EQUINOX CENTER

HEALTHY ENVIRONMENT STRONG ECONOMY VIBRANT COMMUNITIES

H2OVERVIEW PROJECT

The Potential of Water Efficiency and Conservation: Opportunities in Single Family Homes in San Diego

OCTOBER 2012

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ABOUT H2OVERVIEW

Equinox Center is pleased to present its fifth publication in its H_2Overview Project, *The Potential of Water Efficiency and Conservation: Opportunities in Single Family Homes in San Diego*. As our population and economy grow, it is important to prepare today for the difficult decisions our region faces to properly steward our water resources.

H_2Overview provides balanced, easy-to-understand research on San Diego County's water supply to help inform the decision-making process. Previous papers have included an overview of all current and potential sources of water published jointly with the Fermanian Business Enterprise Institute at Point Loma Nazarene University, as well as in depth policy briefs on seawater desalination and purified water recycling. These reports have focused on the benefits, costs and challenges associated with the development of these water supply sources with the intent of spurring informed public dialogue and decision making about our future water portfolio. This report is a first attempt at quantifying the remaining potential of conservation in the region.

ABOUT EQUINOX CENTER

To ensure a healthy environment, vibrant communities and a strong economy for the San Diego Region, Equinox Center researches and advances innovative solutions to balance regional growth with our finite natural resources. We are proponents for our region's responsible growth and we support the conscientious care-taking of the natural and economic assets that we have inherited. www.equinoxcenter.org

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The authors gratefully acknowledge and thank all outside expert reviewers and contributors to this report including Keith Solar (Buchanan Ingersoll & Rooney), Andrew Narwold (University of San Diego), Sean Karafin (San Diego County Taxpayers Association), Jill Witkowski (San Diego Coastkeeper) and staff of the San Diego County Water Authority and City of San Diego.

Special thanks to Equinox Center Fellow Dylan Wood and intern Andrew Talbert for their contributions to this paper.

EXECUTIVE SUMMARY

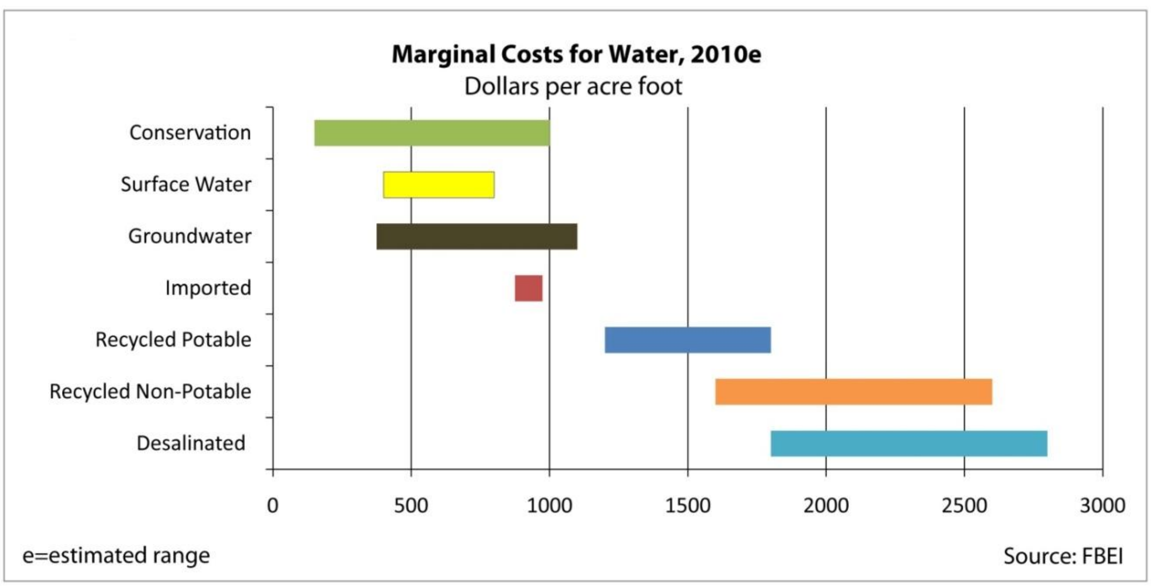
Water is likely to be the most critical resource challenge that the San Diego region will face during the coming two decades as we accommodate the 650,000 new residents expected by 2030. Most of that growth is from our children and grandchildren. Fresh water is the lifeblood of our arid region. Without an adequate, clean, reasonably priced water supply, our biotech, pharmaceutical, agricultural and manufacturing sectors would not be able to thrive, research at our world class universities would be curtailed, and human health would be threatened.

With limited local groundwater or surface water, the San Diego region currently imports 70% of its water supply from northern California or the Colorado River. Yet this supply is vulnerable due to environmental, legal, regulatory and other factors. Climate change and natural disasters put our imported supply at even more risk. And the price of imported water continues to rise.

The vulnerability of imported water supplies and increasing costs thereof is creating a sense of urgency to find ways to use water as efficiently as possible and to develop more local, reliable and cost effective sources of water. In addition, recent surveys by the San Diego County Water Authority (SDCWA) state that 95% of those surveyed in the region believe it is their "civic responsibility to use water as efficiently as possible."

In our 2010 Assessing the Options paper, working with the Fermanian Business Enterprise Institute (FBEI) at Point Loma Nazarene University, Equinox Center determined that conservation is one of the lowest cost and most environmentally beneficial ways to address San Diego County's water challenges.

Marginal Costs for Water:



However, at that time, we noted that additional research was needed to determine just how much potential for conservation and efficiency remain in the region. This report is a first step in quantifying potential water savings in the region. We note that this report pertains only to the residential sector, and within that sector, only to single family households, due to the limitations of the data we reviewed. Our intent is for this report to be helpful to decision makers and the public by providing empirical evidence demonstrating that there is remaining conservation opportunity to be explored in the region. We do not intend for our estimates to be considered final projections for water use and efficiency projections.

Findings

- In the single family residential sector alone, **overall we could use our water 20-30% more efficiently than current projections estimate**, primarily by employing technologies already in existence.

- **Significant savings could come from reducing outdoor usage: roughly 38,000 gallons per year per single family household** (a 41% reduction from 2007 numbers) for a total savings of 28,000 Acre Feet in the City of San Diego by 2035.

- Potential for outdoor savings include **reducing over watering** (on average single family homes in San Diego that use water for landscaping use about 50 gallons/day more than needed), **using more efficient irrigation technologies**, **reducing irrigable area** and **replacing plants** that require high water **with low water plants or xeriscaping**.

- **There are still water efficiencies to be gained inside homes**. With the proper policies and/or educational programs in place to incentivize replacement of older clothes washers, toilets and faucets and by fixing leaks, **we estimate an average 20-37% reduction in water use inside the average single family home in San Diego**.

- Data that Equinox Center analyzed show that only **about 3% of single family homes have installed, exclusively, the most efficient toilets** available, and only about **4% have installed the most efficient clothes washers**.

We believe our estimates of potential reductions of water use in the single family sector in our region are somewhat conservative. Our findings do not include savings to be gained from significant changes in consumer behavior. Research conducted by psychologists such as Cal State San Marcos professor Wesley Schultz suggests that real time feedback to consumers about how their water and energy consumption patterns compare to others in their neighborhood or city can be a powerful influence on consumption rates.

