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Section 3 – Municipal and Industrial Water Conservation Strategies

Municipal water conservation is an essential component of Colorado’s strategy to provide a safe, secure, and sustainable water supply for future generations. This section represents the latest effort by the Colorado Water Conservation Board (CWCB) to integrate water conservation into overall water supply planning and to estimate the water conservation potential that exists in the State up to 2050.

The CWCB defines meaningful water conservation as those measures and programs that provide for measurable and verifiable permanent water savings – which may include measures and programs that are being implemented for political reasons and/or to improve customer satisfaction (CWCB 2010b). 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 Interbasin Compact Committee (IBCC) and other water conservation efforts throughout the state, the CWCB Office of Water Conservation and Drought Planning (OWCDP) has developed several work products which provide technical detail related to water conservation planning. The purpose of this section is to:

- Incorporate previous water conservation-related efforts into the Statewide Water Supply Initiative (SWSI) resources,
- Update the SWSI Phase 2 water conservation savings and penetration rates, and
- Provide water conservation strategies that may contribute toward meeting the projected 2050 water supply gap¹ and addressing Colorado’s future municipal and industrial (M&I) water needs².

The information in this section was prepared for the CWCB by Aquacraft, Inc. and Headwaters Corporation. The approach and results were presented to and reviewed by the OWCDP’s Water Conservation Technical Advisory Group, which includes the following members representing a broad group of water professionals with technical and institutional experience related to water conservation and management:

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

¹ The “gap” is defined as the difference between future statewide water demands and the combination of current water supplies and identified projects and processes (IPPs) which will serve to increase the future available water supply.

² Previous SWSI efforts also included water demands associated with Self Supplied Industrial (SSI) users – large industrial users that have their own water supplies or lease raw water form others. This update includes only the M&I demands associated with a typical municipal system.

SWSI 2010 Update – M&I Water Conservation Strategy
This process was invaluable toward improving the technical content and recommendations developed under this effort.

The information provided in this section is intended to facilitate discussions between the CWCB Board, IBCC, Basin Roundtables, and others as they consider how water conservation can be utilized to help provide sufficient water for future generation of Coloradoans. Water conservation and demand management are key components of all strategies under consideration to meet future urban water needs. Building upon past efforts, this update provides additional clarification and validation to incorporate the best currently available data.

3.1 Water Conservation Strategies Overview

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

- **Statewide Water Supply Initiative – Phase 1 (SWSI 1)** (CWCB 2004)
- **Colorado’s Water Supply Future Statewide Water Supply Initiative – Phase 2 (SWSI 2)** (CWCB 2007a)
- **State of Colorado 2050 Municipal and Industrial Water Use Projections** (CWCB 2009b)
- **SWSI Water Conservation Levels Analysis (SWSI Levels)** (CWCB 2010b)
- **Guidebook of Best Practices for Municipal Water Conservation in Colorado** (CWW 2010)

This section 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 targets. Conservation savings estimates disaggregated into potential program measures based upon the 2010 Guidebook of Best Practices for Municipal Water Conservation in Colorado (CWW 2010) are presented and an update to the SWSI Phase 2 conservation matrix is provided.

Several fundamental concepts applied in this section are discussed below.

SWSI 2010 Update – M&I Water Conservation Strategy
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 fully implemented in a timely manner.

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 an average basin-wide estimate. 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.

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 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 section are not necessary, fully achievable, or might not result in a direct net water savings.

As with previous SWSI planning efforts, the water savings projections presented in this section 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 is not intended to replace water conservation planning and projections prepared by local entities. As better information and data become available, the potential savings and water conservation strategies presented in this section may be updated, building on the analysis framework provided below.

3.2 The Current Status of M&I Water Conservation in Colorado
A substantial amount 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.

3.2.1 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,
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).
Population Data and Baseline Water Demand Estimates

Multiple levels of future water conservation activities have been considered, and different “baseline” water demand projections have been developed by the CWCB throughout the various efforts supporting SWSI. For this project, the word “baseline” represents either a current or forecasted water demand that has been estimated using “current” water use rates. The water demand forecasts first apply the current rate of use, reflecting current passive⁴ and active water conservation activities, to develop a future “baseline” that does not embed additional water conservation potential. The potential savings from additional water conservation are subtracted from the forecasted baseline, to provide an estimate of the future demand with additional water conservation activities. With this method, a baseline projection does not include impacts of potential additional future water conservation efforts.

For SWSI Phase 2, year 2000 reconnaissance-level M&I water use rates⁴ were multiplied by year 2000 county population data to develop a year 2000 baseline water demand for each county:

\[ \text{Baseline Demand}_{2000} = \text{Population}_{2000} \times \text{GPCD}_{2000} \]

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

\[ \text{Baseline Demand}_{2030} = \text{Population}_{2030} \times \text{GPCD}_{2000} \]

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:

\[ \text{Conservation Demand}_{2030} = (\text{Population}_{2030} \times \text{GPCD}_{2000}) \times (1 - \% \text{Savings}_{2030}) \]

As noted in SWSI Phase 1, with this approach, a higher per capita water use rate does not necessarily indicate less efficient use, nor does a lower water use rate necessarily imply more efficient use (e.g.

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³ SWSI Phase 1 (CWCB 2004) first defined the “passive” or naturally-occurring water conservation savings from impacts of plumbing codes, ordinances, and standards to improve efficiency as “Level 1” conservation. These savings generally result from new construction, remodeled buildings, and landscaping ordinances and are referred to as “passive” because they result from activities that are not funded or implemented by water utility programs. The “active” savings result from utility-sponsored water conservation programs.

⁴ 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, they may not represent the total demand to the extent that some of uses are supplied by non-municipal sources such as private wells or ditch rights.
tourism and commercial uses represented in the water use data but not in census population data result in increased per capita demands).

### 3.2.2 SWSI Phase 1 Findings

The first phase of SWSI 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 (Table8-1, CWCB 2004). This information was further refined in SWSI Phase 2, as discussed in subsequent sections below.

*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\(^5\). 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, 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 1, 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 6%), by the end of the 30-year planning

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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), 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 1, 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. 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%. However, 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.

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 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, the active water conservation Levels 2 through 5 were projected to achieve between 170,533 AFY to 699,183 AFY (these are total savings including the 101,900 AFY from passive conservation).

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6 The SWSI 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.

7 As of July 2005 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/)
Many of the water providers’ IPPs 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 AF of the 630,000 AF gap in supply) and that the 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. 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.

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

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8 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.
return flows to the river as shown in Figure 2 (Figure 8-2, CWCB 2004). SWSI 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 additional active water conservation to meet the water supply gap were identified, including:

- 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;
- ‘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:

- 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.

Under SWSI Phase 1, “most providers indicated that they would be more likely to acquire additional agricultural water rights than to implement aggressive levels of water 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.

3.2.3 SWSI Phase 2 Findings

SWSI Phase 1 identified two important findings regarding water conservation and efficiency.

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.

Recognizing the importance of water conservation and wise water use, the CWCB formed a Technical Roundtable (TRT) during the SWSI 2 process, to further explore the opportunities, challenges, and limitations associated with the implementation of water conservation measures at the local and regional level.

As its mission, the M&I Water Conservation TRT set out to "develop a deeper understanding and greater consensus on conservation and efficiency for municipal, industrial, and agricultural water uses." In the category of urban water demand, the TRT made significant advances that forward our understanding of the important role of water conservation and efficiency in municipal water planning. Successes included:

- Reaching consensus on how conservation may affect system reliability under various scenarios;
- Quantification of potential long-term savings available from 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 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’. **If fully and successfully implemented, 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 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.

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 in the savings estimates. SWSI Phase 2 also 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.

3.2.4 Recent Changes in Water Conservation

Several recently completed projects and ongoing efforts being conducted by the OWCDP contribute to providing an updated, scientifically valid foundation for assessing urban water conservation potential in Colorado. The approach includes the following key steps:

1) Creation of a Best Practices Guidebook for Water Conservation in Colorado;

2) Reassessment the classification used in SWSI Phase 1 (Levels 1-5) and the conservation measures within each category;

3) Identification and analysis of the water conservation savings from the year 2000 to present that are permanent versus temporary, with statewide best practices for water conservation; and

4) Identification of the current and forecasted penetration rates for statewide water conservation best practices.

The OWCDP anticipates these efforts will assist in defining water conservation’s role in local and statewide water resource management and in assessing the impact of water conservation on the future water supply gap. It 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. 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.

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 2009b). 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, shown in Figure 3, were developed using methods similar to those used by the SDO. Low, medium, and high scenarios were
developed for the 2050 demand projections because of uncertainty in projecting so far into the future. The report projected that from 2005 to 2050, Colorado’s population will nearly double from approximately 4.8 million in 2005 to between 8.7 and 10.3 million people in 2050, with the majority of the state’s population living in the South Platte and Arkansas River Basins (CWCB 2009b).

Expanding upon the data collected in SWSI Phase 1, updated water provider M&I usage and service population data were collected from various sources. The data sources included water providers’ water conservation plans on file with the CWCB, water provider websites, master plans, independent studies that included water use information, the Colorado Drought and Water Supply Update (2007b), and communication with water providers where clarification was needed (CWCB 2009b). These water use estimates were labeled as “2008” and reflect the best data available representing recent existing uses, including any passive or active conservation practices, up to the year 2008. Similar to SWSI Phase 1, the 2008 projections provide a baseline, and do not include the impact of future water conservation. Results presented in Figure 4 showed that statewide, and in the Arkansas, Gunnison, South Platte, and Yampa/White Basins, gpcd declined compared to the SWSI Phase 1 year 2000 baseline data (Figure ES-3, CWCB 2009b). Statewide water use has decreased since the SWSI Phase 1 efforts from an average 210 to 183 gpcd, a 13 percent reduction in per person daily water use statewide. The report notes that these decreases in water use may be due to conservation savings that are permanent, lingering effects of the 2002 drought and/or driven by economic factors. It is important also to recognize the differences in the user-reported datasets used to estimate the SWSI Phase 1 year 2000 and the updated 2008 baseline estimates. The 2008 data represent the addition of 35 water providers’ data that was not available for SWSI Phase 1. While the 2008 data shows higher water use rates in some counties as compared to SWSI Phase 1, the report indicates that it may be misleading to conclude that actual water use per person has

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9 Data were based on surveys requesting water providers to provide the most “representative” recent data, often based on annual metered water treatment plant data. It was left to the discretion of the water provider to determine the most “representative” recent year for their system, resulting in a range or reported years from 2005 through 2008.

