STATE OF COLORADO

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TO: CWCB Board of Directors

FROM: Veva Deheza, Section Chief
Kevin Reidy, Water Conservation Technical Specialist
Office of Water Conservation & Drought Planning

DATE: July 6, 2010

SUBJECT: **Agenda Item #24, July 20-21, 2010 Board Meeting**
Office of Water Conservation & Drought Planning-Presentation on the Updated Passive Water Conservation Savings from the SWSI Conservation Levels Analysis Report

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Staff Recommendation
This is an *informational* item only and Board action is not required.

Background - Project Goals and Approach – SWSI Conservation Levels Analysis
SWSI Conservation Levels Analysis Project focused on achieving the third goal of the proposed Water Conservation Strategy. The overall goal of this project was to re-assess the water conservation classification “levels” developed and used in the SWSI I to estimate future water demand reductions associated with passive and active water conservation savings based on a review and evaluation of the best available data collected by the CWCB over the past eight years.

As part of this project, a quantitative re-assessment was made of potential future water demand reductions associated with the “passive” water conservation predicted in SWSI I. Follow-up projects to be conducted by CWCB will re-assess and perform quantitative assessments to characterize potential “active” water conservation savings predicted and/or discussed in both phases of SWSI (i.e., SWSI I and II).

Presentation of Passive Savings Analyses
A PowerPoint presentation will be provided that will focus upon the following:
- Drivers to Customer Behavioral and Physical Water Use Changes
- Assumptions for Updated Passive Water Savings Calculations
- Results of Updated Passive Calculations (including a comparison to SWSI I passive savings estimates)

Attachment
Section 5 of the SWSI Conservation Levels Report entitled “Passive Water Savings” is attached for reference and further information as needed.

Section 5
Passive Water Savings

Passive savings, as defined in SWSI I, are those water savings that result from the impacts of plumbing codes, ordinances and standards that improve the efficiency of water use. These conservation savings are called "passive" savings because water utilities do not actively fund and implement programs that produce these savings. (CDM, 2004). In practice, SWSI I estimated passive savings based chiefly upon the expected impact of the 1992 National Energy Policy Act. **For the analyses presented herein, the analysis of passive savings was expanded to include those water savings related to retrofitting homes and businesses with high efficiency fixtures and appliances that are subject to not only the 1992 Act, but to the other relevant regulations and market influences not actively funded or implemented by water utilities as presented later in this section. To this point, passive water savings are calculated to occur as a result of retrofitting housing stock and businesses that exist prior to 2016** (this date is explained further in the following text)**.**

Passive savings could also occur as a result of local, state or federal regulations or requirements not currently "on the books"; however, no attempt was made to predict the effect of potential regulations or requirements on future water use demand given the amount of speculation necessary to conduct such analyses. Additional discussions of what is and is not considered passive savings for purpose of the analyses presented herein are presented below.

Customer Behavioral Changes

Customer behavioral changes are also excluded from the calculation of potential passive savings. There are a number of reasons for this. First and foremost, there is limited data quantifying the nature and permanency of customer behavior change. For example, Colorado witnessed substantial customer water use behavior change in response to the 2002 drought, which was in fact a response to enforced watering restrictions, mass media messaging, and other drought response measures. As a result of the drought and all the lifestyle change implications that accompanied it, water providers in Colorado experienced on average more than a 20% drop in per capita water use. What water providers do not know is when, if ever, this observed drop in customer water use will rebound to pre-drought levels.

Second, although many entities in Colorado believe that a full rebound will never occur, as time passes and new citizens move into the region, our collective memory of the drought and its related challenges will likely fade. In addition, the penalties for excessive water use, which are stiffer now than at any time before the drought, embodied by more aggressive pricing of water and the enforcement of water waste ordinances, do not impact the behavior of all residents and businesses. In fact, previous studies indicate that wealthier individuals have more access to water and therefore consume more water (Corral-Verdugo, et. al., 2003). They may not feel the need to conserve because what they do not have, they can buy. Ilanit, et.al. (2006) suggest that it may also be true that the lower-income individuals know that other groups have virtually unlimited access to water and therefore they do not feel the need to conserve because their water use is already rationed[17]. It is a classic tragedy of the commons dilemma (Hardin, 1968) because there is no immediate or long-term perceived pay off for conserving by either party. Because of these points, assuming that permanent savings will occur as a result of all of the drought-associated water demand reductions is not necessarily reliable.

The estimation of passive water savings is based on permanent savings. Therefore, any current behavioral changes that have been observed as a result of the 2002 drought were not included in the calculation. This is in part due to not having data to suggest the permanency of the change. It is also due to the fact that Colorado's largest water providers are implementing active water conservation efforts to prolong the behavior changes that occurred as a result of the drought (Denver Water, 2007, Colorado Springs Utilities, 2007). Behavioral changes are considered to be either not permanent or a component of active water conservation conducted by water utilities; and therefore, are not included in estimates of future passive savings.