Reducing water consumption in the region could have multiple benefits including reducing or delaying the need for expensive new supply infrastructure, reducing the amount of runoff and pollutants that threaten the water quality of our beaches and bays, saving water utilities money in operating costs, and saving consumers money on their water bills. Reduced water use also reduces regional and statewide energy use, resulting in less pollution and greenhouse gas emissions. Finally, focusing on water efficiency helps water managers maintain more local control over their water supply and is an inherently flexible form of water management that can be adjusted as needed.

Despite the benefits, there are challenges to seeing more aggressive efficiency and conservation practices. Most current water pricing structures in the region do not adequately incentivize conservation and discourage waste, partly because the business and regulatory models in the water industry make it difficult to do so. There is also a need for better real time feedback to the consumer about their water usage and what they can do to reduce it. Finally, there is concern about demand hardening, which could make it more difficult to reduce water consumption in times of drought.

The importance of having accurate water demand estimates and cost effective efficiency policies and targets cannot be underestimated. While conservation cannot increase the total amount of water a region can utilize, it does help existing supplies stretch further. In today's fiscal environment, ratepayers and the region's economy will benefit when the pros and cons of expensive new infrastructure projects are weighed carefully against other options like conservation.

Recommendations

Our policy recommendations and areas for research, along with target audiences, include:

1) **Ensure that future demand estimates at the local and regional level include all new green building codes** that would require buildings to have more water efficient technologies installed. (Target audiences: water retailers and SDCWA.)

2) **Prioritize implementing water pricing structures that incentivize conservation and discourage waste.** There is evidence that steeply tiered and budget based pricing structures do this and also help water utilities keep their revenue and rates more stable during times of drought. More research is needed to better understand the opportunities with this kind of pricing, and how to convey its complexities to ratepayers. (Target audiences: water retailers; non-profit organizations and SDCWA could play a role in facilitating.)

3) **Consider setting more aggressive conservation targets than those laid out in SBX7-7** and reach those targets by maintaining or expanding incentives and rebate programs and creating financing programs that encourage consumers to retrofit existing homes with the most efficient technologies available. (Target audiences: water retailers.)

4) **Coordinate regional water consumer education campaigns** using the latest research from social psychology that shows what messaging is most effective in influencing thoughtful water use behavior. Water agencies can also work with the private sector to develop public-private partnerships that can help move the needle on consumer demand. (Target audiences: SDCWA, water retailers, regional non- profit organizations, academics, businesses.)

5) **Use and invest in billing and data collection systems** that can help water managers **better assist the residents** that are over watering or have significant leaks. (Target audiences: water retailers.)

6) **Explore the possibility of working with other water utilities** throughout the state **to support research on whether/how the sale of water could be decoupled from water efficiency services as is done in the electric utility industry**. (Target audiences: elected officials, water utility managers, SDCWA.)

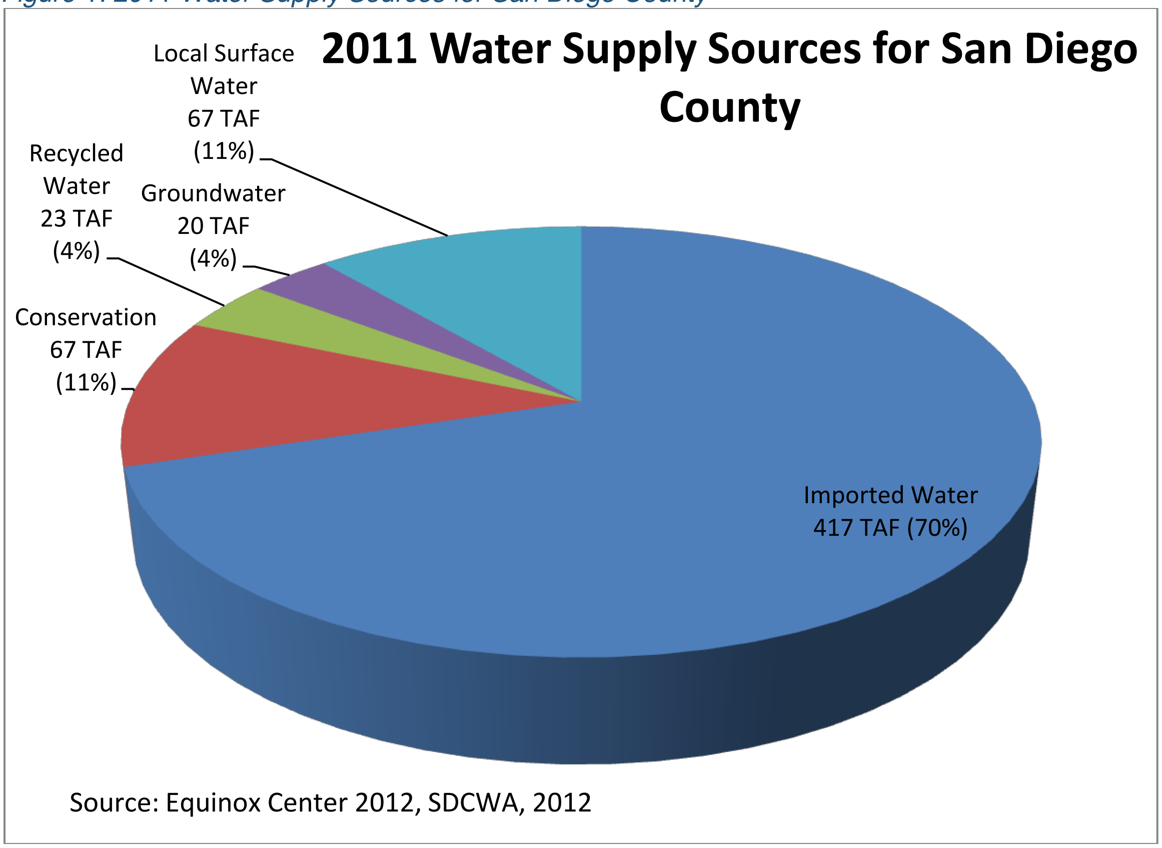
7) **Engage with a wide range of stakeholders in the region**, including the private sector, those from the energy industry, land use planners and others **in a regional dialogue to weigh the options of what our future water portfolio should look like, and to jointly act to implement solutions**. (Target audiences: elected officials, water utility managers, SDCWA, non-profit organizations, academics.)

8) **Conduct research better documenting the costs and benefits of conservation measures versus the costs of new infrastructure projects**, and exploring the issue of who pays for such measures and how. More research is also needed to understand how demand hardening would affect water management efforts in times of drought if more aggressive long term water conservation methods were put in place. (Target audiences: academics, non-profit organizations.)

INTRODUCTION

Historically, the San Diego region has imported almost 90% of the water it uses. Currently, about 70% of the region's water supply comes from northern California or the Colorado River. Due to its semi-arid climate, the San Diego region's average annual rainfall is about 12 inches, and our rainfall patterns are some of the most volatile in the U.S. That means we can't rely solely on local water sources to meet the demand of our growing population and economy. In fact, the last time the region relied solely on local water supplies was 1946.