10 If conservation was embedded into the demand projections, the 2050 M&I water demand projections would take into account conservation measures that would be implemented over the next 40 years. This would result in a lower 2050 projected M&I water demand. The CWCB determined that analyzing conservation measures and their potential savings statewide should not be embedded into the M&I demand projections, to provide a better understanding of the increments of water that additional conservation could supply to Colorado’s future water needs.

**Figure 4: Per capita demands by river basin (Figure ES-3, CWCB 2009b)**
increased in these counties; that it is highly probable that better data was collected and replaced the SWSI Phase 1 estimate (CWCB 2009b).

To develop the 2008 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. County demand forecasts were developed and then aggregated to a basin total. With the gpcd M&I water use rate reductions in some basins and on average statewide, the updated 2008 baseline showed an 11 percent projected “savings” statewide for the year 2030, as compared to the 2000 baseline provided in SWSI Phase 1 (CWCB 2009b). Again, this does not reflect potential savings from future water conservation efforts and solely reflects changes in gpcd water use rates between 2000 and 2008. While the population projections did change (SWSI Phase 1 projected an average growth rate of 1.7% between 2000 and 2030 whereas the updated 2050 M&I Water Use Projections report shows an average annual growth rate of 1.5% between 2005 and 2035), the majority of the decrease in demand is a result of the lower updated gpcd values. It is unknown how much of this gpcd reduction may represent lingering impacts of 2002 drought behavioral changes, and if so, to what extent those may rise as time passes.

**Conservation Effects on Future Demand Projections 2000 – 2050**

The OWCDP recently evaluated potential water savings from three different conservation scenarios: passive (SWSI Level 1) conservation, current conservation through active utility conservation program efforts, and a 1% per year strategy (CWCB 2009a). The “1% per Year” refers to a one percent reduction in demand from the year immediately prior, which is equivalent to a 39.5% reduction over the course of 50 years. It accounts for the fact that demand reductions gradually decrease over time as conservation programs penetrate the customer base. Under the mid-population growth scenario, the baseline 2050 future demand would be as high as 2,298,000 AFY. As shown in Figure 5, the study projected that with passive (Level 1) and active (current conservation) programs,

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11 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.

SWSI 2010 Update – M&I Water Conservation Strategy
achievable

Colorado

selected
programs
implementation,
water
in
and

Examples were provided of many western utility and national programs that are setting goals to reduce water use by 1% per year or greater and the study concluded that a 1% per Year scenario is an achievable goal.

**Colorado Statewide Water Conservation Best Practices Guidebook**

The Colorado Statewide Water Conservation Best Practices Guidebook is being 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, was formed to guide the process and review the technical work products. Over the past several months, a list of best practices has been selected for inclusion (Table 2 below), the draft guidebook was completed in May 2010 for review, and a final product will be available by the end of 2010 with technical workshops offered to water providers across the state. The draft guidebook was utilized for this SWSI water conservation update, as described in subsequent sections.

**Table 2: Colorado’s Statewide Water Conservation Best Practices (CWW/CWCB 2010)**

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<th>NO</th>
<th>BEST PRACTICE</th>
<th>CATEGORY</th>
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<td>Metering, conservation oriented rates and tap fees, customer categorization</td>
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<td>Integrated resources planning, goal setting, and demand monitoring</td>
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<td>3</td>
<td>System water loss control</td>
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<td>Water waste ordinance</td>
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<td>Public information and education</td>
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<td>Landscape water budgets, information, and customer feedback</td>
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<td>Rules and regulations for landscape design and installation and certificatino</td>
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<td>Water efficient design, installation, and maintenance practices for new and</td>
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<td>High-efficiency fixture and appliance replacement for residential sector</td>
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SWSI 2010 Update – M&I Water Conservation Strategy
**SWSI Conservation Levels Analysis**

The OWCDP recently conducted research into the advances that have been made in the science of water conservation at all levels – regional, national, and international shows (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 OWCDP 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. By examining these varied data sets spanning the last 5 years, the OWCDP 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”12) are required to adopt and implement a water conservation plan13. A recent survey by the OWCDP 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 strengthened the language to include requirements of covered entities seeking financial assistance from the State14 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

![Table 3: List of water conservation plans on file with the CWCB](image)

12 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.

13 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.)

14 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.)
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.

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 3) as of January 2010 (CWCB 2010b). Each conservation plan was fully evaluated for information about the water conservation 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 and 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, 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 the drought, with every planning entity observing a decrease in per capita water use between 2000 and 2003. As shown in Figure 6, 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 predrought levels, even in locations without ongoing water conservation programs, and local water experts indicate the impact of the drought will persist at some discernable level for years to decades. The Denver Water Department indicates a 20% decrease in customer demand associated with the drought, and a permanent per capita reduction of about 5% to be maintained through implementation of their selected water conservation measures and programs. Colorado Springs Utilities observed a 17% decrease in water demand and plans to implement water conservation measures and programs to offset any post-drought increase in customer demand.

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This assessment found that the extent of meaningful water conservation occurring in Colorado is unclear. Many existing conservation plans are not on file with the CWCB and 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, and the majority of providers do not 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).

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).15 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. 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.

Utilizing data from the 30 water conservation plans on file with the CWCB, the Levels Analysis updated the estimate 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 utilities16, 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 behavior17: 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. Results are shown in Table 4. Based on the analyses, passive savings are expected to reduce system wide daily per capita use

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

16 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.

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

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by 19 to 33 gpcd by 2050, for a **statewide passive savings of 102,000 to 189,000 AFY by 2030 and 125,000 to 212,000 AFY by 2050** (Table 9, CWCB 2010b).

Table 4: Acre feet of passive savings by major river basin and statewide (Table 9, CWCB 2010b)

<table>
<thead>
<tr>
<th>River Basins</th>
<th>2030 Minimum</th>
<th>2030 Maximum</th>
<th>2050 Minimum</th>
<th>2050 Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td>18,900</td>
<td>35,100</td>
<td>23,200</td>
<td>39,400</td>
</tr>
<tr>
<td>Colorado</td>
<td>6,500</td>
<td>12,000</td>
<td>8,000</td>
<td>13,500</td>
</tr>
<tr>
<td>Dolores/San Juan</td>
<td>2,200</td>
<td>4,000</td>
<td>2,700</td>
<td>4,500</td>
</tr>
<tr>
<td>Gunnison</td>
<td>2,200</td>
<td>4,100</td>
<td>2,700</td>
<td>4,600</td>
</tr>
<tr>
<td>North Platte</td>
<td>30</td>
<td>50</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Rio Grande</td>
<td>1,000</td>
<td>1,800</td>
<td>1,200</td>
<td>2,000</td>
</tr>
<tr>
<td>South Platte</td>
<td>70,000</td>
<td>130,000</td>
<td>86,000</td>
<td>146,000</td>
</tr>
<tr>
<td>Yampa/White</td>
<td>1,000</td>
<td>1,700</td>
<td>1,200</td>
<td>2,000</td>
</tr>
<tr>
<td>Statewide</td>
<td>102,000</td>
<td>189,000</td>
<td>125,000</td>
<td>212,000</td>
</tr>
</tbody>
</table>

*Statewide totals have been rounded to three significant digits.

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, since the volume does not vary by time, per capita use, changes in future population estimates, or lasting impact of drought on future M&I water demands. Further, a given percentage of savings between two periods of time, expressed in terms of gpcd, is not equivalent to the same percentage of savings in water demand between the same periods because population is generally increasing.

- 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.

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.

**Ongoing CWCB Water Conservation Data Efforts**

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 upon. 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, 2010. 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.

This SWSI 3 update provides reconnaissance-level projections of future water savings that are permanent through the implementation of statewide best practices for water conservation.

The OWCDP is also conducting a water conservation permanency and penetration rates feasibility study. The purpose of this project is to assess 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 OWCDP will be able to assess 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 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.

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.

3.2.5 2010 SWSI 3 Update Methodology
Previous SWSI efforts have not tried to designate water conservation as meeting any specific portion of the future water supply “gap”, but rather have attempted to bracket the potential that water conservation provides. To facilitate ongoing IBCC-level discussions, the CWCB recently presented the concept of investigating the potential M&I conservation savings from a 20, 30, and 40 percent reduction in 2000 water uses. These M&I conservation savings were discussed solely as a basis to provide insight into the increments of water that conservation could theoretically supply to Colorado’s future water needs, while the OWCDP was implementing an approach to research and analyze the required data and information needed to develop a comprehensive water conservation technical platform.

One of the goals of the 2010 SWSI update is to utilize scientifically valid and current data and methodologies to fully examine potential conservation savings that can be achieved by 2050 and the types of conservation best management practices, i.e. strategies, that can be utilized to accomplish the savings. This effort replaces the 20, 30, and 40 percent reduction numbers that provided a temporary placeholder for discussion purposes.

The approach utilized in this 2010 SWSI water conservation update incorporates information from many of the previous CWCB efforts. It continues to utilize a driver (population) multiplied by rate of use (gpcd) approach to estimate future demand by county, aggregated to river basin. The most current “2008” water use rate data available from the 2050 M&I Water Use Projection report are used to forecast demands and develop a 2008 baseline, without additional water conservation beyond 2008 levels.18 Future demands were projected through a per-capita water budget approach to estimate future demands from achievable permanent influences. Water demands (both current and projected future) were disaggregated into six water demand categories:

a. Residential (Single Family and Multi Family) Indoor Use
b. Non-Residential Indoor Use
c. Single Family Residential Outdoor Use
d. Multi Family Residential Outdoor Use
e. Non-Residential Outdoor Use

18 The “2008 baseline” was developed using the most recent water use rate data available from the 2050 M&I Water Use Projection report, which is based on a variety of user-reported data representing years 2005 through 2008.
f. Utility Water Loss

This approach offers clarity in communicating demand data within specific water demand categories and describing potential water conservation through specific best practice activities and programs associated with each category. 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. 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 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 limited available water conservation planning data and assumptions described herein, and more accurate distributions between water use sectors may be developed in the future as more and better data become available.

As identified in the SWSI Water Conservation Levels Analyses, the residential indoor savings will be mostly passive – due to technology changes and natural replacement through retrofits and new construction built under conservation-oriented plumbing codes. Savings from the other water demand categories will require active water conservation through water provider programs, local and state regulation, and end user initiative. Information and data provided in the Statewide Best Practices Guidebook were used to develop low, medium, and high water savings strategies, as further described in subsequent sections of this update report. This provided a range of potential volume savings from water conservation with varying penetration rates and a variety of strategies to reducing outdoor water demands, providing flexibility and individual preferences.

