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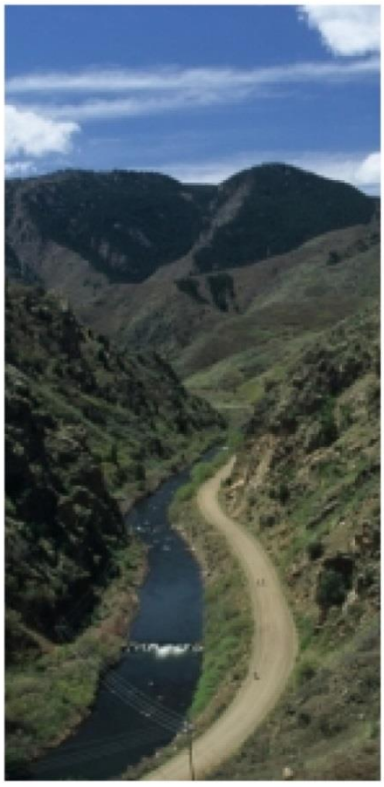

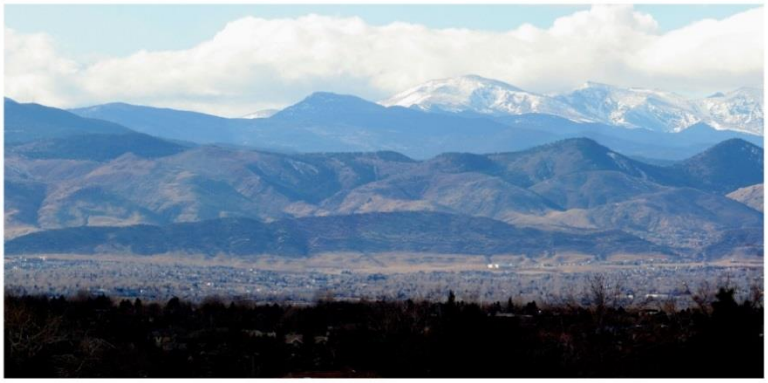

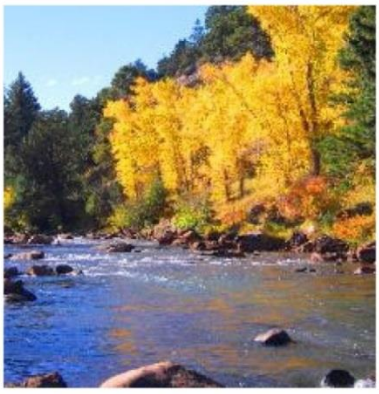

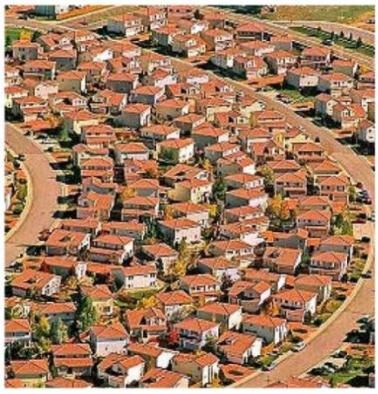

The Keystone Center

COLORADO WATER AND GROWTH DIALOG

Research Report | March 2015

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Introduction

As part of the Colorado Water and Growth Dialog, the Keystone Center retained Clarion Associates to review what actions other states and local governments have taken to reduce water consumption in new development. More specifically, the firm was requested to research what actions have been taken related to comprehensive planning, zoning, subdivision, and land development regulation before initial occupancy of new development that would have a significant impact on water consumption in that project, building, or facility after it is occupied and throughout its useful life. Items to be considered included planning, zoning, subdivision, site planning, and building code regulations and incentives to builders. Consistent with this approach, our research did not include water savings through (1) education of the public to modify its behavior in the use of water (for example, by reducing the frequency of irrigation), or (2) publicly funded programs to offer funding or rebates to property owners who retrofit water saving devices after the initial approval and occupancy of a new house or commercial/industrial property.

In order to address these questions, Clarion Associates conducted a literature and web review and interviewed key individuals in state and local government and research institutions to explore two difference sources of guidance:

(1) We reviewed studies that have been conducted to estimate or measure water savings caused by pre-occupancy decisions (even if they are based on modeling assumptions that have not been implemented by a local government), and

(2) We reviewed examples of pre-occupancy programs, regulations, and incentives to reduce water consumption that have been adopted by state and local governments (even if there has not been post-adoption documentation of water savings).

Our goal was to identify land use approaches and strategies that show promise in measurably reducing the water footprint of new development and redevelopment, as well as quantification of that reduction, if it exists. Our research included, but was not limited to, recent work in Colorado by the Pace University Land Use Leadership Alliance and by the Colorado Water Conservation Board (CWCB).

The research was conducted in December 2014 and January 2015, and our preliminary findings are stated in the pages that follow. Following this Introduction, this document is divided into the following three sections:

Phase 1: Data on Pre-Occupancy Actions that Save Water

Phase 2: Examples of Implemented Water Saving Programs

Conclusions and Potential Strategies

Phase 1: Data on Pre-Occupancy Actions that Save Water

1. Increasing Residential Density

Colorado Water Conservation Board Technical Memo: Calculating Per Capita Water Demand Savings from Density Increases to Residential Housing for Portfolio and Trade-off Tool

This technical memorandum published by the Colorado Water Conservation Board (CWCB)[1] found that population density and water use (calculated as gallons per day per capita) are inversely correlated. With an assumption that residential water use is split evenly between indoor and outdoor use, the expected savings from increasing density by 20% will yield approximately a 10% decrease in water consumption. The savings start to diminish after density reaches 10 dwelling units per acre. [2]

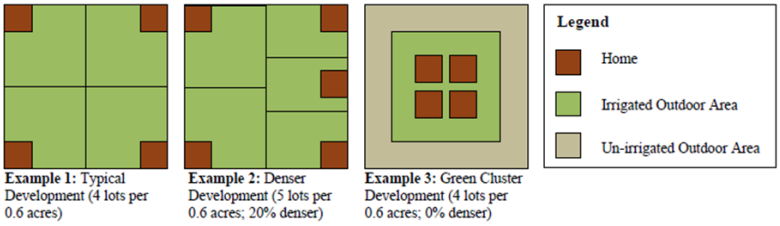


Figure 1: Representation of typical, denser, and green developments.

The figure above shows different types of development patterns, the first example being typical suburban development at 4 lots per 0.6 acres, the second an example of 20% denser with a subsequent 10% in water savings, and the third an example of "Green Cluster Development" which shows even more promise for water savings given the reduction in irrigated landscaping.[3]

[1] The technical memorandum was a theoretical exercise and not based on empirical work done by the CWCB
[2] http://cwcb.state.co.us/public-information/publications/Documents/ReportsStudies/DRAFTDensityTechnicalMemo.pdf
[3] http://cwcb.state.co.us/public-information/publications/Documents/ReportsStudies/DRAFTDensityTechnicalMemo.pdf

Table 1. Theoretical justification for reduction values by units						
Unit Category	Number of Residents	Incremental Increase in Density	Annual Water Use (AF)	GPCD	Per Capita Water Savings	Division Factor
1 unit (status quo)	2.94		0.53	162.00		
1 to 2 units	3.68	20%	0.60	145.80	-10.00%	-2.00
1 to 2 units	4.60	20%	0.68	132.84	-8.89%	-2.25
1 to 2 units	5.75	20%	0.79	122.47	-7.80%	-2.56
3 to 4 units	7.18	20%	0.92	114.18	-6.77%	-2.95
3 to 4 units	8.98	20%	1.08	107.54	-5.81%	-3.44
3 to 4 units	11.22	20%	1.29	102.23	-4.94%	-4.05
3 to 4 units	14.03	20%	1.54	97.99	-4.15%	-4.81
5 to 9 units	17.53	20%	1.86	94.59	-3.47%	-5.77
5 to 9 units	21.92	20%	2.26	91.87	-2.87%	-6.96
5 to 9 units	27.40	20%	2.75	89.70	-2.37%	-8.45
10 to 19 units	34.25	20%	3.37	87.96	-1.94%	-10.31
10 to 19 units	42.81	20%	4.15	86.57	-1.58%	-12.64
10 to 19 units	53.51	20%	5.12	85.45	-1.29%	-15.55
20 or more units	66.89	20%	6.34	84.56	-1.04%	-19.19
20 or more units	83.61	20%	7.85	83.85	-0.84%	-23.74
20 or more units	104.52	20%	9.75	83.28	-0.68%	-29.42

[4]

The table above shows the water savings by increasing residential density by increments of 20%. The savings start to dimish when residential density reaches the projects of more than 10 units or 34.25 residents.

The graphs to the right show these savings in graph form. The data shows that significant savings can be achieved through increasing density from the status quo, one unit, to five to nine units.[5]

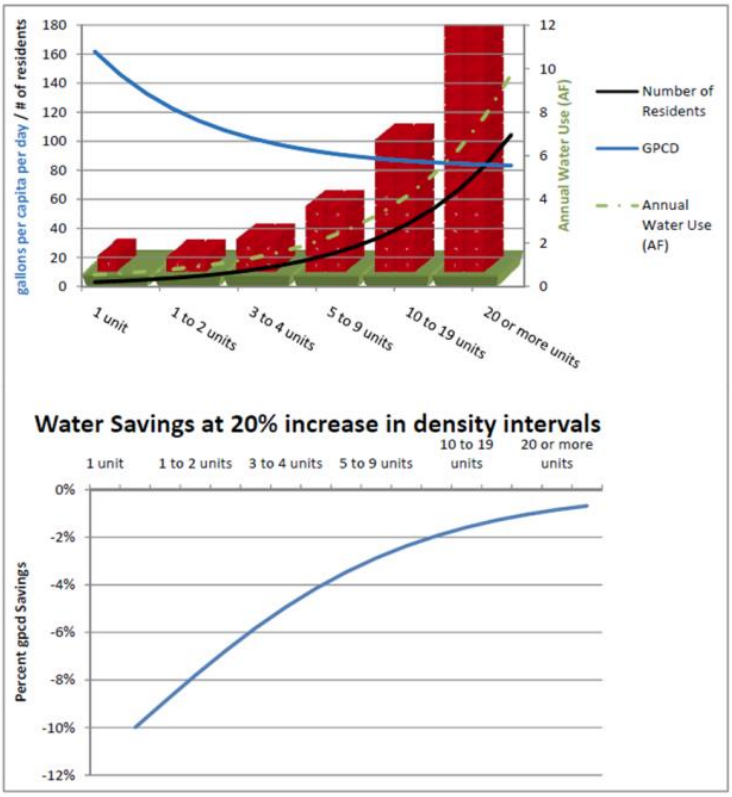


Figure 2. Diminishing GPCD reductions when increasing the density of multi-family units in 20% intervals.

[4] http://cwcb.state.co.us/public-information/publications/Documents/ReportsStudies/DRAFTDensityTechnicalMemo.pdf
[5] http://cwcb.state.co.us/public-information/publications/Documents/ReportsStudies/DRAFTDensityTechnicalMemo.pdf

Environmental Protection Agency: Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies.

This study found that the principles of smart growth development can help communities reduce water infrastructure costs and conserve water. The study points to data from Utah, "where planners determined that water demand drops from approximately 220 gallons per capita per day at a density of two units per acre to 110 gallons per day at a density of five units per acre." The study also cites findings from Sacramento, where demand for water in the "Metro Square Development" (a neighborhood of 46 single-family dwellings on compact lots) was 20 to 30 percent less than suburban development patterns[6]. A study from Seattle found that homes on 6,500 square foot lots used 60% less water than homes on 16,000 foot lots. This data echoes the Colorado Water Conservation Board's findings that water savings can be achieved by increasing density but only up to a certain density level.[7]

Southern Nevada Water Authority: Population Density & Housing Types Influence on Water Demand

Extensive research conducted by the Southern Nevada Water Authority (SNWA) shows that density allows for water conservation savings up to a certain point. The Authority looked at lot sizes and different types of development patterns to understand the linkage between higher density development and water savings. The SNWA created different classes of development types among customers of the Las Vegas Valley Water District primarily based upon the Assessor's Office Land Use Codes. The SNWA differentiates development as pre- or post-2003 because drought conditions imposed major landscape development changes. The following table provides a brief explanation of the different development styles the SNWA compared.

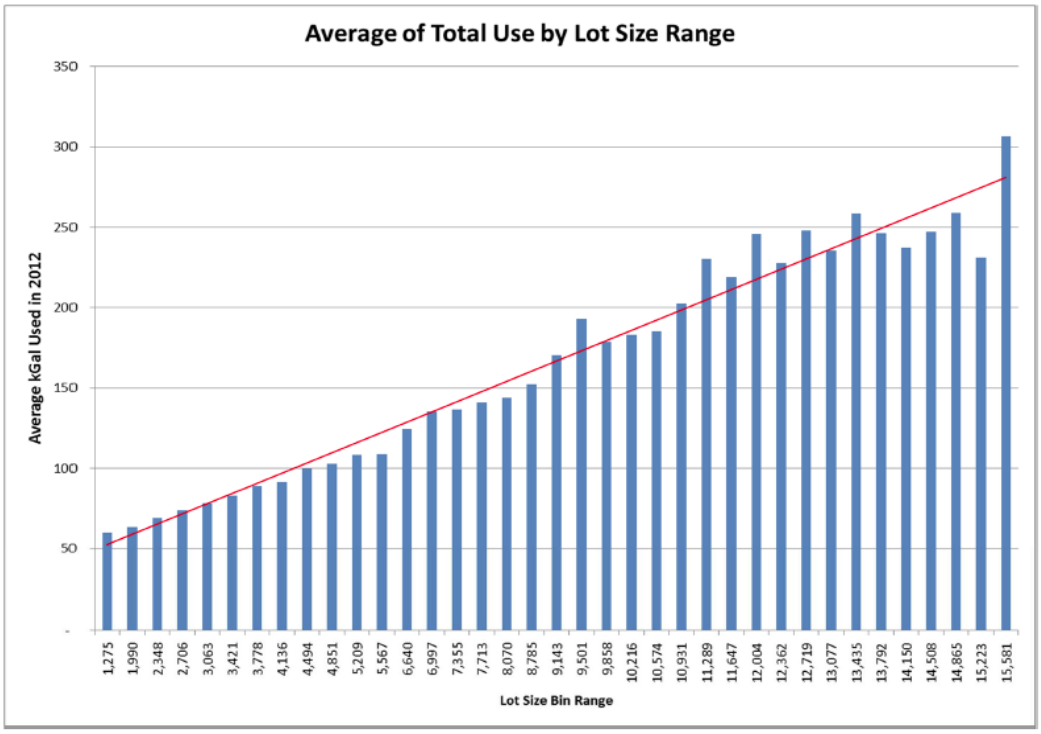
Definition and Explanation of Unit Type Compared by the SNWA		
DEVELOPMENT TYPE	CLARK COUNTY LAND USE CODE	DESCRIPTION
"Average Home"	110: Single family residences, including condominium owned detached residences.	All detached single family residences, all construction years.
"New Homes"	110: Single family residences, including condominium owned detached residences.	All detached single family residences, built between 2005-2007.
"WaterSmart Homes"	110: Single family residences, including condominium owned detached residences.	All detached single family residences built in accordance with SNWA's WaterSmart Homes Program provisions in effect.
"Super-high Efficient Homes without turf"	110: Single family residences, including condominium owned detached residences.	Selected detached single family residences built in 2009-2010 that were outfitted with state-of-the art conservation technologies and which had all water-efficient landscaping without turfgrass.
"Pre-2003 Apartments"	150: Apartments; Five or more household units within a single	Apartments with five or more discrete household units within a single structure, built before 2003.

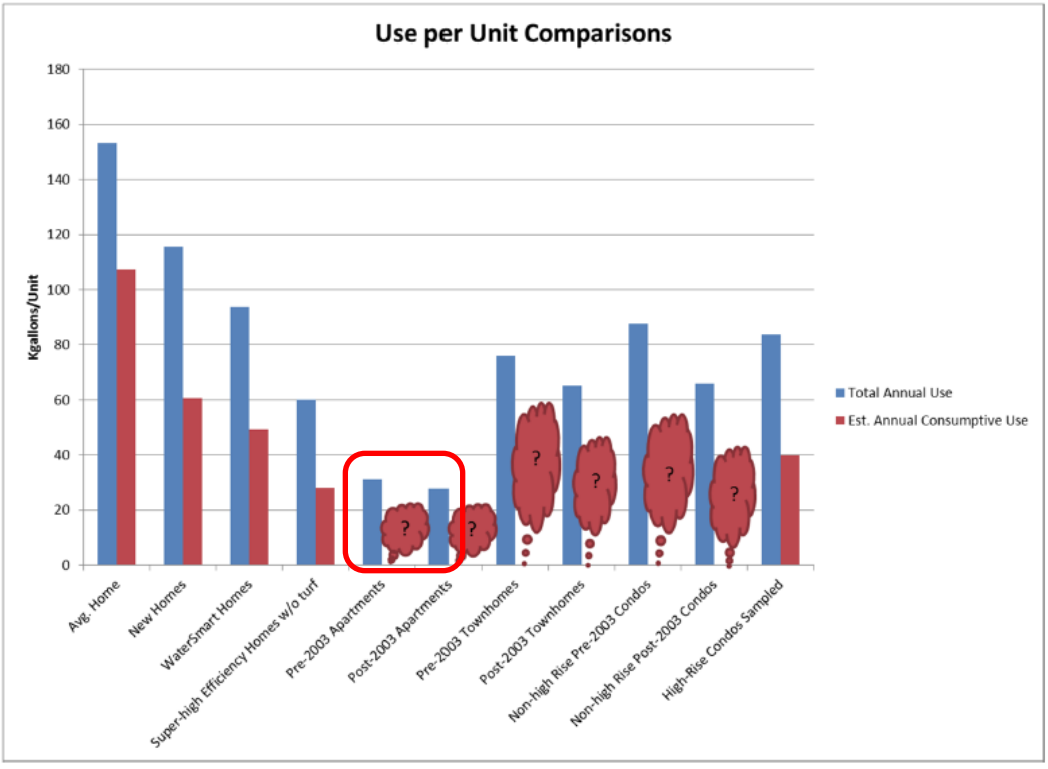
[6] Sacramento did not have water meters in place for this study; water savings were estimated based on comparisons between lot sizes of different neighborhoods.
[7] http://www.epa.gov/smartgrowth/pdf/growing_water_use_efficiency.pdf

	structure.	
“Post-2003 Apartments”	150: Apartments; Five or more household units within a single structure.	Apartments with five or more discrete household units within a single structure, built after 2003.
“Pre-2003 Townhomes”	160: Townhouses: Single family attached residences including condominium-owned townhouses.	Single-family attached type residences including condominium-owned townhouses. Built before 2003.
“Post-2003 Townhomes”	160: Townhouses: Single family attached residences including condominium-owned townhouses.	Single-family attached type residences including condominium-owned townhouses. Built after 2003.
"Non-high Rise Pre-2003 Condos"	170: Multi-Family Structure: This includes low rise and high rise units, typical of condominium owned residences.	LUC 170 properties, excluding properties over 3-4 stories. These are typical condominium-owned residences. Built before 2003. The idea here was to get properties where non-evaporative cooling was used.
"Non-high Rise Post-2003 Condos"	170: Multi-Family Structure: This includes low rise and high rise units, typical of condominium owned residences.	LUC 170 properties, excluding properties over 3-4 stories. These are typical condominium-owned residences. Built after 2003. The idea here was to get properties where non-evaporative cooling was used.
“High Rise Condos”	170: Multi-Family Structure: This includes low rise and high rise units, typical of condominium owned residences.	Selected clearly high-rise developments ("Towers") typical of the popular styles that came into Las Vegas in the 2005-2007 timeframe. Sizes ranges from under 100 to over 600 units.

