available. In addition, these examples do not portray all the ways in which landscape water savings may be achieved, for example improving irrigation efficiency is not depicted. The examples focus on potential savings through changes in landscape plant types and irrigated area, and the theoretical demands shown assume that all landscapes are watered with an efficient automatic irrigation system. Recognizing that all irrigation systems are not as efficient as assumed in these examples, improvements in water application efficiency provide another method to achieve the projected savings.

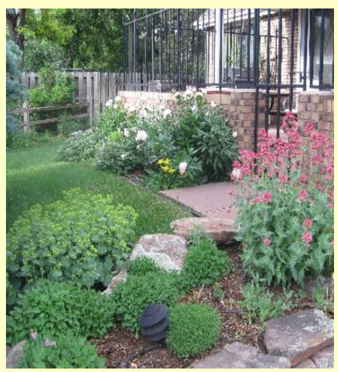
Residential Property – Traditional Landscape Example



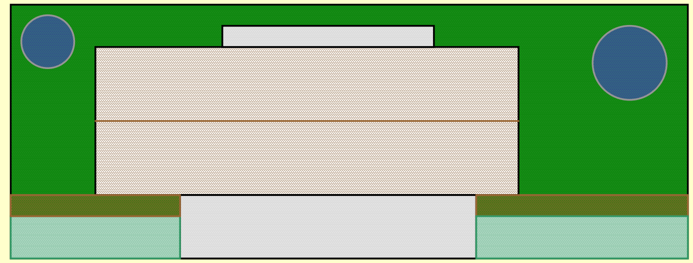
	Area	Gal/SF	Gal/Yr
Non-irrigated	5,000	0	0
Turf	3,500	24.0	84,000
Trees and Shrubs	1000	12.2	12,200
Mixed Planting	500	8.1	4,050
WaterWise	0	3.9	0
Total	10,000	20.1	100, 250

Source: EPA WaterSense Water Budget Water Calculator

Turf - Bluegrass
Planting - Mixed
Irrigation - Rotors (70% eff.) & microspray (90% eff.)
Turf to Planting Ratio - 1.0:0.43



Residential Property – 15% Reduction Example



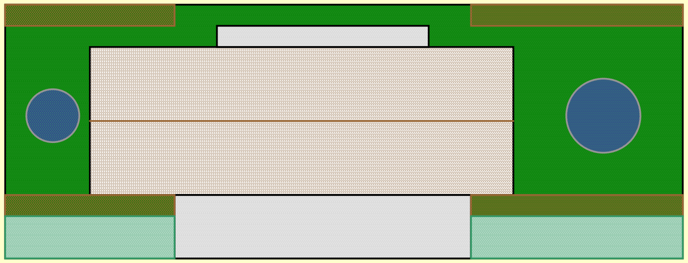
	Area	Gal/SF	Gal/Yr
Non-irrigated	5,000	0	0
Turf	2700	24.0	64,853
Trees and Shrubs	1000	12.2	12,200
Mixed Planting	800	8.1	6,480
WaterWise	500	3.9	1,950
Total	10,000	17.1	85,483

Source: EPA WaterSense Water Budget Water Calculator

Turf - Bluegrass
Planting - Mixed
Irrigation - Rotors (70% eff.) & microspray (90% eff.)
Turf to Planting Ratio - 1.0:0.85

Figure 7: Residential landscape design and theoretical water demands examples – traditional and 15% reduction

Residential Property – 22% Reduction Example

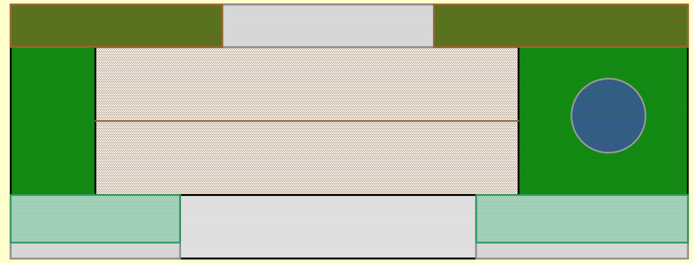


	Area	Gal/SF	Gal/Yr
Non-irrigated	5,000	0	0
Turf	2,200	24.0	52,800
Trees and Shrubs	1,000	12.2	12,200
Mixed Planting	800	8.1	6,480
WaterWise	1,000	3.9	3,900
Total	10,000	15.1	75,380

Source: EPA WaterSense Water Budget Water Calculator

Turf - Bluegrass
Planting - Mixed
Irrigation - Rotors (70% eff.) & microspray (90% eff.)
Turf to Planting Ratio – 1.0:1.2

Residential Property – 30% Reduction Example



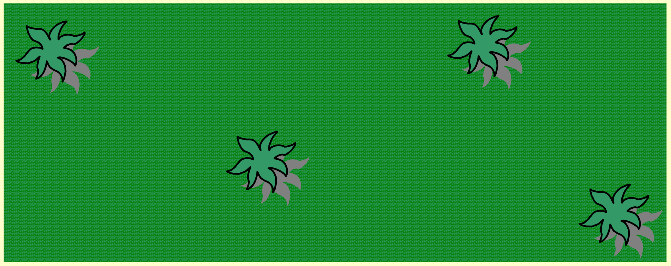
	Area	Gal/SF	Gal/Yr
Non-irrigated	5,500	0	0
Turf	2,100	24.0	50,400
Trees and Shrubs	1,000	12.2	12,200
Mixed Planting	500	8.1	4,050
WaterWise	900	3.9	3,510
Total	10,000	14.0	70,160

Source: EPA WaterSense Water Budget Water Calculator

Turf - Bluegrass
Planting - Mixed
Irrigation - Rotors (70% eff.) & microspray (90% eff.)
Turf to Planting Ratio – 1.0:1.4

Figure 8: Residential landscape design and theoretical water demands examples – 22% and 30% reduction

Non-Residential Property – Traditional Landscape Example



	Area	Gal/SF	Gal/Yr
Non-irrigated	0	0	0
Turf	25,000	24.0	600,000
Trees and Shrubs	0	12.2	0
Traditional Planting	0	8.1	0
WaterWise	0	3.9	0
Total	25,000	20.3	600,000

Source: EPA WaterSense Water Budget Water Calculator

Turf – Bluegrass
Planting – Trees irrigated the same as turf
Irrigation – Rotors (eff.=70%)
Turf to Planting Ratio – 1.0:0.0

Non-Residential Property – 15% Reduction Example

	Area	Gal/SF	Gal/Yr
Non-irrigated	2,500	0	0
Turf	20,000	24.0	480,000
Trees and Shrubs	2,500	12.2	30,500
Traditional Planting	0	8.1	0
WaterWise	0	3.9	0
Total	25,000	22.7	510,500

Source: EPA WaterSense Water Budget Water Calculator

Turf – Bluegrass
Planting – Trees and shrubs
Irrigation – Rotors (eff.=70%)
Turf to Planting Ratio – 1.0:0.2

Figure 9: Non-Residential landscape design and theoretical water demands examples – traditional and 15% reduction

Non-Residential Property – 30% Reduction Example

	Area	Gal/SF	Gal/Yr
Non-irrigated	2,500	0	0
Turf	15,000	24.0	360,000
Trees and Shrubs	2,500	12.2	30,500
Mixed Planting	2,500	8.1	20,250
WaterWise	2,500	3.9	9,750
Total	25,000	18.7	420,500

Source: EPA WaterSense Water Budget Water Calculator

Turf – Bluegrass
Planting – Mixed + Water-Wise
Irrigation – Rotors (eff.=70%) & microspray (eff.=90%)
Turf to Planting Ratio – 1.0:0.5

Non-Residential Property – 40% Reduction Example (a)

	Area	Gal/SF	Gal/Yr
Non-irrigated	10,000	0	0
Turf	15,000	24.0	360,000
Trees and Shrubs	0	12.2	0
Mixed Planting	0	8.1	0
WaterWise	0	3.9	0
Total	25,000	14.4	360,000

Source: EPA WaterSense Water Budget Water Calculator

Turf – Bluegrass
Planting – None
Irrigation – Rotors (eff.=70%)
Turf to Planting Ratio – 1.0:0.0

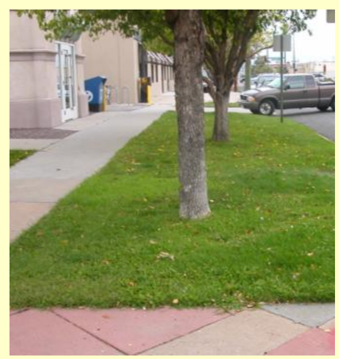
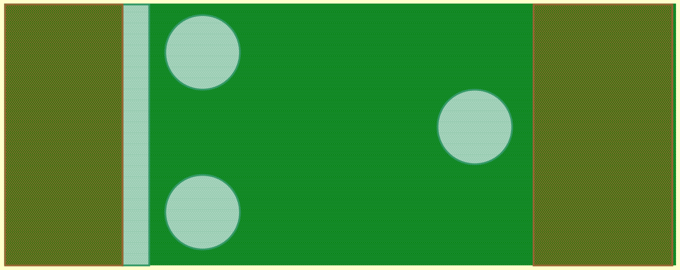


Figure 10: Non-Residential landscape design and theoretical water demands examples – 30% and 40% reduction examples

Non-Residential Property – 40% Reduction Example (b)

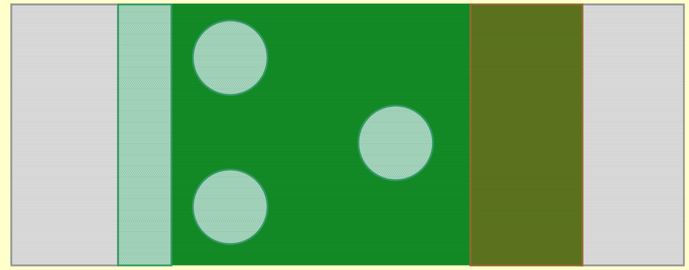


	Area	Gal/SF	Gal/Yr
Non-irrigated	0	0	0
Turf	12,000	24.0	288,000
Trees and Shrubs	2,500	12.2	30,500
Mixed Planting	0	8.1	0
WaterWise	10,500	3.9	40,950
Total	25,000	14.4	359,450

Source: EPA WaterSense Water Budget Water Calculator

Turf – Bluegrass
Planting – Trees and Water-Wise
Irrigation – Rotors (eff.=70%) & microspray (eff.=90%)
Turf to Planting Ratio – 1.0:1.0

Non-Residential Property – 40% Reduction Example (c)



	Area	Gal/SF	Gal/Yr
Non-irrigated	10,000	0	0
Turf	10,000	24.0	240,000
Trees and Shrubs	5,000	12.2	40,500
Mixed Planting	5,000	8.1	61,000
WaterWise	5,000	3.9	19,500
Total	25,000	14.4	361,000

Source: EPA WaterSense Water Budget Water Calculator

Turf – Bluegrass
Planting – Mixed + Water-Wise
Irrigation – Rotors (eff.=70%) & microspray (eff.=90%)
Turf to Planting Ratio – 1.0:1.5

Figure 11: Non-Residential landscape design and theoretical water demands examples – 40% reduction examples

APPENDIX C –SWSI 2010 M&I WATER CONSERVATION STRATEGIES REPORT COMMENTS

Comment No.	Agency	Commentor	Section	Page #, Paragraph, Sentence*	Comment	Comments about response
1	CO Watershed Assembly	Jeff Crane			The Assembly is concerned that the projected water savings from conservation strategies is lower than in previous SWSI reports. This is the wrong direction. There are new technologies coming online all the time that increase water savings. Has the authors of the report thoroughly researched these ideas? It doesn't appear that they have.	Better data and advances in the science of water conservation since SWSI I assisted in refining water conservation projections, as future advances in water conservation science will further refine current projections. These numbers have been reached based on the best available science; research of technologies not currently in use were outside the scope of work for this project.
2	CO Watershed Assembly	Jeff Crane			Conservation strategies should be the primary method to achieve increased water supply for the Front Range. The State should first take the position that supply needs can completely come from conservation and work to provide incentives to achieve that goal.	A mix (i.e., portfolio) of solutions will be necessary for addressing the M&I gap and all elements of the portfolio should be pursued concurrently. This will include the implementation of IPPs, agricultural transfers, new water supply development in the Colorado River system, reuse, and both passive and active conservation as shown in Figure 9. No one strategy alone will meet Colorado's future water supply needs and portfolios explore possible mixes of strategies to weigh the tradeoffs that must be made.
3	CO Watershed Assembly	Jeff Crane			The disconnect between land use and water supply planning also needs additional resources	This report touches briefly on the topic of water conservation and land use planning but did not go into detail. This is a very important topic, is being looked at and could be subject to further study. Please refer to section *7.2.3 Land Use and Water Supply Planning* of the SWSI 2010 report for more information.
4	CO Watershed Assembly	Jeff Crane			We recommend that SWSI set its conservation goals higher and appropriate more resources towards meeting all of our supply needs with conservation.	Please see Response for comment #2