Figure 1: 2011 Water Supply Sources for San Diego County



Imported supplies have contributed to the significant economic growth within the San Diego region over the past several decades, but the region's imported water supply is increasingly vulnerable due to structural, environmental and legal issues and rapidly escalating costs. The San Diego County Water Authority estimates its wholesale treated water rate for municipal and industrial customers increased by 68% between calendar year 2008 and calendar year 2012.

The severe drought that the State of California suffered from 2007-2009, the dry winter in California in 2011-12, and lower than average flow conditions in the Colorado River basin are again causing concern among water managers in the West. In addition, recent climate change studies from Scripps Institute at UCSD indicate that Southern California will become drier and hotter in the next 40-50 years, which will affect both supply and demand of water in our region.

Water is likely to be the ***most critical resource challenge*** *that the San Diego region will face during the coming two decades.*

Water is likely to be the most critical resource challenge that the San Diego region will face during the coming two decades as we accommodate the 650,000 new residents expected by 2030. Most of that growth is from natural births and the children and grandchildren of existing residents choosing to stay in the region.

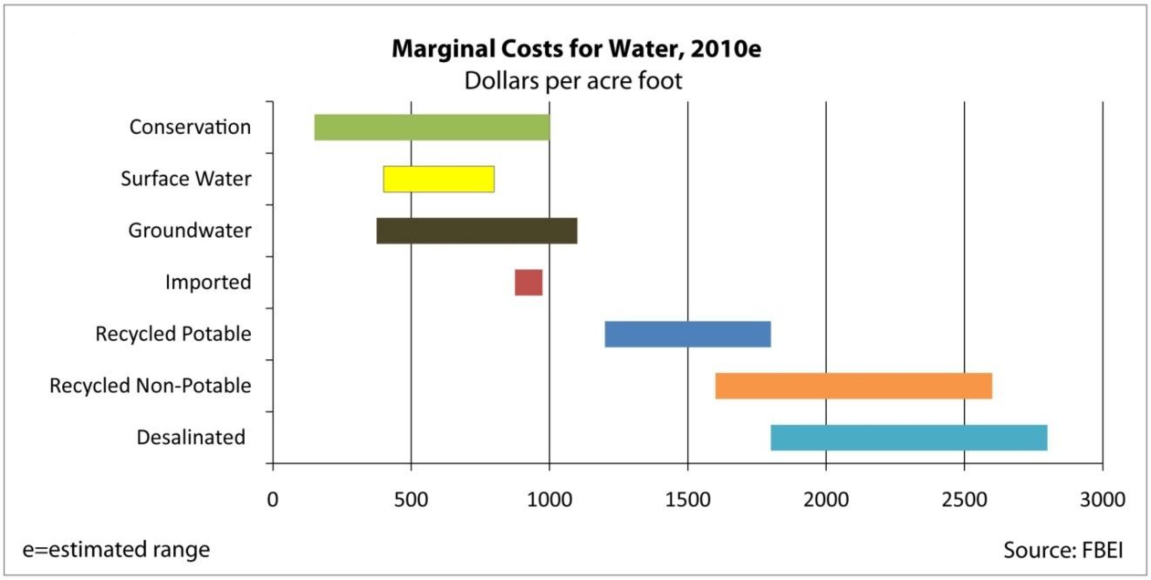
The factors described above are forcing water managers, elected officials, residents, and businesses to re-assess how we use water and to consider many serious concerns regarding the reliability, safety, and efficiency of our current system:

- How can we provide a safe and reliable water supply for today without impinging upon the needs of future generations?
- With an aging infrastructure, what percentage of our scarce financial resources should be dedicated to upgrades and replacement of existing infrastructure, relative to supply expansions?
- Since access to water is the most basic need for both human and ecosystem survival, can we supply water that is affordable through methods of delivery that are ecologically sound?
- How do we spur economic development and attract future business interests to the region with the risk of more future supply shortages and price increases?
- Given constraints due to legal, regulatory, and environmental issues, what is the optimal water supply mix for future purposes?

The objective of this report is not to answer all these questions, but rather to begin to shed light on the continuing role that conservation and water use efficiency can play within our region to help address these questions and mitigate against future challenges and uncertainties – both real and perceived.

In our 2010 Assessing the Options paper, working with the FBEI, we determined that conservation is one of the lowest cost and most environmentally beneficial ways to address San Diego County's water challenges.

Figure 2: Marginal Costs for Water



Note: The cost estimates in the chart are costs incurred by the water utility to procure one more unit of water from that source. Those costs are typically passed on to ratepayers. The costs of conservation do not include costs borne directly by the consumer who may choose to install a more efficient technology.

However, we noted that additional research was needed to determine just how much potential for conservation and efficiency remained in the region. This report aims to begin to uncover whether there is more efficiency to be gained in the region, and if so, how much. We will also discuss the benefits and challenges associated with increased efficiency and hope that our analysis will help facilitate and inform an open discussion about the questions raised above.

REPORT STRUCTURE AND METHODOLOGY

This paper relies heavily on recently released data from a study conducted by Aquacraft, Inc, the *California Single Family Water Use Efficiency Study*, which was administered throughout California in 2005-2008 at the request of the California Department of Water Resources. Although Aquacraft 's data contained samples from homes throughout the whole county of San Diego, our analysis focuses on water demand from homes within the City of San Diego because that was the most complete data set available to us.

The Aquacraft data is revealing because it provides detailed information about *how* water is being consumed at the single family household level within the City of San Diego, and it provides good comparative metrics by which water agencies can track progress in conservation Best Management Practices (BMPs).

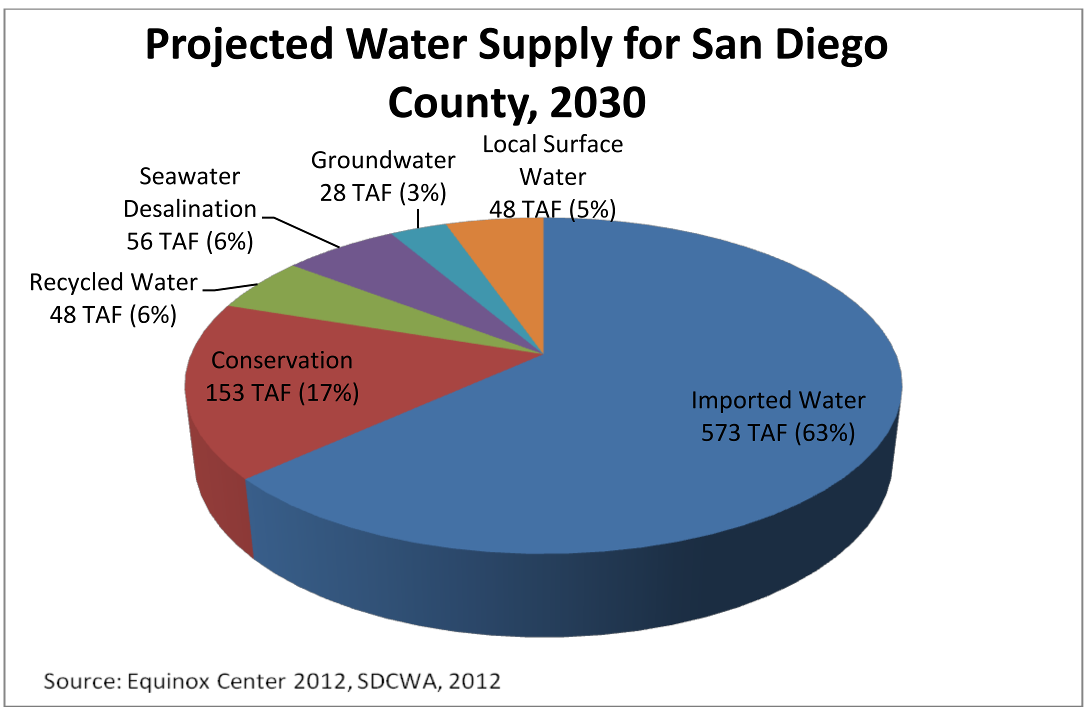
For more details about data sources and our methodology, please see Appendix 1.