*None of the strategies or assumptions used in the 2010 SWSI update require draconian measures, extreme lifestyle changes, or landscaping changes far beyond those already being implemented by residents, businesses, and institutions in many Colorado communities.* Much of the water savings in all three strategies results from improvements in indoor hardware, with no behavioral changes required. These savings are indicative of the long-term potential for savings (by year 2050) that is likely to occur regardless of what policies or programs are implemented.

The long-term low, medium, and high water savings strategies include savings from all water users and are not limited solely to new development. It is important that gpcd water use rate data continue to be investigated and refined to the extent that they are utilized to project potential water savings from water conservation efforts. Recent efforts to collect and analyze measured data and improve overall data quality should continue to be invested in and expanded upon. Similarly, the ongoing efforts of the OWCDP to better understand water conservation permanency and penetration rates are essential to the
statewide water supply planning effort. Continued investigation into the sustainability of reduced demands following the 2002 drought (i.e. drought shadow) should also be supported to better understand the extent to which projected future savings may already be achieved under some existing water conservation programs.

**Relationship Between Water Conservation and Density**

While not quantitatively assessed under the updated forecasting methodology described here, much of the future new housing stock is anticipated to be more dense than historical; resulting in less future irrigated acreage 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).

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" (CDWR 2009, CWCB 2010a).

However, given that water utilities do not control future construction trends, changes in density are not considered to be a result of active water conservation programs; reductions in per capita water use associated with changes in density are not considered passive savings either (CWCB 2010b). The forecasting methodology 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 into the future, this assumption conservatively over-estimates future water demands.

In the three conservation strategies proposed here (Low, Medium, and High) water savings from densification are incorporated into the per capita irrigation reductions assigned to each 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.

**Relationship Between Water Conservation and Return Flows**

The updated methodology presented herein, which estimates current and future water demands by water demand category, allows more explicit characterization of the potential impacts from changes in water demand and efficiency on consumptive use, return flows, and overall water supply portfolios. Some water providers have expressed concern that water conservation may have unintended and

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19 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.
undesirable consequences on municipal water supplies, particularly if the municipality relies on the reuse of return flows for part of its water supply. With reusable return flows, a water provider is able to take credit for the non-consumptive portion of water use that returns to the hydrologic system. The specific measures considered for the water conservation strategies may have varied impacts on this issue.

To demonstrate the complexity of this topic, three simplified outdoor water use scenarios are depicted in Figure 7 below. This pictorial represents a situation where a diversion is made from a stream to meet an irrigation demand; a portion of the diversion is consumed, with the remaining non-consumptive portion returning to the river some distance downstream. The first scenario, Case A, depicts a consumptive demand of 10 acre-feet and irrigation application efficiency of 50%. In Case B, the application efficiency is increased relative to Case A (e.g., sprinkler system improvements). Conservation is achieved in terms of a lower river diversion to meet the same consumptive water demand, requiring less of a draw on the natural river flow (and/or less upstream release from the water user’s storage). However, there is no net gain downstream from the site, due to lower returns flow. With a water supply 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 total water supply. It may provide other benefits in certain situations: if the increased efficiency allows less water to be diverted and more water to be maintained in storage; if minimizing overall impacts on stream flow is desirable; etc. In the case of a water supply portfolio that does not allow the return flows to be reused, an increase in water efficiency will likely produce a net gain to the overall water supply portfolio.

Under a different scenario, depicted in Case C of Figure 7, the consumptive demand is reduced relative to Case A (e.g., changes to lower consumptive planting varieties). In this case, conservation is achieved through a lower diversion and lower consumption, to produce a net gain downstream from the site.

Further complicating the return flow topic, indoor water use is largely non-consumptive (often estimated by water professionals as 10% consumptive or less for newer communities). 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 where water supply can be maintained in storage or where minimizing overall impacts on stream flow is desirable. 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 an integrated resource planning process. 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.
Figure 7: Theoretical water conservation impacts on return flows

One of the benefits of this SWSI updated water conservation approach 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. For this reconnaissance-level analysis update, it was assumed that indoor water use is 10% consumptive and typical current outdoor use and system water losses are 50% consumptive. Recognizing that some of the future outdoor water use savings will be associated with increased irrigation efficiency, the low, medium, and high scenarios were modeled as 50%, 75%, and 90% consumptive, respectively. These reconnaissance-level estimates are not intended to replace estimates and data utilized at a local level and are values chosen to demonstrate a potential scenario, based on professional judgment. For example, newer communities may have lower than 10% indoor consumption (higher return flows); typical current outdoor water use may be more consumptive than 50% (lower return flows); highly efficient outdoor uses may approach 100% consumption; and real physical or apparent water losses may return to the stream system with little consumption. The reconnaissance-level estimated 2050 consumption rates result in an average statewide M&I consumption between 30 and 45% of overall demand. This provides a basis for water balance investigations, and can be improved at a local level with consideration of the physical system and provisions associated with the specific water supply portfolio.
Relationship Between Water Conservation and Water Supply Planning

The results provided in the following sections assume that all reductions in water demand (water savings) as a result of water conservation are permanent or will be maintained. However, no assumptions have been made about the volume of savings that could potentially be made available as a water supply. However, if the savings are indeed permanent then a substantial portion should be available for beneficial use.

The forecasting methodology does not account for management decisions that water providers may make, such as storing a portion of the savings for drought planning or to address other future increases in demand (e.g. to serve new development). While insufficient time has passed since the recent drought to fully assess the drought shadow and permanency of any demand reductions, once the reductions in demand are validated over a longer period, the water supply savings may reasonably be dedicated to new uses. Decisions related to using conserved water will vary at a local level, and should be part of integrated resource planning that considers the specific water supply portfolio and system reliability.

3.3 Water Conservation Strategies and Savings Potential

Three potential urban water conservation strategies were developed to assess the water savings potential for all 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 passive savings over the next 40 years as well as savings from active programs, new codes and regulations, landscape and irrigation changes, and improved utility water loss control measures.

The three conservation strategies are summarized below and explained in more detail later in this Chapter:

- **Low Water Savings Strategy** – Includes anticipated passive water conservation savings from natural replacement of fixtures and appliances, public information and education, limited reduction in customer side leakage, conservation-oriented plumbing and building codes, landscape water use reductions, and improved utility water loss control measures.

- **Medium Water Savings Strategy** – Includes anticipated passive water conservation savings from natural replacement of fixtures and appliances, public information and education, moderate reduction in customer side leakage, conservation-oriented plumbing and building codes, conservation oriented water rates, smart metering with leak detection, submetering of new multi-family housing, targeted utility audits for high demand non-residential and landscape customers, irrigation efficiency improvements, informational landscape water budgets and customer feedback, moderate landscape transformation from high water requirement turf to low water requirement plantings, and improved utility water loss control measures.

- **High Water Savings Strategy** – Includes anticipated passive water conservation savings from natural replacement of fixtures and appliances, intensive public information and education, substantial reduction in customer side leakage, conservation-oriented plumbing and building...
codes, conservation oriented and water budget-based water rates, smart metering with leak
detection, submetering of new multi-family housing, targeted utility audits for high demand
non-residential and landscape customers, irrigation efficiency improvements, landscape water
budgets tied to the rate structure and customer feedback, substantial landscape transformation
from high water requirement turf to low water requirement plantings, and improved utility
water loss control measures.

3.3.1. Methodology
Demand forecasting and water savings methods for this project and the previous SWSI efforts are
essentially identical. All SWSI water conservation-related forecasting efforts have been based on several
pieces of information:

4. Current and forecasted population,

5. Current water use rates, used to estimate current and forecasted water demands,

6. 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.
For this project, the word “baseline” represents either a current or forecasted water demand that has
been estimated using “current” water use rates. The water demand forecasts first apply the current rate
of use, reflecting current passive\(^{20}\) and active water conservation activities, to develop a future
“baseline” that does not embed additional water conservation potential. The potential savings from
additional water conservation are subtracted from the forecasted baseline, to provide an estimate of
the future demand with additional water conservation activities. With this method, a baseline projection
does not include impacts of potential additional future water conservation efforts.

For the current SWSI 2010 Update, current and forecasted population and water use rates were
prepared by CWCB staff and the CDM consulting team and then provided to the Aquacraft/Headwaters
team. 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. For the baseline condition it was assumed that per capita
water use rates for each county stay constant through 2050.

\(^{20}\) SWSI Phase 1 (CWCB 2004) first defined the “passive” or naturally-occurring water conservation savings from
impacts of plumbing codes, ordinances, and standards to improve efficiency as “Level 1” conservation. These
savings generally result from new construction, remodeled buildings, and landscaping ordinances. The “active”
savings result from utility-sponsored water conservation programs.

SWSI 2010 Update – M&I Water Conservation Strategy
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 (SF and MF) Indoor Use
- Non-Residential Indoor Use
- SF Residential Outdoor Use
- MF Residential Outdoor Use
- Non-Residential Outdoor Use
- Utility Water Loss

Data from water conservation plans submitted and approved by the CWCB 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. The general split between seasonal and non-seasonal demands for each basin were assigned based on available data from conservation plans. When reported, the seasonal demand split was found to be quite similar for utilities across the state with 46.0% for non-seasonal and 54.0% for seasonal demands. These values were applied across all river basins. US Census data on the percent of households living in single-family (SF) and multi-family (housing) were obtained for each county in Colorado and these data were used to help disaggregate single-family and multi-family use.

Next, the disaggregated demand percentages were applied to the baseline per capita demands for each river basin prepared by the CDM team. The results are shown in Table 5 below which shows some of the differences in water demands by sector across Colorado. While per capita volume is not a particularly useful way to examine outdoor use or utility water loss, it does provide a basis for evaluating demand levels within a basin and between basins.

Water savings for each of the three conservation scenarios was forecast by applying reduction factors to each demand category in Table 5 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.

In 2050 it is estimated that the population in Colorado will be 9.1 million people, a 74% increase over the 5.2 million people estimated to live in the state in 2010. The population projections used for this analysis are shown in Table 6 and were developed on a county by county basis from data provided the state demographer to the CWCB and the 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 chapter.