5	Aurora Water	Executive Summary	11, 1	In reference to the 18 percent reduction in statewide demand between 2000 and this report, the last sentence states "Better data and information account for a significant portion of the observed changes according to the team that developed the baseline demand profiles". Aurora reduced water consumption by 27% between 2000 and 2008 not because of better data and information. Aurora believes that the other factors listed such as conservation, behavioral changes from the 2002 drought, and socio-economic conditions may account for a more significant portion of the reduction in demand than better data does. Please remove the last sentence or provide supporting data to validate the claim.	The text in this section comes directly from the CWCB FINAL 2050 M&I Water Use Projections. The technical experts who gathered the data for that study noted the change in demand and the impacts. Because this is a statewide document it is possible that some communities experienced demand reduction greater than the statewide average.
6	Aurora Water	WATER CONSERVATION STRATEGIES AND METHODS	pg 42, table 8	The results in Table 8 are confusing with regard to outdoor usage. This is referenced on page 42 in the discussion of how per capita usage has limitation when considering outdoor use. Please expand this or add a footnote that further explains the issues with using gpcd for outdoor use. For example, 29.8 gpcd for SF Res. outdoor use includes total population in the denominator (not just SF population) and therefore greatly underestimates the gpcd if considering usage on an individual lot basis. Can an additional table be added that more clearly states the baseline demands by class?	Per capita use is not a preferred metric for forecasting outdoor use (See the discussion on page 42 of the Conservation Strategies Report). However, the methodology explains how per capita use was calculated and the population used to make the calculation. True, gpcd would be different if a different population value was used; however, the methods employed here were consistent.
7	Aurora Water	WATER CONSERVATION STRATEGIES AND METHODS	46,3	Please add a paragraph under the heading the "Uses of Conserved Water Are Not Assumed" that explains that uses of active conservation identified in this report are not assumed but that Passive Conservation has been used to reduce demand.	No assumptions have been made about the portion of the water savings forecast in this report that could potentially be utilized toward water supply, serving new customers, or meeting the M&I gap. Each water provider must decide how best to apply water garnered from demand reductions within their individual water supply portfolio. Utilities will need to make these decisions based on their integrated water resources planning efforts, consideration of their system's reliability throughout drought periods, impacts of conservation on their return flows and availability of reusable supplies, effectiveness of water rates and impacts to their revenue streams, and other local considerations. Subsequent efforts will be needed to help determine what portion of active conservation savings can be applied to the M&I gap.

8	Aurora Water	WATER CONSERVATION STRATEGIES AND METHODS		the 18% statewide savings since 2000 are assumed to be used for growth and meeting the Gap by reduction in future demand. Many water providers have not yet determined how their portion of the 18% savings since 2000 will be used and this should be considered when determining how much future demand can be met through active conservation.	Statewide M&I water use has decreased since the SWSI Phase 1 efforts from an average 210 to 172 gpcd, an 18 percent reduction in per person daily water use statewide (CWCB 2010c, State of Colorado 2050 Municipal and Industrial Water Use Projections). For most all basins except the North Platte and Yampa-White, system-wide gpcd water use has decreased. The report notes that these decreases in water use may be due to a combination of permanent savings from conservation efforts, lingering effects of 2002 drought-related behavioral changes, driven by socio-economic factors, and/or a result of better data. The updated data represent the addition of 83 water providers' data that was not available for SWSI Phase 1 and some of the planning numbers used in SWSI Phase 1 have been replaced with treated water delivery data (CWCB 2010c, State of Colorado 2050 Municipal and Industrial Water Use Projections). Many utilities have not determined how they will utilize water savings reflected in the current baseline gpcd values, and therefore the current baseline and projected demands are lower than utility planning numbers in some cases. It is for these reasons we are unsure how much of that 18% is real water savings.
9	Aurora Water	WATER CONSERVATION STRATEGIES AND METHODS	50, table 12	Table 12 shows the indoor residential per capita demands, efficiency level, and penetration rates under the low, medium, and high scenarios. Please add a footnote that distinguishes which end uses are considered Passive Conservation and included in the 154,000 af and which are considered active conservation. In the footnote (and elsewhere where passive savings is discussed) please make it clear that one of the main justifications for choosing the highest estimate of passive conservation was that it only looked at 3 end uses and did not consider showerheads, faucets, or passive conservation other than from toilet, clothes washer, and dishwasher replacement.	The passive savings refers only to toilets, clothes washers and dishwashers. Passive savings does not contain faucets, showerheads, or other types of fixtures. 154,000 af is based on these three fixtures, current legislation and current technologies. See pages 37-38 of the SWSI 2010 M&I WATER CONSERVATION STRATEGIES report for further explanation.
10	Aurora Water	Results	67,3	In determining the cost for conservation, the customer side costs were not accounted for. The stated justification for this was that all other strategies only included utility costs. For other strategies such as agricultural transfers and new supply projects there are no direct customer costs and all costs are initially incurred by the utility. The utility in turn charges the customers tap fees and rates to recover the cost of capital and O&M. In the case of conservation, the utility has a cost which is in turn passed onto the customer similar to other strategies, but there is an additional direct customer cost which needs to be accounted for to do an apples to apples comparison. Ultimately, all of the costs for conserved water become customer costs either through rates or home / landscape improvements. To compare conservation costs to other strategies, both the direct and indirect (utility) customer costs need to be accounted for. Please add a sentence that states that costs for conservation cannot be compared to other strategies since the cost	This issue is a recommendation for future research in the current document as noted on page 77... "Many economic evaluations of conservation neglect to include all of the potential benefits and costs associated with reducing future demand. Incorporating triple bottom line economic analysis and other full cost accounting methods into the evaluation of conservation and new supply alternatives is an important future goal. For example, customer side costs (e.g. new indoor fixtures and more efficient landscaping) are not included in the cost estimates and without that contribution, these savings cannot occur. Similarly, benefits such as customers' lower water bills and reduced water treatment plant costs are also excluded."

				do not consider the full cost.	
11	Aurora Water	Results	67,4	Since the conservation strategy only pertains to active savings, the costs for conservation should not be weighted with passive costs. The assumption is that passive will happen regardless and passive savings were subtracted from demand as "free" water. The only water available under the conservation strategy to meet the gap is active conservation. Therefore, the cost of water from the conservation strategy should not be weighted against passive which is part of the demand side of the equation in SWSI 2010.	There are no costs associated with "passive" savings in this document. If the passive savings were removed from an assessment of "average" utility costs then the cost for conservation would be higher. However, if a conservation oriented rate structure (active) induces someone to replace a toilet (passive) then shouldn't those savings be included? In the end active and passive savings are very much inter-related and it is appropriate and standard practice to include both in cost estimates.
12	Aurora Water	General	Appendix B	The examples shown are not used to calculate the conservation savings potential and cause confusion when attempting to compare the examples with the calculated potential savings, since the numbers do not match. Please consider removing the examples in this appendix to eliminate confusion.	The purpose of these examples is to show the type of landscape changes that are required to achieve or exceed the percent reductions in outdoor water use included in the Low, Medium and High saving strategies. These are examples only and were not used to estimate the conservation savings potential and are not intended to fully or accurately represent a specific demand reduction strategy.
13	Aurora Water	General	Appendix B	Please add some discussion in the document regarding the fact that a number of customers currently are under watering thus resulting in an artificially low baseline. Through education and economic recovery, water use by some customers may increase in the future, yet all scenarios assume that the baseline water demand includes the correct water usage for currently irrigated areas. Penetration rates are as high as 100% for some of uses in the high conservation strategy. Please mention this caveat where appropriate in the document.	Please See response for Comment #12
14	Aurora Water	Executive Summary	13, 3	Please add a paragraph under the heading the "Uses of Conserved Water Are Not Assumed" that explains that uses of active conservation identified in this report are not assumed but that Passive Conservation has been used to reduce demand. Also, the 18% statewide savings since 2000 are assumed	Please See response for Comment #7 & 8

				to be used for growth and reduce the Gap by reduction in future demand. Many water providers have not yet determined how their portion of the 18% savings since 2000 will be used and this should be considered when determining how much future demand can be met through active conservation.	
15	CO Springs Utilities	WATER CONSERVATION STRATEGIES AND METHODS	50, table 13	Under the high water saving strategy for toilets, we feel the assumption that penetration rates reach 85-100% for 1.0 gpf toilets is unreasonable at this time. This technology is not really even on the market and it is assumed that penetration will be up to 100% in 40 years. We believe that 95-100% penetration of 1.28 gpf toilets is reasonable in the high scenario; the medium scenario should have penetration rates from 50-90% assuming slower penetration. We also feel that 85-100% penetration for 0.5 gpm faucets is too high. The medium scenario is more acceptable using 1.5 gpm faucets, while the high scenario should use 1.0, both at 85-100% penetration. These changes should put indoor per capita use closer to 32.5 in the high scenario and 36 in the medium.	20 years ago, in 1990, the 1.6 gpf toilet was not a common or functional fixture; today very functional toilets with a flush below 1.6 gpf are common. There are a significant number of 1.0 gpf (and lower) toilets on the market right now and many of them are able to achieve a high MaP test score. Consequentially, it is not unreasonable to assume that in 40 years a 1.0 gpf toilet is the standard and has widespread adoption.
16	CO Springs Utilities	General		This process should be driven from the bottom up by a committee of experts which contributes to the development of underlying assumptions and methodologies which result in targets. The results should not be driven by pre-set arbitrary targets as they have been in this case. In order to "advance the science of water conservation" the State and those of us involved in technical review need to make a better attempt to keep the process and its results free of bias, while still valuing different perspectives.	The WCTAG is comprised of experts who participated in presentations regarding the methodology and development of this document on numerous occasions throughout 2010 and input was repeatedly sought from the WCTAG.
17	CO Springs Utilities	Executive Summary	12,3	Information contained under "Permanency of Conservation Efforts" touches on two separate but closely related issues. One is the fact that essentially one year of data was used to create a baseline. One year is far more likely to be influenced by factors that cannot be accounted for in this analysis - weather, economy, etc. The second is related to the post-drought uncertainty itself - are we seeing drought shadow, how much is efficiency, how much is behavior, is it permanent, etc. Both are important to articulate, particularly considering that one year follows a period of unprecedented policy and technology influence and such dramatic change. So, the first caveat could include and elaborate on the first two sentences and be called something like "Extent and Permanency of Conservation Savings". The first sentence should remain intact and second sentence should read something like, "The extent and permanency of post-drought related reductions in water use are, however, uncertain." and continue... "Some portion	Baseline data were provided by CWCB and are discussed extensively in the 2050 demands report. Issues with these data are more appropriately addressed in other sections of the SWSI report. Please see *Appendix H - State of Colorado 2050 Municipal and Industrial Water Use Projections* in the larger SWSI document.

				of the reductions may not be related be conservation at all, but instead to factors beyond the influence of policy-makers or efficiency technologies, such as weather and/or economic conditions. In some cases, the assumption that reductions will continue into the future may be significantly flawed. More study is needed to better understand both the extent and permanency of existing conservation. The second caveat could elaborate on the quality of the data and potential problems associated with using a baseline established from one year of data. It is important to provide an understanding that this data, while vastly improved from previous SWSI efforts, is still limited and may not provide the best representation of water demand or conservation as they really are in Colorado now and moving forward. The final sentence referring to the importance of 1051 is good.	
18	CO Springs Utilities	Executive Summary	13	There is no caveat given regarding the unknowns associated with the level of commitment required to achieve even the medium savings scenario. It should be stated in this section that it is assumed the political will required to achieve the medium and high levels of conservation is not only possible, but will be there. It is assumed that costs associated with getting to these levels of conservation will be accepted. It is assumed that communities are, at least to some extent, willing to accept or even promote developments and landscapes that look different than they do today. It should be clear that these assumptions or conditions are risky in many communities. We are not saying these conditions are unachievable. It just needs to be more clear that these are the assumptions and that they may be problematic.	As stated on page 45 of the SWSI 2010 MUNICIPAL AND INDUSTRIAL WATER CONSERVATION STRATEGIES, Achieving the water savings objectives of these strategies is not a foregone conclusion, particularly for the Medium and High savings strategies. Implementation of these strategies will require substantial and sustained effort and investment by the State and local governments and by water providers and water customers. Water conservation programs, like water supply projects such as reservoirs and pipelines, must be planned, financed, constructed/implemented, operated, and maintained.
19	CO Springs Utilities	Key Issues	17, 4	The second sentence states "Some water providers who continue to experience a decrease in demand since the 2002-03 drought are uncertain about the longevity of the "drought shadow" and permanency of any demand reductions." It should not be assumed that water providers believe "drought shadow" is still a significant factor impacting demands. The fact is providers are uncertain about the nature of ongoing reductions in demand. Therefore, the sentence should read, "... since the 2002-03 drought are uncertain about the nature, extent, and permanency of any demand reductions."	Comment noted and added to the report. "Some water providers who continue to experience a decrease in demand since the 2002-03 drought are uncertain about the nature, extent, and permanency of any demand reductions."