It found that apartment buildings between two and four stories allowed for the most savings in water use, but also found that high rise condos, popular in Las Vegas, actually do not give significant water savings because of their need for water intensive cooling towers. This finding fits into the narrative that water savings from increasing density can only capture so much in savings before it levels off. The graphs below show the average total use by lot size in the SNWA jurisdiction and unit type comparisons.[8] Note the significant water conservation achievements by pre- and post-2003 apartment complexes.

[8] SNWA: Population Density and Housing Type Influence on Water Demand. File retrieve from Doug Bennett from the SNWA on 1-14-15.





[9]

[9] SNWA: Population Density and Housing Type Influence on Water Demand. File retrieve from Doug Bennett from the SNWA on January 14, 2015. Red "clouds" indicate areas where data was not available.

City of Phoenix: 2011 Water Resource Plan

The City of Phoenix found that from the 1970s to the 1990s the average lot size decreased by 20% and the average landscaped area decreased by 28%. At the same time, the average home size increased in livable square footage, and the number of multi-story homes increased. The plan attributes these findings as a direct response to the rising cost of land through a 20 year period. The graph below shows these reductions in lot sizes and landscaped areas over time. [10]

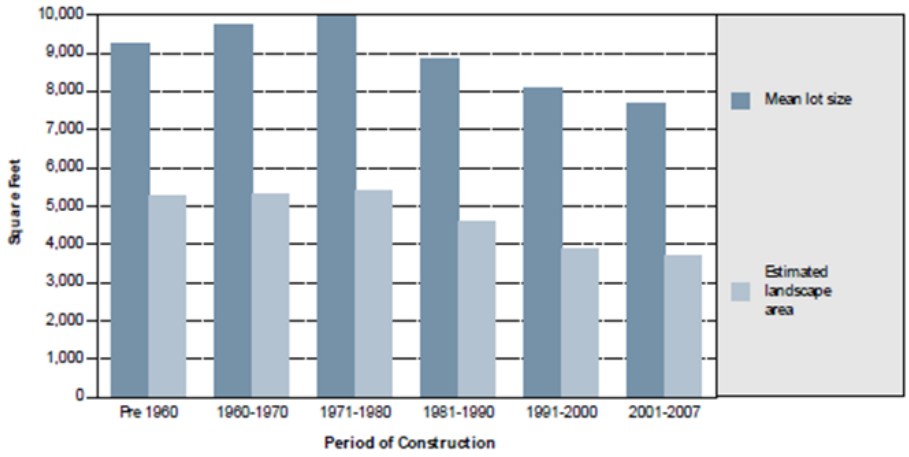


Figure 3-9. Reduction in Lot Size and Landscaped Area [11]

Phoenix has documented significant water savings both in total GPCD and Residential GPCD. While other forces have contributed to these savings, the city concludes that smaller lot sizes and landscaped areas played an important role.

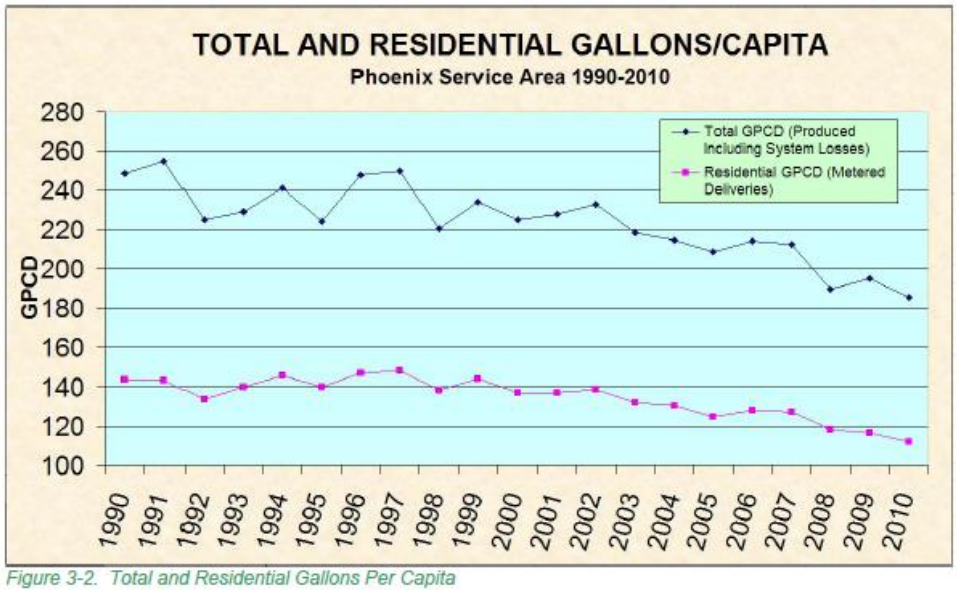


Figure 3-2. Total and Residential Gallons Per Capita [12]

[10] https://www.phoenix.gov/waterservicessite/Documents/wsd2011wrp.pdf
[11] https://www.phoenix.gov/waterservicessite/Documents/wsd2011wrp.pdf

Envision Utah: Phase II: Development Scenarios

Envision Utah used growth scenarios to quantify water conservation savings from increasing density. The organization proposed four growth scenarios ranging from low density auto-oriented to compact/transit oriented development. Its study found that "Scenario C" (focused on transit oriented development, infill redevelopment, walkability, and alternative transportation investments) had the most significant savings in terms of both water conservation and infrastructure cost, while "Scenario D" had the greatest water savings alone. The graphic below shows potential savings achieved both in terms of water demand and cost of infrastructure.[13] The following graphic provides a brief explanation of all the different scenarios.

EXHIBIT 2: Envision Utah Quality Growth Impacts

	Approaches	Baseline	Quality Growth	Quality Growth Savings
Water Demand	• Changes in lot size • Different allocation of population and employment across area • Use of conservation pricing (although overall price of water did not change)	298 gallons per day per capita	267 gallons per day per capita	10.4%
Cost of Infrastructure	• Reduced length of new pipes required • Expanded use of existing infrastructure through infill development	$2.629 billion (in 1999 dollars)	$2.087 billion (in 1999 dollars)	20.6%

Definitions and Explanations of Envision Utah Growth Scenarios					
SCENARIO	DEVELOPMENT PATTERN	HOUSING MIX	AVERAGE LOT SIZE	URBAN AREA GROWTH (1998 TO 2020)	WATER CONSUMPTION
Scenario A	• Dispersed pattern of development.	• 77% single family residential. • Fewer housing choices. • Predominately large lot suburban development.	0.37 acres	95%	Highest water consumption of all scenarios
Scenario B	• If state and local governments follow their 1997 municipal	• 75% single family residential. • Most new housing is	0.32 acres	75%	Second highest water consumption of all scenarios

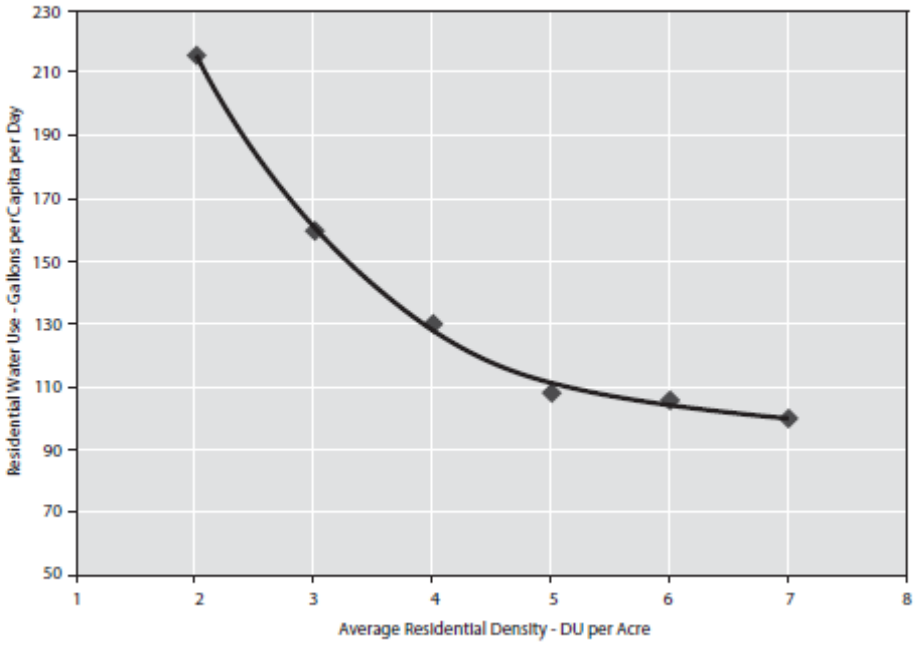
[12] https://www.phoenix.gov/waterservicessite/Documents/wsd2011wrp.pdf
[13] http://envisionutah.org/

Definitions and Explanations of Envision Utah Growth Scenarios					
SCENARIO	DEVELOPMENT PATTERN	HOUSING MIX	AVERAGE LOT SIZE	URBAN AREA GROWTH (1998 TO 2020)	WATER CONSUMPTION
	plans. • Continued dispersed development but not as widespread as A. • Focus on convenience for auto users with transportation investments.	on large lots. • A few more condos, apartments, and small lot homes than A.			
Scenario C	• Focus on walkable communities with mixed uses and proximity to transit. • Accommodate a portion of new growth within existing urbanized areas. • Clustered development around town centers. • Wider variety of housing types than A and B.	• Majority of homes are single family residential, but on smaller lots. • Wider variety of housing options available than in A or B: townhomes, condos, apartments, small lot homes. • New housing located in villages and towns situated along major roads and rail lines.	0.29 acres	29%	Second Lowest water consumption of all scenarios
Scenario D	• Focus on walkable communities with mixed uses and proximity to transit. • Cluster development surrounding a town center with a mix of uses. • Greatest variety of housing options. • Greatly expanded transit system. • Almost half of new growth is focused in urbanized areas.	• Most new homes are single family homes or townhouses on smaller lots. • Wider variety of housing options available than all other scenarios • Most new housing located in existing urban areas and in villages and towns along major roads and rail lines.	0.27 acres	20%	Lowest Water Consumption of all scenarios

The graphic below shows Envision Utah's version of the per capita water savings from higher density development. Even though there are differences in scale and density levels, both the findings of both CWCB and Envision Utah findings tell the same story: increasing residential density leads to significant water savings up until a certain point. While this water use curve levels off at lower densities than the Colorado Water Conservation Board's findings, it still shows that increasing density from one dwelling unit per acre to four or five dwelling units per acre results in considerable water savings.

EXHIBIT 3: Per Capita Water Use Declines with Higher Densities

Per Capita Residential Water Use as a Function of Residential Density



Dave Eckhoff, PSOMAS Engineering
Source: Tim Watkins, Envision Utah, June 24, 2003

Southern Nevada Water Authority: Presentation to the Office of the Nevada State Engineer

This report found that "homes built after the 2003 development standards became effective use about half as much water as homes built just prior. The reduction appears to be largely attributable to higher densities and more efficient landscape irrigation." The report only included homes with a continuous pattern of water use (avoiding unoccupied homes) and excluded homes built between 2000 and 2003 that had participated in the Water Smart Landscapes Program.[14] Like the data provided by Phoenix, the SNWA found significant water savings from newer construction, which are more likely to be at higher densities and to have desert adapted landscapes. The graph below shows these savings in terms of average monthly consumption per home.

[14] http://water.nv.gov/hearings/past/springetal/browseabledocs/Exhibits%5CSNWA%20Exhibits/SNWA_Exh_004_Bennett%20Report.pdf\

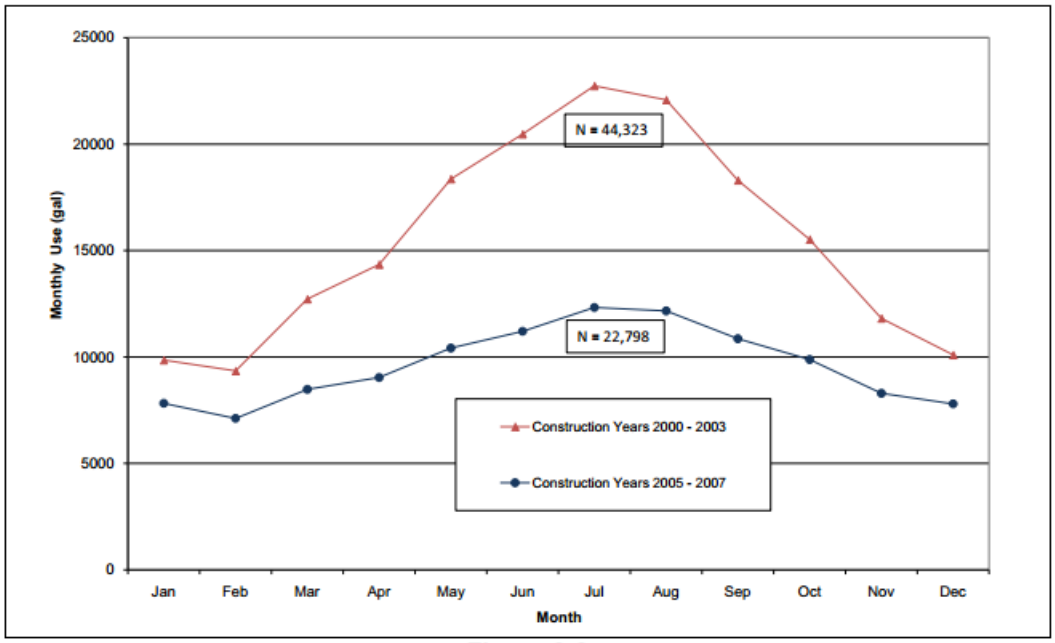


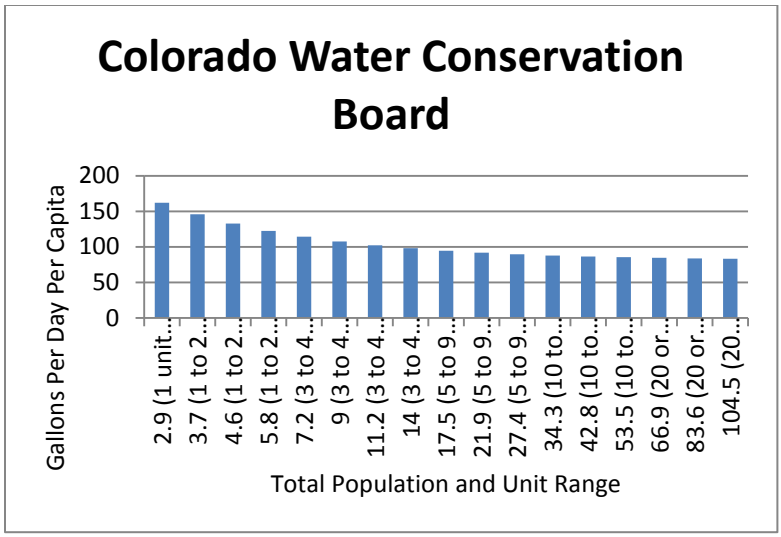
Figure 8-2
Average Home Monthly Consumption 2007-2008

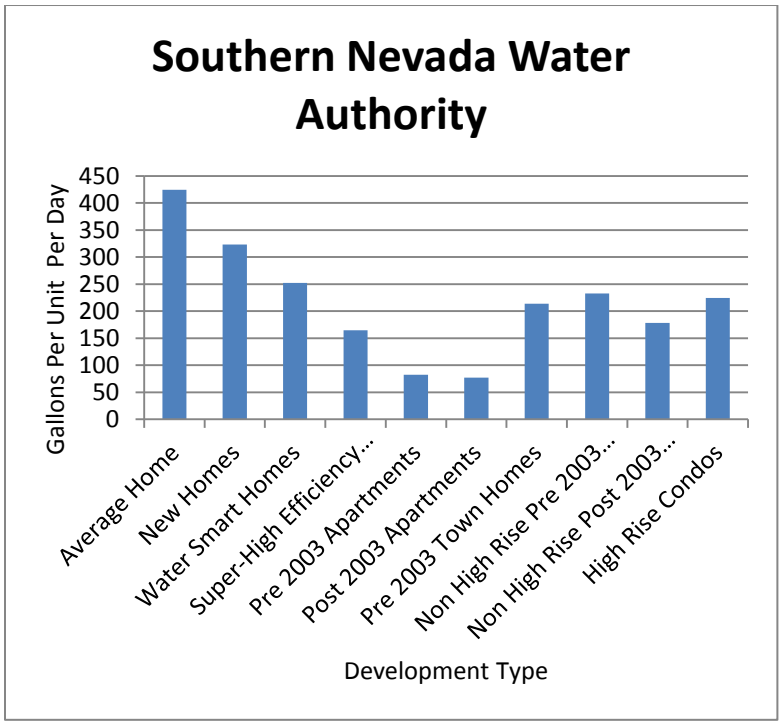
[15]

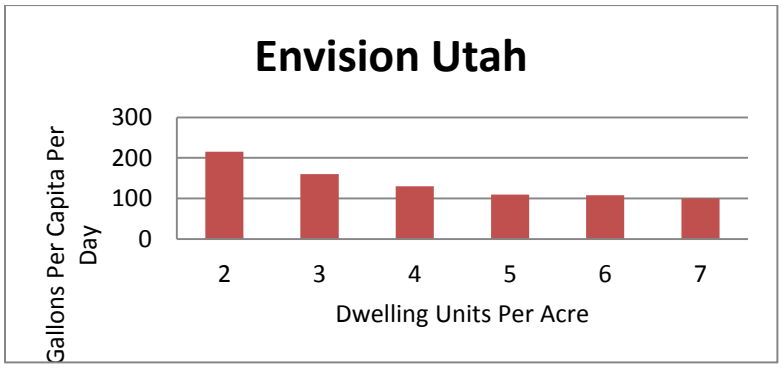
Model Comparisons

We compared the density models created by the Colorado Water Conservation Board, the Southern Nevada Water Authority, and Envision Utah to understand where the most effective water footprint reductions occur. To do this, we had to standardize the data. The Colorado Water Conservation Board data was the most comprehensive, with information on total residents and numbers of dwelling units making it possible to calculate gallons per day per capita. However, this study used ranges of unit sizes (rather than specific unit sizes), making it impossible to accurately calculate the gallons per day per unit amount of water usage. The Southern Nevada Water Authority data only included water use by unit, not per capita. We used the average household size from the US Census to calculate the per capita figure for each housing type but are reluctant to include these figures because household size tends to vary greatly across different types of units, which could misrepresent the data. The Envision Utah data is in dwelling units per acre and has the estimated gallons per capita per day but does not include the average household size per dwelling unit.