SWSI 2010 Update – M&I Water Conservation Strategy
Table 5: Disaggregated baseline per capita water use by river basin

<table>
<thead>
<tr>
<th>Basin</th>
<th>INDOOR</th>
<th></th>
<th></th>
<th>WATER</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Res. (SF &amp; MF)</td>
<td>Non Res.</td>
<td>SF Res.</td>
<td>MF Res.</td>
<td>Non Res.</td>
</tr>
<tr>
<td>Arkansas Basin</td>
<td>53.9</td>
<td>52.5</td>
<td>43.3</td>
<td>4.3</td>
<td>16.0</td>
</tr>
<tr>
<td>Colorado Basin</td>
<td>55.0</td>
<td>42.6</td>
<td>29.5</td>
<td>7.5</td>
<td>39.1</td>
</tr>
<tr>
<td>Gunnison Basin</td>
<td>63.2</td>
<td>30.1</td>
<td>57.9</td>
<td>3.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Metro Basin</td>
<td>43.6</td>
<td>37.4</td>
<td>29.8</td>
<td>4.5</td>
<td>28.4</td>
</tr>
<tr>
<td>North Platte Basin</td>
<td>73.0</td>
<td>104.7</td>
<td>80.2</td>
<td>1.2</td>
<td>26.2</td>
</tr>
<tr>
<td>Rio Grande Basin</td>
<td>77.9</td>
<td>106.0</td>
<td>77.5</td>
<td>3.0</td>
<td>26.5</td>
</tr>
<tr>
<td>Southwest</td>
<td>40.1</td>
<td>23.0</td>
<td>35.4</td>
<td>2.5</td>
<td>30.1</td>
</tr>
<tr>
<td>South Platte Basin</td>
<td>59.5</td>
<td>38.9</td>
<td>47.7</td>
<td>4.7</td>
<td>20.5</td>
</tr>
<tr>
<td>Yampa Basin</td>
<td>71.5</td>
<td>67.5</td>
<td>52.1</td>
<td>6.8</td>
<td>20.6</td>
</tr>
<tr>
<td>Statewide</td>
<td>50.8</td>
<td>41.4</td>
<td>37.5</td>
<td>4.7</td>
<td>24.7</td>
</tr>
</tbody>
</table>

Table 6: Population projections used for demand forecasts with conservation

<table>
<thead>
<tr>
<th>Basin</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2050 (mid level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas Basin</td>
<td>976,996</td>
<td>1,067,382</td>
<td>1,160,728</td>
<td>1,258,475</td>
<td>1,355,310</td>
<td>1,451,034</td>
<td>1,687,627</td>
</tr>
<tr>
<td>Colorado Basin</td>
<td>322,927</td>
<td>366,005</td>
<td>420,866</td>
<td>465,835</td>
<td>510,954</td>
<td>558,243</td>
<td>725,388</td>
</tr>
<tr>
<td>Gunnison Basin</td>
<td>109,733</td>
<td>124,789</td>
<td>140,720</td>
<td>156,765</td>
<td>171,408</td>
<td>183,694</td>
<td>220,103</td>
</tr>
<tr>
<td>Metro Basin</td>
<td>2,601,612</td>
<td>2,845,707</td>
<td>3,057,969</td>
<td>3,266,943</td>
<td>3,450,547</td>
<td>3,622,200</td>
<td>4,144,455</td>
</tr>
<tr>
<td>North Platte Basin</td>
<td>1,491</td>
<td>1,577</td>
<td>1,656</td>
<td>1,723</td>
<td>1,773</td>
<td>1,817</td>
<td>2,196</td>
</tr>
<tr>
<td>Rio Grande Basin</td>
<td>50,162</td>
<td>54,372</td>
<td>58,043</td>
<td>61,658</td>
<td>65,099</td>
<td>68,366</td>
<td>79,593</td>
</tr>
<tr>
<td>Southwest</td>
<td>108,556</td>
<td>123,242</td>
<td>138,493</td>
<td>154,478</td>
<td>169,927</td>
<td>184,637</td>
<td>224,262</td>
</tr>
<tr>
<td>South Platte Basin</td>
<td>1,009,029</td>
<td>1,118,326</td>
<td>1,235,733</td>
<td>1,368,721</td>
<td>1,497,115</td>
<td>1,621,897</td>
<td>1,902,474</td>
</tr>
<tr>
<td>Yampa Basin</td>
<td>47,150</td>
<td>53,191</td>
<td>60,654</td>
<td>68,066</td>
<td>74,539</td>
<td>80,698</td>
<td>116,823</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5,227,656</td>
<td>5,754,591</td>
<td>6,274,861</td>
<td>6,802,664</td>
<td>7,296,672</td>
<td>7,772,587</td>
<td>9,102,920</td>
</tr>
</tbody>
</table>

Table 7,

Table 8, and

SWSI 2010 Update – M&I Water Conservation Strategy
Table 9 present the per capita demand reductions applied under the Low, Medium, and High water savings strategies. Summary results and comparisons with previous SWSI conservation forecasts are presented in Table 10. Per capita use is generally not a preferred metric for estimating water savings from conservation and efficiency improvements, but in this case it was the only available data, normalized across counties, that could be used for this purpose. 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 the 2050 projections are based on population increases, the use of per capita demands was the only real option. Future studies and forecasting efforts may seek to use a different approach, but there are complications with nearly all broad based demand measures.

Table 7: Disaggregated low water saving strategy per capita water use by river basin

<table>
<thead>
<tr>
<th>Basin</th>
<th>LOW WATER SAVING STRATEGY - PER CAPITA WATER USE (gpcd)</th>
<th>INDOOR</th>
<th>OUTDOOR</th>
<th>Water Loss</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas Basin</td>
<td>40.0</td>
<td>44.6</td>
<td>36.8</td>
<td>3.6</td>
<td>13.6</td>
</tr>
<tr>
<td>Colorado Basin</td>
<td>40.0</td>
<td>36.2</td>
<td>25.1</td>
<td>6.3</td>
<td>33.2</td>
</tr>
<tr>
<td>Gunnison Basin</td>
<td>45.0</td>
<td>25.6</td>
<td>49.2</td>
<td>2.9</td>
<td>6.4</td>
</tr>
<tr>
<td>Metro Basin</td>
<td>40.0</td>
<td>31.8</td>
<td>25.3</td>
<td>3.9</td>
<td>24.1</td>
</tr>
<tr>
<td>North Platte Basin</td>
<td>55.0</td>
<td>89.0</td>
<td>68.2</td>
<td>1.0</td>
<td>22.2</td>
</tr>
<tr>
<td>Rio Grande Basin</td>
<td>55.0</td>
<td>90.1</td>
<td>65.8</td>
<td>2.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Southwest</td>
<td>40.1</td>
<td>19.6</td>
<td>30.1</td>
<td>2.1</td>
<td>25.6</td>
</tr>
<tr>
<td>South Platte Basin</td>
<td>40.0</td>
<td>33.0</td>
<td>40.5</td>
<td>4.0</td>
<td>17.4</td>
</tr>
<tr>
<td>Yampa Basin</td>
<td>45.0</td>
<td>57.3</td>
<td>44.3</td>
<td>5.8</td>
<td>17.5</td>
</tr>
<tr>
<td>Statewide</td>
<td>40.3</td>
<td>35.2</td>
<td>31.9</td>
<td>4.0</td>
<td>21.0</td>
</tr>
</tbody>
</table>

Table 8: Disaggregated medium water saving strategy per capita water use by basin

<table>
<thead>
<tr>
<th>Basin</th>
<th>MEDIUM WATER SAVING STRATEGY - PER CAPITA WATER USE (gpcd)</th>
<th>INDOOR</th>
<th>OUTDOOR</th>
<th>Water Loss</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas Basin</td>
<td>35.0</td>
<td>39.4</td>
<td>33.8</td>
<td>3.1</td>
<td>11.5</td>
</tr>
<tr>
<td>Colorado Basin</td>
<td>35.0</td>
<td>31.9</td>
<td>23.0</td>
<td>5.4</td>
<td>28.1</td>
</tr>
<tr>
<td>Gunnison Basin</td>
<td>40.0</td>
<td>22.6</td>
<td>45.2</td>
<td>2.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Metro Basin</td>
<td>35.0</td>
<td>28.1</td>
<td>23.2</td>
<td>3.3</td>
<td>20.4</td>
</tr>
<tr>
<td>North Platte Basin</td>
<td>50.0</td>
<td>78.5</td>
<td>62.6</td>
<td>0.8</td>
<td>18.8</td>
</tr>
<tr>
<td>Rio Grande Basin</td>
<td>50.0</td>
<td>79.5</td>
<td>60.4</td>
<td>2.2</td>
<td>19.1</td>
</tr>
<tr>
<td>Southwest</td>
<td>35.0</td>
<td>17.3</td>
<td>27.6</td>
<td>1.8</td>
<td>21.7</td>
</tr>
<tr>
<td>South Platte Basin</td>
<td>35.0</td>
<td>29.1</td>
<td>37.2</td>
<td>3.4</td>
<td>14.8</td>
</tr>
</tbody>
</table>

SWSI 2010 Update – M&I Water Conservation Strategy
Table 9: Disaggregated high water saving strategy per capita water use by basin

<table>
<thead>
<tr>
<th>Basin</th>
<th>INDOOR</th>
<th>OUTDOOR</th>
<th>Water Loss</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arkansas Basin</td>
<td>30.0</td>
<td>34.1</td>
<td>30.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Colorado Basin</td>
<td>30.0</td>
<td>27.7</td>
<td>20.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Gunnison Basin</td>
<td>35.0</td>
<td>19.6</td>
<td>40.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Metro Basin</td>
<td>30.0</td>
<td>24.3</td>
<td>20.8</td>
<td>2.7</td>
</tr>
<tr>
<td>North Platte Basin</td>
<td>45.0</td>
<td>68.0</td>
<td>56.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Rio Grande Basin</td>
<td>45.0</td>
<td>68.9</td>
<td>54.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Southwest</td>
<td>30.0</td>
<td>15.0</td>
<td>24.8</td>
<td>1.5</td>
</tr>
<tr>
<td>South Platte Basin</td>
<td>30.0</td>
<td>25.3</td>
<td>33.4</td>
<td>2.8</td>
</tr>
<tr>
<td>Yampa Basin</td>
<td>35.0</td>
<td>43.8</td>
<td>36.5</td>
<td>4.1</td>
</tr>
<tr>
<td>Statewide</td>
<td>30.3</td>
<td>26.9</td>
<td>26.3</td>
<td>2.8</td>
</tr>
</tbody>
</table>

3.3.2. SWSI 3 Demand Forecasts and Comparisons with SWSI 1 and 2

A summary of the statewide demand forecasts and total water savings in 2030 and 2050 developed for the SWSI 3 update is presented in Table 10 along with similar forecasts from the SWSI 1, SWSI 2, and recent SWSI Levels analysis. The SWSI 3 analysis of statewide water conservation potential shows that if fully and successfully implemented, the demand management strategies could potentially reduce the 2050 demand by 311,000 AFY to 675,00 AFY, with a medium level estimate of 494,000 AFY.