20	CO Springs Utilities	Key Issues	17, 5	The second sentence states "Management decisions consider legal, temporal, and spatial constraints that must be understood at a local utility level…" Management decisions also consider economic, social, and political constraints. Therefore, the sentence should read, "Management decisions consider legal, temporal, economic, social, political, and spatial constraints that must be understood..."	Comment noted and added to the report."Management decisions consider legal, temporal, economic, social, political, and spatial constraints that must be understood at a local utility level"
21	CO Springs Utilities	Review of Conservation Planning & Forecasts	22, 3	The third to last sentence states "With this method, a baseline demand does not include impacts of potential additional water conservation." The sentence should continue "… nor does it account for other factors which may affect demand in the short-term, such as economic and climatic factors." The following sentence should begin, "The nature and permanency of demand reductions..." It is not simply permanency of reductions that is misunderstood at this point, it is nature. Both are critical to articulate.	Comment noted and added to the report."With this method, a baseline demand does not include impacts of potential future active water conservation (beyond the increasing effects of passive conservation already factored into the analysis) nor does it account for other factors which may affect demand in the short-term, such as economic and climatic factors. The nature and permanency of demand reductions achieved since 2000 may become more apparent in the coming years as additional and better data on demands are available."
22	CO Springs Utilities	Review of Conservation Planning & Forecasts	31,1	The sentence reading, "Many utilities have not determined how they will utilize water savings reflected in the current baseline gpcd values, and therefore the current baseline and projected demands are lower than utility planning numbers in some cases." is flawed. It neglects the fact that providers are also uncertain about the nature and permanency, i.e. the reliability, of the savings reflected in the baseline gpcd figures. It must be stated that in addition to being uncertain about the reliability of the baseline gpcd values because of the unknown nature and permanency of savings reflected in them, many water providers have not determined whether or how they will utilize possible savings.	Comment noted and added to the report. "Many utilities have not determined how they will utilize water savings reflected in the current baseline gpcd values, and therefore the current baseline and projected demands are lower than utility planning numbers in some cases. In addition to being uncertain about the reliability of the baseline gpcd values because of the unknown nature and permanency of savings reflected in them, many water providers have not determined whether or how they will utilize possible savings"
23	CO Springs Utilities	WATER CONSERVATION STRATEGIES AND METHODS	45-46, assumptions and Limitations	Refer to comments under "Executive Summary"	Comment Noted
24	CO Springs Utilities	WATER CONSERVATION STRATEGIES AND METHODS	48, table 12	Savings in the medium and high strategies under "Landscape conservation savings and measures" is still aggressive given the unknowns about where baseline demands really are. If landscape irrigation demands are already in the neighborhood of 16 gallons per square foot in some communities, then the high strategy is putting demands at 10 to 12 gallons per square foot. This level of conservation, while it may be attainable, represents a very different looking urban landscape. This kind of target may not be accepted by residents and businesses in certain communities.	This comment is noted. The majority of public comments received urged that a more aggressive conservation strategy be adopted. The numeric values included in this report are technically sound, reasonable and achievable, particularly given the 40 year time frame.

				Given all of the uncertainty about where demands are currently, we feel this number should not exceed 25% in the high strategy; the medium strategy should not exceed 20%. More study is needed to understand where communities are currently before more aggressive strategies can be pursued.	
25	CO Springs Utilities	WATER CONSERVATION STRATEGIES AND METHODS	48, table 12	We believe non-residential indoor savings projections are too high in the medium and high scenarios. While it is understood and accepted that plumbing codes will have a significant impact on demand in this sector, aggressive assumptions about large savings from process water efficiency improvements are dangerous. Efficiency improvements will undoubtedly occur, but the nature of process water use in 2050 cannot be known at this time. Assumptions that neglect the possibility that larger process water demands, due strictly to business needs of the time, may occur in the future are problematic from a water supply perspective. Therefore, assumptions should be tempered by this significant unknown. We recommend reduction goals of no more than 25% in the high scenario and 20% in the medium.	This comment is noted. The majority of public comments received urged that a more aggressive conservation strategy be adopted. The numeric values included in this report are technically sound, reasonable and achievable, particularly given the 40 year time frame.
26	CO Springs Utilities	Results		Based on the recommended changes in the Strategies section, statewide per capita demands will likely be closer to 130 in the medium strategy and 119-120 in the high strategy.	This comment is noted. The majority of public comments received urged that a more aggressive conservation strategy be adopted. The numeric values included in this report are technically sound, reasonable and achievable, particularly given the 40 year time frame.
27	CO Springs Utilities	Results	67, 3-4	The discussion of costs, while interesting and valuable as a starting point for discussion, should be viewed only as such. These numbers should not be carried forward and relied upon for any further communication about the relative cost of conservation vs. supply options. Full cost analysis of conservation, including customer cost, must be a significant part of the conservation and integrated resource planning process. Conservation measures can vary greatly in cost and benefit and careful measurement of activities and results is critical to understanding what is truly being achieved. As yet, this has not been done to a great extent in Colorado. As this report states, much more research and analysis is needed to understand both costs and benefits and the results provided, therefore, should only be viewed as an example, if not removed from the document all together.	See Response to Comment #10

28	CO Springs Utilities	Conclusions & Recommendations	73,4	Temper the first sentence to say, "The water savings described in this report appear to be technically possible, but are by no means assured. Consensus does not exist that these results are technically achievable. The great many unknowns that currently exist are significant enough that we should be cautious about definitive statements such as this.	Comment noted. This report includes strong cautionary language (Assumptions and Limitations and Introduction sections for example) regarding water savings potential. The literature and research is clear that the level of savings described in this report are technically achievable.
29	CO Springs Utilities	Conclusions & Recommendations	74,2	Improved landscape efficiency alone cannot get most areas of Colorado to 30-50% savings. As the report states, it is likely that landscape water demand reductions will be the most difficult to achieve because it will require both physical and behavioral changes to the landscape and how water is used in it. The necessary physical changes are generally the most expensive and most potentially impactful of all water conservation measures to Coloradans' quality of life. These facts will make it much more economically, socially, and politically challenging to achieve than other measures. It is advisable, therefore, to be cautious when communicating "potential" when too little can be known about the "likelihood of success" of such measures.	Comment Noted, Possible area for Future Research
30	CO Springs Utilities	Conclusions & Recommendations	74,3	It is understated here just how difficult it may be to achieve such regulatory measures at the state, regional, or local level. There also needs to be more research on just how effective ordinances such as these really are at saving water long-term in Colorado. Ordinances rely heavily on design and enforcement to have the desired result and real-world results are necessary to better understand these effects.	See Response for Comment #18
31	CO Springs Utilities	Conclusions & Recommendations	74,4	Water loss may indeed present a significant opportunity, but it is important to better understand what the prospects are for water loss reductions in the next 40 years given the current state of water infrastructure and the massive investments required to improve it significantly given the rate pressures that do/will exist in many communities. Reducing water loss may be much more difficult to achieve than expected, if investments in water systems cannot be made as needed. Proactive leak detection and repair will not be enough to meet the goals stated in this document. Significant investment in infrastructure replacement will also be needed. It is no forgone conclusion that this can or will happen.	See Response for Comment #18
32	CO Springs Utilities	Conclusions & Recommendations	76,5	This should read, "Technical *and financial* assistance to improve water loss control"	Comment noted. The text already includes wording that the State should provide "incentives". Water loss control measures are generally only undertaken if they make financial sense for a utility. The AWWA methodology is quite clear on this.

33	CO Springs Utilities	General		The two weakest elements of this analysis are beyond the direct control of either staff or the consultants. These weaknesses are the 2008 or post-drought baseline and the use of arbitrary targets to drive the analysis. The one-year post-drought baseline introduces a great deal of uncertainty because we do not understand the nature of the variables which may be influencing it. Because we do not understand these variables, we cannot control for them. Without being able to control for them, we are left with uncertainty which can only be accounted for with the use of more conservative estimates of potential than are used in some of the analysis provided in this document. Some of the aggressive assumptions provided may be a result of the fact that arbitrary targets for low, medium, and high scenarios were set in advance of the analysis. Our general recommendation is to "err on the side of caution" with assumptions because of the obvious uncertainty related to the baseline and the criticality of not underestimating the gap.	Refer to *Appendix H - State of Colorado 2050 Municipal and Industrial Water Use Projections* in the larger SWSI 2010 document
34	CO Springs Utilities	General		We feel that assumptions in the medium and high strategies are still a bit aggressive. We are not arguing that they are not achievable assuming policy makers and citizens are willing to accept significantly stronger policies to get there, but given the unknowns, conservative estimates are significantly more acceptable. Much more study is needed to understand baseline use, market potential, and other factors, before any estimates of conservation potential are widely accepted.	The savings numbers in the medium strategy are only moderately aggressive. The high strategy was intentionally designed to be more aggressive - as has been done in previous SWSI efforts. The 2030 savings comparison between this forecast and SWSI 1 and 2 show much less savings in this analysis.
35	CO Springs Utilities	General		HB-1051 guidelines should be driven in part by the lessons learned from this process, so the short-comings of this analysis can be addressed in the near future.	Comment Noted
36	CO Springs Utilities	General		The rush to complete this process for political reasons has hindered the process of providing technical review for this document. Technical committee members and consultants both needed more time to work through concerns and address them completely in the document. The review time for the most recent draft prior to the public comment period was far too short for committee members to provide fully rationed comments. None of the comments provided by Colorado Springs Utilities were incorporated in this public draft, therefore, each of them has been provided again.	Comment Noted
37	Denver Water			we believe that there should be a section that describes the elements where consensus was not reached.	Comment Noted- in the Introduction section there is a statement about consensus not being reached on all issues
38	Denver Water			The scope of work is not discussed in the report. We think it is important to discuss that the objective of this report was to design the Low, Medium and High scenarios around a 20%, 30% and 40% savings	20, 30 and 40% levels of reductions were created for the original scope of work in order to create starting points by which strategies could be applied to. While these were

					created as starting points, the subsequent analyses did not adhere to these reference points.
39	Denver Water			An estimate (in acre feet) of reductions since 2000 is not included in this report. To put it on par with the conclusions, an acre foot estimate would be appropriate.	2000 was not the baseline for this report. 2008 was established by the IBCC as the baseline for the SWSI 2010 update.
40	Denver Water			If you add a rough estimate of statewide reductions since 2000 of 220,000 acre feet (this is equivalent to an 18% reduction) to the 615,000 acre feet in the report, the result is 835,000 acre feet. This is far higher than either of the estimates created in SWSI I and SWSI II. This should be stated more clearly in the report. Because this number is so much higher than previous SWSI estimates, we are still uncomfortable with the high scenario.	Comment noted. The analysis includes a 18% reduction since 2000 which is in fact what has been achieved statewide based on *Appendix H - State of Colorado 2050 Municipal and Industrial Water Use Projections.* The report notes that these decreases in water use may be due to a combination of permanent savings from conservation efforts, lingering effects of 2002 drought-related behavioral changes, driven by socio-economic factors, and/or a result of better data.
41	Denver Water			It is impossible to understand how calculations were made. We have tried to re-create the analysis and there is not enough information in the report to arrive at the conclusions.	A copy of the modeling spreadsheet developed for this study is available upon request. In most research documents it is not generally possible to recreate all calculations from the text.
42	Denver Water			The penetration rates are shown as a range in the report but there is a single number for savings. The specific penetration used in the calculation should be shown in the report.	Earlier versions of this document included a single number for penetration rates and it was recommended that a range be used. The water savings estimate represents the best judgment of what savings will actually be achieved and are tied to the lower end of the penetration rate percentages in each of the conservation strategies.
43	Denver Water			There is no discussion about how quickly measures need to be implemented in order to achieve some of the higher penetration rates. This is another point why we are uncomfortable with the high scenario. We believe, in order to achieve some of the penetration rates, these measures would need to be implemented almost immediately.	The strategies discuss the need for rapid and aggressive implementation. All savings are assumed to be achieved linearly over 40 years.
44	Denver Water		41	the indoor/outdoor percentages do not agree with the table on the same page. Our experience is that indoor use comprises about 58% of total demand	It is assumed that the reference is to Table 7 on page 42 which shows the percentage breakdown by customer category derived from available conservation plans. Table 7 governs the savings numbers in the analysis. The text of page 41 refers to general information from conservation plans which was then adapted into Table 7.