THE IMPORTANCE OF ACCURATE DEMAND PROJECTIONS

The SDCWA projects that by 2030, about 63% of our water supply will be imported (that includes imports from the Colorado River and the State Water Project coming through the Metropolitan Water District, transfers from the Imperial Irrigation District (22%), and upgrades to the All-American and Coachella Canals (9%), while the rest will be supplied in a variety of other ways – desalination (6%), expansions in water recycling facilities (6%), and new and expanded conservation efforts (17%). Only 8% will come from local groundwater and surface water (SDCWA).

The SDCWA projects that by 2030, about 63% of our water supply will be imported. Only 8% will come from local groundwater and surface water.

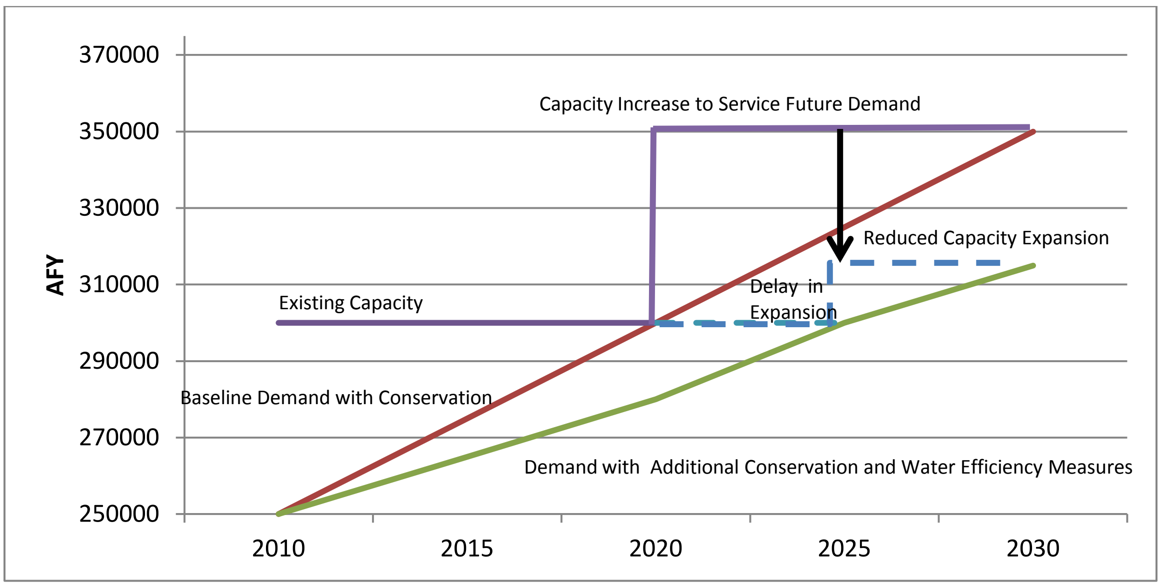
Figure 3: Projected Water Supply for San Diego County, 2030



Assumptions regarding how much water individuals actually will use in the future and through which methods they will consume it is critically important for several reasons. Much like any large scale utility project, the development of new water supply infrastructure is expensive. Supply facilities such as reservoirs, desalination or advanced treated water recycling plants and associated pipelines are "lumpy" assets, generally built as large scale facilities (you wouldn't build a reservoir if you needed only 1 more gallon of water, although in other parts of the world, small scale desalination and water recycling plants have been built). For example, of the San Diego County Water Authority's roughly $1.4 billion two-year budget, 43% goes to capital improvements and debt financing for those improvements. The second largest portion of the SDCWA's expected rate increase for treated water in 2013 is a result of debt service on capital improvements (30% of the increase).

If future demand projections call for the building of a new facility but actual demand in the future is far less than what was expected, the facility may not have been needed after all. It was built, however, and needs to be paid for, which results in higher charges to ratepayers. Figure 3 illustrates the significance of "lumpy assets" in more detail.

Figure 4: Supply and Demand of Water for City X



Source: Equinox Center 2012

Figure 4 provides a theoretical example of water supply and demand to City X. The red line represents projected total water demand given assumptions regarding historical usage, household size/density, weather, price increases, and existing/planned conservation programs. These are the type of parameters included in the models water utilities use to estimate demand in the future. The green line conveys estimates of additional water demand reductions into the future with more efficient tools and conservation practices at play than what are captured in the model. In this scenario, City X has the ability to supply 300,000 AF per year, enough to meet its projected demand until 2020. At that point, since it is difficult to supply water in increments and the city projects it will need another 50,000 AF by 2030, the city may choose to invest in a major capital facility such as a new reservoir, desalination plant or recycled water plant to service demand through 2030 (the lumpy asset represented by the purple line).

Considering the significant upfront capital costs, operation and maintenance, and debt servicing involved with supply expansions, another option would be to aggressively reduce demand to the most reasonable, feasible level possible through the use of well developed program management techniques (price and non-price) that capture the value of and reflect the scarcity of water (green line in Figure 3). Such techniques can be both cost-effective and efficient and could delay the need for expansion and/or reduce the capacity expansion needed (blue dotted line). Our theoretical example shows that with the more efficient use of water by consumers (green line), supply expansion may not be needed for another 5 years (2025) and, even then, the scope and cost of expansion could be far less than what was initially anticipated (the black arrow – the difference between purple line and blue dotted line in 2035).

With more efficient use of water, costly supply expansions may be delayed or scaled back.

CURRENT DEMAND AND PROJECTIONS

Table 1 provides actual and projected end use water demand to single family residential homes within the City of San Diego, as estimated by the City. The city uses an econometric model to develop long range demand projections. The model predicts demand by relating historic water consumption patterns to predictor variables like household income and weather.