Table 10: Statewide forecast water savings from SWSI 1, 2, 3, and Levels Analysis

<table>
<thead>
<tr>
<th>Project</th>
<th>Level</th>
<th>Base Demand (AF)</th>
<th>2030 Projections</th>
<th>2050 Projections</th>
<th>% Savings from Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Volume Savings (AF)</td>
<td>% Savings from Baseline</td>
<td>Volume Savings (AF)</td>
<td>% Savings from Baseline</td>
</tr>
<tr>
<td>SWSI 1</td>
<td>Level 1 (Passive)</td>
<td>1,926,798</td>
<td>101,900 5%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 2</td>
<td>1,926,798</td>
<td>101,900 5%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 3</td>
<td>1,926,798</td>
<td>101,900 5%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 4</td>
<td>1,926,798</td>
<td>101,900 5%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level 5</td>
<td>1,926,798</td>
<td>101,900 5%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>SWSI 2</td>
<td>Low</td>
<td>1,925,000</td>
<td>287,000 15%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>1,925,000</td>
<td>287,000 15%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>1,925,000</td>
<td>287,000 15%</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>SWSI</td>
<td>Low Passive</td>
<td>1,741,702</td>
<td>102,000 5.9%</td>
<td>2,186,310</td>
<td>125,000 5.7%</td>
</tr>
</tbody>
</table>
### Table: SWSI 3 Water Conservation Strategy

<table>
<thead>
<tr>
<th>Levels</th>
<th>High Passive</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>189,000</td>
<td>10.9%</td>
<td>212,000</td>
<td>9.7%</td>
<td>1,405,795</td>
<td>177,872</td>
</tr>
</tbody>
</table>

Water savings estimated from the current SWSI 3 analysis are fairly similar to the estimates in SWSI 1 and SWSI 2, but some important differences exist. Most significantly, SWSI 3 savings are estimated through 2050 rather than 2030, but 2030 savings are available for comparison against SWSI 1 and 2 estimates. Volumetric savings from SWSI 3 estimates at 2030 are considerably lower than SWSI 2 estimates, but the percent change vs. baseline are similar. This is largely due to a significant adjustment to the baseline demands developed as part of SWSI 3. The differences in baseline demands at 2030 are primarily due to three factors:

1. Improved baseline consumption data from Colorado water providers (fewer estimated values are included in SWSI 3)
2. The State Demographer has reduced the population growth rate from 1.7% per year to 1.5% per year.
3. Reductions in water use that have occurred since 2002. In SWSI 2 the statewide average baseline per capita demand was 210 gpcd and in SWSI 3 it was 183 gpcd – a 12.8% reduction.

The SWSI Levels Analysis (Bouvette 2010) used the year 2000 as a baseline consequently the baseline demand was considerably higher than in the SWSI 3 analysis.

Figure 8 presents the SWSI 3 water conservation strategy demand forecasts (Low, Medium, and High) along with the baseline demand forecast and the population forecast from 2010 to 2050.
3.3.3. Impact of Water Conservation Strategies
The three water conservation strategies (Low, Medium, and High) developed and analyzed as part of this project are described in greater detail in the next sections of the report. 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 passive savings over the next 40 years as well as savings from active programs, new codes and regulations, landscape and irrigation changes, and improved utility water loss control measures.

The conservation strategies presented here do not require significant changes in behavior (e.g. fewer or shorter showers, less toilet flushing, elimination of irrigation). Rather the water savings strategies rely on increased adoption of water efficient fixtures and appliances which are then used pretty much as they are today. Landscape water saving strategies include increased irrigation efficiency and the transformation of some (but not all) high demand plant varieties to low demand plantings and hardscape. The conservation strategies emphasize measures that achieve long-lasting, cost-effective water savings that will not decay over time and that do not rely on widespread changes in the way Coloradoans use water.

The three statewide water saving strategies were designed to provide achievable, cost-effective water savings across the state. Achieving these savings, particularly in the Medium and High strategies, is not a foregone conclusion. If Colorado chooses to implement one of these more significant water conservation strategies it will require real effort and investment by the State and local governments as
As water providers. Just as water supply projects such as dams and pipelines are not built by themselves, water conservation savings must be achieved through concerted effort.

There are several important caveats and assumptions regarding the water conservation strategies should be understood so that the results are not wrongly interpreted and misapplied in the future.

**Statewide Strategies to Assess Conservation Potential** – These three strategies were designed to estimate the conservation potential in Colorado. Each strategy was designed to achieve significant, measurable water savings. The savings estimates presented here are expected to be achieved if the programs and measures described are implemented at an approximately equivalent level across the entire state. Each strategy was applied at the basin level and then evaluated for the purpose of estimating the conservation potential across each river basin and across the entire state. The potential to conserve water exists irrespective of an individual water provider’s need or desire to conserve. But it is understood that in all probability conservation will be implemented more intensively in the regions of Colorado where there is greater need.

**Climate Change Not Considered** – The impacts of climate change on water demands were not included in this analysis. Time and budgetary limitation simply did now 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 if possible.

**Future Uses of Water** – For this analysis it was assumed that the end uses of water and human behavior related to water in 2050 will about the same as they are today in 2010. 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 there is no reason to suspect 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 installation rates of swimming pools, spas and/or multi-headed showering systems). Demand increases could counteract some of the savings estimated in this report. Similarly, technology could also serve to reduce future water demands below those estimated here.

### 3.3.4. Estimated Savings from Low Water Saving Strategy

- Estimated Water Savings by 2050 = 311,423 AF (17.7% reduction)
- Estimated 2050 passive savings component = 154,045 AF (49% of total)21

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21 Passive savings estimates at 2050 = 154,045 AF are from Bouvette, T. 2010. CWCB SWSI Levels of Savings for this analysis are less than the total historical, but this analysis only savings starting in 2010 were considered.

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SWSI 2010 Update – M&I Water Conservation Strategy
• Estimated 2050 active savings component = 186,116 AF (60% of total)
• Estimated consumptive water savings = 87,737 (28.2% of total)
• Estimated non-consumptive water savings = 223,686 (71.8% of total)

The Low Water Saving Strategy includes anticipated passive water savings that will be achieved through the natural replacement of fixtures and appliances by most municipal customers as well active water savings achieved as a result of conservation programs, measures, and regulations. The conservation measures in the Low Water Saving Strategy address both indoor and outdoor end uses and utility water loss. A detailed description of each strategy by sector is provided below.

3.3.5. Estimated Savings from Medium Water Saving Strategy
• Estimated Water Savings by 2050 = 494,464 AF (28.1% reduction)
• Estimated 2050 passive savings component = 154,045 AF (31% of total)
• Estimated 2050 active savings component = 325,258 AF (66% of total)
• Estimated consumptive water savings = 183,858 (37.2%)
• Estimated non-consumptive water savings = 310,303 (62.8%)

The Medium Water Saving Strategy includes anticipated passive water conservation savings from natural replacement of fixtures and appliances, public information and education, moderate reduction in customer side leakage, conservation-oriented plumbing and building codes, conservation oriented

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water rates, smart metering with leak detection, submetering of new multi-family housing, targeted utility audits for high demand non-residential and landscape customers, irrigation efficiency improvements, informational landscape water budgets and customer feedback, moderate landscape transformation from high water requirement turf to low water requirement plantings, and improved utility water loss control measures. A detailed description of each strategy by sector is provided below.

3.3.6. Estimated Savings from High Water Saving Strategy

- Estimated Water Savings by 2050 = 675,567 AF (38.4% reduction)
- Estimated 2050 passive savings component = 154,045 AF (23% of total)
- Estimated 2050 active savings component = 463,628 AF (69% of total)
- Estimated consumptive water savings = 289,148 (42.8%)
- Estimated non-consumptive water savings = 386,419 (57.2%)

The High Water Saving Strategy includes anticipated passive water conservation savings from natural replacement of fixtures and appliances, intensive public information and education, substantial reduction in customer side leakage, conservation-oriented plumbing and building codes, conservation oriented and water budget-based water rates, smart metering with leak detection, submetering of new multi-family housing, targeted utility audits for high demand non-residential and landscape customers, irrigation efficiency improvements, landscape water budgets tied to the rate structure and customer feedback, substantial landscape transformation from high water requirement turf to low water requirement plantings, and improved utility water loss control measures. A detailed description of each strategy by sector is provided below.

3.3.7. Description of Three Water Saving Strategies by Demand Sector

The descriptions below explain how the estimated water savings could 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
chapter. Additionally, the sections below outline the anticipated implementation level and penetration rates associated with each of the three water saving strategies.

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.

- **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 11 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 will be achieved by 2050.

Water savings in the indoor residential sector under the low medium and high scenarios are accomplished through the following technological improvements and utility programs:

- Natural replacement of most toilets with 1.6, 1.28, (Low and Medium) and 1.0 gpf fixtures (High).
- Natural replacement of all clothes washers with average vol. per load of 13.5 - 20 gal/load.
- Natural replacement of showerheads and faucet aerators with WaterSense fixtures (or better).
- Reduction in household leakage from toilet replacement (Low) and repairs (Medium and High) assisted by enhanced utility automatic metering infrastructure (smart metering) and leak detection systems to ID potential leaks (High).
- Up to 30% (Low), 60% (Medium), and >75% (High) of new homes built to WaterSense specification.
- Increased adoption of conservation oriented water rate structures.
- Public information and education.
- Submetering of new multi-family housing (Medium and High)
- Conservation oriented tap fees (High) to encourage “built-in” efficiency in new houses.

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 ULF toilets and high efficiency clothes washers 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 (Bouvette 2010). Increased adoption
of conservation oriented water rates and utilization of the WaterSense new home specification helps ensure these savings occur.