						The percentages in the table do not match the discussion exactly because of the inclusion of water loss and because of regional differences by basin. In the Metro Basin the total indoor % used in forecasting was 52.4%, the total outdoor % was 40.5% and water loss was 7.1%.
45	Denver Water			11, 31	an estimate for statewide reductions since 2000 is state as 18%. This number is very misleading because it is a comparison of two years, 2000 and 2008 and may not be representative of pre-drought and post-drought use. If you decide to keep the number in the report, it is important to convert that to a reduction in acre feet.	It is true that these data represent a snapshot in time, but for this report this is the best data available. In order to be consistent with other CWCB reports these years of data were used for this analysis. This is what CWCB is used in the other SWSI sections. The conservation strategies report must remain consistent with other parts of SWSI. The total acre-feet of consumption in 2000 and 2008 is reported in other parts of the SWSI document and is not necessary to repeat in this chapter.
46	Denver Water			64-66	the water loss percentages in the pie charts are inconsistent with percentages stated earlier in the report	Comment noted. Clarifying language added to text. "Whereas in the earlier sections of the report, water loss was represented in relation to total savings (active and passive), the following pie charts represent water loss reductions as a percent of active savings only."
47	Denver Water			36	a figure for passive savings is reported as 19 gpcd. If you use the figures in the report (including the population figure on pg. 44) the per capita savings are 15 gpcd.	The reference to passive savings on page 36 comes from the SWSI levels analysis which differs a little from the passive savings ultimately calculated in the three strategies due to the fact that the range of 19-33 was based on a 2000-2050 timeframe. For the conservation strategies report these ranges are lower due to the fact that the time frame is from 2010-2050.
48	WRA	Drew Beckwith			The impacts of climate change on water demands are not addressed in this report, or any other SWSI update work product. Climate change is projected to cause increased temperatures that will lead to increased irrigation demands in the urban environment. In the face of rising demands, the conservation strategies report needs to push for more aggressive water conservation, at levels greater than currently evaluated.	Climate change is an important consideration; however it was outside the scope of work for this study. It is recommended that future research examine the potential impacts of climate change on water resources in Colorado and its impact on water supplies and the potential need for additional water conservation.

49	WRA	Drew Beckwith			Which Colorado water providers have actually dedicated conserved water to the environment? This is an idea often quoted by water providers, but there is no evidence to suggest any provider has actually used conserved water to improve environmental flows, nor are we aware of Colorado providers with plans to do so. Unless documentation can be found otherwise, the report should reflect what providers actually do with conservation savings.	The report carefully explains that the savings estimates do not account for water providers' individual management decisions regarding what to do with conserved water. Few water providers in Colorado have set out specific uses for conserved water in writing be it in-stream flow, serving new customers, or improving drought reliability. As the science and practice of water conservation matures it is anticipated that more specific information about the uses of conserved water by water utilities will be available to be included in documents such as this.
50	WRA	Drew Beckwith			Regarding the overall challenge of estimating a percentage or quantity of conserved water that could be used to meet new demands, are there no generalizing assumptions that can be made? All of CWCB's work products represent the best-available science at the time of publishing; it seems that the CWCB could make an educated and informed estimate about the amount of conserved water that could be used to meet new demands.	There is little agreement from water providers on percentage of conserved water that could be available to meet new demands under certain circumstance. The authors of the report understand this to be a highly contentious issue for providers at this time. This is an important area for future research.
51	WRA	Drew Beckwith			The WCTAG consists primarily of Front Range water providers, and the conservation savings in this report have been reduced because of their influence. There are nine water utility representatives, several consultants, CO Department of Natural Resources staff, and one conservation organization on the WCTAG. Some providers have a vested interest in decreasing the estimates of conservation potential because they fear this information could influence the rational for building additional water development projects. While many comments provided by utility representatives improved this public draft of the report, the recommendations to reduce the High and Medium conservation strategies were not publically supported by any data or evidence. Unfortunately, the CWCB chose to modify its original savings estimates based upon the input of one stakeholder group on the WCTAG. By contrast, we provide extensive documentation, references, and reasoning for increasing the conservation rates in our other comments submitted on this draft. We hope CWCB uses and an even-handed approach to this report and at least restore the original conservation estimates, if not increase them.	Modifications to the initial conservation strategies and water savings estimates were prepared at the request of CWCB in an effort to achieve a greater degree of consensus on the conservation strategies report. The reductions to the water savings estimates included in subsequent drafts were considerably smaller than what was requested by Denver Water and others. The modifications made to the savings estimates did not impact the overall water conservation strategy developed in this report and are unlikely to impact implementation efforts or levels over the next 20-30 years after which point new and hopefully improved estimates of conservation savings potential will be available.

52	WRA	Drew Beckwith			The purported effects of demand hardening are often an excuse used by water providers for not investing more resources in water conservation. This update provides a well-referenced and thorough explanation of why the excuse of demand hardening is not valid. There is zero published evidence documenting any impacts from demand hardening. With that in mind, this section should be stronger. For example, what about Chesnutt's research suggesting that the importance of demand hardening has been overstated? Or Howe and Goemans memorable quote that ignoring "long-term conservation benefits and to build excess water supply capacity simply to facilitate cutbacks during a drought can be highly uneconomic, akin to overfeeding people so that dieting will be easier"?2 These are relevant points from experienced conservation professionals, and should be included in the section.	This work was outside the scope of work for this project, this is an area for future potential research
53	Conservation Community				water conservation is one of the most important and integral components to ensuring that Colorado will maintain a safe, secure, and sustainable water supply for future generations	Comment Noted
54	Conservation Community				For 2030, the strategies report estimates water savings that are lower (e.g. smaller in magnitude) than the savings estimates developed in either SWSI Phase 1 or Phase 2. This is a step in the wrong direction, considering the importance and practicality of water conservation.	See response for Comment # 1
55	Conservation Community				the High conservation scenario should be greater than the implementation of a moderate conservation plan.	Comment noted. The measures identified as necessary to achieve a high conservation strategy would result in estimated water savings that would exceed that of a water conservation plan that sought to implement measures identified in the medium conservation strategy.
56	Conservation Community				the three conservation strategies in this draft are not aggressive enough	See Response for Comment #1
57	Conservation Community				25 gpcd or lower would be an appropriate level for residential indoor use in the High conservation strategy, considering that greywater reuse – where shower water could be used to flush toilets – has not been considered thus far.	Comment noted. Higher levels of indoor savings may well be achievable through utilization of technologies such as graywater reuse that were beyond the scope of this report. Future studies may choose to include these options.
58	Conservation Community				The High conservation strategy should indicate a 35% reduction in water use for non-residential indoor use, not 30%.	Comment noted. A higher level of non-residential indoor savings may be achievable and these numbers can be adjusted when the State takes this up again in 6 years.
59	Conservation Community				The High conservation strategy should indicate a 35% reduction in water use for residential outdoor use, not 27%.	Comment noted. A higher level of outdoor savings may be achievable and these numbers can be adjusted when the State takes this up again in 6 years.

60	Conservation Community				The High conservation strategy should indicate a 45% reduction in water use for multi-family and nonresidential outdoor use, not 35%.	Comment noted. A higher level of outdoor savings may be achievable and these numbers can be adjusted when the State takes this up again in 6 years.
61	Conservation Community				Water loss in the High conservation strategy should be 4%, not 6%, especially considering that water loss is defined to be real, physical losses of water, not apparent losses.	Comment noted. As more Colorado utilities adopt the AWWA water loss methodology, and the nature of water loss is better understood it is likely that these numbers can be adjusted. That may be part of a future SWSI effort.
62	Conservation Community				Colorado citizens and water rate payers deserve the cheapest, most ecologically friendly water supply, and this report should do more to emphasize the financial benefits of water conservation.	Comment noted. This report has been criticized for being too aggressive and for being not aggressive enough. At this point in time it makes the most sense to adopt a "middle road" where critiques come from both sides.
63	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		The conservation plan does not address the most significant tool that Colorado can use to enhance conservation, and that is to address the state's rate of growth.	The CWCB did not address the state's rate of growth in this report as it is beyond the scope of work.
64	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		Not using modified rates of growth as a variable in demand assumption scenarios is a fatal flaw of this study and should, at least for discussions sake, be added to the document.	Please see *Appendix H - State of Colorado 2050 Municipal and Industrial Water Use Projections* in the larger SWSI 2010 document for a full explanation of population projections and assumptions used in SWSI 2010.
65	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		The report neglects to integrate the projected conservation savings with climate change scenarios to identify potential real benefits.	Climate change is an important consideration; however it was outside the scope of work for this study. It is recommended that future research examine the potential impacts of climate change on water resources in Colorado and its impact on water supplies and the potential need for additional water conservation.
66	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		This report fails to make the linkages to enforce and/or make mandatory water conservations goals through building design, land use patterns, redevelopment standards and landscape requirements.	See Response to Comment #3
67	Pitkin County Board of County Commissioners	Rachel E. Richards			The report further fails to link how conservation efforts will in fact be tied to saving the state's agriculture or improving the natural environment. All savings seem to be headed into new municipal growth, thus hardening demand in out years.	This report specifically focused on municipal and industrial water conservation and did not study the connection between M&I conservation and benefits to agriculture. Additionally, this report did not assign where conservation savings will be used at the local level. Water providers will need to make these decisions based on their integrated water resources planning efforts, consideration of their system's reliability throughout drought periods, impacts of conservation on their return flows and

						availability of reusable supplies, effectiveness of water rates and impacts to their revenue streams, and other local considerations.
68	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		Projecting lower water savings in the report than in SWSI 1 or 2 is a step in the wrong direction.(ENDORSEMENT OF WESTERN RESOURCE ADVOCATES COMMENTS ON WATER CONSERVATION REPORT)	See response to comment #1
69	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		Water conserving technology has improved significantly over the past few years, and this trend will continue. The water savings forecasts should be higher.(ENDORSEMENT OF WESTERN RESOURCE ADVOCATES COMMENTS ON WATER CONSERVATION REPORT)	The report does address this phenomenon and does include a reasonable amount of technology improvement in coming years. In future SWSI revisions, technology will be tracked to determine quantities of savings that can be reasonably obtained.
70	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		The three conservation strategies are not aggressive enough. Multi-billion dollar pipeline projects are being evaluated for the "New Supply" section, equally aggressive water conservation strategies should be considered- including one where conservation can fully meet the gap.(ENDORSEMENT OF WESTERN RESOURCE ADVOCATES COMMENTS ON WATER CONSERVATION REPORT)	See response to Comment #1
71	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		Conservation is by far the lowest cost new water supply option(ENDORSEMENT OF WESTERN RESOURCE ADVOCATES COMMENTS ON WATER CONSERVATION REPORT)	See response to Comment # 48
72	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		Given the potential impacts of climate change, Colorado must start planning for more water conservation, not less(ENDORSEMENT OF WESTERN RESOURCE ADVOCATES COMMENTS ON WATER CONSERVATION REPORT)	Climate change is an important consideration; however it was outside the scope of work for this study. It is recommended that future research examine the potential impacts of climate change on water resources in Colorado and its impact on water supplies and the potential need for additional water conservation.
73	Pitkin County Board of County Commissioners	Rachel E. Richards	Demand Hardening		The demand hardening section in the report is a good, honest description of the state of the science on demand hardening. Don't change a thing or make it even stronger. (ENDORSEMENT OF WESTERN RESOURCE ADVOCATES COMMENTS ON WATER CONSERVATION REPORT)	See response for Comment #52
74	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document		The WCTAG (the technical group tasked with reviewing and editing this document before the public comment period) is stacked with Front Range providers , and this report is weakened because of their influence.(ENDORSEMENT OF WESTERN RESOURCE ADVOCATES COMMENTS ON	Comment noted. At present time, the WCTAG is being expanded to include more West Slope representation.