[15] http://water.nv.gov/hearings/past/springetal/browseabledocs/Exhibits%5CSNWA%20Exhibits/SNWA_Exh_004_Bennett%20Report.pdf\


Colorado Water Conservation Board
Gallons Per Day Per Capita
200
150
100
50
0
2.9 (1 unit...
3.7 (1 to 2...
4.6 (1 to 2...
5.8 (1 to 2...
7.2 (3 to 4...
9 (3 to 4...
11.2 (3 to 4...
14 (3 to 4...
17.5 (5 to 9...
21.9 (5 to 9...
27.4 (5 to 9...
34.3 (10 to...
42.8 (10 to...
53.5 (10 to...
66.9 (20 or...
83.6 (20 or...
104.5 (20...
Total Population and Unit Range


Southern Nevada Water Authority
Gallons Per Unit Per Day
450
400
350
300
250
200
150
100
50
0
Average Home
New Homes
Water Smart Homes
Super-High Efficiency...
Pre 2003 Apartments
Post 2003 Apartments
Pre 2003 Town Homes
Non High Rise Pre 2003...
Non High Rise Post 2003...
High Rise Condos
Development Type


Envision Utah
Gallons Per Capita Per Day
300
200
100
0
2
3
4
5
6
7
Dwelling Units Per Acre

While each dataset had limitations and were unable to be completely standardized[16], we can make some initial observations about the relationship between increased density and reduced water consumption. In all three locations, an increase in density did result in reduced water footprints to a certain point. All of the models show a sharp decrease in water consumption when going from a traditional suburban development pattern to a more compact form. In the case of Colorado and Utah, going from 1 to 2 units to 3-4 dwelling units per acre, and in the case of Nevada going from an average single-family detached homes to townhomes. After an initial reduction, the data begins to diverge. The Colorado and Utah data suggests that the savings start to taper off after 10 dwelling units and 7 dwelling units per acre respectively, while the Nevada study suggests the highest savings are from apartment style developments. These studies focused exclusively on unit density and do not take environmental or social differences into consideration. This finding was confirmed by Doug Bennett from SNWA, who stated that the lowest footprints were from apartment buildings that tended to be two to three stories tall, and that buildings taller than that often require water intensive technology to cool the building.[17]

Limitations

An interview with Ray Quay, a Research Professional at the Decision Center for a Desert City, offered some potential limitations with water savings associated with increasing density. While multifamily development has led to significant water savings in some locations, planners should not view this as an automatic route to significant water conservation. Quay stated that in some cases federal standards for fixtures, market trends towards native landscaping, and reductions in lot sizes can result in single-family detached residential units with water consumption on par with multifamily uses. In addition, "resort-style" multifamily living that include amenities such as swimming pools and turf landscaping consume large amounts of water, so it is often useful to estimate potential water use in long-term multifamily residential complexes and resort-oriented multifamily projects differently. Due to difficulties in obtaining accurate disaggregated data for multifamily housing, often due to the lack of sub-metering for individual units, developments being built out over longer periods of time (and therefore being only partially occupied during part of the study period), and unattributed irrigated landscapes, more research needs to be done in the field to provide greater clarity in potential water savings available from multifamily residential development.[18]

2. Landscaping and Turf Limitations

California Department of Water Resources and Sonoma State University: Integrating Water and Land Management: A Suburban Case Study and Locally Adaptable Tool.

This study was conducted through a partnership between the California Department of Water Resources and Sonoma State University to develop a locally adaptable tool to "help guide land use and land cover

[16] The spread from the Envision Utah data is greater with a higher GPCD starting point while the CWCB data shows a smaller spread with a lower CPCD starting point, but the points of inflection are similar.
[17] Although the CWCB study analyzed per capita use by building type and per capita occupancy, the same results would hold true if the analysis were conducted based on an acre of land developed with each of the building types used in the study. Telephone call with study author Jacob Bornstein, February 12, 2015.
[18] Interview: Ray Quay: Research Professional, Decision Center for a Desert City. Conducted 1-16-15.

decisions [and among other goals] quantify relationships between land use alternatives and key water management benefits relating to water supply."[19] While this study had a greater focus on stormwater management, many of the concepts are transferable to water conservation.

The study created a tool with land cover and water infrastructure (not development density) as its inputs. Outputs included water metrics (percent impervious surface, storm water runoff, outdoor water requirements, and greenhouse gas emissions) and monetary metrics (cost of implementation over different time horizons). The tool was used to compare four different types of development in Sonoma County with different densities and storm water management practices. The traditional development was single family residential with densities at 4 units per acre and with "predated stormwater policies" and no "explicit incorporation" of Low Impact Development (LID) or Leadership in Energy and Environmental Design (LEED). The Local Standard development had higher residential densities of 9 units per acre and followed the Standard Urban Stormwater Mitigation Plan (SUSMP) which was "an earlier local requirement" with some LID strategies. The GreenPoint Development is a subdivision with densities of 5.5 units per acre which incorporates "many LID and LEED strategies that exceeds SUSMP and earned a GreenPoint certification." The One Planet development has densities of 8.5 units per acre and was "designed with water conservation and quality as a major component." The following tables show the different types of stormwater management and water conservation practices used at each development. The highlighted practices are especially pertinent to water conservation.[20]

[19] http://www.waterplan.water.ca.gov/docs/meeting_materials/caucus/2013.05.09/DRAFT_DWR-Report_4_30_13.pdf

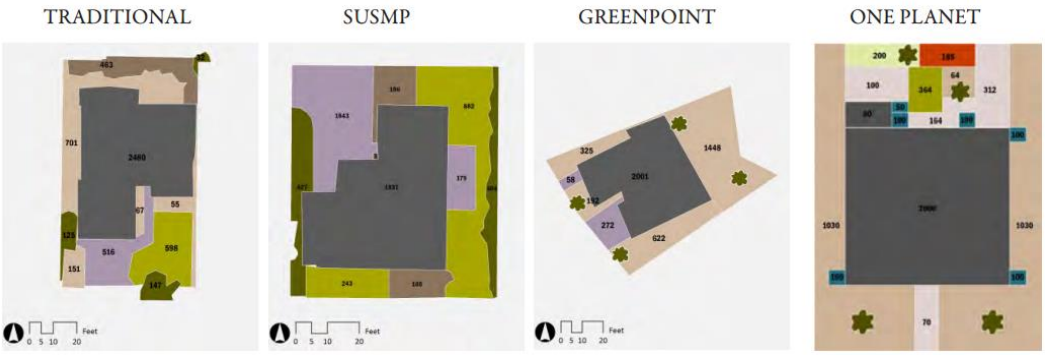
[20] http://www.waterplan.water.ca.gov/docs/meeting_materials/caucus/2013.05.09/DRAFT_DWR-Report_4_30_13.pdf

	Traditional (1977)	SUSMP (2005)	GreenPoint (2005)	One Planet (2010)
SUSMP				
Source Controls				
Downspouts—Drain to Landscaping	•	•		
Benign Roof Materials (e.g., Tile)				
Roof Gardens				•
Cluster Unit Development		•		
Multi-Story Buildings		•	•	•
Avoid Exposing Bare Earth (e.g., Bark, Mulch, Gravel)		•	•	•
Vegetated Strips	•	•	•	•
Hollywood Driveways		•		
Minimize Directly: Connected Impervious Areas		•	•	•
Flow Through Landscaped Area Before Going to Storm Drain		•	•	•
Label Inlets: "No Dumping—Drains to Creek"		•	•	
Spray Irrigation		•	•	
Targeted Spray Irrigation				•
Drip Irrigation		•	•	•
Bubblers				•
Subsurface Irrigation				•
Plants Maintained through Minimal Water Use		•	•	•
Naturally Treat Stormwater		•	•	•
Avoidance of Natural Areas (e.g., Wetlands)		•	•	•
Naturally Vegetated Setback	•		•	•
Buildings Away from Natural Areas		•	•	•

	Traditional (1977)	SUSMP (2005)	GreenPoint (2005)	One Planet (2010)
Treatment Controls				
Vegetated Swale			•	•
Bioretention Area	•		•	•
Extended Detention Basin			•	•
Vegetated Buffer Strips	•	•	•	•
Constructed Wetlands			•	
Wet Pond				
Media Filter				
Manufactured Media Filter				
Infiltration Basin				•
Manufactured Vortex Separator			•	
Manufactured Drain Inserts		•		
CALGREEN				
Rain Barrels				•
Permeable Pavers (No Less Than 20%)				•
Shade Trees			•	•
Limit Turf (Not More Than 50%)			•	•
75% Native California / Drought-Resistant Plants			•	•
Hydro-zone Irrigation Techniques			•	•
Automatic Irrigation Controllers			•	•
Rainwater Capture System				•
Landscape Irrigation Design Reduces Use of Potable Water				•
LEED				•
One Planet				•

The researchers took a case study approach and identified one lot in each neighborhood that was representative of single family lots throughout each respective neighborhood. The following graphics show the different case study lots and respective data. In this case, we emphasize peak monthly outdoor water use across the four different lots. When standardizing for lot size, the Traditional development uses 0.67 gallons per square foot, SUSMP uses 0.91 gallons per square foot, GreenPoint uses 0.38 gallons per square foot, and One Planet uses 0.48 gallons per square foot during peak monthly outdoor water consumption. This highlights the significant water savings from integrating LID and LEED practices into stormwater management. GreenPoint and One Planet development styles were most successful in conserving peak monthly water consumption.[21]

[21] http://www.waterplan.water.ca.gov/docs/meeting_materials/caucus/2013.05.09/DRAFT_DWR-Report_4_30_13.pdf



	Traditional	SUSMP	GreenPoint	One Planet
Total lot size (sf)	5,589	4,712	4,918	5,509
Impervious land cover (sf)	2,996	2,738	2,331	2,080
Peak monthly water runoff from impervious cover (gal)	13,943	12,742	10,848	8,184
Peak monthly outdoor water consumption (gal)	3,738	4,291	1,874	2,653
Peak monthly CO_2 emissions from outdoor water use (lbs)	3.8	4.4	1.9	2.7

Colorado Springs, CO: Landscape Code and Design Manual Update

A 2002 Colorado Springs study found that comparing traditional landscape versus two different xeric landscapes resulted in water savings ranging from 22% to 63% after implementing rules and regulations from the 1998 CO Springs Landscape Code and Design Manual. The Manual stresses the importance of water wise landscaping by creating a "framework for understanding the local natural environment and to facilitate landscape design that references and reinforces [Colorado Springs'] regional character." The Manual promotes the objectives of "water conservation, landscape conservation, landscape sustainability, and the protection of regional character" by embracing the principles of xeriscape and applying them to Colorado Springs' unique landscapes which are predominately semiarid.[22]

Southern Nevada Water Authority: Xeriscape Conversion Study

In 2005, the SNWA and the U.S. Bureau of Reclamation published the Xeriscape Conversion Study that focused on per-unit area water application data to calculate water savings from xeriscaping in Southern

[22] https://www.springsgov.com/Files/landscape.pdf

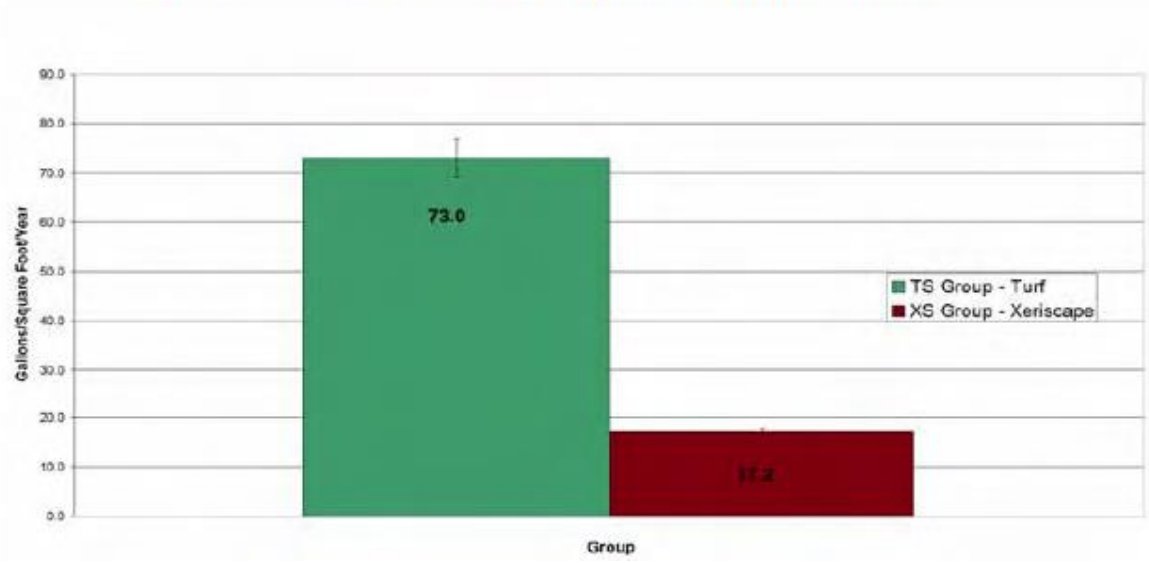
Nevada. The study involved hundreds of participants in two treatment groups: Xeric Study (XS), Turf Study (TS), and Control Groups as well as the use of submeters to collect data. The study team recruited participants who lived in single-family residences within the limits of the SNWA. For the Xeric Study group, the team tracked the water use of residents who converted at least 500 square feet of traditional turfgrass landscape or installed new xeric landscaping (combination of desert-adapted shrubs, trees, some ornamental grasses, mulch, or rock). These landscapes were planted to have a minimum of 50% canopy coverage upon maturity so they were truly xeric landscapes and not zeroscapes. There were a total of 472 properties in the Xeric Study group and the average conversion was 2,162 square feet. The Turf Study group was comprised of a total of 253 properties with an average of 2,462 square feet of landscaped area with traditional turfgrass. A third control group was established to account for any potential bias in non-contacted comparison groups. These were properties with similar landscapes and footprints and in the same neighborhood as the TS and pre-conversion XS groups. These properties were subject to the same external forces (weather, water rates, and conservation messaging) as the other properties.[23]

Below are some key findings from the landmark study[24]:

- Homes in the study saved an average of 96,000 gallons annually following completion of an "average-size conversion" project, or 30% savings in total annual consumption.
- Over the timeframe of the study, the total yearly savings have neither eroded nor improved over the years—the consumption drops immediately and quickly stabilizes.
- Xeric landscaping remained below the evapotranspiration rate year round, while turfgrass exceeded it every month but March with the greatest excess from May through November.
- Amount of turfgrass, property value of residence, the age of residence, total income of the property's residents, whether or not the turfgrass present at the residence is a Fescue all had a positive correlation with water consumption at single-family residences.
- The average conversion cost from turfgrass to xeric was $1.55 per square foot. The average cost for work done by the resident was $1.37 per square foot and $1.93 per square foot with a contractor. The study suggests these prices are most likely higher today given inflation and a stronger market for conversion projects.
- Comparing 60% or more xeric landscapes with 60% or more turf landscapes, those with xeric required an average of a 2.2 hours less per month for landscape maintenance and an average of $206 annual savings in direct maintenance expenditures.
- Comparing two identical homes: one near the average for consumption, the other the same with an average size xeric conversion:
    - Annual water bill savings for Las Vegas Valley Water District was $239.92 ($0.15 per square foot) which contributed to a 54% savings total annual charges for water consumption;
    - Savings vary over the seasons, from 25% savings in December to 70% in July.