As shown in Table 11, indoor residential per capita demand can be reduced to 35 gpcd (Medium) and 30 gpcd (High) through relatively modest reductions in toilet flushing, clothes washing, faucet use, showering, and dishwashing. An average indoor per capita use of 35 gpcd has been achieved in some homes retrofit as part of a recent retrofit study (Aquacraft, 2004). Achieving an efficiency level of 30 gpcd indoors will require additional improvements in conserving fixtures and appliances, but appears readily achievable given steady advances in plumbing and appliance efficiency and metering technology (Bouvette 2010).

Indoor residential demand reductions account for 106,637 AF (34%) of the total water savings in the Low Water Saving Strategy, 157,649 AF (32%) in the Medium Water Saving Strategy, and 208,632 AF (30%) in the High Water Saving Strategy.
Table 11: Estimated indoor residential per capita demands, efficiency level, and penetration rate under three conservation scenarios.

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<td>69.3</td>
<td>40.4</td>
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<td>30.0</td>
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</table>

*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.

Sources:

Non-Residential Indoor Water Savings Assumptions

- **Low Water Saving Strategy** – Non-residential per capita indoor water use is reduced statewide by 15% by 2050.

- **Medium Water Saving Strategy** - Non-residential per capita indoor water use is reduced statewide by 25% by 2050.

- **High Water Saving Strategy** - Non-residential per capita indoor water use is reduced statewide by 35% by 2050.

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

Water savings in the indoor non-residential sector under the low medium and high scenarios are accomplished through the following technological improvements and utility programs:

- Natural replacement of most toilets with 1.6, 1.28, (Low and Medium) and 1.0 gpf fixtures (High).
- Natural replacement of showerheads and faucet aerators with WaterSense fixtures (or better).
- Reduction in leakage from toilet replacement (Low) and repairs (Medium and High) assisted by enhanced utility automatic metering infrastructure (smart metering) and leak detection systems to ID potential leaks (High).
- Natural replacement of urinals with 0.5 gpf fixtures (Low) or 0.25 gpf and waterless fixtures (Medium and High).
- Natural replacement of various CII equipment and fixtures including clothes washers, water cooled ice machines, other once through cooling, PRSVs, etc. (Low, Medium, and High)
- Conservation-oriented water rates for non-residential customers. (Low, Medium, and High)
- Targeted utility audits for high demand customers. (Medium and High)
- Tap fees and regulations to encourage water efficiency in new construction. (Medium and High)
- Aggressive conservation-oriented pricing (High)
- Smart metering to ID leaks and track usage (High)
- Reduction/Elimination of single-pass cooling (Medium/High)
- General technological improvements in equipment and metering and planned expansion of WaterSense CII program. (High)

While water savings in the residential sector are anticipated to be achieved largely 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

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plumbing fixtures and appliances alone 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 35% estimates of non-residential indoor savings (Medium and High scenarios) will require substantial effort on behalf of utilities and customers. 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 35% reductions. Utility conservation programs must increasingly focus on outdoor use and non-residential customers. A utility billing data base 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. A concerted effort to reduce and eliminate single-pass water cooling statewide through 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 easily sufficient to achieve the Low and Medium water saving strategies. The high strategy will likely require additional efficiency improvements, but given the advances in the past 5 years it appears likely that additional water savings will 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.

Indoor non-residential demand reductions account for 63,306 AF (20%) of the total water savings in the Low Water Saving Strategy, 105,510 AF (21%) in the Medium Water Saving Strategy, and 147,714 AF (22%) in the High Water Saving Strategy.
Outdoor (SF, MF, and Non-Residential) Water Savings Assumptions

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

- **Medium Water Saving Strategy** –
  - SF Residential Outdoor – 22% reduction in per capita outdoor use.
  - MF Residential Outdoor - 28% reduction in per capita outdoor use.
  - Non-Residential Outdoor - 28% reduction in per capita outdoor use.

- **High Water Saving Strategy** –
  - SF Residential Outdoor – 30% reduction in per capita outdoor use.
  - MF Residential Outdoor - 40% reduction in per capita outdoor use.
  - Non-Residential Outdoor - 40% reduction in per capita outdoor use.

In this analysis it was assumed that multi-family and non-residential irrigators have a 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 (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:

- General irrigation efficiency and technological improvements. (Low, Medium and High)
- Expanded use of smart controllers and soil moisture sensors. (Medium and High)
- Regulations governing landscape design and installation. (Low, Medium and High)
- Certification of landscape professionals. (Low, Medium and High)
- Improved water efficient design, installation, and maintenance practices for new and existing landscapes. (Medium and High)
- Targeted irrigation efficiency evaluations with follow-up to ensure implementation of recommendations. (Medium and High)
- Replacement of up to 40% high water requirement turf with lower water requirement plantings including alternative turf grasses. (Low, Medium and High)
- 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)
- Public information and education campaign focused on outdoor water use. (Low, Medium and 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.

Anyone who has lived in the Colorado Front Range over the past 10 years has probably noticed a significant change in landscape preferences over that time period. 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 US) 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.

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 12 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 12: Summary of existing outdoor program and regulatory requirements (Headwaters 2010)

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Landscape water savings represent between 32% and 35% of all water savings forecast at 2050 in the three water saving strategies analyzed here. As discussed above landscape water savings are 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 the proposed 15 – 40% landscape water use reductions proposed in the three conservation strategies could be accomplished a series of illustrative examples were developed. The purpose of these examples is to show what type of landscape changes are required to achieve the percent reductions in outdoor water use included in the low, medium and high saving strategies.

Figure 9 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 as specified in the low water saving strategy. 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 9 and Figure 10 are based on a 10,000 square foot lot and 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. 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 10 presents theoretical landscape design and theoretical water requirements for the same 10,000 SF property under the medium and high water saving scenarios. The annual theoretical water requirement for the 10,000 SF property under the high scenario represents a 30 percent reduction from the baseline shown in Figure 9. These examples show but one way in which the 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 the 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 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 11, Figure 12, and Figure 13 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 savings strategy, a 40% reduction in non-residential landscape demand is projected. To better explain how a 40% reduction might be accomplished, three different high strategy examples (a, b, and c) were developed and are presented in Figure 12 and Figure 13. 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.
Figure 9: Residential landscape design and theoretical water demands examples – traditional (baseline) and low saving strategy.
Figure 10: Residential landscape design and theoretical water demands examples – medium and high saving strategies.
Figure 11: Non-Residential landscape design and theoretical water demands examples – traditional (baseline) and low saving strategy.
Figure 12: Non-Residential landscape design and theoretical water demands examples – medium and high (a) saving strategies.
Figure 13: Non-Residential landscape design and theoretical water demands examples – high (b) and (c) saving strategies.
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 5% 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 and described in this best practice) 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 are accomplished through the following utility efforts:

- Implementation of the AWWA water loss accounting methodology by 90-100% of 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 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 by water utilities to achieve. The first step is to implement the AWWA M36 SWSI 2010 Update – M&I Water Conservation Strategy
water loss accounting methodology and to establish and annual updating procedure so that all water in the utility distribution network can be accounted for. Water providers should 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 simply 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 must work toward implementing the bottom up approach.

State Actions to Improve Water Loss Control

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, it is expected that the State will take a leadership role and will 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 incent) 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.
• 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).

Water savings from water loss reductions account for 39,102 AF (13%) of the total water savings in the Low Water Saving Strategy, 62,855 AF (13%) in the Medium Water Saving Strategy, and 84,475 AF (13%) in the High Water Saving Strategy.

3.3.8. Demand Hardening

For some water professionals, the issue of demand hardening looms large as 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, although there is little if any documentation in the literature of it ever occurring in Colorado or elsewhere (Mayer and Little 2006). Demand hardening could be an issue for water providers in certain situations, but its importance has been overstated (Chesnutt 1997).

By definition, demand hardening is 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, conservation will allow more water to be kept in storage (either in reservoirs or in aquifers underground), thereby reducing the risk and potential impacts of drought (DeOreo 2006). Since demand hardening is only a consideration during a shortage, reducing the recurrence of water shortages through conservation reduces the likelihood of demand hardening impacting a provider. Second, the technologies and economics of water-use efficiency are constantly changing. 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 only and issue during a water shortage, a well thought out drought and water shortage mitigation plan can help mitigate the potential impacts of demand hardening.

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). These Colorado-based economists concluded, “to ignore 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” (Howe and Goemans 2007).

The issue of demand hardening is something utilities should be mindful of and is worthy of future study. Based on the current published knowledge base on the subject, concern about demand hardening is not a sound argument against implementing long term water conservation.

3.4 SWSI Conservation Matrix Update

As part of the SWSI 2 project 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 3 update, a revised water conservation matrix was developed to estimate where water savings might be achieved. The SWSI 3 matrix is presented in Table 13 and the SWSI 2 matrix is provided in Appendix A.
The methodology used to develop the SWSI 2 and 3 matrices was significantly different and since the SWSI 2 matrix has been used extensively over the past five years it is worthwhile to explore the differences.\(^{22}\) The SWSI 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.

In contrast, the SWSI 3 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 3 water savings were disaggregated among the various best practices using available information from CWCB conservation plans, research on conservation effectiveness, the 2010 SWSI Levels analysis (Bouvette 2010), and engineering estimates. The total savings shown in the SWSI 3 matrix are intentionally matched to the statewide estimates discussed earlier in this document. In the SWSI 3 matrix, water savings are grouped by customer category 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 contributing 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 2 matrix.

For comparison, the SWSI 2 matrix was used to estimate potential water savings ranging from 287,000 AF to 459,000 AF by 2030 while the SWSI 3 matrix was used is disaggregate potential water savings ranging from 311,000 AF and 676,000 AF by 2050. A comparison of the 2030 demand estimated in the SWSI 3 effort is shown in Table 10 earlier in this document.