Changes in Population Density

Another factor that will undoubtedly impact future water demand in Colorado will be the increased density of new construction as urban infill development continues. Increased density of housing associated with infill construction will reduce outdoor water use as development go "up" rather than "out." Given that outdoor water use is over 50% of current M&I demand, changes in housing density will decrease per capita water use as outdoor demand decreases.

Water utilities do not control future construction trends such that changes in housing density are not currently 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, under the definitions provided herein. Therefore, per capita water demand reductions associated with increased housing density are considered to fall into a fourth category of future water savings – one which is not drought related, nor passive or active.

Customer Physical Changes

Passive water savings are directly linked to the replacement of older, inefficient water using fixtures and appliances with high efficiency fixtures and appliances. There are a number of key legislative acts that have or will influence the rate and type of fixtures and appliances that will be replaced. These include the following:

> **1992 – National Energy Policy Act** - this Federal act required uniform water efficiency standards on nearly all toilets, urinals, showerheads, and faucets manufactured after January 1994; and included efficiency standards for toilets used in commercial installations by 1997.

[17] Rationing is used in this article by Ilanit, et.al. as a means to indicate that low income water customers can not afford as much water as high income water customers, which is considered to be a form of rationing. This reference to rationing is not related to outdoor watering restrictions or government imposed restrictions.

2002 – California Energy Commission (CEC) Water Efficiency Standards – the California legislature ordered the CEC to establish water efficiency standards for residential clothes washers. Accounting for a reported 22% of an average household's water usage; washing machines are prime candidates for increased water efficiency regulation. The proposed standards required machines to meet a certain "water factor" (WF) ratio calculated by dividing a washer's gallons of water used per load by its water capacity starting in 2007. Although the federal Energy Policy and Conservation Act (ECPA) expressly preempts states from regulating "energy efficiency, energy use, or water use of any product covered by federal energy efficiency standards," the CEC requested a waiver from the DOE that would allow California to regulate water efficiency standards for residential washing machines. CEC won its request for a waiver in 2009 (Proctor, 2010).

2007 – California Assembly Bill 715 – this bill required high-efficiency (HE) standards for all toilets (1.28 gallons per flush (gpf) or less) and urinals (0.5 gpf or less) sold in the state after January 1, 2014[18].

2009 – US Department of Energy State Energy Efficient Appliance Rebate Program – is a program that will provide states with $300 million to design and implement rebate programs that encourage consumers to turn in their old, inefficient appliances for new energy efficient ENERGY STAR models. Water-efficient dishwashers and clothes washers are included under the ENERGY STAR label and will be targeted to receive the biggest rebates. Using these funds, the State of California targeted dishwashers (Griffiths-Sattenpiel, 2009).

The specific impacts of these acts on Colorado's urban water demand have been mixed. For example, no appreciable water demand reductions were seen in association with the 1992 National Energy Policy Act, even though many Colorado water providers pointed to this piece of legislation as a firm part of their water conservation programs, helping reduce urban water demand in customer's homes and businesses. The lack of observed water savings from the 1992 Act is due to technology challenges before 2002, and that water conservation savings associated with the 1992 Act were small enough to not necessarily be measurable versus other water demand impacts. For example, the technology of low flow toilets produced before 2002 did not necessarily reduce flushing flows, since prior to that time toilet performance which was previously thought to be homogeneous showed a wide variation.

> "With utility funding, the National Association of Home Builders (NAHB) Research Center put 49 popular toilets through a battery of tests and reported in 2002 that nearly three-quarters of them performed unsatisfactorily. In October 2002, Consumer Reports published an article on toilet performance that used very different testing methods and produced strikingly different results. Consumers and builders were left frustrated and without a place to turn for toilet performance information they could trust.

[18] The import and relevance of this bill to the production and sales of high efficiency toilets and urinals in California and the western United States was further increased by the passage of California Senate Bill 407 which requires point-of-sale retrofits for all residential and commercial property sold after January 1, 2014.

> In response, more than a dozen municipal water utilities in the United States and Canada—including agencies that were actively promoting water conservation—funded projects to develop a comprehensive testing protocol that would accurately measure toilet flush was the Maximum Performance (MaP) testing. MaP measures how much mass of a standardized testing media (cultured soy encased in latex sleeves) a toilet will flush successfully in two out of three tries" (Wilson, 2006).

The Maximum Performance testing program provided an objective standard by which to compare toilet flush performance thus leveling the toilet industry. Along with the MaP testing, EPA's WaterSense program (launched in June 2006) has substantially improved toilet reliability, and therefore, efficiency of high-efficiency toilets. However, water savings associated with the 1992 Federal act were difficult to ascertain prior to this time.

In addition, new construction has been found to utilize about the same amount of water as older homes (Mayer, 2010). This is presumably due to the fact that while indoor water use in toilets and other appliances has been reduced, outdoor water use has increased in association with the installation of automated irrigation systems (versus older homes without automated systems). Although more data is needed to better clarify residential and commercial "end use", analyses conducted have not verified the savings expected at the time the California 2007 legislation was enacted.