				WATER CONSERVATION REPORT)	
75	Pitkin County Board of County Commissioners	Rachel E. Richards	entire document	Finally, the extremely short timeframe to provide comments severely limited quality responses. Of special not, there was no presentation of the final draft water conservation plan to the Colorado River Basin 1177 Roundtable in a timeframe which allowed them to fully discuss and make comments as a group. This compressed timeline has reinforced a sense that this is a top-down approach that negates the grassroots/bottom-up approach that the Basin roundtables were intended to embody.	comment noted
76	Northwest Colorado Council of Governments Water Quality/Quantity Committee (QQ)	Shanna Koenig & Lane Wyatt		it is a well researched and comprehensive assessment of opportunities to improve municipal water conservation in Colorado. In particular, we appreciate the recognition you have given to the complex problem of water demands associated with transient populations in resort communities like those in our region	comment noted
77	Northwest Colorado Council of Governments Water Quality/Quantity Committee (QQ)	Shanna Koenig & Lane Wyatt		NWCCOQ/QQ found the M&I Conservation document to be overly cautious in its prescriptions for conservation. We strongly encourage you to consider the detailed recommendations on this matter in the comment letter from Western Resources Advocates. We have reviewed their comments and support their arguments that more aggressive conservation is reasonable.	comment noted
78	Northwest Colorado Council of Governments Water Quality/Quantity Committee (QQ)	Shanna Koenig & Lane Wyatt		An additional concern pertains to the makeup of the Water Conservation Technical Advisory Group [listed on p.15 of the M&I Conservation]. This group consists of multiple Front Range Water Providers, but unfortunately is void of west slope representation. Being that most of the State's water supply is on the western slope, we're not sure why this was overlooked. Clearly the advisory group was made up of entities that have complex conservation plans in place and were therefore able to add a certain level of expertise to the group. While many west slope communities don't have sophisticated water conservation plans in place there are some that have greatly reduced their water demands through diverse conservation efforts. The City of Aspen – through strategies such as stringent conservation requirements in their land use codes, a golf course irrigation efficiency program (that saves 100 million gallons of water per year), an appliance rebate program, and free low flow shower heads, kitchen aerators, low flow spray nozzles – currently uses less water than	Comment noted. At present time, the WCTAG is being expanded to include more West Slope representation.

				they did in 1976 while their population has doubled over that time. We feel having a west slope municipality, such as the City of Aspen that is knowledgeable about water conservation and understands how conservation efforts can help to minimize future transmountain diversions would have added value to the advisory group and overall to the Strategies Report.	
79	Northwest Colorado Council of Governments Water Quality/Quantity Committee (QQ)	Shanna Koenig & Lane Wyatt		QQ also believe the study did not adequately consider the influence of land use planning and development codes to achieve conservation results. We understand the study incorporated water savings based on a slight projected increase in development density statewide, however it fails to consider some level of urban densification as a conservation strategy. The M&I Conservation document cites the savings in outdoor water use associated with the forecast densification of development in Colorado as about 10% (page 54); however that consideration does not find its way into the projected scenarios.	Comment noted. The projection of 10% from densification is included in the outdoor water conservation savings that make up the low, medium and high strategies.
80	Northwest Colorado Council of Governments Water Quality/Quantity Committee (QQ)	Shanna Koenig & Lane Wyatt		Lastly, it's our understanding that reuse is not being considered as a conservation strategy. Currently there are multiple water providers in the state utilizing various levels of reuse strategies, Aurora certainly being the most sophisticated. With new technologies on the rise, reuse will likely become more feasible and cost effective over the next forty years. If reuse is not appropriate in this section of SWSI 2010 then it certainly should be considered in other chapters.	Comment noted. Please see *Section 5 - Consumptive Projects and Methods and the M&I Gap* and *Section 7 - Portfolios and Strategies to Address the M&I Gap in the larger SWSI 2010* document where the issue of re-use is addressed more fully.
81	Northwest Colorado Council of Governments Water Quality/Quantity Committee (QQ)	Shanna Koenig & Lane Wyatt		We think our concerns could most easily be addressed by adjusting the level of conservation achievable in the three scenarios to be more in line with the Western Resource Advocates suggestions.	comment noted
82	City of Greeley	Jim Hall, Water Resources Manager		We are concerned that there is limited discussion of the cost of the water user associated with achieving the conservation saving except for brief comments primarily on page 77. The cost to customers to meet the medium and high strategy could be substantial. The report does present the "utility side" cost for low, medium, and high conservation strategies on page 67. Despite stating these are "utility side" costs, we are concerned that some will misunderstand these "utility side' costs as the total costs of the various strategies when comparing with other supply options.	Please see response to Comment *#10*

			Other supply options may have different or no customer costs. Perhaps the text in this area could be clarified to make clearer that the total costs are not represented and thus cannot be used directly in comparing supply alternatives.	
83	City of Greeley	Jim Hall, Water Resources Manager	The report should address whether the savings of all the strategies will exist even during drought periods.	As this was a conservation strategies report it does not address drought periods. Water conservation savings should exist regardless of drought periods but a future area of research could be the interaction of long range conservation programs and measures and response to drought.
84	City of Greeley	Jim Hall, Water Resources Manager	We are concerned that some may try to use this report as the basis for stating each community should achieve certain savings. This is despite the fact that the report makes clear in several places that these are general results and should not be used for individual utilities as their "potential to conserve differs". We would ask that the CWCB address any attempt to misuse the information in the report since the report is clear on this issue.	Comment noted.
85	City of Greeley	Jim Hall, Water Resources Manager	We are also apprehensive that others will use the report to say that all savings should be used for meeting the "gap". Once again, the report clearly states that no assumptions are made "about the portion of the forecast water savings that should be utilized toward water supply" or drought reserve. Once again, we would ask that the CWCB address any attempt to misuse the information in the report since the report is clear on this issue.	Comment noted.
86	City of Greeley	Jim Hall, Water Resources Manager	We agree that additional research concerning several of the topics listed on pages 75-77 would "improve understanding of water demand patterns, customer behavior, demand hardening and future conservation potential"	Comment noted.
87	Douglas County Water Resource Authority	Mark Shively, Executive Director	The draft is replete with lingo, aimed at participants involved with the technical advisory panel process. Few other people will embrace this draft, so the reach will be limited. If reading the draft proves arduous, people will be pushed away from the conservation conversation. For these reasons, the strategies draft may not move the ball down the field appropriately. As a matter of fact, the draft may even give false hope that Colorado can conserve our way out of our water issues, precluding timely pursuit of prudent actions. This is destructive to addressing the needs of water for current and future residents of	Comment noted.

				Colorado.	
88	Douglas County Water Resource Authority	Mark Shively, Executive Director		A conservation strategies draft should not be restricted to M&I. Conservation programs and techniques should be designed to maximize the preservation of existing water. This draft could be taken out of context to suggest all the state's conservation needs could or should come from M&I. Agricultural interests have undertaken significant effort on determining best efficiencies in their use of water. Trumpet their efforts! In addition, conservation strategies should be expanded beyond M&I to include recreational interests and environmental interests as all of these efficiencies are interrelated. As is, the draft runs the risk of pursuing a "once size fits all" approach, but delivering a "one size fits none" result.	The SWSI 2010 focuses on municipal and industrial conservation only. Future revisions of SWSI may address agricultural conservation, but this was outside the scope of work for this project.
89	Douglas County Water Resource Authority	Mark Shively, Executive Director		By the time all the caveats and variables were defined prior to the core discussion in the strategies draft, one saw clearly there is little value in attempting to forecast these variables 40 years into the future. Estimates are described as technically achievable, but nothing to rely upon. This being the case, additional studies of this nature should be avoided. The funds should be reprogrammed per the recent EPA funded Water Research Foundation's "Water Conservation: Customer Behavior and Effective Communications" which supports funding of education for school-aged children and television ads touting conservation. Ultimately, the public will only adopt what it defines as acceptable. Let's unite to change expectations for what is considered normal water consumption behaviors. Let's spend money collectively to "raise up a child."	Comment noted.
90	Douglas County Water Resource Authority	Mark Shively, Executive Director		Statewide gpcd has decreased by 18% since SWSI Phase I. Offer greater recognition of the considerable efforts that were undertaken to achieve this success. These were never passive efforts and should be heralded, not dismissed, nor taken for granted as something suspect of drought shadow.	See response to Comment #5

91	Douglas County Water Resource Authority	Mark Shively, Executive Director		Climate change is not included in the draft. While some increasingly shrill advocates suggest no new water storage projects should be built due to climate change, the draft suggests more storage will be needed for drought (as differentiated from supply). In order to produce the electricity needed by the state over the next forty years, more storage is definitely needed. However, if the biggest reservoir in the State is not Blue Mesa, but the snowfields on the sides of mountains, and if this snow is converted to water earlier each year, the reservoirs needed to capture the runoff that has been historically held by the snowfields will need to be more numerous, larger, and deeper in order to accommodate the larger runoff events and the longer time needed for storage. We need to pull together to streamline the permitting process and find ways to support and fund these necessary facilities, shrill advocates notwithstanding.	See response to Comment # 48
92	Douglas County Water Resource Authority	Mark Shively, Executive Director		"If fully implemented, SWSI Phase I could meet 80% of the 2020 gap, or 511,800 ac-ft." As is, this is an inflammatory statement. It may scare people, and push them away from water efficiency. Still the strategies draft report points out that even if meeting the 80% gap is technically achievable, the strategies are not implementable because saved water in one geographic area cannot be delivered to gap areas. If implementation is infeasible, why talk about it? Instead talk about something that can be implemented, such as supporting projects to meet the needs of the gap areas. Inefficiency is a very effective strategy in hoarding supplies.	Comment Noted
93	Douglas County Water Resource Authority	Mark Shively, Executive Director		New water is needed for new growth. So long as people keep having children, we need to keep building water projects. Otherwise, when there is drought water supplies will be insufficient, and communities will suffer. Colorado shares a fully appropriated resource, and the new water that is needed for our children and grandchildren should come from efficiency, agriculture, and the environment. A societal goal for human populations is to stay in communities and avoid relocation due to lack of water supply in one area in favor of a more abundant water supply in another area. The amount of conserved water stored for drought protection should be defined. Also in need of definition is the location of the drought reserve i.e. in the blue grass lawn, in the alluvium, in an aquifer, or in a reservoir, or in releases as environmental flows. A discussion of societal costs and societal benefits of each storage choice should be included in the discussion.	The use of conserved water was not defined in this report as water providers will need to make these decisions based on their integrated water resources planning efforts, consideration of their system's reliability throughout drought periods, impacts of conservation on their return flows and availability of reusable supplies, effectiveness of water rates and impacts to their revenue streams, and other local considerations.

94	Douglas County Water Resource Authority	Mark Shively, Executive Director		It is suggested that decreases in gpcd have outpaced the increased rate of population growth because population growth has been greater than forecast in the 1980's and water demands are lower than projected in the 1980s. Linking these two pieces of data to arrive at that conclusion reflects disconnected thinking. A simpler explanation is that the forecasts from the 1980s were incorrect. Current forecasts suggest population will grow from 5.1 million in 2008 to between 8.6 million and 10.5 million in 2050. If these forecasts are as inaccurate as the forecasts used in the 1980s, we could have upwards of 12.1 million people living in Colorado. Simply put, we are guessing how many people will live in Colorado 40 years from now. If the number is higher than forecast, Colorado should be prepared with an answer for the larger population figure.	Please see *Appendix H - State of Colorado 2050 Municipal and Industrial Water Use Projections* of the larger SWSI 2010 document for a full explanation of population projections.
95	Douglas County Water Resource Authority	Mark Shively, Executive Director		The practicality of achieving the low/medium/high numbers of gpcd 142/126/113 should be identified. As an indicator of renewal, energy efficiency retrofits have totaled six million units nationwide in the past thirty years. The call now is for one hundred million units in the next forty years. This indicator shows renewal occurs and should be included as a strategy. By 2050, many of the existing homes in Colorado communities will be over 100 years old, perhaps most. These homes may be torn down as some sort of massive urban renewal project. The economics and environmental impacts of that action should be reviewed. It is the retrofits of the installed housing that is also the part of the iceberg below the water for our efficiency pursuits. Assolutions to that aspect of the issue become apparent, greater efficiency is possible. If both economic and environmental benefits and costs are identified, a decision for the greater good i.e. a new water project or a massive urban renewal effort, or both can be made. Move away from the academic "it's technically possible" exercises to more applied approaches such as "what is implementable?" in order to determine the correct choice. In the future, let's focus time, money, and energy on what is deliverable.	Comment noted.
96	Douglas County Water Resource Authority	Mark Shively, Executive Director		The strategies draft failed to generate a number for how much of the gap can be addressed by conservation. As mentioned previously in item 4, statewide gpcd has decreased by 18%. Set a goal of conserving an additional 15%, and let's saddle up. Once we reach that goal, evaluate what more might be possible with new technologies, new attitudes, or new economies. Strive to be more pragmatic in the near to intermediate term, rather than conjuring numbers that panic partners away from the tasks at hand.	Conservation savings goals and the use of conserved water were not defined in this report as water providers will need to make these decisions based on their integrated water resources planning efforts, consideration of their system's reliability throughout drought periods, impacts of conservation on their return flows and availability of reusable supplies, effectiveness of water rates and impacts to