\(^{22}\) Peter Mayer of Aquacraft was a member of the SWSI 2 TRT and the chief architect of the SWSI 2 matrix.
### Table 13: Matrix of water conservation measures and savings based on Colorado WaterWise Best Practices Guide and State Water Supply Initiative savings estimates

<table>
<thead>
<tr>
<th>#</th>
<th>Measure</th>
<th>CWW Best Practice?</th>
<th>Sector Impacted</th>
<th>Estimated Implementation or Penetration Level by 2050</th>
<th>Low Water Saving Strategy Savings (AF)</th>
<th>Medium Water Saving Strategy Water (AF)</th>
<th>High Water Saving Strategy Water (AF)</th>
<th>Estimated Utility Cost Range of Program per AF of Savings ($) per AF</th>
<th>Expected Durability of Savings</th>
<th>Sources and Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full metering</td>
<td>BP 1</td>
<td>All</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers</td>
</tr>
<tr>
<td>2</td>
<td>Conservation oriented rates</td>
<td>BP 1</td>
<td>All</td>
<td>70 - 100%</td>
<td>Contributing factor to savings listed in other sectors.</td>
<td>Contributing factor to savings listed in other sectors.</td>
<td>Contributing factor to savings listed in other sectors.</td>
<td>$1,000 - $8,000</td>
<td>No deterioration</td>
<td>2010 Colorado Best Practices Guidebook, City of Westminster, City of Broomfield</td>
</tr>
<tr>
<td>3</td>
<td>Conservation oriented tap fees</td>
<td>BP 1</td>
<td>All</td>
<td>10 - 75%</td>
<td></td>
<td></td>
<td></td>
<td>$500 - $2,000</td>
<td>Dependent on Utility or Governing Board Decisions.</td>
<td>AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers</td>
</tr>
<tr>
<td>4</td>
<td>Integrated resources planning, goal setting, monitoring</td>
<td>BP 2</td>
<td>Utility</td>
<td>70 - 100%</td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers</td>
</tr>
<tr>
<td>5</td>
<td>Water loss control</td>
<td>BP 3</td>
<td>Utility</td>
<td>100%</td>
<td>39,000</td>
<td>62,000</td>
<td>84,000</td>
<td>$2,000 to $7,000</td>
<td>No deterioration as program is on-going.</td>
<td>AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers</td>
</tr>
<tr>
<td>6</td>
<td>Conservation coordinator</td>
<td>BP 4</td>
<td>All</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers</td>
</tr>
<tr>
<td>7</td>
<td>Water waste ordinance</td>
<td>BP 5</td>
<td>All</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers</td>
</tr>
<tr>
<td>8</td>
<td>Public information and education</td>
<td>BP 6</td>
<td>All</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>AWWA Manuals - M1, M50, M52; 2008 Water Budgets and Rate Structures, 2001 Amy Vickers</td>
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<tr>
<td>9</td>
<td>Landscape water budgets</td>
<td>BP 7</td>
<td>Outdoor irrigation</td>
<td>50 - 100%</td>
<td></td>
<td></td>
<td></td>
<td>$2,500 - $5,000</td>
<td>Limited deterioration if budgets are set fairly.</td>
<td>2007 Water Budgets and Rate Structures, 2009 EPA WaterSense, 2008 GreenCO</td>
</tr>
<tr>
<td>10</td>
<td>Rules and regs. for landscape design and installation</td>
<td>BP 8</td>
<td>Outdoor irrigation</td>
<td>50 - 100%</td>
<td>102,000</td>
<td>168,000</td>
<td>235,000</td>
<td>$500 - $1,500</td>
<td>Limited deterioration.</td>
<td>2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association</td>
</tr>
<tr>
<td>11</td>
<td>Certification of landscape professionals</td>
<td>BP 8</td>
<td>Outdoor irrigation</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td>Little or no cost.</td>
<td>Limited deterioration.</td>
<td>2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association, EPA WaterSense</td>
</tr>
</tbody>
</table>

**SWSI 2010 Update – M&I Water Conservation Strategy**
<table>
<thead>
<tr>
<th>#</th>
<th>Measure</th>
<th>CWW Best Practice?</th>
<th>Sector Impacted</th>
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<th>Low Water Saving Strategy Savings (AF)</th>
<th>Medium Water Saving Strategy Water (AF)</th>
<th>High Water Saving Strategy Water (AF)</th>
<th>Estimated Utility Cost Range of Program per AF of Savings ($/AF)</th>
<th>Expected Durability of Savings</th>
<th>Sources and Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Water efficient design, installation, and maintenance practices for new and existing landscapes</td>
<td>BP 9</td>
<td>Outdoor irrigation</td>
<td>50 - 100%</td>
<td>Customer bears cost, except for inspection - $500 - $2,000</td>
<td>Limited deterioration.</td>
<td>$2,000 to $8,000 (assuming utility pays $200 - 500 per audit and customer pays system repair costs)</td>
<td>Same as if no audits are conducted - i.e. standard irrigation system on-going maintenance issues.</td>
<td>2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association, 2001, Amy Vickers</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Irrigation efficiency evaluations</td>
<td>BP 10</td>
<td>Outdoor irrigation</td>
<td>30 - 100%</td>
<td>Customer bears cost, except for inspection - $500 - $2,000</td>
<td>Limited deterioration.</td>
<td>$2,000 to $8,000 (assuming utility pays $200 - 500 per audit and customer pays system repair costs)</td>
<td>Same as if no audits are conducted - i.e. standard irrigation system on-going maintenance issues.</td>
<td>2010 Best Practices Guidebook, 2008 GreenCo, Irrigation Association, 2001, Amy Vickers</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Rules for new residential construction</td>
<td>BP 11</td>
<td>Res.</td>
<td>30 - 100%</td>
<td>Customer bears cost, except for inspection - $500 - $2,000</td>
<td>No deterioration if new fixture/appliance standards implemented and old units disposed</td>
<td>No deterioration if new fixture/appliance standards implemented and old units disposed</td>
<td>2010 Best Practices Guidebook, EPA WaterSense, 2008 WaterSmart Guidebook</td>
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<tr>
<td>17</td>
<td>Submetering of multi-family res.</td>
<td></td>
<td>Res.</td>
<td>10 -50%</td>
<td>Variable ($0 to $4,000) depending upon who pays for the metering.</td>
<td>No deterioration</td>
<td>No deterioration</td>
<td>2004. National Submetering and Allocation Billing Program Study</td>
<td></td>
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<tr>
<td>18</td>
<td>High efficiency fixtures and appliances - Non-Residential</td>
<td>BP 12</td>
<td>CII</td>
<td>Passive / 100%</td>
<td>$0 - assumes all savings are passive</td>
<td>No deterioration</td>
<td>No deterioration</td>
<td>2010 Best Practices Guidebook, 2008 WaterSmart Guidebook, 2001 Amy Vickers, 2000 Commercial and Institutional End Uses of Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Measure</td>
<td>CWW</td>
<td>Sector Impacted</td>
<td>Estimated Implementation or Penetration Level by 2050</td>
<td>Low Water Saving Strategy Savings (AF)</td>
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<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>19</td>
<td>Specialized non-residential surveys, audits, and equipment efficiency improvements</td>
<td>BP 14</td>
<td>CII</td>
<td>20 - 90%</td>
<td></td>
<td></td>
<td></td>
<td>$3,300 to $16,300 (assuming utility pays $500 per audit and customer pays any repair costs)</td>
<td>Limited deterioration</td>
<td>2010 Best Practices Guidebook, 2008 WaterSmart Guidebook, 2001 Amy Vickers, Commercial and Institutional End Uses of Water</td>
</tr>
<tr>
<td>20</td>
<td>Rules for new non-residential construction</td>
<td>BP 11</td>
<td>CII</td>
<td>30 - 100%</td>
<td></td>
<td></td>
<td></td>
<td>Customer bears cost, except for inspection - $500 - $2,000</td>
<td>No deterioration if new fixture/appliance standards implemented and old units disposed</td>
<td>2010 Best Practices Guidebook, EPA WaterSense, WaterSmart Guidebook</td>
</tr>
</tbody>
</table>

**TOTAL PASSIVE SAVINGS**

|                          | 154,000 | 154,000 | 154,000 |

**TOTAL ACTIVE SAVINGS**

|                          | 157,000 | 340,000 | 522,000 |

**TOTAL**

|                          | 311,000 | 494,000 | 676,000 |
3.5 Water Conservation Strategy Conclusions

This report section represents the latest effort by the CWCB to integrate water conservation into overall water supply planning and to estimate the water conservation potential that exists in the State up to 2050. Through the research, analysis, and writing efforts of Aquacraft, Inc. and Headwaters Corp., 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.

3.5.1 Key Findings and Conclusions

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

This study provides reconnaissance-level estimates of the statewide conservation potential as a building block for future efforts. As with previous SWSI planning efforts, the water savings projections presented in this section 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 is not intended to replace water conservation planning and projections prepared by local entities. As better information and data become available, the potential savings and water conservation strategies presented in this section may be updated, building on the analysis framework provided below.

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 section 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 savings strategies developed, it is believed that water savings ranging from 311,000 – 676,000 AF could be achieved by 2050. These savings represent reductions of between 18 and 38% from the forecast baseline demand. If achieved at any of the three levels proposed, these savings could significantly reduce the gap in supply currently forecast.

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 double digit decline in demand since 2002, additional conservation potential exists through the measures and programs outlined in this report.
WSWI 1, 2, and 3 conservation forecasts yielded similar results using different methodologies. SWSI 1 and 2 forecast water savings through the year 2030. SWSI 1 forecast 2030 savings ranging from 101,900 – 699,183 AF. SWSI 2 forecast 2030 savings ranging from 287,000 – 459,00 AF. This SWSI 3 update forecast 2030 water savings ranging from 178,000 – 360,000 AF. Each of these projects used a different methodology to forecast water savings over the next 20 years, but when compared side by side the forecasts are quite similar. SWSI 3 forecasts at 2030 are actually somewhat lower than comparable SWSI 1 or 2 forecasts. This is because SWSI 3 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 achievable statewide water savings.

Achieving water savings from conservation will require substantive effort and action the State, local, and customer level. The water savings described in this section are achievable, but are not destined to occur. 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 section, 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 policies 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.

None of the strategies or assumptions used in this update require draconian measures, extreme lifestyle changes, or landscaping changes far beyond those already being implemented by residents, businesses, and institutions in many Colorado communities. Much of the water savings in all three strategies results from improvements in indoor hardware, with no behavioral changes required. These savings are indicative of the long-term potential for savings (by year 2050) that is likely to occur regardless of what policies or programs are implemented.

Anticipated passive conservation from national plumbing codes and efficiency programs is significant. The SWSI Levels analysis (CWCB 2010b) determined that substantial passive water savings are likely to be achieved in Colorado. Passive reductions include 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, including retrofitting housing stock and businesses. The SWSI 3 analysis indicates that passive savings account for 23 – 49% of the water savings forecast under the three water saving strategies. Passive savings can be ensured and accelerated through education and information programs as well as active utility conservation programs. It is not correct to assume that all the passive savings forecast can be achieved without an investment in creating a culture of conservation in Colorado.