In fact, the legislation in California has arguably had a greater impact on Colorado's urban water use than the 1992 Federal Act. This is primarily due to the size and power of California's economy. Creating and satisfying demand in California dominates the manner in which manufacturers and suppliers operate in the western US. Thus, California's actions have dominated the clothes washer and dishwasher markets in recent years, in combination with actions by the California Energy Commission and the US EPA (through their Energy Star and WaterSense programs). It is becoming increasingly difficult for consumers in Colorado to purchase clothes washers that are not substantially more water efficient than those produced before 2005. Commercially available top loaders are 24% more water efficient and front loader are 40% more water efficient than their predecessors. Similarly, dishwashers have become 25% more water efficient when compared to those available prior to 2005.

No other type of indoor or outdoor water use was included in the passive saving estimates since other domestic and commercial water uses are subject to potential quality of life issues. For example, low flow showerheads could save considerable water, not to mention energy; however, customers have the propensity to not select high efficiency showerheads for reasons that are not entirely clear. Faucet aerators could easily be downsized to 0.5 gallon per minute (gpm) flow rates in bathrooms. However, many newer faucet and lavatory configurations require special hardware configurations for the aerator to attach to the spigot which do not lend themselves to the 0.5 gpm option. Hot water on demand may or may not reduce water use in a home or business depending on the configuration of the system and its use.

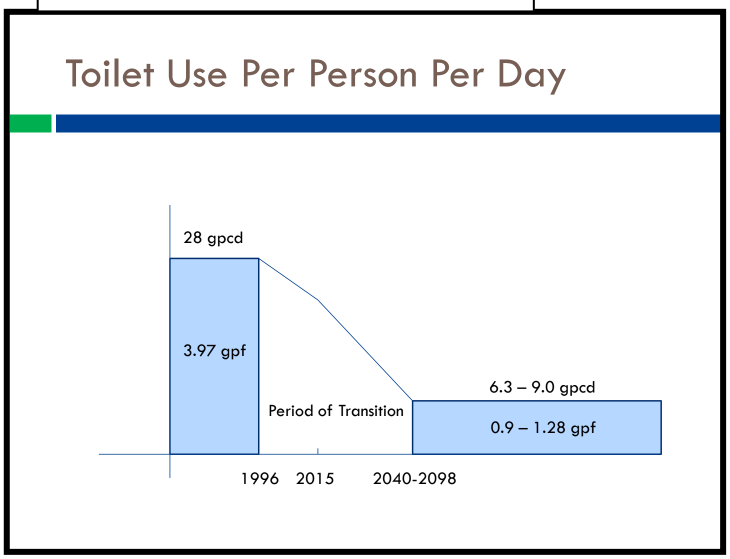
As previously indicated, outdoor water use has increased with new construction. For those entities willing to remove current landscape in favor of native plantings and Xeriscape material, water use reductions can be substantial for existing construction. However, there are a substantial number of home and business owners that are installing automated irrigation systems to maintain turf each year. For this reason, there does not appear to be adequate data to support passive calculations that extend beyond toilets, clothes washing machines and dishwashers.

Passive Savings Calculations

Based on these observations, future water demand reductions associated with passive savings were calculated for each year beginning in 1996, which is when benchmark toilet flushing volume data from Denver was available. The calculations used to estimate future demand reductions were developed for reasonable minimum and maximum scenarios based on the assumptions related to the retrofit of existing housing and commercial construction with high-efficiency toilets, clothes washers and dishwashers as indicated below. The calculations based on these assumptions were used to estimate a range of future passive water savings for each year starting in 2000 and continuing until 2050. Limitations related to the use of these assumptions are discussed at the end of this section.

Toilets – Beginning in 1994, homes and businesses were required to replace older, inefficient toilets with 1.6 gallons per flush (gpf) toilets at the time that toilet replacement was needed (e.g., remodeling, replacement of broken equipment). The first Colorado specific data that was available to characterize average toilet use from this period was from 1996, which indicated that the average flushing volume per toilet in Denver was 3.96 gpf (Aquacraft, Inc., 2006). This average flush volume (which was in the range of other average flush volumes in the literature (SFPUC, 2004)) and the average number of flushes per person per day (which includes both residential (5.05) (Mayer, et. al., 1999) and commercial (2) uses (Vickers, 2001)) of seven was used to calculate the average per capita daily toilet water use in 1996[19]. Future year per capita demand reductions were calculated based on these data and the following assumptions:

Figure 4



- Range for toilet replacement rates - 1.2% (Google, 2010) (minimum) to 4% per year (Alliance for Water Efficiency, 2009) (maximum).
- For pre-1994 construction, toilet retrofits include 1.6 gpf toilets until 2015 at which point all toilets are replaced with 1.28 gpf toilets.
- For pre-2016 construction, all toilets including those replaced since 1996 will be replaced with 1.28 gpf toilets.
- Minimum passive savings are calculated using 1.28 gpf toilets, where as maximum passive savings are calculated using dual flush 1.28 gpf toilets (which average 0.9 gpf) (Caroma, 2009).