						their revenue streams, and other local considerations.
97	Douglas County Water Resource Authority	Mark Shively, Executive Director			On pages 20 and 21, the “Demand Hardening” concept appeared to be dismissed. This action appears naïve. Overlooked is the reality that once we are capable of meeting net ET, the next 1% cutback will cause soil moisture to approach permanent wilting point (PWP); the point at which plants die. The plants perish; not just turn brown or shed leaves. The result has a very harsh economic impact due to non-recoverable landscape and the need to fully replace the plants following the PWP event. Also, mention should be made of the salt accumulation from merely meeting net ET. As moisture migrates downward, it dissolves salts and carries the salt it started with into and below the root zone. With limited irrigation, the only dilution is from heavy rains, if and when they occur to fully saturate the root zone resulting in a good probability that the salts will not be flushed. This accumulation over time reduce soils viability. This occurrence in early URBR projects led to massing drain structures to clear the salt out. The process may be slow in urban environments, but it is a looming unintended consequence of outdoor water conservation that should be tackled.	Comment noted.
98	LSPWCD				LSPWCD provided several comments related to the potential effect of water conservation on return flows and water availability in a water-short basin. Through follow-up discussion, LSPWCD provided further explanation that the example provided in its comment letter specifically considers potential reductions in water supply to Cities B and C associated with City A’s return flow reductions when water was “imported” into a water-short basin (e.g. transbasin diversions, non-tributary groundwater pumping, etc.) to meet City A demands. Related LSPWCD comments include 1) As the report outlines, in various situations, conserved water may not be available to meet future needs. The report should also point out that multiple water providers’ existing and future water supplies may yield significantly less water (or be taxed more in certain conditions) due to the increased conservation and reuse efforts of various other water providers within the basin. 2) For reasons stated above LSPWCD disagrees with the automatic reduction in the 2050 statewide water demands by 154,000 ac-ft due to passive water conservation. Passive	Impacts of demand reduction, and associated return flow reduction, by one water provider may negatively impact the supply available to other water providers in certain situations. As stated in the report, this report provides information regarding technical potential for water savings but does not determine how the saved water may be used, which is determined at a local level through integrated water resources planning, including system reliability and drought mitigation planning. While this report does not include a return flow/watershed analysis, currently the CWCB is developing a decision support system (DSS) for the South Platte Basin. The DSS will have a return flow component in its modeling efforts. It may be possible, in the future, to evaluate the impacts of

					water conservation is defined as the natural replacement of toilets, clothes washers, and other standard domestic fixtures (CWCB 2010b). It appears that the use of passive water conservation provides a one for one reduction in water demand, yet in basin water supplies are not reduced due to the impacts on other water providers from passive conservation. 3) In addition, LSPWCD would like to see a recommendation added for future research that basin wide analyses occur statewide to determine the impacts from conservation and reuse on existing and / or future water supplies.	conservation on return flows in the South Platte. Results from this report are integrated into the SWSI planning efforts, and will be incorporated as input to the SWSI assessment tool. This will allow consideration of a variety of future demand and supply scenarios. However, the SWSI assessment tool is intended to be a high level planning tool, where as the CWCB basin DSS' provide more ground level information. Impacts of water conservation on water supply availability must be investigated through a combination of local, regional, and statewide planning efforts. The recommendation for "Regional analysis of future supply needs and conservation potential and water tracking infrastructure" has been updated to provide further clarity. The recommendation for "Improving water demand data" should also assist in further understanding the relationship between water demands and return flows.
99	LSPWCD				LSPWCD agrees with the limitations and constraints of conservation and reuse spelled out by the report and thinks that there are further limitations outlined above. For these reasons, LSPWCD would like to see the impacts of conservation and reuse on statewide and basin wide water supplies added as a key finding and conclusion in the report.	This report provides information regarding technical potential for water savings through demand reduction; however water supplies are considered under other aspects of the SWSI planning process. However, the SWSI assessment tool is intended to be a high level planning tool, where as the CWCB basin DSS' provide more ground level information. The report recommendations for integrated resources planning, with both local and regional consideration, will assist in further understanding potential impacts of water conservation on return flows and water supplies, which can also be further examined with the SWSI assessment tool.
100	LSPWCD				Net benefits from conservation and reuse should be reduced to correspond with the findings of such research. Finally, LSPWCD highly recommends that until such findings are made, CWCB and others should reduce stated benefits from passive conservation (reductions in water demand) by at least 50% statewide. Similar reductions in overall basin wide water supplies should be made for active conservation and water reuse due to losses in overall water supplies from these efforts.	The comment is noted and may be further considered with the SWSI assessment tool.

101	Earth Justice	Greg Speer			The two key defining elements for quality of life in Colorado are our mountains and our rivers. We are very much in anger of losing this second element. We can no longer tolerate business as usual with our approach to managing Colorado's rivers. It is time to break up the ossification that has characterized how we deal with our water issues for so many years. We are way overdue for enlightenment. The dinosaurs must go!	Comment Noted
102		Philip Beranato			How about ELIMINATING the COUNTLESS number of sprinklers surrounding planned developments to water grass bordering the development of which half usually ends up in the streets.	Comment Noted
103		Michael Schubert			No matter how many dams we build or rivers we drain there will never be enough water to sustain Colorado population growth at current water consumption rates. Any strategy to ensure that Colorado has sufficient water for the future must include aggressive water conservation proposals and plans. Colorado has already experienced near catastrophic destruction of many rivers and streams. For instance, I live in Fort Collins and it is heartbreaking to see the Poudre flow through town as nothing more than a trickle incapable of supporting any life for many months of the year. We simply cannot continue to use water at the current per user rates and must identify technologies and incentives to drive water use to lower levels.	Comment Noted
104		Gary Miller			This comment refers to the Colorado's Statewide Water Supply Initiative (SWSI) report. No matter what strategies are adopted for increasing and "firming" water supplies in Colorado, it is unarguable that conserving water will eventually need to be a top priority. With this finite resource, it can be no other way. Therefore, I strongly recommend and request that today's SWSI be a more forward-looking document that gives greater thought and emphasis to the eventuality of conservation and sustainability strategies - strategies that are highly likely to be more cost-effective that the "usual" engineered solutions. Let's have a document that our children and grandchildren will applaud - rather than thinking "What the Heck were they Thinking??".	Comment Noted
105		Kent Vick			Water is more important than fossil fuels!!! Colorado's survival is dependent on water- not gas or oil. Denver should not provide their water to the suburbs. Colorado should not permit new developments unless they use desert landscaping and utilize water savings toilets and showers.	Comment Noted

106		Barbara Crossan			It's been my observation that in good months or years when our average rainfall or snow pack has brought an abundance of water, our conservation rules fly out the window, instead of insisting that everyone keep the habit of practicing good conservation. Again, conservation is the single most effective way to keep our water from being wasted and should be practiced at all times, not just when water is scarce.	Comment Noted
107		Cameron Scott			As a fly-fishing guide and writer who relies on healthy rivers and waterflow in the Roaring Fork Valley, as well as recreation on rivers throughout the state, I urge you to take a good look at the economic engine generated by healthy Colorado rivers.	Comment Noted
108	Earth Justice	Julie McMath			The term "conservation" as used here is not related to the term "conservancy", which is most often used by organizations whose purpose is often aligned with water development projects and watercourse dimunition.	Comment Noted
109		Kevin Jones			My situation: I own property on both sides of the Continental Divide, a home in Golden and a home in Hot Sulphur Springs. My livelihood and business depends on water. I own a tree and technical lawn care company that serves the Denver metro area. And it takes water in order for this type of vegetation to survive. Most of recreational time is spent fishing either in the Colorado River or in reservoirs in Grand County. As such, water is very important to me both for income purposes and recreation. In my travels around the Denver area for work I see, and pay attention to, how we as individuals, communities and cities use landscape plant materials in the urban environment. Of course all of this plant material requires water to live. Possibly the most questionable and potentially wasteful use of water is how line our streets and entrances to neighborhoods with great expanses of Blue grass. These blue grass strips and mini-parks really serve no other purpose than for aesthetics. No one really uses these green areas for anything except for occasionally a place to let their dog defecate or urinate. You never see anyone playing sports there or having a picnic. The only people who are on these areas the most are the lawn mowing crews. My point to this is that we need to look at how we use water and then honestly answer if what we use it for is for the best interests of all. I don't know for sure but if we eliminated all the grass lines streets and neighborhood entrance mini-parks a lot of water could be saved. There are many landscape options available to decorate our street areas. If we just think about and explore all the options and then implement new ideas for any given	Comment Noted

					situation where water is concerned I am certain we could conserve a lot of water.	
110		Brian Eagleson			Why do people feel they need to water their lawns? We live in an arid climate with plants that don't require much water and yet we choose to bring in plants and grass from other areas. We haven't learned from other areas mistakes like Arizona. Arizona used to be a great place to move for allergies but with everyone bringing their plants and trees from other parts of the country the pollen is as bad there as in the places people were trying to get away from.	Comment Noted
111		Ian Pearson			I am a retired hydrogeologist, conservationist and a life-long believer in intelligent and responsible use of natural resources. Through my professional career and private life I've seen how often bad planning (usually as narrowly scoped and piecemeal planning) has led to exhaustion, irreparable damage and degradation of natural resources. It's usually because planners have narrow objectives and use a narrow set of solutions to meet them. Long term consequences and impacts are rarely considered. Moneyed short term interests and 'do it like we've always done it only bigger' approaches also lead to poor outcomes. Please avoid making these mistakes and emphasize conservation in water projects for now and the future.	Comment Noted
112	Earth Justice	Kristi Chapin			I strongly support the water conservation strategies update to Colorado's Statewide Water Supply Initiative (SWSI) report. We can meet our future water needs with conservation and efficiency improvements. Waste not, want not! Thank you for considering my views.	Comment Noted

113		Brandon Clarry			I have one question. What are you going to do when there is no more water to take from the Fraser and other such headwaters? They are close to not having anymore water to spare. So my suggestion is whatever you planned on doing once the water ran out, do that now! Instead of waiting, leave the precious low water levels in the Fraser and other strained headwaters alone and act on the plan as if they didn't exist.	Comment Noted
114		Stephen Pavlick			I've taken steps to reduce my water use significantly, these include low flow shower heads and faucets, efficient toilets, xerascaping, and drip irrigation for my garden. Many of these changes are very inexpensive and I can't even notice them in my day to day life. If little things like this can keep water in Colorado Rivers, they should be encouraged whenever possible and even subsidized. I live in Durango, CO, and one of my favorite features of this City is the Animas River. People love water, it's undeniable.	Comment Noted
115		Ryan Huggins			1) i fully agree with everything TU has said and i'm sure you've gotten plenty of those comments. sucking our rivers dry to feed lawns in denver is OBSCENE. 2) the SWSI report is a valuable planning mechanism and i commend the state on taking big steps towards planning. the CWCB drought studies and climate change studies are also valuable and forward thinking. But the point is what is NOT what can we do to retain the status quo. the status quo is and has always been broken and its what gets us into this shortage in the first place. we need mandated changes to our aesthetic. we simply cant justify widespread environmental havoc for the sake of watering lawns. 3) the SWSI needs to suggest new mechanisms. how to encourage conservation by potentially providing HCU credits that can be sold for using water more efficiently, by placing more emphasis on the environmental review of diversions, not just the balance or who happens to object, more ISF! 4) the Colorado river. is the SWSI showing the need for water a tool for claiming Colorado's full portion of the Colorado River? that would seem logical. but not at the expense of watering golf courses in Colorado. or California or Vegas. all these states need to work together, you need to take initiative to be a leader, and SET CONSERVATION MEASURES THAT MUST BE MET BY EACH STATE BEFORE IT CAN CLAIM MORE WATER FROM THE COLORADO. there are plenty of environmentalist in California that would jump on that band-wagon too. there is no risk in taking that initiative and forcing their politicians to make a stand. surely Arizona politicians cant afford to say	Comment noted

					water efficiency isn't important.	
116		Margaret Levy			I live in Gunnison County, and do not want to see the state put its faith in expensive diversions and other projects as the first way to meet increasing demands. Our summer-time economy increasingly depends on adequate in-stream flows to protect fishing, rafting and boating activities, not to mention the wildlife who need water and who form the basis of our fall hunting season economy. Crippling our economic health to serve Front-Range lawns is a terrible solution when conservation and efficiency can be a win-win for the whole state. Conservation and efficiency are much easier and much less expensive ways to address the problems.	Comment Noted
117		Stephen Chuckra			Hello, My name is Stephen Chuckra, I firmly believe Colorado needs to engage in forward looking (sustainable water use) in order to preserve its water resources. Currently the Colorado River is a text book example of unsustainable water utilization yet politicians and developers continually seek to divert more water from a resouuce that already supplies 64% of its native stream flow for Front Range water use. The Colorado river is only one example of many poorly adopted water stratagies that aim at providing non sustainable development growth on the Front Range.	Comment Noted
118	Earth Justice	Timothy McGovern			As an avid outdoors person, I've had many opportunities to enjoy the rivers and adjoining riverine areas throughout Colorado. I constantlyremind myself not to take these wonderful natural resources for granted, and I certainly do my part in conserving, protecting, and enjoying them.	Comment Noted