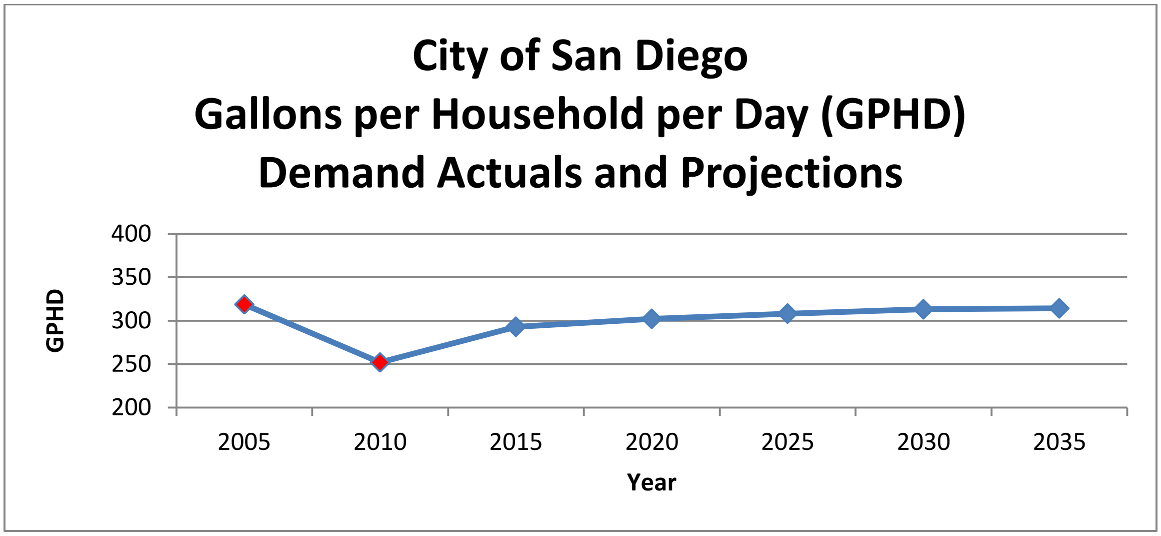
Table 1: City of San Diego Water Deliveries and Projections:

City of San Diego Water Deliveries and Projections (Single Family Residential)							
	Actual		Projected				
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
# of Accounts	217,982	220,862	231,346	236,369	241,491	244,138	245,682
Total AF[1]	77,864	62,367	75,922	79,992	83,370	85,633	86,471
GPHD[2]	319	252	293	302	308	313	314

Source: City of San Diego Urban Water Management Plan (UWMP)
[1] AF = Acre Feet. 1 AF = 325,851 gallons.
[2] GPHD = gallons per household per day. Households are represented by # of accounts.

Based on projections within the 2010 Urban Water Management Plan, the City of San Diego estimates an additional 24,820 single family homes will be built within its jurisdiction over the next 25 years. Despite a significant drop in household demand in 2010 (based partially on a difficult economic climate, consumer response to price increases, conservation programs, and on mandatory restrictions brought on by a statewide Level 2 Drought), the model predicts a small but steady increase in household water demand from 2015 onward. This predicted trend is evident in Figure 5.

Figure 5: City of San Diego Gallons per Household per Day (GPHD)



Source: City of San Diego Urban Water Management Plan, 2010

Forecasting techniques like the city's model that identify trends in demographic, climatic, and behavioral predictors of water use are important for future planning purposes, but the estimates they provide need to be examined thoroughly. The city's model predicts baseline water demand and adds future savings from current and future conservation programs to those totals. However, during our research it became clear that the demand estimates for the 2010 UWMP calculated using the model, do not include certain factors or assumptions such as the implementation of California's Green Building Standard Code, although City staff has commented that those will be used in the 2012 demand estimates. In addition, the current demand estimates include only modest investments in efficiency and conservation-oriented activities by the City and also do not include trends in behavioral changes that have been documented in social psychology research studies.

> *There is additional potential for increased efficiency and conservation in the region if the most readily available and efficient technologies and practices are employed throughout the region.*

Based on our analysis of the data from the Aquacraft study, Equinox Center finds that there is additional potential for increased efficiency and conservation in the region if the most readily available and efficient technologies and practices are employed throughout the region. The analysis that follows identifies potential opportunities for reduced water use and rough estimates of long range demand for the Single Family Residential Sector that could be lower than what the City's model predicts. Again, our intent is to stimulate informed discussion about water use scenarios for our region rather than provide definitive numbers.

OVERVIEW OF RESIDENTIAL WATER USE IN THE CITY OF SAN DIEGO

Table 2 provides an estimated breakdown of water demand for indoor and outdoor purposes in the single family residential sector for the City of San Diego, according to Aquacraft data. In 2007 the average single family household was consuming 146 GPD for indoor purposes (45%) and 177 GPD for outdoor use (55%) – roughly 117, 895 gallons per year. This translates to roughly 125 gallons per person per day (based on 2.6 persons per household).

Table 2: Mean Water Demand from AQ Sample:

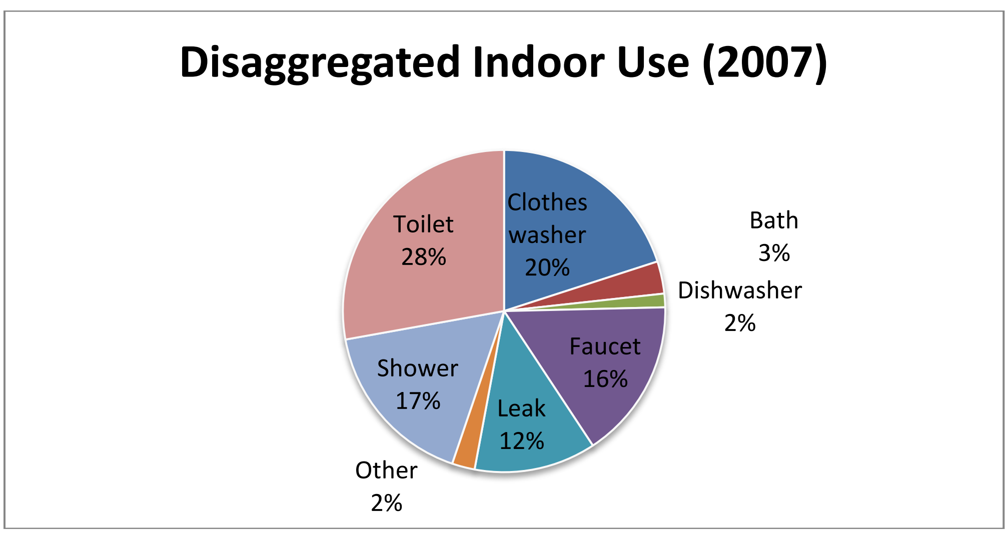
Mean Demand from AQ Sample			
	Indoor	**Outdoor**	**Total**
Total AF/Year	35664	43331	78996
GPHD	146	177	324
Percent	45%	55%	100%

Source: Aquacraft 2011, Equinox Center 2012

Indoor Usage

Figure 6 depicts how indoor water usage breaks down within the homes in the sample where measurements were taken. In the average single family home, 48% of water is consumed by toilets and clothes washers, with showers(17%) and faucets (16%) consuming almost equal amounts. In addition to the demand of these appliances and plumbing fixtures, 12% of water is lost to leaks.

Figure 6: Disaggregated Indoor Use In Single Family Homes in San Diego (2007):



Source: Aquacraft 2011

OPPORTUNITIES FOR EFFICIENCY INDOORS

Toilets

If the average City of San Diego single family household were equipped, exclusively, with the most efficient, widely available toilet technology (1.28 GPF), it would save roughly 6,900 gallons of water per year.