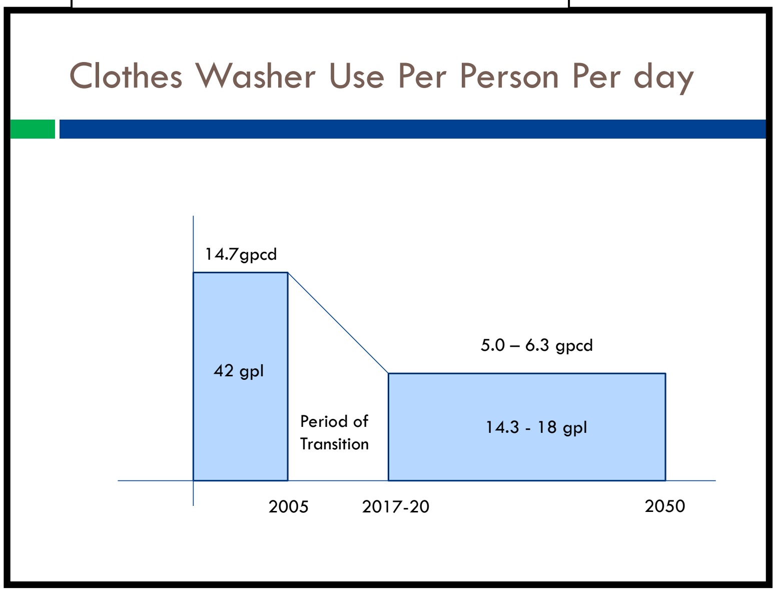
Clothes Washers – The typical top loading washing machine in service in homes and apartments in 2000 used approximately 40 to 45 gallons of water per load (Alliance for Water Efficiency, 2009). Today's high-efficiency

[19] Water savings from the period 1994 to 1996 are assumed to be included in the per capita toilet use data reported for 1996 by Aquacraft, Inc., 2006.

horizontal axis washing machines with a 3 cubic foot capacity can use as little as 12 gallons of water per load, with a typical range of between 15 and 30 gpl (Alliance for Water Efficiency, 2009). Future year per capita demand reductions were calculated based on these data and the following assumptions:

- The replacement rate for clothes washer was estimated to range from every 12 years (8.3% per year) (Alliance for Water Efficiency, 2009) to every 15 years (6.7% per year) (SFPUC, 2004).
- It was further assumed that 42 gallon per load (gpl) clothes washers would be replaced with a combination of HE horizontal axis washing machines and HE vertical axis machines. Project calculations used 14.3 gpl for maximum savings and 18 gpl for minimum savings based on the characteristics of EPA's Energy Star listed clothes washers (see Appendix D).
- Finally, it was assumed that the number of loads of wash per day per person would be 0.35 based on the likely range identified by the Chestnut (2004).

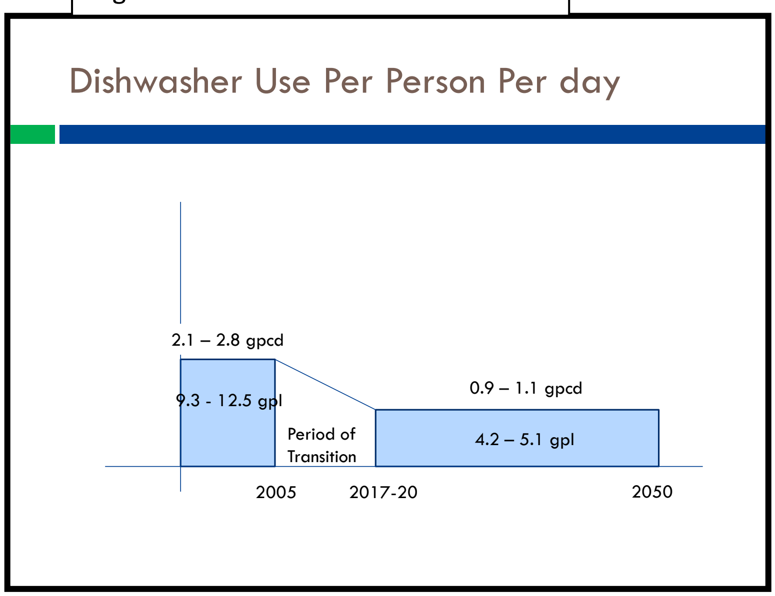
Figure 5



Dishwashers - In 2000, the average gallons of water used per load of dishes was about 6 to 10 (Soap and Detergent Organization, 2000), although the SFPUC estimated its customer's average dishwasher use to be 12.5 gpl in 2000. US EPA indicated that prior to 1994, dishwashers used on average 13 gpl or more, whereas new Energy Star dishwashers use less than 5 gpl (US Environmental Protection Agency and US Department of Energy, 2010). The typical number of loads washed per person per day was estimated to range between 0.1 and 0.3 (Mayer, et. al., 1999). Future year per capita demand reductions were calculated based on these data and the following assumptions:

- The replacement rate for dishwashers was estimated to range every 12 years (8.3% per year) (Alliance for Water Efficiency, 2009) to every 15 years (6.7% per year) (SFPUC, 2004).
- It was also assumed that 9.3 to 12.5 gallon per load (gpl) dishwashers would be replaced with EPA Energy Star dishwashers. Project calculations used 4.2

Figure 6



gpl for maximum savings and 5 gpl for minimum savings based on the characteristics of EPA's Energy Star listed dishwashers (see Appendix D).