119	Earth Justice	Delia Malone			As an ecologist who lives in the Roaring Fork Watershed on the Crystal River I place tremendous value on the naturally free-flowing water in our rivers and the native fishery that these waters support. Conserving water for wildlife has inherent value and keeping sufficient water in our rivers to sustain that wildlife is an essential to maintaining our natural heritage.	Comment Noted
120	Earth Justice	Christine Dildine			I am VERY DISAPPOINTED that the State has NOT fully acknowledged the potential of water conservation in this draft report. We have a creek on our property that provides an important riparian habitat for countless species. Water is a finite resource that must be conserved. A free-flowing river is priceless!	Please see response for Comment #1
121		Mikel Tennant			The Fraser river is not healthy! It is dirty and smells bad at times. Please promote conservation, do people really need front yards of grass, at least mandate something to mitigate the wasting of our most precious resorce. I am begging you.	Comment Noted
122		Thad Miller			I am constantly in awe of how irresponsible people are with water in our part of the country. I firmly believe that we need to make sure that people make a responsible choice where water is concerned. If the residents of Colorado are not able to see and make this choice for themselves, then our leaders need to encourage this choice through increased fees or caps on water use per capita and not through stealing more water from the ecosystems that require it to survive.	Comment Noted
123	Earth Justice	Jake Hodie			So many of our waters have already been ruined by development, drilling, pollution, and man! Enough is enough! Our waters, wilderness, forests. and public lands are under threat from so many angles. They desperately need to be protected. Our waters are supposed to be a place of peace and quiet, for us and for the animals who live there. PLEASE let our public lands stay as beautiful and peaceful as Mother Nature intended!! Their future is in your hands! PLEASE help save our waters for ALL future generations!!	Comment Noted
124		Jeff Faucette			This seems very obvious to me. Robing Peter to pay Paul makes no sense when it comes to water. Instead, EVERYONE should be responsible for conservation of this resource.	Comment Noted

125	Winter Park Ranch Water and Sanitation District	Thomas Kalan			I am on the board of directors of the Winter Park Ranch Water and Sanitation District. I have received a disturbing letter from Colorado Environmental Coalition about the draft report prepared by the Colorado Water Conservation Board. You have by now heard about various reasons why citizens on the West Slope are not happy with the report. One would think that the Colorado Water Conservation Board is in the business of conserving water, but this does not seem to be the case. I agree with the objections, and I would like to emphasize that the lack of water conservation along the Front Range is for me the most glaring deficiency in any discussion of water use in Colorado. According to surveys, more than 50% of single family residential water use in the Front Range is for outdoor lawn watering. This is a completely unacceptable situation. While rivers, such as Fraser River, the 3rd most endangered river in the United States, are to be drained even further, the residents in the Front Range are allowed to water their non-native grasses at will. As long as more stringent conservation measures are not imposed on this wasteful use of water in our semi-arid climate, I stand with the rest of the concerned citizens in demanding a meaningful conservation policy from the Colorado Water Conservation Board.	Comment Noted
126	Earth Justice	Jan Peterson			The water conservation strategies update to Colorado's Statewide Water Supply Initiative (SWSI) report presents an opportunity for our state to think critically about the way we use water and to develop a framework to transition towards more sustainable solutions for meeting future water needs, especially since global warming is projected to reduce snowpack in the Rockies in coming decades. Given the importance of our rivers, which are and will continue to be targeted by new water development projects and declining recharge from snowpack.	Comment Noted
127	Earth Justice	Donna Bonetti			For instance the Front Range should become an area where watering of lawns is restricted. Xeroscape gardening should be mandated or strongly encouraged. Showers at public recreation centers can have shut-off timers and people can be encouraged to take "Navy showers" there and at home. I see water wasted everywhere I go and most of it is due to a lack of public awareness.	Comment Noted
128		Peg Thompson			Recently I drove to Vail and home through Leadville. Every stream I saw was alarmingly low--many of them controlled by dams. This worries me both as an angler and as one who love Colorado and all the creatures that depend on water. I cannot understand why we keep taking water from wildlife while we fail to institute stringent conservation measure on the Front Range.	Comment Noted

129	Earth Justice	Barb Shaw			I and my grandchildren support your considered investigation of sustainable water use in Colorado. The reason-based points are listed below, but bottom line is that our water is not unlimited, and at some point the FRONT RANGE needs to SLOW DEVELOPMENT while its cities and counties implement significant water use reduction and water recycling and reuse projects.	Comment Noted
130		Fred Rasmussen			Times are past when urban areas do not have to face the facts that their water uses in this dry climate are inappropriate and extravagant and destroying our west slope rivers. Every water bill should have photos of dried up creeks and rivers caused by them. The true costs of water, mitigation of abused native waters, should be a parts of their water bills. GROWTH that mantra of Front Range land owners and businesses should have to pay UP FRONT for any and all water demands that are created before an ounce of concrete is poured.	Comment Noted
131		Robert Getz			I have lived in Colorado for 25 years. The resources we share stewardship for are among the most beautiful in the country while also sustaining more people than some other national treasures. I would hope that you sense the need for foresight and do as much as possible to encourage HOAs and communities to sponsor Xeriscape, low volume toilets, High efficiency washers and dish washers, and water conservation measures. We have implemented these along with new-design lighting and heating, and we have seen our consumption decrease along with our utility bills. Drive through our neighborhoods and see concrete and asphalt being watered, see sprinklers running daily in what should be a crime while ecosystems are drying up and leaving future generations with a questionable future. The history of lawns in America is tied to royalty. At one time the picket fence and the Victory Garden were the norm compared to the highly over-watered lawns we see today. Of all the rhetoric in government, conservation is one topic we can all support and realize great benefits from. I urge you to support water and energy conservation today so we have a future tomorrow. We could entertain a far more detailed conversation regarding specific watersheds, programs, government involvement, and more. I am open to discussion and involvement in public forums.	Comment Noted

132		George Sievers			I own a small farm in SW Colorado. I have stock on my property and raise hay. I am very concerned in the conservative use of water in this state. From my experience both rural and city dwellers waste water. As our population grows so do the demands on our finite supply of water. I believe it is incumbent on all users of water but especially entities that make water policy to encourage the best conservation practices. Please consider approving measures that will enhance conservation of our limited water in Colorado.	Comment Noted
133	Earth Justice	Richard Creswell			Don't let the rivers in our state become like the mouth of the Colorado in Mexico.	Comment Noted
134	Earth Justice	Betty Armstead			With todays growing population, much of our natural resources are being sacrificed. This is not sommething we can keep doing. Colorado rivers must keep flowing.	Comment Noted
135	Earth Justice	William Butler			It took Nature about 5 million years to create the river systems of Colorado. There is no price tag for the value of such an important asset. Do the right thing environmentally and protect this resource.	Comment Noted
136	Earth Justice	Kurt Newton			When I first came to Colorado over 40 years ago I was told a joke about water in Colorado. "An old rancher said "Don't mess with my wife or my water and not necessarily in that order!" Water is and will be very important. In addition to the above issues we must address the millions of gallons of water that are removed from the earth DAILY by the natural gas industry as a WASTE PRODUCT! Some day we will pay a price for the depletion of this ground water! We should at least be making better use of this resource than spraying it on gravel roads! The gas companies will tell you they do it as a public service to reduce the dust on the roads! BULL----! They do it to get rid of the water because they have to much to deal with! And as the water then evaporates we are left with the salts, metals and minerals to contaminate the dust we breath from these roads! Thank you for your attention to our water!!	Comment Noted
137		Marilyn Hunter			I have lived both on the front range of Colorado and in Grand County and have personally seen both the waste of water in the Denver metropolitan area as well as the diminishing water in the mountains as it is diverted to the front range.	Comment Noted
138	Earth Justice	Charles Goff			I am a Ph.D. biologist who lives near Salida, in the Upper Arkansas River watershed. We have an energy-efficient home, and are supportive of measures that help to ensure a sustainable future for all Coloradans	Comment Noted

139		Dennis Buechler			One of your most important charges as a Board is to promote water conservation in this state. Please take immediate strong steps to initiate a dramatic change in how our residents, particularly along the Front Range, perceive their conservation responsibilities and opportunities. It is only a matter of time before we have do it anyway so why not start now rather than wait for a crisis? The Statewide Water Supply Initiative provides a great avenue to demonstrate your critical leadership in this effort. Good conscience would seem to dictate that these steps be initiated before you approve any new water storage projects that involve transferrring water from the west slope to the Front Range. During the drought of 2002 the Denver Water Board demonstrated that significant steps can be taken without causing major problems for their clients. In fact, the many opportunities that they identifed in their long range water conservation plans were not even fully employed. Yet they met essential water needs utilizing their existing system and achieved water conservatin goals years ahead of schedule. They need to fully employ all of the practical measures before proceeding to enlarge Gross Reservoir, and the rest of the Front Range needs to follow their leadership. Other communities in the west have taken bold and effective steps. For example, I believe Phoenix offered homeowners about $1.50 a square foot to convert bluegrass turf into xerascaping. This makes a lot more sense and would be more economical in the long run than building more dams. We also should be following Denver Water Board's intial efforts to recycle our waste water as much as possible. It is overdue for us to take dramatic new steps for water conservation. I hope you are one of the major players now and in the future.	Comment Noted
140	Earth Justice	Claire Carren			I am an avid whitewater kayaker and rafter and care very much about our state's beautiful rivers, especially our local river the "Poudre". I am also a parent thinking about my daughter and her generation's future.	Comment Noted

141	Earth Justice	Pat Musick			I am a native of Colorado; grew up in the ari\dity of 15 inches of rain a year. I've lived in moist climates (Pacific Northwest, British Isles) and now live in Colorado again. I've wtinessed the growth of population in Colorado; I've witnessed changes in rivers via water development projects and the gradual draining of ancient aquifers faster than they can replenish themselves. The only sustainable answer to water needs is conservation. Possibly the greatest asset of Colorado is our natural environemnt--headwaters to so many rivers, outdoor recreation, wildlife, national forests. Water develoopment projects that would affect our rivers would have a cascading effect in, essentially, "killing the goose that lays the golden eggs,". By landscaping with native and arid-climagte plants, I rarely need to water my yard at all. This is one small way that saves enormously on water use in just one household--a practice whose effects, multiplied would save thousands and thousands of acre-feet of water just by itself. There are many other water-conservation strategies that can make unnecessary the development of river-draining water projects.	Comment Noted
142	Earth Justice	Phillip Notz			Please don't sell our children's future. People have visited Colorado and moved here from New York, California, Texas and the Midwest because of the vast amounts of undeveloped natural beauty. We don't need a change for the worse.	Comment Noted
143	Earth Justice	Dave Gardner			In addressing long-term water needs and strategies, the state of Colorado needs to treat population projections not as a fait accompli. Knowing the limitations of our water resource, Colorado has no business doubling its current population - over any time period. Such population growth is not inevitable. It will happen only if the state and its communities continue to pursue economic development strategies that subsidize migration to the state. The strategies focus on attracting business (and in the bargain, population) to the state. The subsidies include economic development incentives, ad campaigns and junkets, but more importantly they include massive water projects - the cost of which is never completely passed on to the new residences and businesses requiring that water. This must change.	Comment Noted
144	Earth Justice	Ginny Griffin			Replacing greedy grass lawns with xeriscaping. And not approving development projects unless there truly is "wet" water available.	Comment Noted

145	Earth Justice	Ken Connell			I live at a 64-acre seniors facility that has a greenbelt of evergreens around the perimeter of the property. We installed a drip system to conserve and accurately direct water applications to maintain over 500 trees with considerable success and substantial savings in water consumption. Show us the way and provide appropriate incentives, and many people and organizations will adopt robust conservation approaches.	Comment Noted
146	Earth Justice	S.K. Baker			We must conserve water or the future generations will no longer have water. We must turn to xeriscaping methods instead of huge green blue grass lawns with the water running down the streets. We must also conserve water so the farmers can farm and we can have more local produce.	Comment Noted
147		Don Thompson			Unless you start to discuss population growth and the impacts from additional users of water in Colorado, there is no way that we can look forward to a sustainable water supply. It is past time to educate the water community to the dead end that population growth means to water availability.	Comment Noted
148		Lige Brown			It continues to baffle me that these letters are needed when the results of wasting water seem to be self evident.	Comment Noted
149		Murlin Goeken			Making more water available is only going to continue the obserd population growth of Colorado.	Comment Noted
150		Richard Andrews			I am a farmer and am concerned with the future agriculture in Colorado which is absolutely dependent on a reliable water supply, as well as protecting our natural environment. I am also a strong supporter of maintaining stream flows for aquatic life and recreational uses of our streams. Urban uses of water must be controlled and even reduced. Agricultural users need to be more efficient also.	Comment Noted
151		Kirk Klancke			Conservation of water is a far less expensive alternative and has developed large ammounts of water in other western municipalities like Las Vegas and Pheonix.	Comment Noted
152	Save the Poudre: Poudre Waterkeeper	Gary Wockner			Please provide a scientific explnation as to why the CWCB changed the conservation savings potential numbers from the first draft to the second.	See response to Comment # 51
PLEASE NOTE: All individuals listed below this line signed onto a form letter. The following immediate five comments were made by each of the individuals listed below as added language to the form letter.						
153	Earth Justice	Greg Speer			The conservation strategies offered in this report are insufficient. Efficiency and a greater emphasis on conservation could clearly play a much larger role in helping meet our future water needs than is	See response to Comment #2