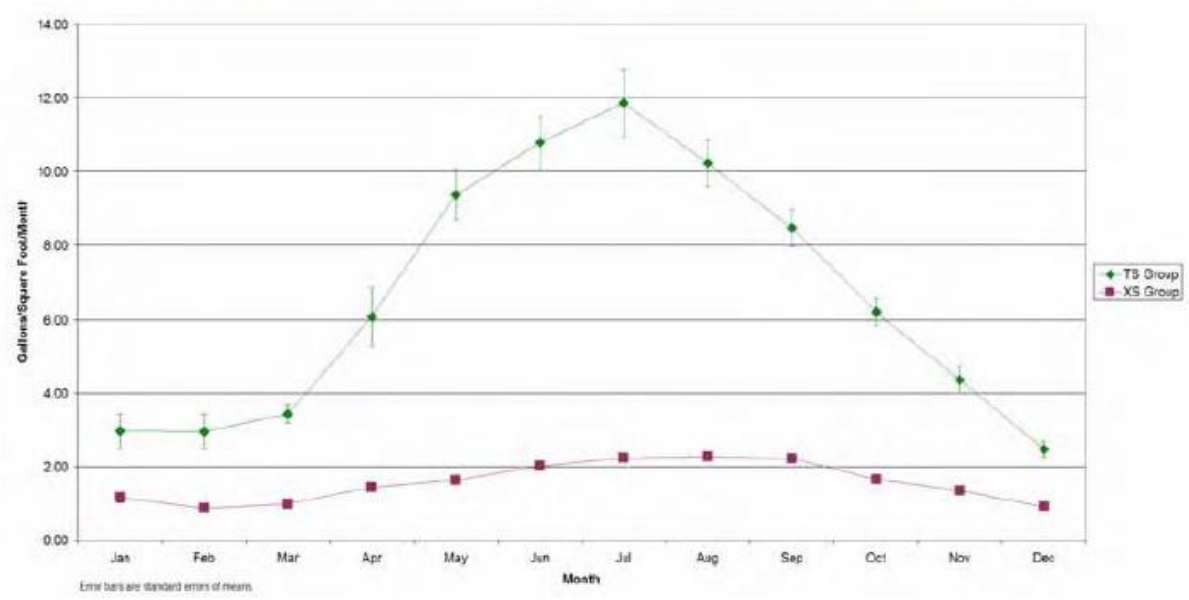
[23] http://www.snwa.com/assets/pdf/about_reports_xeriscape.pdf
[24] http://www.snwa.com/assets/pdf/about_reports_xeriscape.pdf

FIGURE 3: Annual Per Unit Area Application to Turf and Xeriscape



The figure above shows that on average, residents apply 73 gallons per sq. ft. to turfgrass compared to 17.2 gallons per sq. ft. to xeric landscape. These savings have been found to be equivalent when applied to commercial properties.[25]

FIGURE 5: Monthly Per-Unit Area Application for Turf and Xeric Areas



The figure above shows that water application to a square foot of xeric landscaping is significantly lower throughout every month of the year. The water application to xeric landscapes remains relatively stable

[25] http://www.snwa.com/assets/pdf/about_reports_xeriscape.pdf

throughout the year while the application of water to turfgrass spikes in the summer. During the peak month of July, Xeric landscaping uses 9.62 fewer gallons of water per square foot than turfgrass.[26]

FIGURE 12: Average Monthly Maintenance Time and Annual Direct Expenditures for Participants Having At least 60% Turf or Xeriscape

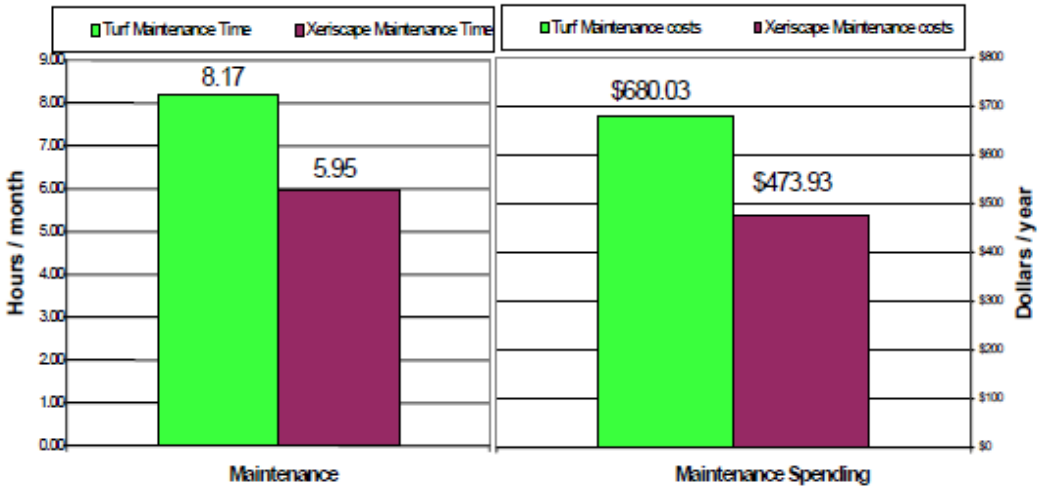
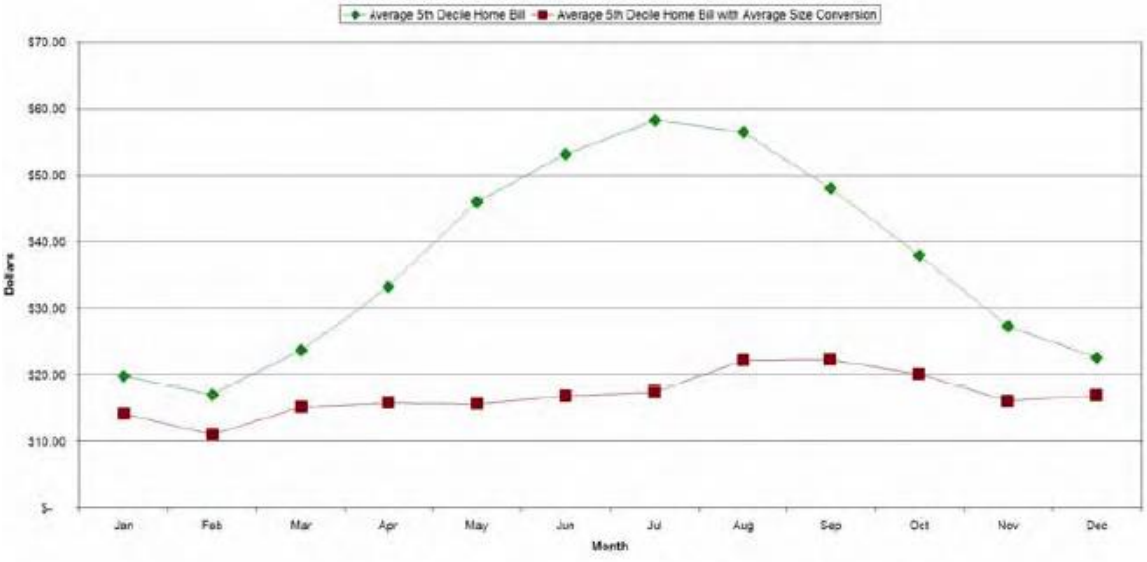


FIGURE 13: Modeled Monthly Water Bill for a Typical Las Vegas Area Home and The Same Home with an Average-Size Conversion

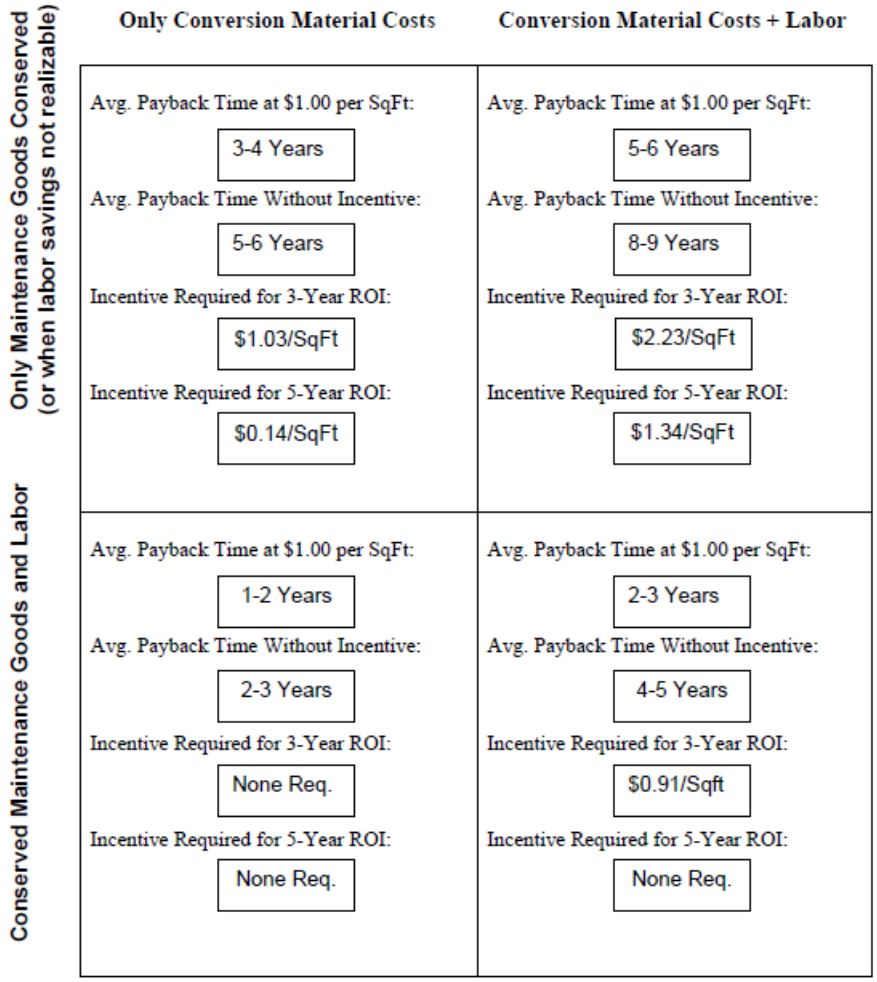


The figures above show that xeric landscapes are also economically efficient. The first figure shows that they require less monthly maintenance time and less annual maintenance spending. The second figure

[26] http://www.snwa.com/assets/pdf/about_reports_xeriscape.pdf

shows that residents realize significantly lower water bills from an average-size xeriscape conversion. Their water bills remain relatively flat over the course of the year compared to the traditional spike in the mid-summer months due to turfgrass watering needs.[27]

FIGURE 15: Summary of Economics of Typical Single-Family Xeriscape Conversion Projects Under Different Scenarios



This figure shows that xeriscape conversions have the ability to pay for themselves ranging from 2 to 9 nine years depending on whether hired labor was needed. The study also calculated the incentives needed for a 3 year and 5 year return on investment.[28]

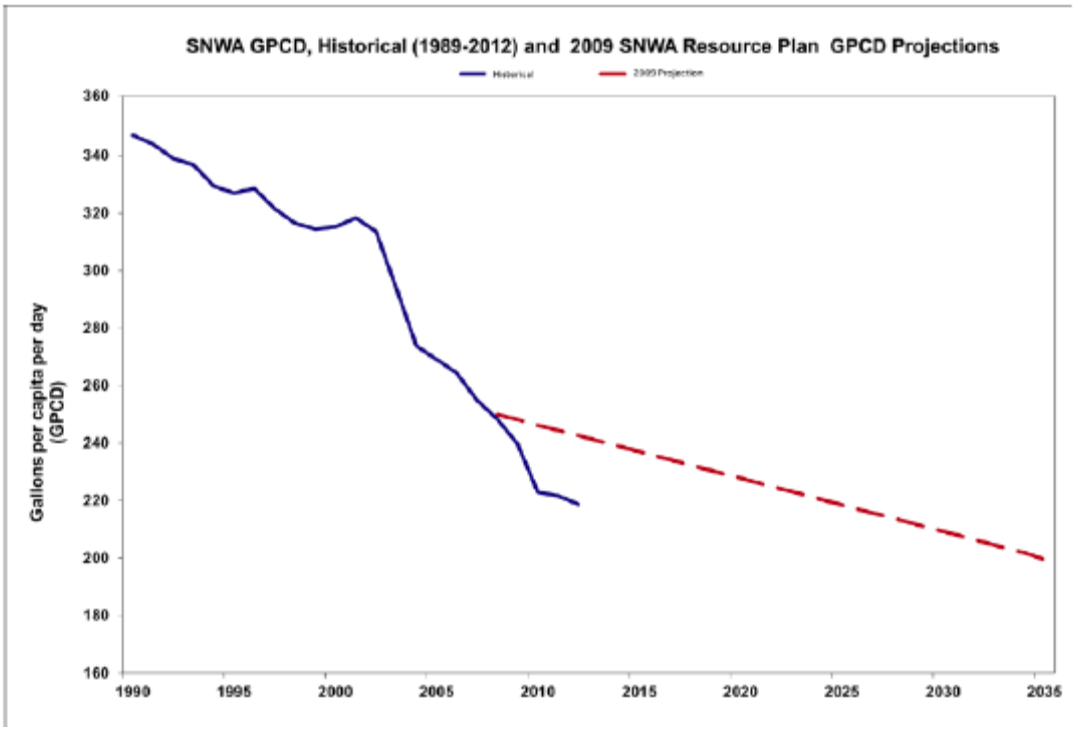
Southern Nevada Water Authority: Water Conservation Plan 2014-2018

The Southern Nevada Water Authority has achieved very large water use reductions through a variety of conservation measures. The figure below outlines the progress made so far and potential future savings

[27] http://www.snwa.com/assets/pdf/about_reports_xeriscape.pdf
[28] http://www.snwa.com/assets/pdf/about_reports_xeriscape.pdf

from ongoing conservation measures. While the savings shown below have come from a variety of different conservation approaches and tools, the SNWA has historically achieved significant water savings through encouraging water wise landscapes.

Figure 1 – Conservation Achievements (1990-2012) and Projections (2008-2035)



According to their Water Conservation Plan, the Water Smart Landscape Rebate Program helped convert 167 million square feet of lawn to water-efficient landscapes, saving more than 68 billion gallons of water. The Authority has also published related per capita demand reductions from an array of different conservation approaches. The following figure shows the total reduction in gallons per capita per day for landscape related conservation tools.[29]

	Water Pricing Influence Coefficient	Water Pricing Influence GPCD	Education & Ethic Influence Coefficient	Education & Ethic Influence GPCD	Other Influence Coefficient	Other Influence GPCD	TOTAL REDUCTION (GPCD)
Water Smart Landscapes Program	40%	0.152	40%	0.152	20%	0.076	0.38
Landscape Development Codes	0%	0	0%	0	100%	0.35	0.35

[29] http://www.snwa.com/assets/pdf/about_snwa_conservation_plan_2014.pdf

Water Smart Landscapes achieve a 0.38 GPCD reduction while Landscape Development Codes provide a 0.35 GPCD reduction, both significant figures given that the Authority provides water for over two million people.[30]

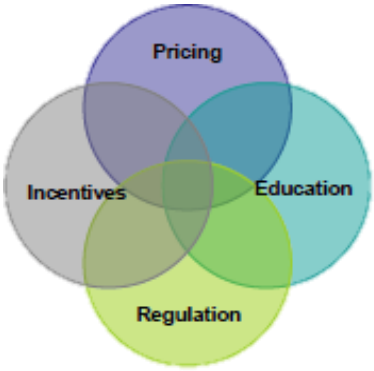
Limitations

In spite of the proven water conservation successes from turf regulations and restrictions, interviews conducted with Stephanie Duer, Water Conservation Programs of Salt Lake City, Utah, and Doyle Wilson, Water Resources Coordinator for Lake Havasu City, Arizona, pointed out a few potential limitations. Duer stated that landscape ordinances have become overly complicated and too focused on plant types. Instead, municipalities should take a performance/goal based approach to identify irrigation efficiency. Many consumers lack the knowledge of efficiently maintaining xeric landscapes.[31] Doyle Wilson reported that turf bans can be extremely unpopular and politically unfeasible. While Lake Havasu City has taken the lead by requiring landscaping in public places to be drought tolerant, addressing water conservation landscaping on private property has been a voluntary situation. Instead, Lake Havasu City has been investigating effluent delivery systems to provide irrigation to new development.[32]

Phase II: Examples of Implemented Programs

The purpose of Phase II of this report is to highlight successful policies, mechanisms, and tools used by municipalities across the arid west to reduce the water footprint of new development and redevelopment. We have divided our approaches to water conservation into those that: (1) remove existing barriers, (2) create new incentives, or (3) adopt new regulations. We then applied these three "lenses" to the wide array of tools and regulations that local governments use to regulate and administer land use policy, specifically comprehensive plans, subdivision regulations, zoning ordinances, and utility regulations. Finally, we address an additional potential tool – the adoption of new state legislation (which local governments can support, but not control).

After numerous interviews with public officials and conservation experts and extensive research on best practices, we point to specific policies that have achieved documented water savings. Many of the interviewees stressed that there is no silver bullet when it comes to water conservation and that an integrated and holistic approach is needed to address this complex and far reaching issue. The image below shows that effective conservation



[30] http://www.snwa.com/assets/pdf/about_snwa_conservation_plan_2014.pdf
[31] Interview: Stephanie Duer, Salt Lake City Water Conservation Programs, January 16, 2015.
[32] Interview: Doyle Wilson, Lake Havasu City, Water Resources Coordinator, January 26, 2015.

measures must incorporate pricing schemes, incentives, regulations, and education.[33]

While behavior change through outreach and education has led to significant water savings, the focus of this report is to better understand potential water savings from decisions made in the design and construction of new development projects prior to initial occupancy. Potential savings through education and behavior change were not explored, because they do not fall into this category. The examples below suggest that significant savings are possible through increasing density, the use of more native drought tolerant species (and less turfgrass), and use billing structures and fees to better reflect the true cost of water use.

A. Approaches

1. Remove Barriers

Many municipalities across the arid west have barriers within their land use codes that discourage water conservation. For example, the City Council of Aurora, Colorado, passed an ordinance declaring that private covenants and HOA agreements contrary to city policy are invalid. Many of these covenants require turf grass landscaping. The City's action removed a barrier to homeowners' installation of xeric landscaping. The State of Colorado has also adopted statutes that prohibit enforcement of restrictive covenants from prohibiting or limiting "the installation or use of drought-tolerant vegetative landscapes, or requires cultivated vegetation to consist wholly or partially of turf grass[34]" allowing for owners to freely pursue xeric landscaping options. The City also removed turf requirements in tree lawns/park strips/boulevards and now allows stamped, stained, or integrally colored concrete, natural stone pavers, or manmade pavers. In other words, it removed a barrier that its predecessors have adopted in order to reflect the increased importance of water conservation.

2. Create Incentives

Incentivizing water conservation through a variety of mechanisms has shown considerable success in reducing the water footprint or new developments. Municipalities and counties across the west have provided density bonuses, offered discounted tap or connection fees, and extend utility rebate programs to homebuilders engaged in water-smart development. As part of its 2002 Infill Redevelopment Strategy, the City of Sacramento, California, waived its water development (connection/tap) fee for small residential projects in redevelopment areas where the median age of the housing is earlier than 1965, where the proposed development would be consistent with community plans and zoning, and is surrounded by development on three sides. Depending on the quality of existing infrastructure, infill redevelopment generally creates projects that have higher densities and smaller irrigated landscapes therefore smaller water footprints. Communities in Texas such as San Antonio and Corpus Christi have also used this approach to promote infill redevelopment.

[33] http://www.snwa.com/assets/pdf/about_snwa_conservation_plan_2014.pdf

[34] C.R.S. 37-60-126. In addition, the State has also prohibited enforcement of restrictive covenants that it views as contrary to public interest related to restrictions on solar collectors and retractable clothes lines.

3. Add Regulations

Adopting new regulation as a tool to reduce water footprints has yielded some of the most impressive water reductions on new development. Many jurisdictions across the arid west have integrated WaterSense plumbing and fixtures into their building development codes. Desert communities, such as Las Vegas have imposed restrictions on turf grass for new development in favor of xeric options. Additional examples are shown in the section below.

B. Key Tools

1. Comprehensive Plans

All municipalities in Colorado have been expressly authorized—but not required—to create a planning commission. Once a planning commission is created, however, it is required to develop and adopt a land use master plan. In 2001, the Colorado General Assembly amended the municipal planning and zoning statutes to require that municipalities in certain categories adopt a master plan no later than January 7, 2004. The municipalities covered by the statute include any municipality with a population of 2,000 or more that is located wholly or partially within a county subject to the mandatory master planning requirements of C.R.S. § 30-28-106(4). In addition, the General Assembly clarified that once a municipality (or the county in which it is wholly or partially located) meets the population or population increase thresholds requiring adoption of a master plan, those obligations continue even if the population or rates of population growth later fall below those trigger points. The Colorado Department of Local Affairs is charged with monitoring when municipalities become subject to these requirements and to notify them, after which the municipality has two years to complete its master plan. As of 2010, 32 Colorado counties and 91 cities were subject to this planning requirement.