Beginning in the 1990s, the confluence of a major drought and incentives for consumers to replace inefficient toilets with more efficient ones, brought about significant reductions in water consumed by toilets. Many older models (3.5 Gallons Per Flush or GPF) were quickly replaced by more efficient Ultra Low Flush (ULF) toilets that consumed an average of 1.6 GPF. Water agencies, including the City of San Diego, offered rebates to households willing to replace their inefficient toilets with ULFs.

As of 2010, the City of San Diego reported savings upwards of 10,000,000 Gallons Per Day (GPD) from conservation programs aimed at replacement of older toilets. The Aquacraft data confirm that the City of San Diego has made significant strides in ULF toilet retrofits, but the data also suggest that there are considerable efficiency gains still to be had. For example, Aquacraft data show that 31% of homes in their sample were outfitted with toilets that flushed at less than 2.2 gallons per flush. However only 3% of homes had toilets flushing at 1.6 GPF or less.

If single family homes that do not already have ULFs installed moderately efficient toilets (1.6GPF) they would save roughly 4,200 gallons per year. If they installed the most efficient toilets available (1.28 GPF) they could save roughly 6,900 gallons per year.

There are statewide and local regulations that will move homeowners in this direction. New California building standards (CGBSC) or CalGreen, require all new homes constructed after July 1, 2012 to be equipped with 1.28 GPF toilet technology. In addition, a CA state law (AB715) passed in 2007 requires that all toilets sold in California after January 1, 2014 be High Efficiency Toilets, flushing at less than 1.28 GPF. And the City of San Diego's municipal code SDMC 147.04, the plumbing retrofit upon re-sale ordinance, requires that existing homes that are sold after January 1, 2000 be retrofitted with 1.6 GPF toilets.

If the entire existing single family housing stock in the City of San Diego was equipped with a minimum of 1.28 GPF technology by 2035, 4,600 AF of water could be saved per year.

Clothes Washers

If the average City of San Diego household were equipped with the most efficient clothes washer technology available they would save roughly 6,400 gallons per year.

Clothes washers account for, on average, 20% of indoor water usage. Like ULF toilets, there have been significant advances in clothes washer technology over the past decade. High Efficiency Washers (HEWs) use anywhere between 14 – 30 GPL, compared to older models that use 40-50 Gallons Per Load (GPL). According to Aquacraft data, the typical San Diego household averages .88 loads per day and, as of 2007, the average amount of water consumed by household clothes washers was 36 GPL.

SoCal Water$mart, a program funded by MWD of Southern California, provides rebates to customers who purchase HEWs with a Water Factor of 4 or less (Water Factor correlates to the gallons of water used per cubic foot of wash load). As of 2010, the City of San Diego estimates savings of roughly 731,000 GPD (2.2 AF) through their water conservation program BMP 3.3 – High Efficiency Clothes Washers.

Table 3 provides estimates of HEW penetration rates within single family households in San Diego as well as the average annual savings per household if homeowners replaced their inefficient clothes washers with one of the more efficient devices.

Table 3: Conservation Potential from Clothes Washers

Conservation Potential from Clothes Washers		
Device Efficiency	**% of Homes**	**Average Potential Household Yearly Savings (Gallons)**
Total # of Homes w/ CW	97%	
CW GPL < 30.6[1]	32%	2435
CW GPL < 21.6[1]	21%	4471
CW GPL < 14.4[1]	4%	6362

[1] GPL is a function of size of washer (cubic ft) and water factor (WF). An average of 3.6 cubic feet was used to determine the maximum GPL based on 3 WF thresholds – 30.6 GPL (8.5 WF), 21.6 GPL (6 WF), and 14.4 GPL (4 WF).

Table 3 indicates that 32% of single family households are equipped with efficient clothes washers but only 4% of households have the most efficient technologies. Clothes washers are not regulated under CalGreen standards for new construction, but proposed standards by the California Energy Commission (CEC) may make more advanced HEW technologies a requirement when any home is purchasing a new appliance. Those standards have been challenged in court, but even if they aren't upheld, rebates for

If every existing home were equipped with the most efficient clothes washer technology (<14.4 GPL) by 2035, 4,300 AF of water could be saved per year.

accelerated and natural replacement of high GPL clothes washers for the large portion (68%) of households that do not currently have them mean the additional potential future savings from High Efficiency Washers could be significant.

CASE STUDY: Payback for the Consumer Who Chooses to Invest in the Most Efficient Clothes Washer Technology

Suppose a household is in the market for a new clothes washer. The most efficient appliance on the market (14.4 GPL) is $200 more than a similar, less efficient model (30.6 GPL). Aside from the price difference, both washers perform equally well, require the same level of maintenance, and have an identical life span (about 20 years).

The most efficient washer will save its owner 3,927 gallons of water per year. Assuming water rates increase at 5% per year and waste water rates increase at 3% per year, the owner who purchases the 14.4 GPL clothes washer will recoup the extra $200 investment in 5 years ($3.33/month). If the consumer were to take advantage of an $85 dollar rebate from the local water utility, the payback period would be reduced to 3 years ($3.19/month). It is important to note that this example does not take into account the electricity savings from the more efficient model which would make the payback period even shorter.

Shower Use and Faucets

While the cumulative demand within a typical household for shower use and faucets is 33% of total indoor usage, Aquacraft found that the vast majority of homes in their sample (91%) were already employing best available technologies (BATs). Technological improvements in faucet and shower fixtures have increased their efficiency substantially, and penetration rates for efficient technologies are quite high, so potential savings in this area are lower than for other technologies. However, behavioral changes, which will be discussed in the next section, have the potential to further reduce water usage from faucets and showers and we have calculated savings based on slight modifications of behavior.

If the average single family household reduced demand for water from faucets and showers by 10% or 20%, 670 to 1,350 AF of water, respectively, could be saved by 2035.

Leaks

The Aquacraft data suggest that 12% of indoor water each day is lost to leaks. The mean water loss within the single family home sample was 18.6 gallons per day. However, the median 6.6 GPD, suggests that only a few homes are losing significant amounts of water to leaks. In fact, 57% of the homes in the sample were losing less than 10 gallons per day to leaks, and only 10% of homes were losing more than 50 gallons per day. Policies and feedback mechanisms that target the homes with excessive leaks could provide meaningful reductions in wasted water.

If leaks were reduced to, at most, 10 gallons per day or less for ALL households, 3,080 to 4,600 AF of water could be saved per year.

OPPORTUNITIES FOR EFFICIENCY OUTDOORS

If an average City of San Diego single family household did not over- water their landscape, they would save approximately 17,000 gallons per year.

About 70% of the homes in the Aquacraft sample used outdoor water for irrigation purposes. The average lot size for these homes was 6,892 square feet and the irrigable area was about 3,672 square feet or 52% of total lot size.