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 represents the greatest challenge to achieving the water savings forecast in this study.

Reducing landscape demands from 15 – 40% can be accomplished while maintaining the green and beauty Colorado residents have come to expect. Some water professionals have expressed concern that greater landscape water efficiency will require the desertification of Colorado’s outdoor urban environments. The examples provided in this study (Figure 9 - Figure 13) show that efficiency improvements ranging from 15 – 40% can be achieved while maintaining beautiful and attractive landscapes that still include sizeable turf areas. Coloradoans have already embraced landscapes that incorporate reduced turf areas, waterwise planting beds, and some hardscape. The continuation of this waterwise landscape ethos along with anticipated efficiency improvements to irrigation systems and new lower water demand turf types make possible and even likely the 15 – 40% savings forecasts presented here.

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.

The State can take an active role in improving water loss control measures in Colorado. 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, it is expected that the State will take a leadership role and will provide incentives and promulgate regulations to ensure that water providers take the necessary steps to reduce real losses in their system.

Demand hardening should be studied, but is not a sound argument against implementing long term water conservation. By definition, demand hardening is only a consideration in a water shortage and if a significant portion of conserved water has been used to serve new customers. There are no documented cases 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. 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. The issue of demand hardening is worthy of future study, but based on the current published knowledge base it is not reasonable to cite fear of demand hardening as a rationale for not implementing long term water conservation measures.

3.5.2 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 study 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. 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 need not “re-invent the wheel” once again. Colorado’s new water data reporting rule 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.

Penetration rate of efficient fixtures and appliances. How quickly are Colorado residents adopting high efficiency toilets, clothes washers, and other appliances? Currently water planners must estimate adoption rates, but research by CSU funded by the CWCB Office of Water Conservation and Drought Planning could shed light on this fundamental water planning question.

Colorado landscape transformation. Water use is down up and down the front range and turf by itself is no longer the preferred landscape design. What landscape changes are occurring in Colorado? How fast and wide-spread are waterwise principles being implemented? What are the typical efficiency rates of irrigation systems? 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.

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 remains largely a mystery. 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.

Understanding demand hardening. The concept and analytics of demand hardening are simple and 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. The Alliance for Water Efficiency is considering funding a demand hardening study that may answer some of the lingering questions.
### Appendix A – SWSI 2 Conservation Matrix

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

<table>
<thead>
<tr>
<th>Measure</th>
<th>Estimated Implementation or Penetration Level by 2030</th>
<th>Potential Water Savings Range - Per Customer (thousand gals/year)</th>
<th>Potential Water Savings Range - Entire Program (thousand gals/year)</th>
<th>Potential Water Savings Range - Entire Program (AFY)</th>
<th>Estimated Cost Range of Program per AF of Savings ($/AF)</th>
<th>Expected Durability of Savings</th>
<th>Updated Potential Water Savings Range from CWCB Conservation Plans – Per Customer (thousand gals/year)</th>
<th>Sources/Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turf replacement</td>
<td>25 percent of single family (SF) residents with no more than 60 percent turf</td>
<td>30 to 60</td>
<td>41,000,000 to 69,000,000</td>
<td>125,800 to 211,700</td>
<td>$7,000 to $25,000 depending on level of rebates offered</td>
<td>Limited deterioration anticipated.</td>
<td>No conservation plans had savings outside of the range developed in SWSI Phase 2</td>
<td>2005. Xeriscape Conversion Study results; Southern Nevada Water Authority (SNWA) 2004 &quot;Cash for Grass - A Cost Effective Method to Conserve Landscape Water&quot;; 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.</td>
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<tr>
<td>Utility water loss reduction programs</td>
<td>90 percent of public water suppliers</td>
<td>3 to 5 percent of total system demand</td>
<td>16,952,000 to 28,264,200</td>
<td>52,000 to 86,700</td>
<td>$2,000 to $7,000</td>
<td>Relies on continued utility leak detection program.</td>
<td>2% (Source: City of Northglenn)</td>
<td>Harold Evans, City of Greeley, American Water Works Assoc. (AWWA) Water Loss Control Committee</td>
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<td>Toilet rebates</td>
<td>80 percent by 2030</td>
<td>14.6 per household based on 2.6 SF residents</td>
<td>18,192,000</td>
<td>55,000 in 2030</td>
<td>$7,230 @ $150 rebate per toilet (avg 2 per unit)</td>
<td>Deterioration as flappers wear. Requires ongoing education or flapperless toilets</td>
<td>9 to 19 per household (Source: Firestone and Castle Pines, respectively)</td>
<td>Amy Vickers and Associates, Pacific Institute, California Urban Water Conservation Council (CUWCC), Westminster</td>
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<tr>
<td>Conservation oriented water rates - increasing block rates, water budgets, excess use surcharges, information oriented billing</td>
<td>100 percent of municipal customers</td>
<td>Varies by customer class, current rate structure, and other variables</td>
<td>10,000,000</td>
<td>30,675</td>
<td>$6,000 (assuming an implementation cost of $180 per customer)</td>
<td>Dependent on Utility/Governing Board Decisions.</td>
<td>3% to 7% decrease from conservation pricing (Source: Castle Pines and Alamosa, respectively)</td>
<td>Experience of various TRT members</td>
</tr>
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<td>Measure</td>
<td>Estimated Implementation or Penetration Level by 2030</td>
<td>Potential Water Savings Range - Per Customer (thousand gals/year)</td>
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<td>Estimated Cost Range of Program per AF of Savings (SAF)</td>
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<tr>
<td>Washer rebates</td>
<td>80 percent by 2030</td>
<td>3.6 to 8.5 per household based on age of unit and density</td>
<td>5,550,150 to 13,104,500</td>
<td>17,000 to 40,200 by 2030</td>
<td>$4,000 to $28,000 rebate range $100-$300</td>
<td>No deterioration if new appliance standards implemented and old units disposed</td>
<td>9.4 (Source: East Larimer)</td>
<td>Amy Vickers and Associates, Pacific Institute, CUWCC</td>
</tr>
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<td>Cooling Towers increased cycle concentration</td>
<td>50 percent by 2030</td>
<td>Not Applicable</td>
<td>1,000,000 to 8,000,000</td>
<td>3,100 to 24,500</td>
<td>$1,000 to $5,000</td>
<td>10 percent deterioration possible</td>
<td>No conservation plans had savings outside of the range developed in SWSI Phase 2</td>
<td>1995 U.S. Geological Survey (USGS) Com./Ind. Use &amp; Denver Water internal estimates</td>
</tr>
<tr>
<td>Rebates for landscape retrofits other than turf replacement</td>
<td>2.0 to 2.5 percent of residential customers</td>
<td>15 to 20 percent of irrigation or 11 to 36</td>
<td>1,000,000 to 6,000,000</td>
<td>3,100 to 18,400</td>
<td>$2,439 to $10,678</td>
<td>Permanent</td>
<td>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)</td>
<td>Evaluation of Water Conservation Program, Maddaus Water Management, July 2003 coupled with Customer Information System (CIS) Data and Internal Analysis and Assumptions</td>
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<tr>
<td>Residential landscape audits (includes irrigation system upgrades, shut-off devices, weather-based controllers, other new technology)</td>
<td>25 percent of all residential customers - targeted at high users</td>
<td>5 to 15</td>
<td>1,250,000 to 3,750,000 by 2030</td>
<td>3,800 to 11,500 by 2030</td>
<td>$2,000 to $7,000 (assuming utility pays $100 per audit and customer pays system repair costs)</td>
<td>Same as if no audits are conducted - i.e., standard irrigation system on-going maintenance issues.</td>
<td>2.6 (Source: Pagosa)</td>
<td>1999. Residential End Uses of Water. AWWA, Amy Vickers, Aquacraft landscape irrigation studies, engineering estimates.</td>
</tr>
<tr>
<td>Residential Indoor Audits</td>
<td>25 percent of all residential customers - targeted at high users</td>
<td>3 to 9</td>
<td>750,000 to 2,250,000</td>
<td>2,300 to 6,900</td>
<td>$3,600 to $11,000 (assuming utility pays $100 per audit and customer pays any repair costs)</td>
<td>Limited deterioration anticipated.</td>
<td>No conservation plans had savings outside of the range developed in SWSI Phase 2</td>
<td>1999. Residential End Uses of Water. AWWA, Amy Vickers, Aquacraft landscape engineering estimates.</td>
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<td>Submetering in multi-family housing</td>
<td>20 percent of multi-family (MF) housing by 2030</td>
<td>6 to 17/apartment unit/year</td>
<td>600,000 to 1,700,000 by 2030</td>
<td>1,800 to 5,200 by 2030</td>
<td>Variable ($0 to $4,000) depending upon who pays for the metering.</td>
<td>No deterioration.</td>
<td>No conservation plans had savings outside of the range developed in SWSI Phase 2</td>
<td>2004. National Submetering and Allocation Billing Program Study</td>
</tr>
<tr>
<td>Commercial landscape audits (includes irrigation system upgrades, shutoff devices, weather-based controllers, other new technology)</td>
<td>25 percent of all commercial irrigators - targeted at high users</td>
<td>20 to 75</td>
<td>500,000 to 1,875,000 by 2030</td>
<td>1,500 to 5,800 by 2030</td>
<td>$2,000 to $8,000 (assuming utility pays $500 per audit and customer pays system repair costs)</td>
<td>Same as if no audits are conducted - i.e. standard irrigation system on-going maintenance issues.</td>
<td>109.6 (Source: Left Hand)</td>
<td>2000. Commercial and Institutional End Uses of Water: AWWA, Aquacraft landscape irrigation studies, Amy Vickers, engineering estimates.</td>
</tr>
<tr>
<td>Commercial Indoor Audits</td>
<td>25 percent of commercial customers - targeted at high users</td>
<td>10 to 50</td>
<td>250,000 to 1,250,000</td>
<td>800 to 3,800</td>
<td>$3,300 to $16,300 (assuming utility pays $500 per audit and customer pays any repair costs)</td>
<td>Limited deterioration anticipated.</td>
<td>110 (Source: Firestone)</td>
<td>2000. Commercial and Institutional End Uses of Water: AWWA, Amy Vickers, engineering estimates.</td>
</tr>
<tr>
<td>Metering of all utility customers</td>
<td>Very few customers in Colorado were not metered as of 2005</td>
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<td>Review of conservation plans suggests that most communities across the state are metered</td>
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<td>TOTAL (not including duplicates)</td>
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