It is the duty of the planning commission to make and adopt a master plan for the physical development of the territory within the municipal boundaries. More particularly, the planning commission is directed to develop a master plan for the purpose of "guiding and accomplishing a coordinated, adjusted, and harmonious development of the municipality and its environs which will, in accordance with present and future needs, best promote the health, safety, and order, convenience, prosperity, and general welfare"(C.R.S. § 31-23-207) of the citizens. In preparing a master plan, a planning commission is directed to "make careful and comprehensive surveys and studies of present conditions and future growth of the municipality with due regard to its relation to neighboring territory" (C.R.S. § 31-23-206(1)).

There is no state-wide standard for what land use plans must contain. Many are divided into elements such as present and future land uses or water conservation elements, and then articulate goals, objectives, strategies, and implementation techniques for each element. One key step to lay a strong foundation is to include a water conservation element in the community's comprehensive plan. Once that foundation has been established, a number of different programs can be linked to and supported

by references to the community commitment to this important goal. An ideal comprehensive plan for the purposes of conservation would:[35]

- Include water conservation in its list of high level **goals** for the community;
- Include short and intermediate water conservation **objectives**; and
- Refer in some detail to strategies and implementation **techniques and strategies** that will be used to meet those objectives. These should be sufficiently detailed to enable the planning commission or governing body to make decisions based on whether they are consistent or inconsistent with the listed strategies and techniques.

Listed below are a number of examples of materials that can be included in the comprehensive plan.

- Ensure that the growth projections – and the breakdown of those projections by land use type and development density – are the same as is used in water supply capacity planning. There is some evidence that different assumptions have been used for these purposes in some Front Range communities.

- Some comprehensive plans have a specific objective of reducing per capita water consumption by, for example, 10 percent by 2035 or reducing gallons per day per capita water consumption from 220 to 110 or less.

- Some of the Front Range community comprehensive plans explicitly incorporate their local water conservation plans – or those of the utility or service provider -- by reference.

- It may be useful to document the potential water savings that can be achieved through increasing residential density (multifamily housing, town houses, small lot single-family homes, and infill development) and by implementing restrictions on turfgrass and irrigation.

- Include supporting data for the selected strategies and techniques, such as: "Studies…have shown that the installation of high-efficiency toilets, high-efficiency clothes washers, and low-flow bathroom faucet aerators can reduce residential indoor per capita use [from c. 60] to 40 gpcd (or less)."

- Incorporating relevant data on limited water resources or delivery capacity, and the potential savings that can be achieved by the listed strategies and techniques, will make the plan stronger and can advance the public debate about appropriate water policies.

- One community did a specific study that showed that water wise interior conservation standards in homes are currently achieving eight gallons less consumption per day per capita, noting that this is only a portion of the interior water savings achievable using such strategies to their fullest extent.

[35] Much of the information in this section is from Colorado Land Planning and Development Law (2012, Bradford Publishing, Don Elliott, Editor) and from the conclusions drawn from a series of workshops on land use and water supply planning conducted by the Pace University Land Use Law Center in Denver in the fall of 2013.

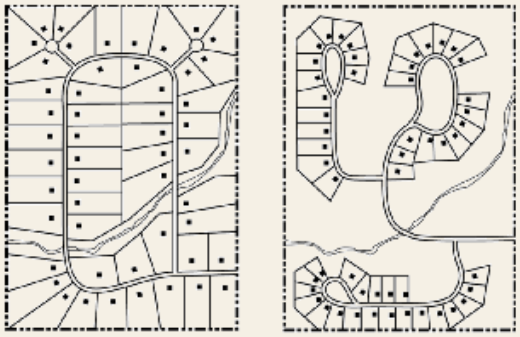
- One plan notes specifically, “The City will encourage and require, where appropriate, new developments to incorporate water saving measures, such as using xeriscaping (drought tolerant) landscape.”

2. Subdivision Regulations

Subdivision is the process by which land is divided or combined into parcels appropriate for development. For a variety of reasons, the public has a strong interest in how this is done. First, since developed land is bought and sold more often than raw undeveloped land, it is important that the location of the boundaries of each parcel be precisely defined, and that the possibility for future mistakes in the legal description is minimized. Second, it is important that each lot offered for sale is large enough (or not too large), is appropriately shaped for its intended use, and has access to the public road system. Third, the layout of lots offered for sale needs to make adequate provision for required parks, street rights-of-way, storm drainage area, and utility infrastructure. By requiring landowners to prepare an official map of their land identifying the size and location of lots offered for sale and identifying the boundaries of each parcel for the public record, and by providing that the local government review approve, and record that map in the public records, all of these goals can be achieved.

Counties and municipalities in Colorado are mandated by state statute to enact and enforce subdivision controls through their planning commissions. County subdivision regulations govern the land within county boundaries and outside the boundaries of the incorporated areas of municipalities, (but may not be applied to divisions of land where every resulting tract is 35 acres or larger). Subdivision regulations of the statutory cities and towns govern land within their boundaries and may also govern outside the city boundaries (or halfway to the next city, if the land is within five miles of both cities). Home rule cities and towns also regulate subdivision of property but procedures and requirements vary substantially. Subdivision regulations establish both a process for local governments to review land development and the substantive requirements that must be met by the applicant to get an approval.

Subdivision regulations are an important tool to implement water conservation measures, since the layout of private development lots determines the density of single-family, two-family, and townhouse units. This is the stage when water efficient small lot or clustered development must be “locked in” if the land is to be developed in those patterns. Once land is subdivided into large lots, and infrastructure is sized for those developments, it is often difficult to change the pattern to one with smaller lots – or to change a land pattern for single-family homes to one that will accommodate townhouses or apartments.



Left is a subdivision typical in Larimer County. Right is a clustered plan with the same number of lots and preserved open space.

However, many subdivision regulations for single-family detached development (i.e. places where each house is placed on a separate lot), often say “the minimum lot size is set by the zoning ordinance – you

have to design your plat to match those standards". So the operative document in those cases is the zoning ordinance. On the other hand, many communities try to encourage cluster development – neighborhoods or groups of houses in which each lot is allowed to be smaller than what would otherwise be permitted under the zoning ordinance if the developer sets aside a large amount of the land (often 50-70%) in undeveloped open space. This can be a very strong tool for water conservation, since the resulting smaller lots are more efficient (see Phase I above) and the large open space set-aside is usually required to be left in a natural state without irrigation. When cluster subdivision is to be encouraged, the subdivision regulations are usually – but not always -- the operative document. In some cases, some parameters for cluster subdivision are contained in the zoning code while others are found in subdivision regulation.[36] Two examples of cluster subdivision ordinances are presented below.

University of Georgia: Conservation Subdivision Model Ordinance

The University of Georgia's Institute of Ecology published a model conservation subdivision ordinance which can be used to help municipalities draft appropriate subdivision language that promotes conservation and low impact development. [37]

Purposes of Conservation Subdivision:

A. To provide a residential zoning district that permits flexibility of design in order to promote environmentally sensitive and efficient uses of the land.

B. To preserve in perpetuity unique or sensitive natural resources such as groundwater, floodplains, wetlands, streams, steep slopes, woodlands and wildlife habitat.

C. To preserve important historic and archaeological sites.

D. To permit clustering of houses and structures on less environmentally sensitive soils which will reduce the amount of infrastructure, including paved surfaces and utility easements, necessary for residential development.

E. To reduce erosion and sedimentation by minimizing land disturbance and removal of vegetation in residential development.

F. To promote interconnected greenways and corridors throughout the community.

G. To promote contiguous greenspace with adjacent jurisdictions.

H. To encourage interaction in the community by clustering houses and orienting them closer to the street, providing public gathering places and encouraging use of parks and community facilities as focal points in the neighborhood.

I. To encourage street designs that reduce traffic speeds and reliance on main arteries.

[36] http://www.larimer.org/planning/planning/master_plan/chapter_2.htm#2.5.1
[37] http://www.rivercenter.uga.edu/research/tools/subdivisions/con_sub_model_ord.pdf

J. To promote construction of convenient landscaped walking trails and bike paths both within the subdivision and connected to neighboring communities, businesses, and facilities to reduce reliance on automobiles.

K. To conserve scenic views and reduce perceived density by maximizing the number of houses with direct access to and views of open space.

L. To protect prime agricultural land and preserve farming as an economic activity.[38]

According to the model ordinance, densities and lot sizes are determined by the underlying zoning and the area of the tract of land. The model ordinance calls for the minimum restricted Open Space requirements to be 40% of the gross tract area. Slopes over 25% of at least 5000 square feet of contiguous area, areas within the 100 year floodplain, bodies of open water over 5000 square feet, and designated wetlands shall be excluded from the calculation of developable land but can be included in the Open Space calculation. At least 75% of the Open Space shall be contiguous.[39]

Pima, Arizona: Conservation Subdivision Guidebook

In 2001, the City of Pima, Arizona published a Conservation Subdivision Guidebook which was subsequently revised in 2007. The City states that the goals of conservation site planning are to "protect conservation features, riparian areas, native plants and plant communities, areas near public reserves, wildlife habitat areas, biological corridors, and sites of archaeological and cultural value."[40]

According to the ordinance, "a minimum of 50% of the area of the subdivision after deducting major streets and scenic routes right-of-way dedications shall be set aside and restricted to conservation natural areas."[41] The maximum density yield will depend upon the underlying zoning. The ordinance lists permitted zones in which these subdivision controls can be used. The maximum density yield is found by "dividing the minimum area per dwelling unit standard allowed under the zone of the property into the gross area of subdivision site."[42]

While conservation subdivision regulations do not specifically call out water conservation as a goal, the development patterns they promote have the potential to reduce water footprints by reducing landscaped areas and encouraging density. While some subdivision regulations include landscaping requirements – and those requirements could be modified to require water conserving landscaping – that approach is increasingly rare. Instead, many modern subdivision regulations simply cross-reference the landscaping requirements in the zoning ordinance, since actual development on the lots may occur many years after the platting of the lots, and it makes little sense to require landscaping (through the subdivision regulations) far in advance of actual development of the lots.

[38] http://www.rivercenter.uga.edu/research/tools/subdivisions/con_sub_model_ord.pdf
[39] http://www.rivercenter.uga.edu/research/tools/subdivisions/con_sub_model_ord.pdf
[40] http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Development%20Services/Building/Cons_Sub.pdf
[41] http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Development%20Services/Building/Cons_Sub.pdf
[42] http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Development%20Services/Building/Cons_Sub.pdf

3. Zoning Regulations

Zoning is the division of a city or county into zones or districts to facilitate regulation of land use, buildings, and other improvements. Zoning is the fundamental planning tool used by most local governments to balance the interest of the public welfare with private landowners' rights to use their land as they see fit. Although local land uses are increasingly subject to contractual limitations in the form of private restrictive covenants, such covenants are always subordinate to public zoning powers.

The general purpose of zoning is to regulate uses of land and the physical improvements to land in the interest of public welfare, without imposing undue burdens on landowners. The regulation of land uses is a legitimate purpose of zoning. Regulation of the density and intensity of land uses and regulation of improvements upon the land are also legitimate purposes of zoning. A municipality may adopt reasonable regulations with respect to the height and size of structures; regulate the size of building plots; establish building setback or build-to requirements to benefit the public and enhance the aesthetic value of the municipality; and establish requirements for landscaping of individual building sites.

By establishing minimum lot sizes within a zoning district, and by establishing the maximum density of attached or multifamily residential development, zoning regulations can either prevent or allow those types of residential development that have lower rates of consumption. Since many subdivision regulations simply cross-reference the lot size, building size, and development density restrictions in the zoning ordinance, this is the key document for addressing those issues.

Although communities can adopt a freestanding landscaping or water conservation ordinance, those regulations are increasingly included in the zoning ordinance (with the exception of water conservation provisions that are constructed inside the building, which are often linked to the building code). For example, many zoning ordinances include landscaping requirements with water-conservation requirements that apply to all new development, or to all residential development, or to all multifamily and non-residential development. Improved water conservation measures can be required, or may instead be encouraged through incentives. For example, a zoning ordinance might allow for expedited site-planning and building permitting for developments meeting LEED-ND water conservation standards,[43] or it might allow added development density in exchange for reduced water use in multifamily developments.[44]

City of Aurora, Colorado: Landscape Ordinance Revisions to Promote Conservation

In 2009, three significant changes were made to the Aurora, Colorado, landscape ordinance to further incentivize xeric/low water plant material. First, the amount of land coverage maturity estimated at the time of planting) for perennials and shrubs were increased to allow those types of vegetation to meet more of the 50% living plant material matter requirement for landscaping. Second, private and HOA covenants contrary to city policy were declared invalid, allowing homeowners to pursue xeric options instead of turf requirements set by Homeowners Associations. Third, turf is no longer required in tree

[43] http://www.law.du.edu/documents/rmlui/sustainable-development/Water-Conservation.pdf
[44] http://www.law.du.edu/documents/rmlui/sustainable-development/Water-Conservation.pdf

lawns/park strips/boulevards; stamped, stained, or integrally colored concrete, natural stone pavers, or manmade pavers, may be used.[45]

Turf Limits

The City of Aurora also places turf limits for all new commercial and multifamily development areas except for playfields and golf courses. According to Aurora's Turf Regulations, "the use of cool-season grass sod, seed, and seed mixtures that contain cool-season grass species (turf), shall be limited to not more than 33% of the site's total landscaped area."[46] The code defines high water usage cool season grasses as plant species that require one and a half inches or more of water per week to survive. Moreover the city requires the use of drought tolerant/resistant landscaping and plant species: "75% of all annuals and trees and 100% of all shrubs, perennials, groundcovers, and ornamental grasses used to landscape each site regulated by this article shall be selected from the City of Aurora Recommended Xeriscape Plant List; the Colorado State University Extension Fact Sheet on Xeriscaping, or other approved water wise, resource wise, or xeriscape plant material references."[47] Single family detached, two family, and single-family attached duplex homes, are regulated by different standards, which are outlined below.[48]

Xeric Option

The City of Aurora also provides a "xeric option" for front yards of single-family residential dwellings in their Landscape Design Manual. Developers who pursue this option receive a $1,000 credit on their tap fee charges. The city also provides design and plant selection assistance. [49] The following figures compare the turf and xeric options for single-family residential landscaping.

Table 14.3A Home Yard Landscaping—Turf Option[50]
Front, Side, and Rear Yard Landscaping Requirements for Single-Family Detached, Two-Family, and Single-family Attached Duplex Homes

FRONT YARD		
	(A) Plant Quality and Type	(B) Requirements
1.	Turf. (At corner lots with a side yard visible to public view, turf areas shall include both front and side yard areas)	**Minimum and Maximum Turf per Lot size** Small (3,700 sf-5,999 sf)—40% and 50% Max. Standard (6,000 sf – 8,999 sf) –30% Min. and 40% Max Large (9,000 sf—14,999 sf)—25% Min. and 40% Max Estate (15,000 sf +) –25% Min and 40% Max.
2.	1 Shade Tree, and either	2 ½ inch caliper
	1 Ornamental Tree	2 inch caliper

[45] Interview: Melissa Grove, Aurora Water Conservation, December 4, 2014.
[46] https://www.municode.com/library/co/aurora/codes/building_and_zoning?nodeId=BUILDING_ZONING_CODE_CH146ZO_ART14LA_DIV3GEST_S146-1427TURE
[47] https://www.municode.com/library/co/aurora/codes/building_and_zoning?nodeId=BUILDING_ZONING_CODE_CH146ZO_ART14LA_DIV3GEST_S146-1427TURE
[48] https://www.municode.com/library/co/aurora/codes/building_and_zoning?nodeId=BUILDING_ZONING_CODE_CH146ZO_ART14LA_DIV3GEST_S146-1427TURE
[49] Interview: Melissa Grove, Aurora Water Conservation, December 4, 2014.
[50] https://www.auroragov.org/cs/groups/public/documents/document/005465.pdf

	Or 1 Evergreen Tree	6 foot height
3.	Front Yard shrubs per lot size: Small—8 Standard—16 Large—26 Estate—36	• Shrubs—5 gallon container Min. –Plant material shall conform with American Standard for Nursery Stock, Ansi Z60.1 current edition. • Fabric may be omitted under annuals, perennials, and groundcovers. • Use a variety of shrubs and plant materials that will provide visual interest during all seasons.
SIDE YARDS		
Internal side yard, not exposed to public view—no plant material is required but mulches are required for soil stability. External side yards on corner lots exposed to public view—shall be landscaped with turf, and shrubs and trees at the rate of one tree and 10 shrubs per 40 linear feet of side yard.		
REAR YARDS		
• Turf or xeric landscaping is not required. In rear yards the use of natural turf shall be limited to not more than 45% of the area to be landscaped. • No maximum restriction shall apply to the use of the artificial turf. Rear yards at corner lots exposed to public view shall be landscaped with turf or xeric landscaping.		

Table 14.3B Home Yard Landscaping—Xeric Option[51] Front, Side, and Rear Yard Landscaping Requirements for Single-Family Detached, Two-Family, and Single-family Attached Duplex Homes		
FRONT YARD		
	(A) Plant Quality and Type	(B) Requirements
1.	Applicability	Requirements to all lot sizes
2.	Turf	No turf is required
3.	Request and landscape plan	Submit request in writing to Director of planning accompanied with landscape plan at a Min. scale of one inch equals 10 feet.
4.	Rock and inorganic mulches (See Note 1)	• Rock mulch is limited to not more than 50% of the area to be landscaped. • 50% of all rock and other mulch areas shall be covered with living plant material
5.	Plant Materials (See Note 1)	All plant materials shall comply with requirements found in Sec. 146-1426 Plant Material Requirements
6.	Pavers (See Note 1)	Brick pavers, asphalt pavers, and natural stone limited to not more than 40% of the landscaped area
7.	Features	One of the following features shall be incorporated a. Wall –1 ft. to 2 ½ ft. high decorative natural stone, stucco, or approved CMU wall. b. Fence—in accordance with art. 17 Fence. c. Berms—low earth berm 2 ½ ft. tall max. Slopes not

[51] https://www.auroragov.org/cs/groups/public/documents/document/005465.pdf

		to exceed one foot rise for each 4 feet of run. d. Natural boulders—3- two feet by three feet min.
8.	1 Shade Tree, and either	2 ½ inch caliper
	1 Ornamental Tree	2 inch caliper
	Or 1 Evergreen Tree	6 foot height
9.	Shrubs (Perennials and ornamental grasses may be substituted for shrubs at 3 one-gallon perennial or ornamental grass species per one five-gallon shrub)	• Shrubs—5 gallon container Min. –Plant material shall conform with American Standard for Nursery Stock, Ansi Z60.1 current edition. • Fabric may be omitted under annuals, perennials, and groundcovers. • Use a variety of shrubs and plant materials that will provide visual interest during all seasons.
SIDE YARDS		
Internal side yard, not exposed to public view—no plant material is required but mulches are required for soil stability. External side yards on corner lots exposed to public view—shall be landscaped with turf, and shrubs and trees at the rate of one tree and 10 shrubs per 40 linear feet of side yard.		
REAR YARDS		
Turf or xeric landscaping is not required. In rear yards the use of natural turf shall be limited to not more than 45% of the area to be landscaped. Rear yards at corner lots exposed to public view shall be landscaped with turf or xeric landscaping.		
NOTE 1: At corner lots with a side yard visible to public view, front and side yard areas shall be combined for calculation of xeric requirements.		