The methods required to estimate theoretical irrigation demand, the amount of water landscapes should require to satisfy specific plant needs and well functioning irrigation systems, are discussed in the Methodology Section. Based on the Aquacraft data, 60% of homes appear to be using no more than their theoretical requirements, while 40% of homes are over- irrigating. The data suggest that the average household within San Diego is over-irrigating by 47 GPD (15% of their total water usage).

Projected to the population, a potential savings of 8,074 AFY can be realized, if over-irrigation alone is quelled.

CASE STUDY: Return on Investments for Consumers Who Choose to Use Water More Efficiently Outdoors

Several examples from customers of Blue WatchDog, a local water efficiency company founded in 2009, illustrate the potential of savings in the outdoor realm. By installing weather based irrigation systems, flow sensors, and monitoring and management systems, the company has been able to reduce its customers' water usage by anywhere from 20-61%. In many cases, customers' annual water bills are cut in half and the initial investment in the new technologies and systems are recouped in 1-3 years.

For example, working with a 5 acre property in Rancho Santa Fe whose water bill was $20,000/year, Blue Watch Dog was able to reduce outdoor annual water consumption on the property from 4,325 units to 1,860 units, cutting the water bill in half. The initial investment of $9,000 to install a Weather Based Irrigation Controller and a Flow Sensor was recouped in 11 months.

On a smaller 1.5 acre property in the City of San Diego, water consumption was reduced from 1,400 units per year to 693, a 53% reduction. The investment to install new irrigation equipment was recouped in about 3 years.

SCENARIOS FOR IMPROVED EFFICIENCY

The data from the Aquacraft report provide evidence of significant future efficiency savings within single family residential water usage. To provide an overall picture of potential savings, we have used the previously calculated estimates from sections above to develop 2 scenarios. The scenarios are based on the use of Best Available Technologies, some behavioral changes, efficiencies that will be gained with the implementation of regulatory requirements, changes in landscape design, and projections of new homes being built over the next 20 years within the City of San Diego.

Indoor

If the average City of San Diego single family home was outfitted with the most efficient plumbing fixtures and appliances, it would consume roughly 92 – 117 gallons per day for indoor purposes – a 20 - 37% reduction from an average of 146 GPD in 2007.

Table 4: Actual and Estimated Single Family Homes

Actual and Estimated Number of City of San Diego Single Family Homes (2005 – 2035)							
	Actual		Projected				
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
# of Existing Accounts	217,982	220,862	220,862	220,862	220,862	220,862	220,862
# of New Accounts (Cum.)			10,484	15,507	20,629	23,276	24,820

Source: SDUWMP, 2010

Scenario One

Existing house stock – 220, 862 (2010)

- Clothes Washers – **30.6 GPL** (mean estimate from AQ was 36.4 GPL – 68% of homes used Clothes Washers with greater than 30.6 GPL). 30.6 GPL represents a 3.6 cubic foot washer with 8 WF.
- Toilets – **1.6 GPF** (mean estimate from AQ was 2.78 GPF. 69% of homes used, on average, toilets with greater than 1.6 GPF). The 1.6 GPF target represents an average for the entire home.
- Leaks – Minimize water lost to leaks **to, at most, 25 GPD or less per household.** As stated earlier, the average household is already below this threshold. This threshold targets the homes with chronic and major leaks.
- Faucets – **10% GPD reduction**. Assuming marginal upgrades in fixture efficiency and slight behavioral modifications.

New housing stock

- Clothes Washers – **30.6 GPL**
- Toilets – **1.28 GPF** (standard for new builds from Section 4303.2 of California Green Building Standards Code (CalGreen)).
- Leaks – Minimize water lost to leaks to **10 GPD or less** (an assumption based on the relative efficiency of new plumbing and fixture technology).
- Faucets – **20% GPD reduction** (target standard applied from Section 4303 of CalGreen).

Scenario Two

Existing house stock

- Clothes Washers – **14.4 GPL** (represents a 3.6 cubic foot washer with 4 WF).
- Toilets – **1.28 GPF**
- Leaks – Minimize water lost to leaks to **10 GPD or less**.
- Faucets – **20% GPD reduction**.

New Housing Stock

- Clothes washer, toilets, leaks, faucets same as targets under existing housing stock.

The Aquacraft data provides reliable quantitative measures (length of shower, number of flushing events per day, clothes washer load per day, etc.). Our estimates don't require any behavioral changes for clothes washers or toilet use, and minor behavioral changes for faucet use and leak detection/correction. The scenarios primarily change the devices themselves – the efficiency of plumbing, fixtures, and appliances for both retrofits and new builds. Table 5 displays those projections, along with the baseline demand (146 GPHD) for indoor usage estimated in the Aquacraft report.

Table 5: Savings From Indoor Baseline Demand for Single Family Homes in San Diego

Baseline Demand - 146 GPD		GPHD	GPHD savings from baseline	% Savings
Scenario 1	Existing Homes	117	29	20%
	New Builds	102	44	30%
Scenario 2	Existing Homes	92	54	37%
	New Builds	92	54	37%

Source: Aquacraft 2011, Equinox Center 2012

These estimates are similar to results found in other reports developed by Aquacraft, Inc. at the request of the U.S. Environmental Protection Agency and the water utility in Albuquerque, NM. The EPA Retrofit Study examined indoor water use from randomly selected single family households in Seattle, Tampa, and San Francisco (average household size 2.04, 2.41 and 2.31 respectively) that were retrofitted with high efficiency toilets, clothes washers, showers, and faucets. The mean indoor usage estimate from those retrofitted homes was 107 GPHD, down from 175 GPHD (39% reduction). The study prepared for the Albuquerque water utility and published in 2011 found even more significant reductions. The efficiency thresholds in this retrofit study were a bit more rigorous and average indoor water usage went from 174 GPHD to 101 GPHD post-retrofit (42% reduction).

Outdoor

If an average City of San Diego household eliminated over-irrigation, reduced total irrigable area by 10%, and replaced its current mixed turf landscape with xeriscaping, it would be saving roughly 38,000 gallons per year. This represents a 41% reduction in outdoor water usage from an average of 177 GPD in 2007. With the elimination of over-irrigation alone, that household could reduce outdoor water demand by 26%.

The last section outlined the potential average indoor household savings given 2 different scenarios, based on the penetration rates of best available technologies with minimal behavioral changes. This section provides scenarios for long term potential household savings for outdoor water use. As stated earlier, according to Aquacraft data, the average single family household within San Diego is wasting approximately 47 GPD by over-irrigating its landscape. This figure is similar to a study conducted by the Irvine Ranch Water District (IRWD) that concluded that 43 Gallons Per Household Per Day (GPHD) was being wasted by over-irrigation. IRWD examined 2 methods to capture savings from over-irrigation – mailing out watering schedules and installing weather based irrigation controllers (WBICs). IRWD results revealed that installing WBICs captured almost 80% of potential savings.

Beyond eliminating over-irrigation, there are at least 2 other ways homeowners can reduce the amount of water consumed by landscaping. One way is to reduce the overall irrigable area of their yard. In other words, homeowners can replace planted areas that require irrigation with areas that don't require water (artificial turf, gravel, or mulch). Second, homeowners can employ xeriscaping techniques, replacing water intensive plants and turf with flora that don't require as much water.