- Finally, it was assumed that the number of loads of wash per day per person would be 0.225 based the likely range identified by the Chestnut (2004).

The passive saving calculations were made by calculating the adjustment to per capita water use for each fixture/appliance for each year in the planning period (i.e., 2000 to 2050) in accordance with the reduction that occurs as the market penetration rate shifts from inefficient to high efficiency fixtures and appliances. The market penetration shift occurs over the periods indicated in each of the figures shown previously. This calculation is represented by the equation below.

$$\Delta\ GPCD^{yr}_{fix/app} = \%\ Old\ GPCD^{yr}_{fix/app} * Old\ GPCD_{fix/app} + \%\ New\ GPCD^{yr}_{fix/app} * New\ GPCD_{fix/app}$$

$Old\ GPCD_{fix/app}$ = gallons per capita per day for use of inefficient fixture or appliance

$New\ GPCD_{fix/app}$ = gallons per capita per day for use of high-efficiency fixture or appliance

$\%\ Old\ GPCD^{yr}_{fix/app}$ = percent of inefficient fixtures or appliances remaining in use versus total number of fixtures or appliances in use for target population in target year (see Table 5)

$\%\ New\ GPCD^{yr}_{fix/app}$ = percent of high-efficiency fixtures or appliances in use versus total number of fixtures or appliances in use for target population in target year (see Table 5)

The change in per capita water use by county from the baseline demands of 2000 defined in SWSI I for any given year thereafter is the sum of the individual savings related to the replacement of toilets, clothes washing machines, and dishwashers. This sum is calculated for each year in the planning horizon for both the minimum and maximum savings scenarios.

The total water use for each county was then calculated for each year using the following equation:

$$WU^{yr}_{County} = (GPCD_{County} * POP^{yr}_{County}) - (\sum_{fix/app}(\Delta\ GPCD^{yr}_{fix/app} * POP^{fix/app}_{County}))$$

WU^{yr}_{County} = Total water use per county for each year[20] (gallons per day)

$GPCD_{County}$ = Gallons per capita per day for each county in the baseline year of 2000 (from SWSI I, see Appendix E)

POP^{yr}_{County} = Population of each county for each year (from SDO, 2010; CDM, 2004, 2010, see Appendix F)

$POP^{fix/app}_{County}$ = Population relevant to each type of retrofit for each county (see Table 5)

[20] Total Water Use for each county was calculated using this equation for those counties that are predicted to grow. For those counties that are not predicted to grow, or do not grow during any single year, the Total Water Use for that county was calculated as $(GPCD_{County} - \sum_{fix/app}(\Delta\ GPCD^{yr}_{fix/app})) * Pop^{yr}_{County})$. Counties with which did not have some growth in every year of the planning period included Baca, Bent, Cheyenne, Clear Creek, Conejos, Costilla, Jackson, Kiowa, Lincoln, Otero, Phillips, Prowers, Rio Blanco, Rio Grande, San Juan, Sedgewick, and Washington. All population in Broomfield County was treated as new growth.

Table 5 – Summary of Years Relevant to Fixture and Appliance Retrofits	
1.6 gpf Toilets	All pre-1994 construction (beginning the transition in 1996)[1]
1.28 gpf Toilets	All pre-2016 construction with 1.6 gpf or greater toilets
Clothes Washers	All pre-2006 construction
Dishwashers	All pre-2006 construction

[1] passive savings prior to 1996 were assumed to be included in the per capita toilet use reported in the literature for 1996 (Aquacraft, Inc., 2006).

Separate calculations were made using the minimum and maximum scenario values presented included in Table 6. **Note that the minimum and maximum passive savings scenarios were developed using only the "middle" population projects developed by CDM for 2050 as reported in Appendix F.**

Table 6 – Summary of Passive Saving Calculation Assumptions

	Per Use[1]		Rate of Use (daily)		Replacement Rate	
	Min	Max	Min	Max	Min	Max
Toilets						
Average Pre-1996 Toilet	3.97 gpf	3.97 gpf	7	7	25 years	83 years
1.6 gpf Toilet	1.6 gpf	1.6 gpf	7	7	25 years	83 years
1.28 gpf Toilet	0.9 gpf	1.28 gpf	7	7	25 years	83 years
Clothes Washers						
Pre-2005	42 gpl	42 gpl	0.35	0.35	12 years	15 years
Post-2005	14.3 gpl	18 gpl	0.35	0.35	12 years	15 years
Dishwashers						
Pre-2005	9.3 gpl	12.5 gpl	0.225	0.225	12 years	15 years
Post-2005	4.2 gpl	5.1 gpl	0.225	0.225	12 years	15 years