City of Aurora, CO: "Z" Zones Landscapes

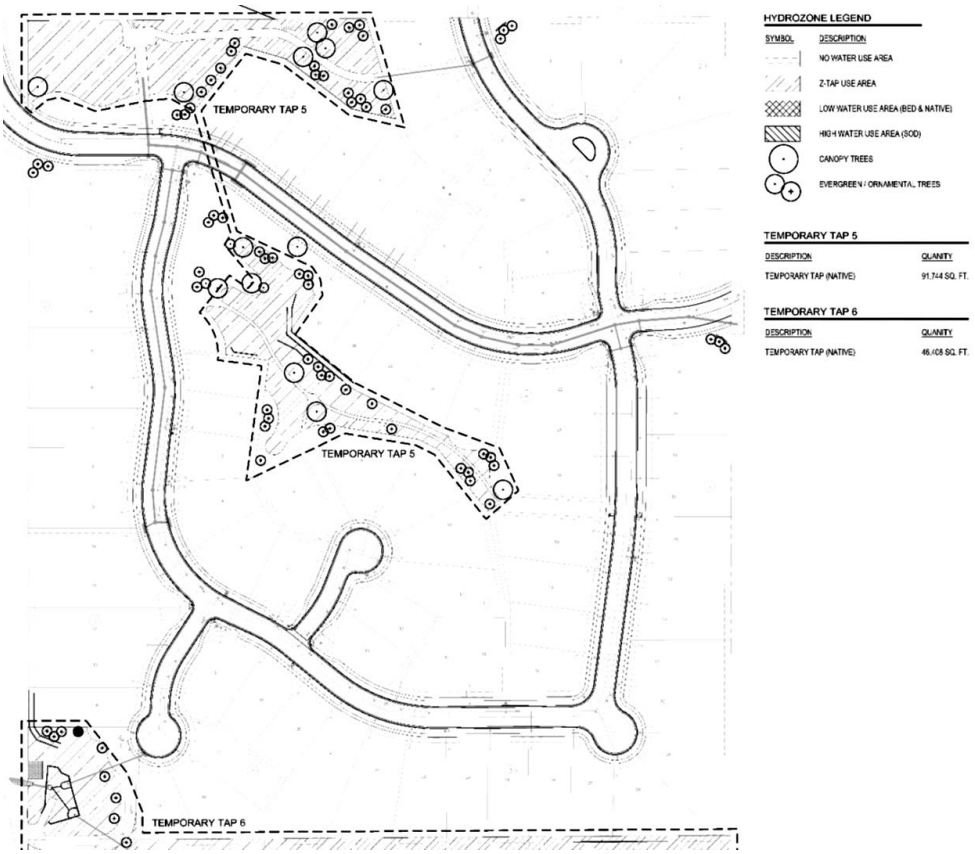
The City of Aurora has introduced a new landscaping option that will ultimately not require any irrigation. The "Z" Zone option is for common areas such as parks, medians, and shared open spaces. The landscape is designed to require no supplement irrigation after a three year plant establishment period, so owners are not assessed a tap fee. The owner receives a three year water allocation for temporary irrigation based on plant needs (not tap size) and must pay a $250 administration fee and $25,000 deposit. The deposit protects the city from instances where the plant establishment fails and a tap fee is required.[52]

This is an administrative process that requires multiple steps to complete. Developers must include a hydrozone map that clearly indicates the watering needs throughout the landscape plan along with tables showing the square footage of zone types and tree count by size within the Z-Zone area. The Planning Department then sends the plans to Water Conservation for review and to determine a water allocation. Water Conservation sends that information to Planning and a water allocation to Billing and Permitting. Then Water Conservation contacts owner/contractor/developer to review process and expectations. Water Conservation conducts an annual review and report on vegetation establishment on the site. If the establishment is successful, then the developer gets the deposit back. The temporary

[52] Lyle Whitney, Aurora Water Conservation Supervisor. Z-Zone Tap Fee Process and Requirements.

tap is removed upon plant establishment after three years. If the plant establishment is unsuccessful, the tap will remain and a tap fee will be assessed.[53]

The figure below show the required hydrozone maps that are reviewed to determine where permanent irrigation taps will go and temporary taps to form the Z-Zone.



54

City of Las Vegas, Nevada, Landscaping Ordinance

The City of Las Vegas, Nevada, has some of the strictest set of turf limit regulations in the country. According to the Southern Nevada Water Authority (SNWA), turf limitations for residential development and outright prohibition of turf for commercial development within the SNWA jurisdictions have been very successful in lowering water use.[55] The city's landscaping ordinance limits the planting of turf from 25% to 50% of landscapable land on a parcel depending on the type of development. The remaining landscapable area is to be water efficient landscaping.[56]

The following bullets are highlights from the City of Las Vegas Landscaping Code[57]:

[53] Lyle Whitney, Aurora Water Conservation Supervisor. Z-Zone Tap Fee Process and Requirements.
[54] Lyle Whitney, Aurora Water Conservation Supervisor. Z-Zone Tap Fee Process and Requirements
[55] Interview: Doug Bennett, SNWA Water Conservation, January 14, 2015.
[56] http://www.snwa.com/consv/restrictions_turf_lv.html
[57] http://www.snwa.com/consv/restrictions_turf_lv.html

- *Single-family:* No new turf is allowed in front yards. New turf installed in rear and side yards may not exceed 50% or 100 square feet (whichever is larger). Turf area dimension may not be more than 5,000 square feet.
- *Multifamily:* New turf is prohibited in common areas, except for public and privately owned parks as long as turf area is not less than 10 square feet.
- *Non-Residential:* New turf installation is prohibited, unless specifically permitted by approval of land use application.

Site Plan Regulations

Although this tool is not mentioned in Colorado land use statutes, many local governments adopt site plan regulations, and those regulations can be particularly effective in promoting water conservation. They can apply to land that has already been subdivided and zoned. Site plan regulations typically apply to certain types of development that will be developed without being further subdivided, such as multifamily residential, condominiums, office parks, or retail malls. In Colorado, site plan regulations are seldom made applicable to single-family detached homes; instead the standards governing the layout and design of subdivisions is often included in the subdivision regulations. When such regulations have been adopted, individual parcels subject to their terms may not be developed until a site plan has been submitted, reviewed, and approved. Site plan regulations require that certain elements be shown on the drawing, including access, parking, landscaping and buffering, drainage, utilities, roads, curbs, lighting, and the location and dimensions of the principal and accessory buildings and any other intended improvements. They can also include provision on the design of landscaping and open spaces, including special requirements for water conserving landscaping and for site designs that will reduce irrigation requirements.

4. Plumbing Codes[58]

In most communities, almost every building constructed must comply with a building code adopted by the local government (or by the state, and made applicable to its local governments). There is not just one building code, however. The general term "building code" includes many other codes such as electrical codes, mechanical codes, and plumbing codes, and there are often different versions of those codes applicable to new construction, renovations, and historic buildings.

Traditional Plumbing Codes

Some of the codes currently being used in the U.S. include:

- The Uniform Plumbing Code, published by the International Association of Plumbing and Mechanical Officials (IAPMO);
- The International Plumbing Code (ICC), published by the International Codes Council; and
- The National Plumbing Code, published by the Building Officials and Code Administrators International (BOCA).

[58] Much of the material in this section was prepared for the Pace Land Use Law Center for an upcoming Land and Water Manual, and is used with their permission.

This field of regulation is becoming somewhat more standardized, however, as many communities adopt some version of the International Building Code or the International Residential Code. If the jurisdiction decides to adopt a separate plumbing code, most states and local governments adopt some version of the ICC International Plumbing Code or the IAPMO Uniform Plumbing Code. Each of these codes, however, include many opportunities for cities and counties to choose among optional provisions to best meet their needs. So there is not just one International Building or Residential Code.

New Codes and Code Supplements

Recently, new codes have emerged that require higher levels of electrical efficiency, thermal efficiency, water efficiency, sustainable materials, non-polluting/non-off-gassing materials, and recyclable materials. Sometimes called "reach codes", these alternatives are intended to encourage local governments to "reach" for higher levels of performance by offering them an "approved" set of standards to reach that goal – even if there is no agreement among those codes as to what the standard should be.

While zoning, subdivision, and site planning standards and criteria are still usually custom-made for each city and county, the same is not true of building construction standards. Very few cities create a plumbing, electrical, or building code based on their own knowledge and judgments about building safety. Because the field is so technical, and requires deep knowledge of engineering, almost all cities work from an accepted model and then choose among "pre-approved" options that have been declared safe by the authoring agency to meet their local needs. As a result, the decision process in this area is not how to draft new and efficient regulations, but what features to choose from the field of pre-approved alternatives.

Some of the "reach" codes in the field of water conservation and efficiency include:

- The International Association of Plumbing and Mechanical Officials (IAPMO) 2012 Uniform Plumbing Code green plumbing supplement (on Alternative Water Sources for Nonpotable Applications and for Nonpotable Rainwater Catchment Systems) now being updated for 2015), including;
- The International Code Council (ICC) green plumbing supplement; and
- The plumbing sections of the International Green Construction Code (IgCC).[59]

Not surprisingly, some of the features required by some of the reach codes are also available as optional provisions under the more widely used international codes. Some of the features included in alternative water codes include:

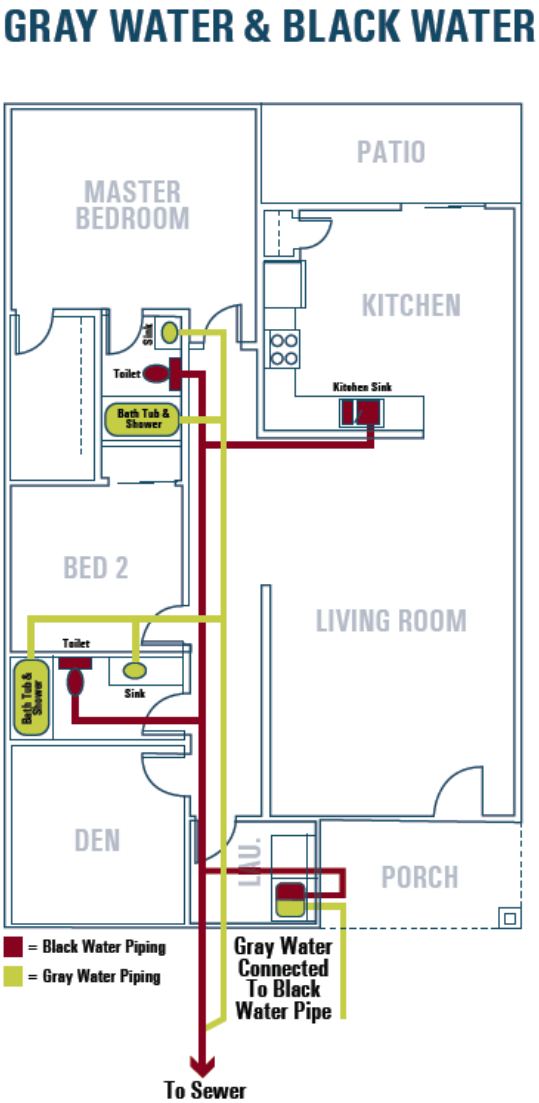
- Minimum indoor fixture efficiency standards -- including but not limited to U.S. EPA's "WaterSense", "WaterSense at Work", and "WaterSense" Hotel Challenge standards;
- Systems to reuse indoor water from sinks and showers for non-potable uses such as toilets or irrigation;

- Requirements that individual apartments in apartment buildings each have a separate water meter (which is very effective in reducing water use, but surprisingly seldom required because of the additional cost of initial metering);
- Minimum standards for irrigation system efficiency (which can include rain sensors to stop irrigation during rainstorms, high efficiency spray nozzles, or even requirements for installation of drip rather than spray irrigation for trees);
- Requirements for "water harvesting" (capture and reuse of rainwater from rooftops and impervious surfaces in tanks or cisterns for reuse in irrigation and other non-potable purposes);
- Features to reuse air conditioning condensate and basement drain water;[60] and
- Requirements that portions of the plumbing system automatically shut off if a leak is detected.

City of Tucson, Arizona: Gray Water Recycling

In 2008, The City of Tucson approved Ordinance 10579 or the Gray Water Ordinance, requiring all new single-family and duplex residential construction to include gray water systems. Gray Water is water previously used by the interior of the house for outdoor irrigation: clothes washers, bathtubs, showers, or bathroom sinks. Using gray water for irrigation purposes can save a typical household 13,000 gallons of potable water a year.[61]

- Starting in June 2010, developers must include plumbing for future gray water distribution. Development plans for single-family and duplex construction must "show a building drain(s) for lavatories, showers, and bathtubs, separate from all other plumbing fixtures, with a connection a minimum of three (3) feet from the edge of the foundation." The systems need to be designed and operated according to the provisions of permits authorized by ADEQ under the Arizona Administrative Code, Title 18, Chapter 9.
- The following figure shows how gray water piping and black water piping interact in a residential unit.



[60] http://www.facilitiesnet.com/plumbingrestrooms/article/ Water Codes And Standards Continue To Tighten Water-Usage-Limits--14929

[61] http://www.tucsonaz.gov/files/water/docs/GrayW_Info_Guide_6-11.pdf

Non-Code Initiatives

While not technically a plumbing code, LEED-EBOM (for Existing Buildings: Operation and Maintenance) version 4 is a point-based rating system with water conservation elements that were revised and extended in November 2013. Building level water metering and indoor water use reduction measures are now mandatory, and different types of buildings and facilities get more tailored treatment. The 12 points that it is now possible to earn for water conservation cover indoor and outdoor water use, water metering, and cooling towers. In addition, three additional points are available for rainwater harvesting, and one point is available for landscape features related to water conservation. A table showing the breadth of LEED treatment of water issues is shown below.

Summary of Water Efficiency Points in LEED v4[62]		
Water Efficiency	Description	Maximum Points
Prerequisite 1	Indoor Water Use Reduction	Required
Prerequisite 2	Building-Level Water Metering	Required
Credit 1	Outdoor Water Use Reduction	2
Credit 2	Indoor Water Use Reduction	5
Credit 3	Cooling Tower Water Use	3
Credit 4	Water Metering	2
Total Possible Points		**12**

The above discussion should make clear that there are several different alternative plumbing codes that could be adopted – and would almost always be tailored – to achieve significant water savings. The challenge for local governments is to (1) choose which alternative code to start from, (2) tailor that code for local conditions (for example, cold or warm climates that may lead to unusual risks of pipes freezing in the cold or expanding in the heat), and (3) organizing political support to adopt the code as the city or county's mandatory construction code. In most communities, a fourth step – training the local building and plumbing contractors on the new requirements – may be required, but in practice those professions are generally involved in both the choice of which code to adopt and in the tailoring the code to local conditions.

Limitations

When using building and plumbing codes to promote water efficiency, however, it is important to ensure that the codes do not duplicate and are not inconsistent with water conservation measures included in zoning or subdivision regulations. It is not uncommon, for example, to find landscaping regulations that offer incentives for (or require) irrigation features that do not align with the requirements of the plumbing code governing irrigation systems. Not only do those types of

[62] http://www.facilitiesnet.com/plumbingrestrooms/article/Plumbing-Codes-Technologies-And-Rating-Systems-Are-Driving-Water-Efficiency-In-Restrooms--14928

inconsistencies cause frustrations for builders, but they often require additional administrative effort to review something twice when it only needs to be reviewed once.