					suggested in the report.	
154		Philip Beranato			water conservation technology has improved significantly over the past few years, and this trend will continue. Why is the State projecting lower water savings in this report than in either of the previous two SWSI efforts? This is a step in the wrong direction; water savings forecasts should be higher now that technology has advanced.	See response to Comment #1
155		Michael Schubert			I am concerned the "technical group" that was charged with reviewing and editing this document before public comment is imbalanced and stacked with Water Providers who stand to benefit from lower conservation estimates.	See response to Comment #16
156		Gary Miller			The conservation savings estimates in this draft of the update are lower than in previous versions specifically for the "medium" and "high" water conservation strategies. Could you provide an explanation as to why the Colorado Water Conservation Board changed these estimates?	See response to Comment # 51
157		Kent Vick			The demand hardening section in the report is a good, honest description of the state of the science on demand hardening, make it even stronger.	See response to Comment # 52
	Organization	**Signatory**	**Organization**	**Signatory**	**Organization**	**Signatory**
		Barbara Crossan		Stan Hayes	Earth Justice	James Potter
		Cameron Scott	Earth Justice	Naomi Richard	Earth Justice	Judith Falco
	Earth Justice	Julie McMath	Earth Justice	Kathleen Kubinak	Earth Justice	Michael Cook
		Kevin Jones	Earth Justice	Jeanne Tyler	Earth Justice	John Lemmon
		Brian Eagleson		Willis McCarty	Earth Justice	Jennifer Barbour
		Ian Pearson	Earth Justice	Mark Serour	Earth Justice	Bruch Pech
	Earth Justice	Kristi Chapin	Earth Justice	Chris Goodwin	Earth Justice	Ricardo Corrales
		Brandon Clarry	Earth Justice	Doug & Jan Parker	Earth Justice	Susan Taylor
		Stephen Pavlick	Earth Justice	Jill Biedka	Earth Justice	Sandra M. Zwingleberg
		Ryan Huggins	Earth Justice	Fred Inman	Earth Justice	Tracy Rodgers
		Margaret Levy	Earth Justice	Ward Ranson	Earth Justice	Cindy Reynolds
		Stephen Chuckra		Juan Ramirez	Earth Justice	Amie Kings
	Earth Justice	Timothy McGovern		Julie Church	Earth Justice	Myrna Castaline
	Earth Justice	Delia Malone		Eric Blackwell	Earth Justice	Robert Liedike
	Earth Justice	Christine Dildine		Tom Parr	Earth Justice	Paul Hartig
		Mikel Tennant	Earth Justice	Jene' Starr		Jill Suffin
		Thad Miller	Earth Justice	Kenan Edmiston	Earth Justice	Dulcey Simpkins
	Earth Justice	Jake Hodie	Earth Justice	Michael Neil	Earth Justice	Steve Harding
		Jeff Faucette	Earth Justice	Nancy White	Earth Justice	E Wichern

	Winter Park Ranch Water and Sanitation District	Thomas Kalan	Earth Justice	Mike Turner	Earth Justice	Angelina Maio
	Earth Justice	Jan Peterson	Earth Justice	T Piker	Earth Justice	Kathy Durrum
	Earth Justice	Donna Bonetti	Earth Justice	Dick Gray	Earth Justice	Milada Lee
		Peg Thompson		James Hughes	Earth Justice	Robert Moore
	Earth Justice	Barb Shaw		Sue Plecity	Earth Justice	Hazel McCoy
		Fred Rasmussen		Martha W D Bushnell	Earth Justice	Bruce Stotts
		Robert Getz		Tim Moret	Earth Justice	Susan Ross
		George Sievers		Marge Vorndam	Earth Justice	Donna Plutschuck
	Earth Justice	Richard Creswell		Joseph Montoya	Earth Justice	Ara Cruz
	Earth Justice	Betty Armstead	Earth Justice	Sharon Balzano	Earth Justice	Beth Williamson
	Earth Justice	William Butler	Earth Justice	Patricia Youngson	Earth Justice	Holly Petitt
	Earth Justice	Kurt Newton	Earth Justice	Ania Serafin	Earth Justice	Rita Falsetto
		Marilyn Hunter	Earth Justice	Frank Taylor	Earth Justice	Melissa Crutcher
	Earth Justice	Charles Goff	Earth Justice	LaRoy & Mary Seaver	Earth Justice	Deborah Streufert
		Dennis Buechler	Earth Justice	Sonya Yeager-Meeks	Earth Justice	Ambrey Nichols
	Earth Justice	Claire Carren	Earth Justice	Ellen Sassano	Earth Justice	Vicki Ulibarri
	Earth Justice	Pat Musick	Earth Justice	Janeene Porcher	Earth Justice	Jennifer Russell
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	Earth Justice	Dave Gardner	Earth Justice	Jason Monroe	Earth Justice	Derek Koloditch
	Earth Justice	Ginny Griffin	Earth Justice	Martin Vuerhard	Earth Justice	James Thrailkill
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		Don Thompson	Earth Justice	Ron Courson	Earth Justice	Kim Cavanagh
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		Murlin Goeken	Earth Justice	Katherine Kautz	Earth Justice	Wayne Andrews
		Richard Andrews	Earth Justice	Nancy Groswold	Earth Justice	Stephanie Ray
		Kirk Klancke		Gary Mierau	Earth Justice	Zbyslaw Owczarczyk
		John Orr		Amissa Kitzberger	Earth Justice	D. Scott Lorenz
		Eric Tscherter		Jamie Lindsay	Earth Justice	Lois K Vanderkooi
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	Earth Justice	Martha W D Bushnell	Earth Justice	Christine Boisse		Kathleen Turnbull
		Alex Zipp	Earth Justice	Ginger Ikeda	Earth Justice	Kay Hawklee
		Michael Garner	Earth Justice	Denise Walters	Earth Justice	Paul Barlin
	Earth Justice	D Lyons		Ian Havlick	Earth Justice	Tanya Bergstrom
		Mike		Tom Sykes	Earth Justice	Michelle Ku

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	Earth Justice	Chris Cox		Rick Hammel	Earth Justice	Erica Burr
		Ben Furimsky		Hans Rohner	Earth Justice	Katey Buster
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	Earth Justice	Lauren Winn-Dallmer		Kimberley Sweitzer	Earth Justice	Sheryn Olson
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		Gary Okizaki		Michael Miller	Earth Justice	Julius Lisi
		Kimberly Brenon		Barbara Venezia	Earth Justice	Nadyne Orloff
	Earth Justice	Michael Johnson		Liam Doran	Earth Justice	Nancy Dunavan
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	Earth Justice	Marnie Gaede	Earth Justice	Mark Shinkle		Jennifer Giacomini
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	Earth Justice	Bonnie Mandell-Rice	Earth Justice	Todd Vandegrift	Earth Justice	Eileen Skahill
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		Dave Hernden		Kerala Rush	Earth Justice	Damon Copeland
	Earth Justice	Dolores Heath		Carol Etheridge	Earth Justice	Mark Trumbull
	Earth Justice	Monya McCoy		Larry Smith	Earth Justice	Bill Rivers
		Greg Yording		Bryan Williams	Earth Justice	Susan Peirce
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	Earth Justice	Ray Bernhardt		Matthew McMeeking	Earth Justice	Leslie McCutchen
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		Steve MacDonald	Earth Justice	Elaine Howes	Earth Justice	David Harris
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	Earth Justice	Andreia Shotwell		Michael Eisenhauer	Earth Justice	Diane Argenzio
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		Tim Trunnell		Charles Gilman	Earth Justice	Elaine Gates
		Duff Lacy		William Gedeon	Earth Justice	Zsolt Esztergomy
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		Douglas Dunkle		Patricia Good	Earth Justice	Laurie McLean
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	Earth Justice	Jonathan Augello		David Feasby	Earth Justice	Chris LeHouillier
	Earth Justice	Chad Bowers		Colbert Cushing	Earth Justice	Teresa Finnell
	Earth Justice	Steven Tempelman		Jeffrey Thompson	Earth Justice	Audrey Franklin
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	Earth Justice	Kathleen Doyle		Mike Malec	Earth Justice	Anne-Marie Mokritsky-Martin
		David Berry		Rice Reavis	Earth Justice	Michael Allen
		Chad Bowers		Stephen Thrapp	Earth Justice	Barbara Harvey
	Earth Justice	Cheri Jo	Earth Justice	Trish Chaney		Patricia Buchanan
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	Earth Justice	Geoff Bommolaere	Earth Justice	Kristyn MacPhail		Ross Kelman
	Earth Justice	Lisa Yowell	Earth Justice	Victor Arosemena		Michael Rees
	Earth Justice	Jan Kochmeister	Earth Justice	Faith Conroy		Rebecca Richman
		Gregory	Earth Justice	Casey Hearne		Lawrence Crowley

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	Earth Justice	Lee L'Enfant	Earth Justice	Zach Moore		Neal Misbach
	Earth Justice	Paula Hansen	Earth Justice	Jim Kennison		Tom Jackson
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	Earth Justice	Peter Hackett	Earth Justice	Sarah Smoot		Barbara Kauffman
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	Earth Justice	Mark Quire	Earth Justice	James Hardy		Richard Murray
		Thomas Vargish	Earth Justice	Sarah Chamberlain		Laurie Laurie Lakin
		Jim Oelsner	Earth Justice	Sara Avery		Chris Menges
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	Earth Justice	Kamla Presswalla	Earth Justice	Doreen Petersen		Rob Zillioux
	Earth Justice	Thomas Jones	Earth Justice	Gary Hewitt		Laine Ludwig
		Scott Leach	Earth Justice	Georgia Mattingly	Earth Justice	Shirley Hao
	Earth Justice	Nancy York	Earth Justice	Kathryn Dumm		Kathy Ryan
		Barbara Hart	Earth Justice	Cindy Massey		Karen Lampke
		Carolyn Dickerson	Earth Justice	Will Roush		Beth Crumbaker
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		Jim Henriksen	Earth Justice	Michael Bloch		L. Shaffer
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	Earth Justice	Virginia Lippert	Earth Justice	Darrick Christodaro		Benjamin Lenth
		M Looper	Earth Justice	E. B. Zukoski		Sam Asseff
		Shawn Morrissey	Earth Justice	Dawn Byford		Diane Curlette
		James Scoggins	Earth Justice	Will Spangler		Courtney Bennett
		Jay Weaver	Earth Justice	Kelly Lyon		Todd Hill
	Earth Justice	Diana Keyser	Earth Justice	Clee Sealing		Kira Deupree
	Earth Justice	Keith Wilkinson	Earth Justice	Tim Lippert		John Cornely
		Jeff McPherson	Earth Justice	Eric Polczynski		Joshua Schnabel

	Earth Justice	Geoffrey Bruce	Earth Justice	John Saccardi		Kevin McGraw
		Bill Langley	Earth Justice	Mindy Eckhardt		Michael McManus
	Earth Justice	Eric Rickord	Earth Justice	Russ Bonny		Donna Gilmore
	Earth Justice	Linda Falk	Earth Justice	Carla Behrens		
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	Earth Justice	Chuck Clark	Earth Justice	Steven Saiz		
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	Earth Justice	Nada Djokic	Earth Justice	George Smyser		
	Earth Justice	Paul Amend	Earth Justice	Amanda Wilkinson		
	Earth Justice	Peg LeClair	Earth Justice	June Maddock		
	Earth Justice	Sarah Waterson	Earth Justice	Natalie Anderson		
		Claudia Strijek	Earth Justice	Deborah Brush		
		Kurt Olesek	Earth Justice	Agustin Goba		
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		Newton Logan	Earth Justice	Linda Levy		
		Wilford Reynolds	Earth Justice	Susan Gemmill		
	Earth Justice	Corinda Gray	Earth Justice	Terri Stewart		
	Earth Justice	Beverly Baker	Earth Justice	Davin Cain		
		Tom Sodoro	Earth Justice	Paul Adams		

		Ron Thompson	Earth Justice	Megan Faber		
	Earth Justice	Elizabeth Phillips	Earth Justice	Elizabeth Kelson		
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	Earth Justice	Mary Ferraro	Earth Justice	Dawn Robinson		
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	Earth Justice	The Wojciechowski's	Earth Justice	Jennifer Stewart		
	Earth Justice	Margaret Donharl	Earth Justice	Elizabeth Corley		
	Earth Justice	James Button	Earth Justice	Lori Fortier		
	Earth Justice	Enid Brodsky	Earth Justice	Rick Marchesani		
	Earth Justice	Kimberly Myhre	Earth Justice	Rick Nepomnick		
	Earth Justice	Margaret Stefanick	Earth Justice	William Rosenthal		
	Earth Justice	Paul Leming	Earth Justice	Ronald Gordon		
		Ben Griffith	Earth Justice	Robert Jackman		
		Juan Pablo Parodi	Earth Justice	Mark Cohen		
		David Dunn	Earth Justice	Art Wahl		
		C Gordon Shaffer	Earth Justice	Shelly Young		

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