[1] gpf – gallons per flush; gpl – gallons per load

Results

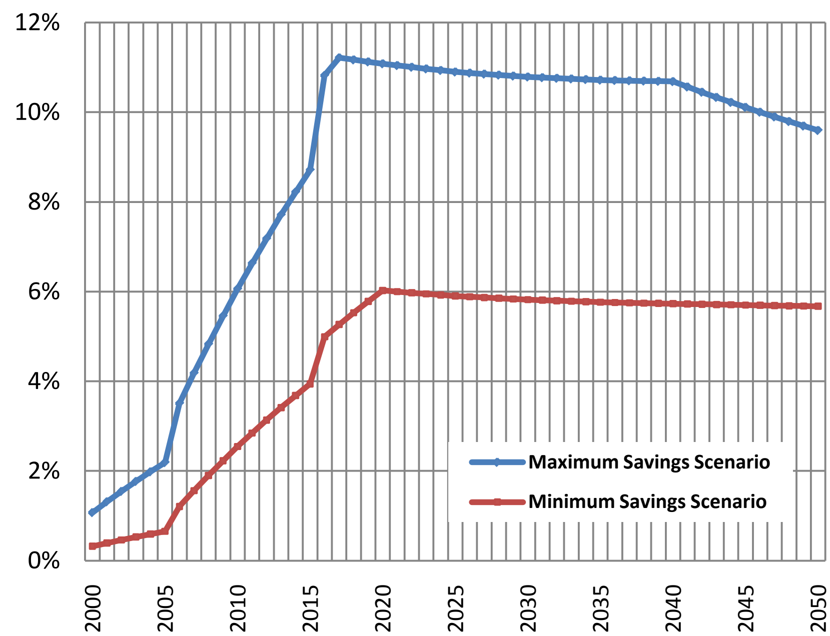
The results of the passive savings analyses indicate that future demand reductions, measured as a percentage of future statewide or basin wide M&I water demand[21], are dependent on both location and time. This is due to the fact that passive savings (measured as a percent of total M&I demand) are dependent on the age of the housing stock, the rate of population growth, current and future per capita water use, and the timing of fixture and appliance replacement. This observation is illustrated by the graph presented in Figure 7. Figure

[21] The method that was used by SWSI I involved developing percent saving estimates to predict passive water savings by basin and statewide. This report presents a similar analysis for comparison purposes.

7 presents the percent of passive savings versus the State's total M&I water demand for each year from 2000 to 2050 using the SWSI I defined baseline (i.e., 2000) gpcd demands by county (see Appendix E) using those assumptions listed in this section of the report.

From this figure, it can be seen that the percent of passive savings relative to statewide M&I demand changes each year. To begin with, a small amount of passive savings is shown to occur as a result of fixture replacements that occur from 1996 to 2000. For the period from 2005 to 2017 (or 2020, depending on the scenario), the percent of passive savings increases rapidly due to the replacement of clothes washers and dishwashers. It can further be seen that once the clothes washers and dishwashers have been replaced by either 2017 or 2020, the percent of passive savings relative to the statewide M&I demand decreases. This observed decrease results from the population increase generating additional demand which out paces the passive savings associated with the installation of high efficiency toilets. After 2017 or 2020, the percent of passive savings are expected to decrease statewide until the end of the planning period.

Figure 7 - Percent Statewide Demand Reduction From Passive Savings



Two key points of interest should be noted by the reader. First, the observed decrease in the percent of passive savings after 2017 (or 2020) may be offset or reversed in the future if technology enhancements or new regulations are developed to improve residential and/or business water use efficiency beyond that represented in the analyses conducted herein. Technologies may be developed to reduce any number of domestic or commercial water uses that would positively impact passive saving estimates after 2020. New ordinances and/or regulations dictating water use efficiency could also be established at the local, regional, state or federal level penetrating 100% of the targeted market, thus allowing for significant increases in passive water savings not included in the current analyses.

Table 7 brings into sharp focus the potential savings that could be realized by statewide legislation, new ordinances or regulations that effect new construction such as those that have been created in California. This table, which summarizes the number of new homes that will exist in Colorado over the coming decades, as compared to those that exist in 2010, provides some insight into the size of the new construction market and therefore the potential impact of new construction ordinances and/or regulations.