Southern Nevada Water Authority: Water Conservation Plan

The Figure below shows the total gallons per capita per day reductions from the Water Efficient Technologies Program and the Adoption of improved equipment, appliances, and fixtures. Increasing the efficiency of fixtures and appliances will lead to the greatest GPCD reductions of any other program.[63]

	Water Pricing Influence Coefficient	Water Pricing Influence GPCD	Education & Ethic Influence Coefficient	Education & Ethic Influence GPCD	Other Influence Coefficient	Other Influence GPCD	TOTAL REDUCTION (GPCD)
Water Efficient Technologies Program	**40%**	**0.064**	**20%**	**0.032**	**40%**	**0.064**	**0.16**
Adoption of improved equipment, appliances and fixtures	**25%**	**0.1875**	**25%**	**0.1875**	**50%**	**0.375**	**0.75**

[64]

5. Pricing and Metering

City of Frederick, Maryland: Water and Sewer Allocation and Impact Fee

The City of Fredrick, Maryland, was forced to impose a building moratorium in 2001 because of water shortages. In an effort to connect the true cost of water services to the development process, the city addressed this issue by passing an ordinance that requires all new residential and non-residential projects to obtain an allocation of water. The City Engineer determines the total amount of water and sewer capacity available for allocation purposes after taking into account existing development projects and reports these findings to the Mayor and Board of Aldermen at least once per calendar year.[65] Water allocations will be granted at the application for a building permit and the subsequent fees are based on the allocation amount granted. The city's water rates encourage conservation, but are not tied to specific allocations. As new development creates an increased demand on water services, the Frederick Board of Alderman found that "responsibility for satisfying the demands made upon the City's water and systems by new development should be with the new development creating the demands."[66]

Water and Sewer Allocation Fees[67]

Residential: Water and Sewer Allocation Processing	$ 100.00 per Building Permit
Non-Residential: Water and Sewer Allocation Processing	$ 250.00 per Building Permit
Allocation Amount Calculated by Method Other Than the Flow Factor Matrix	$ 750 per Building Permit
Water and Sewer Service Contract Amendment Processing	$ 200.00 Base Amount plus $ 20.00 per Residential Unit $ 200.00 per Non-residential Lot
Water Service Contract Extension Processing	$200.00
Appeals	$300.00

[63] http://www.snwa.com/assets/pdf/about_snwa_conservation_plan_2014.pdf
[64] http://www.snwa.com/assets/pdf/about_snwa_conservation_plan_2014.pdf
[65] http://www.cityoffrederick.com/DocumentCenter/Home/View/1551
[66] http://www.cityoffrederick.com/DocumentCenter/Home/View/1483
[67] http://www.cityoffrederick.com/DocumentCenter/Home/View/1551

Water and Sewer Impact Fees[68]

Water:
New or additional demand as allocated in gallons per day, divided by 250 (Gals./EDU) multiplied by $5,981.00 (Total allocated GPD multiplied $23.92 per Gallon)

Sewer:
New or additional demand as allocated in gallons per day, divided by 250 (Gals./EDU) multiplied by $5,250.00 (Total Allocated GPD multiplied $21.00 per Gallon)

EDU (Equivalent Dwelling Unit)
GPD (Gallons per Day)

City of Sacramento, California: Promote Infill Development through Waiving or Reducing Water Related Fees

In an effort to promote infill development, the City of Sacramento lowered the fee structure for redevelopment in infill areas. The City found that average permit fees in infill areas add up to approximately $14,000 per single family residential unit, with the largest shares coming from school impact fees ($2,300 per unit), regional sewer impact fees ($4,500 per unit, reduced to $2,300 per unit in infill areas), park development impact fees ($1,900 per unit), and the water development fee (approximately $1,900). To encourage infill development and its numerous conservation benefits, the City further reduced the regional sewer impact fee to $923 per unit and waived the water development fee. Small residential projects that qualify for these reductions must be in redevelopment areas and in areas where the median house was built prior to 1965, where proposed development is consistent with community plans and zoning, and is surrounded by development on three sides.[69]

City of Aurora, Colorado: Specialized Tap/Connection Fees

The City of Aurora adjusted its taps fees in 2013 as a means to collecting the true cost of providing water from new customers by basing fees on development type and size. Aurora Water developed a unit demand cost based on the 20 year Water Capital Improvement Plan. The new fee is the sum of five different charges: a water resource fee, source of supply, treatment and distribution, carrying costs, and water losses. The sum of these charges is then multiplied by the average indoor use per development type to get the cost of delivering water to that development type. For residential development, Aurora creates different fee classes based on the unit type, number of bathrooms, and lot size. With all of this information, Aurora creates a customized tap fee based on predicted water use. The new development fee schedule addresses how development decisions correlate to water use by encouraging higher densities and smaller yards. [70] The figures below outline the different ways Aurora Water Conservation calculates the tap fee associated with the type of development.

[68] http://www.cityoffrederick.com/DocumentCenter/Home/View/1550
[69] portal.cityofsacramento.org/~/media/Corporate/Files/CDD/Planning/infill-strategy1.pdf. Since Sacramento did not have water meters at the time of these changes – and is only partially metered today – the savings resulting from any increased infill development resulting from these fee changes has not been measured.
[70] Interview: Melissa Grove, Aurora Water Conservation, December 4, 2014.

Previous tap fee rate schedule.[71]

Fee Type	Previous Fee
Single-family Detached	$24,460/ home
Single-family Attached	$13,515/unit
Multifamily	$12,494/unit
Irrigation: High Water Use	$0.71 per square foot
Irrigation: Low Water Use	$0.36 per square foot

New Rates for Single-Family Residential: Only one meter is needed for both indoor and outdoor use.[72]

Lot Size (Square Feet)	1-2 Bathroom Use	3-4 Bathroom Use (Average)	5+ Bathroom Use
-	$5,509	$8,901	$15,425
5,000	$10,214	$13,606	$20,130
6,000	$11,155	$14,547	$21,071
7,000	$12,096	$15,488	$22,012
8,000	$13,037	$16,429	$22,953
9,000	$13,978	$17,370	$23,894
10,000	$14,919	$18,311	$24,835
15,000	$19,624	$23,016	$29,540
20,000	$24,330	$27,721	$34,245
50,000	$52,560	$55,952	$62,476
100,000	$99,612	$103,004	$109,528

Single-family Attached and Multifamily Units

Multifamily units are assessed both an indoor and irrigation tap fee. The indoor assessment is based on the average gallons per day (GPD) of water use multiplied by the unit demand charge equaling $8,814 per unit. The irrigation component is based upon the type of landscaping used by the developer. The fee schedule is shown below:[73]

Water Service Connection Fee	
Landscape Type	**Water Service Connection Fee**
Non-Water Conserving	$2.75 per square foot of landscaped area
Water Conserving	$1.47 per square foot of landscaped area

Commercial and Industrial

For indoor use, the charge is based upon meter size plus the irrigation schedule above. The indoor rates for commercial and industrial went down due to the rising cost of outdoor irrigation. Aurora Water

[71] Aurora City Council, Infrastructure and Operations Policy Committee, August 21, 2013.
[72] Aurora City Council, Infrastructure and Operations Policy Committee, August 21, 2013.
[73] Aurora City Council, Infrastructure and Operations Policy Committee, August 21, 2013.

Conservation is charging more for outdoor irrigation because it is trying to charge the true cost providing irrigated water.[74]

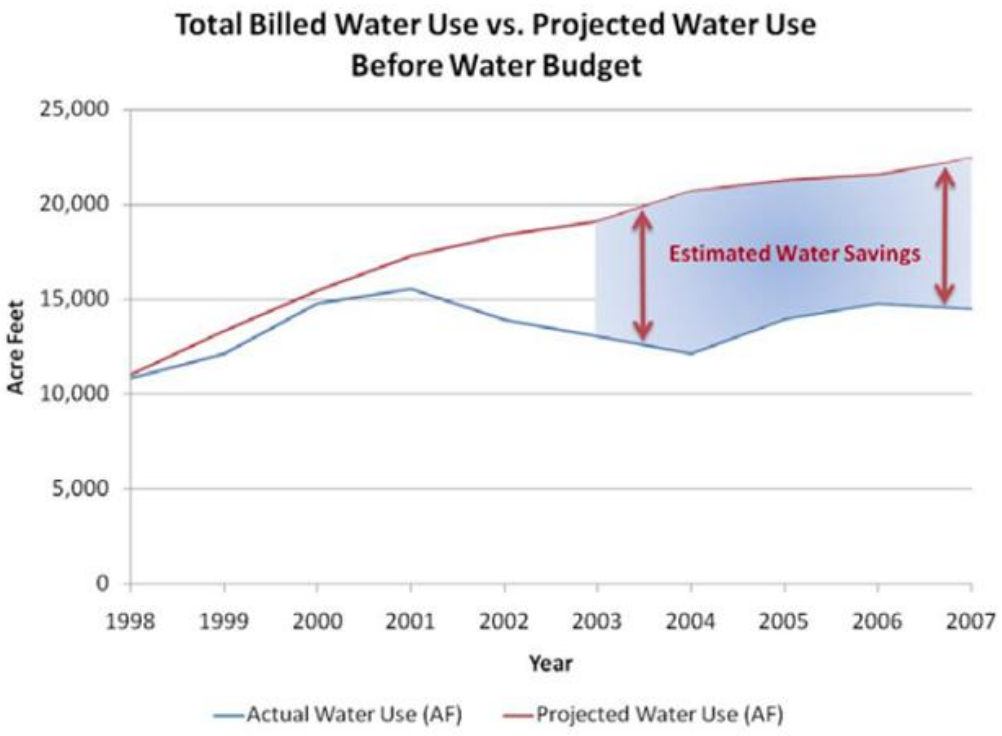
Meter Size	Proposed	Existing	Difference
¾"	$20,043	$24,460	($4,417)
1"	$35,791	$42,365	($6,574)
1 ½"	$78,741	$97,620	($18,879)
2"	$143,166	$173,374	($30,208)

Centennial Water and Sanitation District: Water Budget

Landscape water budgets allocate specific amounts of water for specific uses, and require the property owner to pay for excesses above the budgeted amount. Budgets compare actual metered consumption against legitimate outdoor water needs based on landscape types, plant type, and weather conditions. Water budgets are an important tool to help utilities identify users who are over-irrigating and use market forces to encourage conservation.

After the 2002 drought, The Centennial Water and Sanitation District implemented a water budget rate structure with two key components: a fixed water service availability fee and a variable water consumption rate. The fixed water service availability fee assures revenue stability to meet on-going debt service and staff obligations. The variable water consumption rate created a four-tier rate structure where the break point between tiers is based on a percentage of water budget assigned to each customer.[75] According to the water conservation plan, the Water Budget rate structure has achieved approximately 21% in annual water savings.[76] The figure below shows those savings:

[74] Aurora City Council, Infrastructure and Operations Policy Committee, August 21, 2013.
[75] http://centennialwater.org/wp-content/uploads/2011/12/WaterConservationPlanFinal.pdf
[76] http://centennialwater.org/wp-content/uploads/2011/12/WaterConservationPlanFinal.pdf



For residential users, the budget is calculated both on indoor and outdoor use. For indoor use, users are budgeted 12,000 gallons every two months based on assumed 65 gallons per capita per day for a family of three. Customers are able to sign an affidavit to receive an additional allowance for larger families. For outdoor use, the budget is based on the customer's actual lot size multiplied by an irrigable area factor of 45%. Users are given an allowance of 27 inches of water based on historical Evapotranspiration rates for the area, minus average annual measureable rainfall is provided. Budgeted outdoor amounts are then based on historical evapotranspiration for the weeks within each billing cycle. In 2007 the rates were as follows:[77]

Percentage of Water Budget	Water Rate per 1000 gallons (Kgal)	
	Summer	Winter
Usage up to 100% of Budget (< 100%)	$ 2.30 per Kgal	$2.30 per Kgal
Usage of 101% to 120% of Budget (101% - 120%)	$ 3.45 per Kgal	$3.45 per Kgal
Usage of 121% to 140% of Budget (121% - 140%)	$ 5.20 per Kgal	$3.45 per Kgal
Usage over 140% of Budget (> 140%)	$ 7.80 per Kgal	$5.20 per Kgal

While users can go above their water budgets, the water rates increase dramatically if they do so, which strongly encourages conservation efforts.

Non Residential development receives different water budgets for indoor and outdoor/irrigation use. The indoor component is based upon the size of the meter serving the business. Businesses are allotted

[77] http://centennialwater.org/wp-content/uploads/2011/12/WaterConservationPlanFinal.pdf

189,000 gallons per ¾ inch equivalent tap. The outdoor component is based on actual irrigated areas for the customer. The customer is responsible for supplying landscape area data to District.[78]

2007 Non-Residential Rates: Indoor

Percentage of Water Budget	Water Rate per 1000 gallons (Kgal)
	Summer
Usage up to 100% of Budget (< 100%)	$ 2.30 per Kgal
Usage of 101% to 120% of Budget (101% - 120%)	$ 3.45 per Kgal
Usage of 121% to 140% of Budget (121% - 140%)	$ 5.20 per Kgal
Usage over 140% of Budget (> 140%)	$ 7.80 per Kgal

2007 Non-Residential Rates: Irrigation

Percentage of Water Budget	Water Rate per 1000 gallons (Kgal)	
	2006	2007
Usage up to 100% of Budget (< 100%)	$ 2.30 per Kgal	$2.30 per Kgal
Usage of 101% to 120% of Budget (101% - 120%)	$ 3.45 per Kgal	$4.00 per Kgal
Usage of 121% to 140% of Budget (121% - 140%)	$ 5.20per Kgal	$7.00 per Kgal
Usage over 140% of Budget (> 140%)	$ 7.80 per Kgal	$12.00 per Kgal

Multiple issues have been resolved since the adoption of the fee structure. The District introduced a permit program to allow for increase in budget once per year for customers wanting to add new sod in April, May, September, or October, which discourages planting in the middle of the summer. As mentioned earlier, households with populations greater than 3 people are issued a variance for their budgets.[79]

The District also increased water budgets by 1,000 gallons per month during the winter to accommodate winter watering of trees and shrubs. In 2007, the District increased the rate for non-residential irrigations to promote further conservation. Non-residential indoor use was previously calculated by using historical use, but the new system based on meter size more effectively promotes conservation. [80]

According to Jon Klassen, the Water Conservation Coordinator for the Centennial Water and Sanitation District, the budget program has been successful in reducing water use and remains an important part of the District's water conservation strategy. In terms of comparing single-family residential use and multifamily residential use, The District has found that multifamily units tend to only use around 50% of their 6,000 gallon water budget, so only 3,000 gallons. While single-family residential use is not broken down by indoor and outdoor consumption, the average use winter time use is 4,500 gallons. Winter use

[78] http://centennialwater.org/wp-content/uploads/2011/12/WaterConservationPlanFinal.pdf
[79] http://centennialwater.org/wp-content/uploads/2011/12/WaterConservationPlanFinal.pdf
[80] http://centennialwater.org/wp-content/uploads/2011/12/WaterConservationPlanFinal.pdf

generally has little to no outdoor irrigation. These figures suggest that, on average, multifamily water use is 33% less than single-family indoor use.[81]

Boulder, Colorado: Water Budget and Increasing Block Structure

In 2009, the City of Boulder updated their methodology for calculating user's water budgets and subsequent water fees to better "promote water conservation and the efficient use of water, support community goals, reflect the value of water, send a price signal to customers who waste water, and avoid the costs of new water development and expanded water treatment.[82]" Like Centennial, the water budget is based on the customer's anticipated indoor and outdoor water needs. Customers are divided into four different classes: single-family residential, multifamily residential, CII, and metered irrigation.

Historic ET Rate for Outdoor Irrigation:

Historic ET Rate	
Month	Share of Annual Outdoor Allocation
January	0%
February	0%
March	1%
April	7%
May	14%
June	20%
July	20%
August	18%
September	12%
October	7%
November	1%
December	0%
Total	**100%**

Single-Family Residential:

Single-family residential rates have an indoor and outdoor component. For indoor use, the unit is allocated 7,000 gallons per month for a household up to four people. The outdoor allocation is based upon "customer-specific irrigable areas as determined by the city's GIS system." The GIS system differentiates hard surface and property boundaries. The outdoor component is as follows:

- First 5,000 sq. feet of irrigable area: 15 gallons/sq. ft.
- Next 9,000 sq. feet irrigable area: 12 gallons/sq. ft.
- For irrigable areas in excess of 14,000 sq. ft.: 10 gallons/sq. ft.

To account for differing seasonal water needs, "the total annual allocation of water for irrigable area shall be distributed to each month based upon that month's annual outdoor amount as described by the

[81] Interview: Jon Klassen, Centennial Water and Sanitation District: Water Conservation Coordinator, January 28, 2015.
[82] https://www-static.bouldercolorado.gov/docs/water-budget-rules-1-201304191236.pdf

historic monthly ET rate.[83]" In certain instances, such as occupancy, water budgets adjustments may be granted by the city.

Multifamily Residential:

Like single-family residential, multifamily budgets also have an indoor and outdoor component. Each unit is budgeted 4,000 gallons per month for indoor use. The same GIS mapping techniques as single-family residential are used to calculate outdoor water needs for multifamily outdoor budgets with annual application rate of 15 gallons/sq. ft. This amount is seasonal variable to account for higher ET rates in the summer months.

Commercial/Industrial/Institutional (Non-residential)

The CII average monthly use budget is based upon historical average monthly use (AMU) for a 12 month period in 2005. A customer's historical monthly use (HMU) is based upon the most recent three-year average for each month, and is recalculated every year. Indoor use is based upon a customer's average winter consumption (AWC) and outdoor use is calculated based on the city's GIS analysis with a rate of 15 gallons/sq. ft. and apportioned seasonally.

Example: Single-family dwelling with 14,400 square feet of irrigable area:

Indoor Allocation: 7,000 gallons per month

Outdoor Allocation: 187,000 gallons per year. For calculating monthly allocation, multiply monthly share by total outdoor allocation (For example in July, the monthly share is 20%, so 20% x 187,000 = 37,400 gallons). The rules call for rounding up to the nearest 1,000 gallons.

Irrigable Area (square feet)	Gallons per Square Foot	Total Gallons
5,000	15	75,000
9,000	12	108,000
400	10	4,000
Annual Outdoor Allocation		**187,000**

[84]

In July, the monthly budget for this customer would be 7,000 gallons (indoor) and 38,000 gallons (outdoor) for a total of 45,000 gallons. If the user used 70,000 gallons (twice the amount budgeted for) in July, the bill structure would be as follows:

Rate Block	% of Budget	Gallons per Rate Block	Billed Water Usage (gallons)
Block 1	0-60% of budget	0 – 27,000	27,000
Block 2	61-100% of budget	27,001 – 45,000	18,000
Block 3	101-150% of budget	45,001 – 68,000	23,000
Block 4	151-200% of budget	68,001 – 90,000	2,000
Block 5	over 201% of budget	Over 90,000	0

[85]

[83] https://www-static.bouldercolorado.gov/docs/water-budget-rules-1-201304191236.pdf
[84] https://www-static.bouldercolorado.gov/docs/water-budget-rules-1-201304191236.pdf

The City of Boulder couples this innovative budgeting methodology with an escalating block rate structure which rewards users for using less than their budget and sends pricing signals to users who use more than they are budgeted for. The differences in the blocks are large enough to encourage conservation. For instance, block 3 is twice the base rate, block 4 is three times the base rate, and block 5 is five times the base rate. For users who use less than their allocation, they pay ¾ of the base rate.

2015: Block Charges:

BLOCKS	BLOCK RATES	BLOCK SIZE (PERCENT OF MONTHLY WATER BUDGET)
Block 1	$2.55	0 - 60 percent
Block 2	$3.40	61 - 100 percent
Block 3	$6.80	101 - 150 percent
Block 4	$10.20	151 - 200 percent
Block 5	$17.00	Greater than 200 percent

[86]

Salt Lake City, Utah: Innovative Water Rate Structure

Many communities across the west use increasing block rate structures to encourage conservation by charging more for greater consumptive use. According to research done by Western Resource Advocates, there is a close correlation between cities with dramatically increasing block rates and those with the lowest per capita consumption levels.[87] The organization identifies key design elements to a block structure that lead to conservation successes. They are:

- "Provide water at low prices for basic and essential needs, so that all customers can afford it;
- Reward conserving customers with lower unit rates for water;
- Encourage efficient use by sending a strong conservation price signal;
- Assign water supply and development costs proportionally to the customers who place the highest burden on the supply system and the natural resources; and
- Do all of the above while still maintaining a stable flow of revenue to the utility."[88]

According to an interview with Stephanie Duer, from Water Conservation Programs of Salt Lake City, the City derived an average unit per month consumption based on city and non-city customers. The City then established tiers/blocks of water price that aim towards conservation. The blocks are used in the summer months (April through October) when water consumption is at its highest, and remains at a flat rate during the winter time months (November through March). The water rate takes into account location as well -- the rates for development in the County are significantly higher than the city. Duer partially attributes the reduction in overall demand and peak demand in Salt Lake City to the water rate structure. [89]

[85] https://www-static.bouldercolorado.gov/docs/water-budget-rules-1-201304191236.pdf
[86] https://bouldercolorado.gov/water/utility-rates
[87] http://www.westernresourceadvocates.org/media/pdf/Utah%20Water%20Rate%20Analysis%20-%20300dpi.pdf
[88] http://www.westernresourceadvocates.org/media/pdf/Utah%20Water%20Rate%20Analysis%20-%20300dpi.pdf
[89] Interview: Stephanie Duer, Salt Lake City Water Conservation Programs, January 16, 2015.