Table 7 – Estimated Percent Change in New Housing Stock in Colorado

	2020	2030	2040	2050
% Increase from 2010	20%	40%	57%	75%

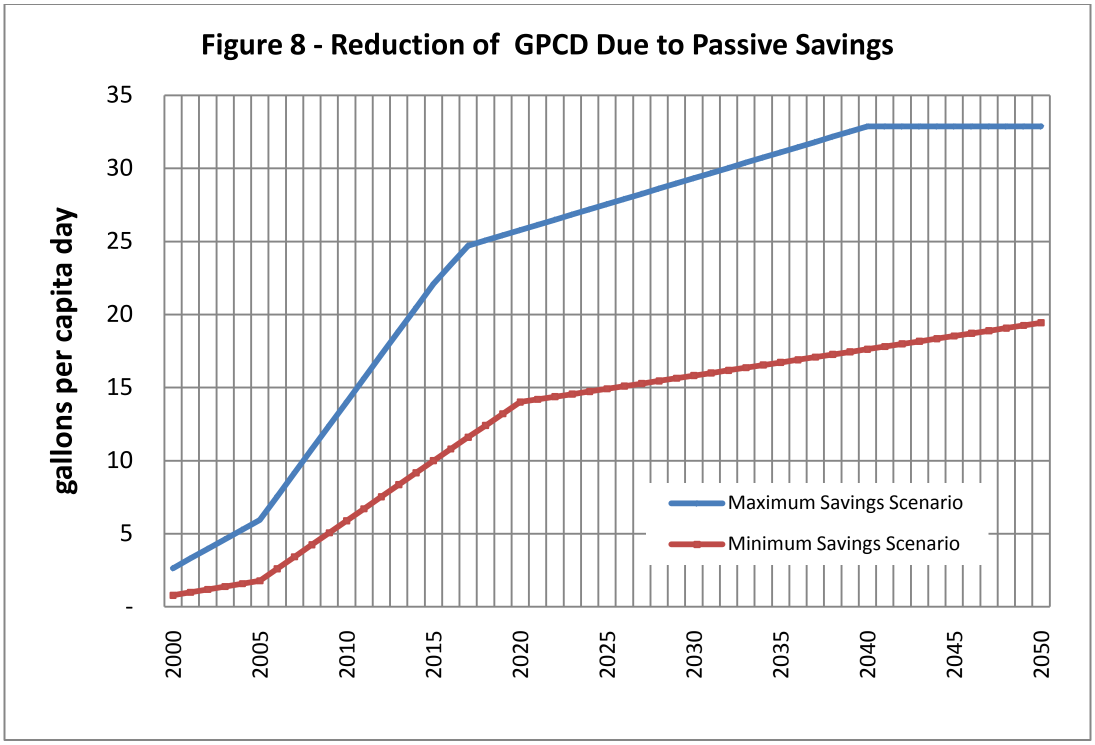
Second, the percentages of passive savings as presented in Figure 7 are impacted by the lasting effect of the 2002 drought on current and future water demand in the state[22]. Any lasting drought-related demand reduction that is not considered to be a component of future active water conservation would effectively decrease the State's total M&I demand, and result in an increase in the relative percentage of passive savings. The analyses presented in this report did not discount future M&I demand by any lasting impact of the 2002 drought.

Importantly, the impact of the passive savings on daily per capita water use is not affected by population growth, or the lasting impact of the drought. Figure 8 presents the reduction of daily per capita water use as natural toilet, clothes washer and dishwasher replacement occurs in the State. This figure exhibits the same general trends indicated in Figure 7 – namely the change of savings related to when clothes washers and dishwashers are replaced; however, Figure 8 shows only the change to daily per capita water use, which does not decrease at any point in time, but rather flattens out once maximum passive savings have been realized.

Based on the analyses presented in Figure 8, passive savings are expected to reduce system wide daily per capita water use by between 19 and 33 gpcd by 2050. These savings, which are chiefly associated with residential indoor water use, represent a reduction of between 23% and 39% of the average indoor water use reported by Western Resource Advocates (2003) of 69.3 gpcd[23].

[22] A 22% reduction in M&I demand that was observed in 2003 as a result of the 2002 drought – based on the impact of media messaging, watering restrictions, and other customer behavioral changes. Many water providers in Colorado (Joint Technical Activities Committee, 2010) have indicated that pre-drought water demands may not be observed for many years. If water demand does not fully rebound to pre-drought levels, then passive savings will be greater as a percentage of the reduced M&I demand. Note that in some cases, (e.g., Denver Water and Colorado Springs), local Water Conservation Plans call for the implementation of specific measures and programs that will extend the effects of the drought on customer water use. In these cases, prolonging the drought impact is considered to be active water conservation. In cases where the impacts of the drought extend beyond active water conservation practices, the percentage of passive water savings relative to total &I demand would need to be revised accordingly.

[23] The maximum and minimum savings for residential indoor water use were estimated to be about 17 and 27 gpcd, respectively. The remaining passive water savings relate to water use at businesses associated with increased toilet efficiency.



Another important aspect of passive savings is the predicted water demand reduction by river basin. Passive savings vary by major river basin in Colorado due to differences in housing stock, current system wide per capita water use and expected rates of population growth. Table 8 presents the passive savings estimated for each major river basin in 2030 (to allow for a ready comparison between the 6% passive savings used for passive savings in SWSI I and the results of the analyses performed as a result if this project) and 2050, as a percentage of total M&I demand. Based on the information contained in Table 8, it can be seen that the percent of passive conservation ranges from a low of 4.0% to a high of 11.1% in 2030, with a statewide average of between 5.8% and 10.8% in 2030. These percentages of passive savings decrease over time from 2030 to 2050 as presented in Table 8.

An estimate of the acre-feet of passive savings is a better metric to support planning efforts (e.g., the SWSI update) than the percentage of passive savings, since the acre-feet of savings do not vary by time, per capita water use, changes in future population estimates (after current projections for the years 2010 through 2015), or the lasting impact of drought on future M&I water demand. This is due to the fact that total acre feet of passive savings are only a function of per capita water use caused by the impact of retrofits and /or fixture replacement and the population of each county in 1994, 2005 and 2015 (based on the assumptions provided herein). Population projections changes for the years after 2015 will not change the total acre feet of passive savings estimated using the methodologies presented in this report. Table 9 presents the acre-feet of passive water savings calculated based on the assumptions presented in this section.

Table 8 – Percent of Passive Savings by Major River Basin and Statewide[1]

	2030 (%)		2050 (%)	
	Minimum	Maximum	Minimum	Maximum
Arkansas	5.9	11.0	5.9	9.9
Colorado	4.7	8.7	4.0	6.8
Dolores/San Juan	5.6	10.3	5.2	8.7
Gunnison	5.6	10.4	5.4	9.1
North Platte	5.5	10.2	5.4	9.2
Rio Grande	4.0	7.5	4.1	6.9
South Platte	6.0	11.2	6.0	10.2
Yampa/White	4.8	9.0	3.7	6.2
Statewide	**5.9**	**10.9**	**5.7**	**9.7**

[1] As a percentage of total M&I demand without including self-supplied water supplies.

Table 9 – Acre Feet of Passive Savings by Major River Basin and Statewide

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

[1] Statewide totals have been rounded to three significant digits.

Discussion and Recommendations

In practice, it is expected that actual passive savings that will be realized over the coming decades will trend toward the maximum savings estimates presented in Table 9 for a number of reasons. To begin with, water and energy savings will become increasingly important to water customers as water and fuel costs rise. As water customers seek more efficiency in their homes and businesses, high efficiency fixtures and appliances will become increasingly efficient as technology improves and customers strive to reduce their variable costs related to water and energy.

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

Regulation of existing construction can be developed using the California models, to require and inspect for the installation of high-efficiency toilets, shower heads, faucet aerators, dishwashers, and clothes washers as real estate is bought and sold. Regulation of new construction can be even more far-reaching and substantial with respect to future per capita water use demand reductions – since both indoor and outdoor water use can be addressed for all customer types (i.e., residential, commercial, industrial, etc.). Table 7 provides insight into how many new homes will be created in Colorado overtime, as an indication of the potential breadth and relevance of new construction regulations.

Finally, the impact of commercial retrofits (e.g., restaurants, motels, ski area condominiums, centralized laundries, commercial laundries, bars, etc.), is not well captured in the passive savings analyses since information regarding numbers of and ages of individual types of commercial properties were not available. Passive savings estimates will increase as more commercial, industrial and/or institutional water customers install retrofits.

For all these reasons, it is more realistic to expect 200,000 plus acre-feet of passive water savings statewide by the year 2050, than less than 200,000 acre-feet.

There are of course limitations related to the analyses presented in this section. It is vital for any entity or individual that chooses to use the data presented in the passive analyses to understand these limitations. To begin with, total water use adjustments using percentages have limited accuracy. Although information associated with water use by individuals using toilets, clothes washers and dish washer can be estimated on average, substantial differences may exist between counties and river basins due to the age and nature of housing stock and commercial water uses. It is more accurate to utilize estimated reductions in per capita water use for housing stock that is a candidate for retrofits, as opposed to percentages, since percentages change both spatially and temporally.

The impact of passive savings on future M&I water use demand is only one part of the overall puzzle related to predicting future water demands in Colorado. Water use demand reductions in the future may result from any one of the following impacts, in addition to passive water savings:

- Drought related (either related to lasting impacts of the 2002 drought in locations that have not implemented active conservation efforts to prolong drought water use behaviors, or the impacts of future droughts)
- Active savings (related to measures and programs implemented directly by water providers to reduce customer water demand and improve customer water use efficiency)
- Other savings (e.g., increases in density of new construction)

As water demand reductions occur in the future, it will be difficult to discern which of these categories of factors create the observed changes in water use, especially in locations with multi-faceted water conservation programs. Therefore, passive savings may be lumped into other categories of future water savings observed by utilities, such that it may be difficult to measure the exact impact of passive savings within any specific utility's service area without a focused data collection and related customer evaluation program. To this point, verifying passive savings in the future will require coordinated data collection efforts conducted by water utilities and the state taking into consideration the effects of ongoing water conservation programs.

Data collection efforts by water utilities and the State will need to include tracking water use and water savings by individual water customers and customer classes related to specific measures and programs that a utility chooses to implement. The water utilities should also track dollars spent per water conservation measure and program, timing of program implementation, and market penetration rates. More information regarding the data collection efforts that are most valuable will be developed by the Office and the Water Conservation Technical Advisory Group.