The graphic below highlights the fee schedule. One unit is equal to 100 cubic feet of water.[90]

Residential & Commercial	BLOCK 1* (Winter Rate)		BLOCK 2		BLOCK 3		BLOCK 4	
	City	County	City	County	City	County	City	County
Per Unit Charge	$1.08	$1.46	$1.61	$2.16	$2.23	$3.01	$2.34	$3.15
Single	1 unit thru 10		11 units thru 30		31 units thru 70		71 units & Above	
Duplex	1 unit thru 13		14 units thru 30		31 units thru 70		71 units & Above	
Triplex	1 unit thru 16		17 units thru 30		31 units thru 70		71 units & Above	
Fourplex	1 unit thru AWC		>100% to 300% AWC		>300% to 700% AWC		>700% AWC	
Commerical & Industrial	1 unit thru AWC		>100% to 300% AWC		>300% to 700% AWC		>700% AWC	

Note: AWC is the Average winter Water consumption and varies per each commercial customer

Salt Lake City created a new tier of water rates called the Irrigation Meter Rate Structure. This irrigation-only meter is for properties with large campuses, parks, or areas requiring extensive irrigation. According to the fee schedule, the water budget means "the estimated amount of water consumed per acre, as established by the Public Utilities Director, or his designee each year for customer based on factors including, but not limited to, evapotranspiration, and considering efficient water practices. A different target budget is established for each month of the irrigation season. The fee schedule is shown below:[91]

Account Type	Amount Used	Rate (Summer)		Flat Rate (Winter)	
		City	County	City	County Cost
Irrigation	100 Cubic feet to target budget	$1.61	$2.16	$1.61	$2.16
	Over target budget Up to 300% of target budget	$2.23	$3.01		
	Over 300% of target budget	$2.34	$3.15		

Sierra Vista, Arizona: Submetering

Submetering has the potential to help residents in multifamily developments understand their actual water use. A building is submetered when each tenant has its own separate water meter instead of the having only one meter per development. In 2004 a study sponsored by the EPA, 10 municipal water utilities, and 2 national apartment associations found that submetering reduced annual consumption by an average of 15% compared to properties that included water charges in unit rent.[92] In 2013, Sierra Vista required all new multifamily development greater than four units to require sub metering. Exceptions apply in cases where 80% or more of the tenants are low income or if the building provides other water savings designs. Exceptions are dealt with on a case-by-case basis.[93]

[90] http://www.slcdocs.com/utilities/PDF%20Files/UtilityRates/WaterratieswebCurrent.pdf
[91] http://www.slcdocs.com/govt/cfs.pdf
[92] http://www.westernresourceadvocates.org/water/pdf/Submetering%20Fact%20Sheet.pdf
[93] http://www.westernresourceadvocates.org/water/pdf/Submetering%20Fact%20Sheet.pdf

6. State Legislation

This section of the report reviews some examples of state legislation in states other than Colorado that aim to reduce water consumption across a wide range of activities and locations. In many cases, it does not represent a different conservation tool, but rather a different mechanism to require or encourage local governments to implement one or more of the water conservation measures described in earlier sections of this report. In other cases, state legislation makes some of those decisions on behalf of local governments or private entities, and prevents or discourages them from making different decisions.[94]

State of California: Projected Water Supply/Demand

California's Senate Bill 610 requires water suppliers to estimate their projected water supply/demand balance for the jurisdictions that they provide water to. The law then puts the burden on cities and counties to consider these projections before approving large scale developments. While the law does not force cities and counties to reject proposals based on water supply, it makes them take water supply into account with the development process.[95] In addition, Senate Bill 221 requires water agencies or city/county jurisdictions to "verify an adequate water supply for developments before they issue building permits."[96] This review is required only for residential developments of 500 units or more and exempts infill and low income housing projects. Both of these laws together help create consistency throughout the development process by connecting water implications to growth.[97]

California: High Efficiency Fixtures

California has set standards for all new toilets and urinals either purchased or installed after January 1, 2014, to be efficient and beyond federal standards.

> (b)(1) All water closets sold or installed in this state shall use no more than an average of 1.6 gallons per flush. On and after January 1, 2014, all water closets, other than institutional water closets, sold or installed in this state shall be high efficiency water closets.
>
> (2) All urinals sold or installed in this state shall use no more than an average of one gallon per flush. On and after January 1, 2014, all urinals, other than blow-out urinals, sold or installed in this state shall be high-efficiency urinals.
>
> . . . .
>
> (g) As used in this section, the following terms have the following meanings:
>
> (1) "Blow-out urinal" means a urinal designed for heavy-duty commercial applications that work on a powerful nonsiphonic principle.

[94] The terms "water withdrawal applicant", "water withdrawal permit", "water right permit" and similar terms varies by state and it is beyond the scope of this report to analyze the state-by-state differences in water allocation systems. These examples instead focus on steps each state has taken to improve conservation under its own system.
[95] http://www.epa.gov/smartgrowth/pdf/growing_water_use_efficiency.pdf
[96] http://www.epa.gov/smartgrowth/pdf/growing_water_use_efficiency.pdf
[97] http://www.epa.gov/smartgrowth/pdf/growing_water_use_efficiency.pdf

(2) "High-efficiency water closet" means a water closet that is either of the following:

(A) A dual flush water closet with an effective flush volume that does not exceed 1.28 gallons, where effective flush volume is defined as the composite, average flush volume of two reduced flushes and one full flush . . . .

(B) A single flush water closet where the effective flush volume shall not exceed 1.28 gallons . . .

(3) "High-efficiency urinal" means a urinal that uses no more than 0.5 gallons per flush.

(4) "Institutional water closet" means any water closet fixture with a design not typically found in residential or commercial applications or that is designed for a specialized application, including, but not limited to, wall-mounted floor-outlet water closets, water closets used in jails or prisons, water closets used in bariatrics applications, and child water closets used in day care facilities.[98]

State of Massachusetts: Conservation and Water Permitting

According to the Alliance for Water Efficiency, three states have extensive permitting requirements related to water conservation. In Massachusetts, the State requires "water withdrawal applicants to include a description of existing and planned water conservation measures and a water conservation program and implementation timetable."[99] The agencies that review these applications must consider conservation practices in their final decision and the permits are conditioned on implementation.

Relevant text from the Massachusetts Law are shown below:

"Every registration statement must contain, at a minimum . . . (f) Conservation measures instituted, or to be instituted, by the registrant . . . .[100]

. . . .

Each permit application filing shall include, at a minimum . . . (f) a description of water conservation measures instituted or to be instituted by the applicant, including a schedule for implementation of those measures.[101]

. . . .

Each permit applicant must submit, in accordance with guidelines developed by the Department, a detailed water conservation program and implementation timetable with the permit application.[102]

. . . .

In reviewing a permit application, the Department shall consider at least the following . . . (h) reasonable conservation practices and measures . . . .[103]

. . . .

[98] Cal. Health and Safety Code Section 17921.3.
[99] Water Efficiency and Conservation State Scorecard. An Assessment of Laws and Policies. Sept. 2012.
[100] MASS. REGS. CODE tit. 310, § 36.06(2).
[101] MASS. REGS. CODE tit. 310, § 36.20(1).
[102] MASS. REGS. CODE tit. 310, § 36.25(1)
[103] MASS. REGS. CODE tit. 310, § 36.26(1).

> All permits shall be conditioned on at least the following . . . (e) implementation of water conservation measures. . .[104]
> . . . .
> Each permit holder shall file an annual statement of withdrawal which includes at least the following . . . (b) conservation measures instituted in the past 12 months; (c) savings due to conservation measures implemented . . . .[105]"

State of Georgia: Conservation and Water Permitting

In Georgia, the law requires water withdrawal permits to be made "in accordance with the statewide and regional water management plans."[106] The law is as follows:

> "The division shall make all water withdrawal permitting decisions in accordance with this chapter, the comprehensive state-wide water management plan that has been approved or enacted by the General Assembly as provided by this article, and any applicable regional water development and conservation plan, including, but not limited to, restrictions, if any, on diversion from or reduction of flows in other watercourses. Any political subdivision or local water authority that is not in compliance with the plan shall be ineligible for state grants or loans for water projects, except for those projects designed to bring such political subdivision or local water authority into compliance with the plan.[107]"

State of California: Conservation and Water Permitting

In California, all permits contain a water conservation condition that is more extensive than either Georgia or Massachusetts' laws, "establishing the continuing authority of the permitting agency to impose additional requirements at a later date to eliminate waste of water and avoid unreasonable draft on the source.[108] The law is as follows:

> "In addition to the applicable standard terms which are included in each permit, the following terms shall be included in every water right permit issued by the board, and shall be included in every existing permit as a condition for granting an extension of time to commence or to complete construction work or to apply the water to full beneficial use:
>
> > (a) Continuing Authority… The continuing authority of the board may be exercised by imposing specific requirements over and above those contained in this permit with a view to eliminating waste of water and to meeting the reasonable water requirements of permittee without unreasonable draft on the source. Permittee may be required to implement a water conservation plan, features of which may include but not necessarily be limited to:

[104] MASS. REGS. CODE tit. 310, § 36.28(1).
[105] MASS. REGS. CODE tit. 310, § 36.33(1).
[106] Water Efficiency and Conservation State Scorecard. An Assessment of Laws and Policies. Sept. 2012.
[107] GA. CODE ANN. § 12-5-522(e).
[108] Water Efficiency and Conservation State Scorecard. An Assessment of Laws and Policies. Sept. 2012.

(1) reusing or reclaiming the water allocated;
(2) using water reclaimed by another entity instead of all or part of the water allocated;
. . . .
(4) suppressing evaporation losses from water surfaces;
. . . . and
(6) installing, maintaining, and operating efficient water measuring devices to assure compliance with the quantity limitations of this permit and to determine accurately water use as against reasonable water requirements for the authorized project.[109]

California: Water Conservation Plan

Multiple states have addressed water conservation plans in their state laws (including Colorado) but California's is noted because it "requires conservation planning within its mandated urban water management plans" [110] The law is as follows:

"(a) Every urban water supplier shall prepare and adopt an urban water management plan . . . .
(b) Every person that becomes an urban water supplier shall adopt an urban water management plan within one year after it has become an urban water supplier. . . .[111]

(a) The state shall achieve a 20-percent reduction in urban per capita water use in California on or before December 31, 2020.[112]
. . . .
(e) An urban retail water supplier shall include in its urban water management plan due in 2010 pursuant to Part 2.6 (commencing with Section 10610) the baseline daily per capita water use, urban water use target, interim urban water use target, and compliance daily per capita water use, along with the bases for determining those estimates, including references to supporting data...
(g) An urban retail water supplier may update its 2020 urban water use target in its 2015 urban water management plan required pursuant to Part 2.6 (commencing with Section 10610).[113]

Conclusions and Potential Strategies

The information presented above shows that there are several strategies for planning and regulation of development or redevelopment before initial occupancy that could result in significant water savings. The two tools explored in Phase I research (density increases and restrictions on irrigated landscaping) showed significant documented water savings, and each of the sponsors of the programs listed in Phase II believed that they would produce significant reductions in water consumption (although in many cases the amount of water savings had not been documented).

[109] CAL. CODE REGS. tit. 23, § 780.
[110] Water Efficiency and Conservation State Scorecard. An Assessment of Laws and Policies. Sept. 2012.
[111] CAL. WAT. CODE § 10620(1)(b).
[112] CAL. WAT. CODE § 10608.16(a).
[113] CAL. WAT. CODE § 10608.20.

Conclusions

To summarize the information above:

1. **Smaller Residential Lots.** Reducing the size of single-family residential lots produces clear and significant water savings, primarily through reduction of irrigated lot area. The savings continue to grow as lot sizes shrink – there is no lot so small that the savings trends reverse. The most significant savings appear to occur when densities are increased from about 1 to about 7-10 dwelling units per acre. In some cases, it was unclear whether development in the 7-10 dwelling units per acre was small lot single-family development or townhouse development.
2. **Moving from Single-family to Multifamily Development.** Some of the studies above suggest that multifamily development, on average, consumes only 50-65% as much water per unit as single-family detached units – although those savings can vary significantly depending on the assumptions made.
3. **Increasing Multifamily Residential Density.** Increasing the density of attached and multifamily development also produces water savings – up to a point. The trends reverse for very high density or high rise condominiums, where cooling towers or water intensive amenities may consume part of the water saved through less site irrigation. Some studies appear to indicate that savings taper off and reverse when building exceed 3 or 4 stories in height. These trends are probably weaker in resort-oriented housing developments that include water-consumptive amenities such as golf courses or swimming pools.
4. **Turf/Irrigation Restrictions.** Restrictions on the installation of turf grass also have a very significant impact on water consumption. Several studies have found that outdoor water use constitutes 50% of residential use. While water savings from various xeric landscape programs range from 15-63%, savings in the 35-50% range were not uncommon.

Each of the four tools discussed above are implemented primarily through zoning regulations or related site plan regulations. Zoning is the most direct tool to control minimum and maximum residential lot sizes, minimum and maximum residential densities, whether single- or multifamily housing is permitted in an area, and what types of landscaping can or must be installed for different types of development.

5. **Water Conserving Plumbing Codes.** A number of water conserving alternatives or supplements to the traditional Uniform Plumbing Code, the International Plumbing Code, and the National Plumbing Code are now available. Each of the alternatives – including but not limited to the UPC green plumbing supplement, the ICC green plumbing supplement, and the International Green Construction Code – are specifically designed to reduce water consumption – with the amount of savings depending on the code chosen and the options chosen within that code.

Building and plumbing codes are implemented separately from zoning, subdivision, and land development codes, and apply to specific types of building and building uses regardless of where zoning may or may not allow those types of buildings and uses.

6. **Water Pricing and Rate Structures.** It also appears clear that adopting water pricing rate structures that accurately reflect the amount of water consumed by different sizes and types of residential development can produce significant reductions in water use. This is also true of water budget systems, where users above a calculated average use value pay significantly higher rates as a penalty for exceeding that value. Savings from pricing structures depend on the rates adopted, but in some cases rate changes have produced water consumption savings in the 20% range, while submetering of apartments may produce savings in the 15% range.

Water connection fees and water consumption charges are not set through land use regulations, but through the rate setting procedures of the public or private utility or water provider.

7. **State Legislation.** California, Georgia, and Massachusetts (among others) have adopted state legislation that either (a) limit withdrawals of water that are under state control, or (b) create a permitting system to impose water conservation measures on certain types of development, or (c) require or encourage their local governments to implement specific types of water conservation standards or regulations. There is no doubt that these programs will reduce water use in their respective states, with the amount of reduction based on the details of the controls included.

In contrast, two of the topics addressed in Phase I and Phase II of this document do not appear to have significant impacts on water consumption.

- **Comprehensive Plans.** It is a best practice to include water conservation goals, objectives, and strategies in the community's comprehensive plan. They articulate shared values that can then inform policy discussions in other areas (i.e. landscaping and land use), can help align the assumptions and projections used by land use planners and water supply planners, and can lead to Capital Improvements Plans that reflect their aligned approaches to water conservation. However, including advisory language in a comprehensive plan does not, by itself, save water. In Colorado, comprehensive plans are advisory unless the city or county acts to make them regulatory documents. So comprehensive plan statements regarding water generally only take effect if the local government lists them as one of the criteria for making decisions in its zoning and subdivision regulations.

- **Subdivision Regulations.** Subdivision regulations can be effective in reducing water use when they encourage or require "cluster development" (allowing smaller lots in return for setting aside 50-70% of a subdivision tract as open space). This is the one instance in which lot sizes are addressed in subdivision regulations rather than in zoning controls (although they can also be included in zoning regulations). Generally, minimum and maximum lot sizes are addressed in the zoning regulations, and subdivision regulations simply state that the zoning parameters be followed.

  If a local government (generally a county) were to require (rather than just encourage) aggressive clustering of residential lots, it could result in significant water savings, but that does not occur often. More often, cluster development is offered as an option, and its impact on

water savings are limited by the fact that many property owners choose not to exercise that option.

Although some older subdivision regulations include landscaping requirements, those types of regulations are also more frequently found in zoning regulations, because land may be subdivided long before development occurs and zoning regulations will govern that development when it does occur.

Possible Strategies

Although many of the tools discussed above could reduce water consumption in future development and redevelopment in the state, the amount of water savings to be gained, and the challenges to be overcome in implementing them vary. In the table below, we summarize both the potential water savings and potential challenges to implementation for each of them.

Tool	Potential Water Savings	Implementation Challenges	Notes
Smaller Residential Lots	High	Residential dwelling type is primarily driven by market demand. Efforts to push smaller lots or Multifamily development beyond demand will be strongly opposed by developers	
Changing from SF to MF Development	High		
Increasing MF Densities	High – to a point		
Turf/Irrigation Restrictions	High		If these are implemented, the potential savings from smaller lots, changing from single-family to multifamily development, and increasing multifamily densities will be lower
Water Conserving Plumbing Codes	High		
Water Pricing and Rate Structures	High	This would affect all users – not just new development, so potentially lots of opponents	
Comprehensive Plans	Low to Moderate		
Subdivision Regulations	Low to Moderate	In Colorado, few local governments have been willing to require (rather than just allow) the levels of clustering required to produce significant water savings	
State Legislation	High	Land use and plumbing codes have traditionally been viewed as matters of local concern	

Because of the implementation challenges outlined in the table above, and the potential water savings involved, it may be most useful to pursue solutions based on turf/irrigation restrictions, water conserving plumbing codes, and water pricing and rate structures. While substantial savings might also be achieved through Smaller Lots, more Multifamily Development, and Increasing Multifamily Densities, the ability to implement those changes is highly constrained by market forces. Stated differently, the potential savings to homeowners from choosing a smaller lot, a multifamily rather than a single-family house, or an apartment in a more dense (rather than less dense) development are not likely to be large enough to sway market decisions in favor of those options – and builders will resist building requirements for which there is less market demand. State legislation could theoretically be used to require local government to impose any or all of the other types of water conservation strategies, but will probably face an uphill struggle in light of Colorado's strong Home Rule tradition.