Table 6 provides estimates of theoretical requirements within the City of San Diego using the equation developed in the Methodology section for outdoor use.

Table 6: Landscape Watering Needs for Average Single Family Home in San Diego.

Landscape Watering Needs for Average Single Family Home in City of San Diego		
Landscape Type	GPY	GPD
yr round turf	77551	212
non-turf	63011	173
Xeriscape	29082	80

Source: Aquacraft 2011, Equinox Center 2012

Based on Aquacraft's data and our analysis, we conclude that the typical landscape within the city is mixed turf with flora that demand moderate water. To create our scenarios for outdoor water use, we assumed that the 47 GPD of over-irrigation is captured through system efficiencies (WBICs, rotating nozzles, etc.), and estimated other savings based on changes to landscape type and reductions in overall landscape area. Table 7 provides estimates of average water demand given 2 scenarios (10% reduction in irrigable area and 20% reduction in irrigable area).

Table 7: Estimates of Average Water Demand in Single Family Home Landscapes, San Diego

Irrigable Area	Landscape Type	GPY	GPD
City Average (3672 square feet)	yr round turf	77551	212
	non-turf	63011	173
	xeriscape	29082	80
10% Reduction	yr round turf	69796	191
	non-turf	56710	155
	xeriscape	26174	72
20% Reduction	yr round turf	62041	170
	non-turf	50408	138
	xeriscape	23265	64

Source: Aquacraft 2011, CA Dept of Water Resources, 2012, Equinox Center 2012

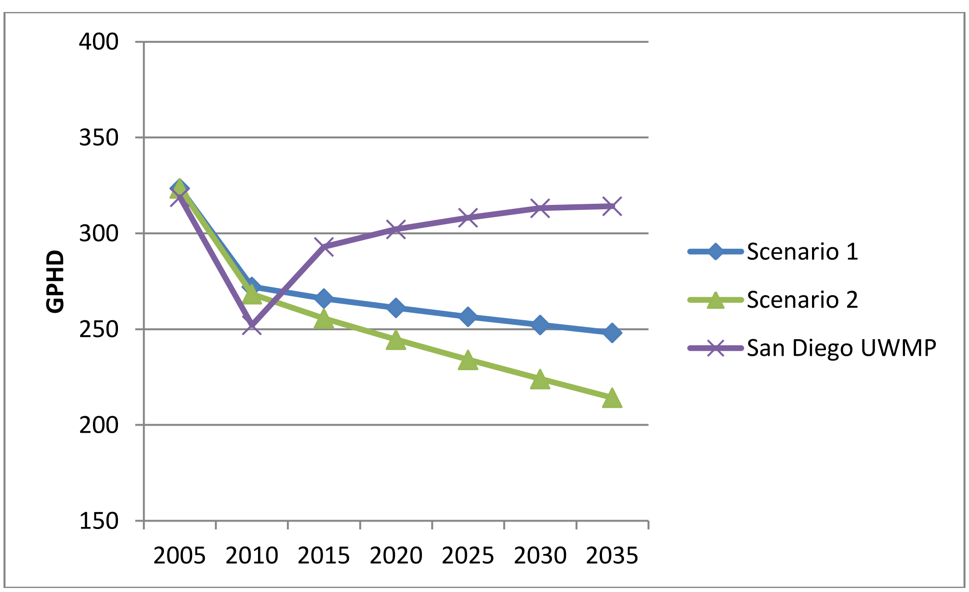
As a result of the recent drought, we anecdotally observe that numerous households in San Diego actually did reduce the irrigable areas of their home landscaping, but it is difficult to know how many homeowners did this and by how much. We selected 10% and 20% reduction numbers for purposes of demonstration. We also recognize that if homeowners were to reduce irrigable areas by replacing them with impervious material such as pavement, water quality issues could emerge as the result of increased urban runoff when it rains. To reduce this risk, homeowners would need to be educated, and possibly incentivized to reduce irrigable areas by using pervious materials.

ALTERNATIVE SCENARIOS FOR WATER DEMAND IN SINGLE FAMILY HOMES

The following graphs combine the indoor and outdoor demand estimates calculated above. The 2 scenarios in Figure 7 below assume a 3% per year penetration rate for indoor plumbing/appliance retrofits in existing homes and adherence to CalGreen standards for all new homes. Likewise, these scenarios account for over-irrigation being eliminated permanently. As a point of reference below we compare the 2 scenarios against the demand projections found in the 2010 City of San Diego Urban Water Management Plan. It is important to note that Equinox Center projected reductions between 2005-2010 are similar to actual demand reductions that occurred. In fact, actual demand in 2010 was less than our projections. The difference in 2010 could be attributed to several factors – a greater than 3% penetration rate for actual retrofits, households converting landscapes to less water intensive plants, increases in the price of water, conservation messaging, and the impact of the economic recession. The important point to note in Figures 7 and 8 is that the City of San Diego's projections do not assume that these demand reductions are permanent, whereas our scenarios do count on at least a reduction in over-watering being permanent.

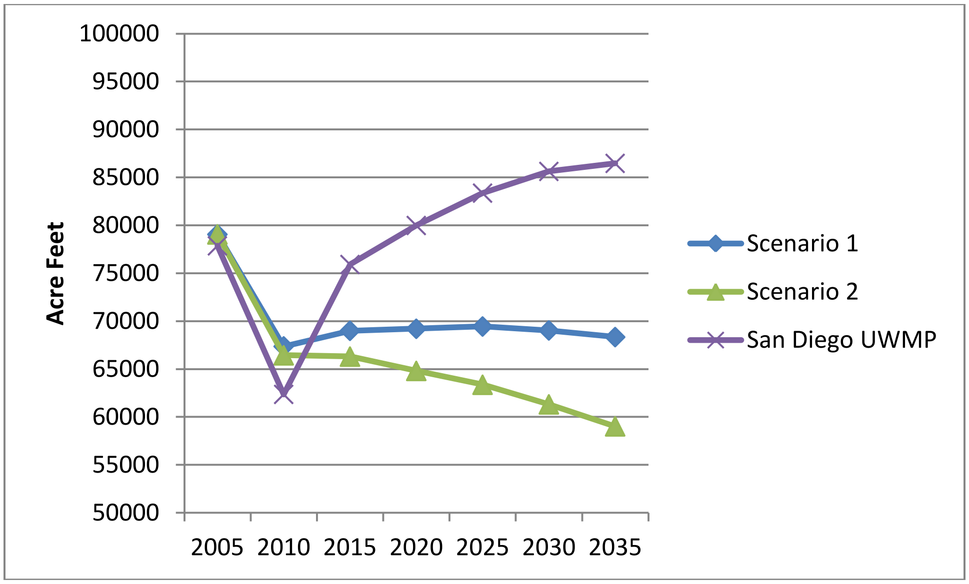
Figure 7 illustrates the change in usage in gallons per household per day (GPHD) over the next 20 years given the parameters laid out above. GPHD is a good metric to convey since utilities bill single family households and not individuals.

Figure 7: 2 Scenarios for Household Water Usage in Single Family Homes in City of San Diego



Source: Aquacraft 2011, Equinox Center 2012, SDUWMP 2010

Figure 8: 2 Scenarios for Total Water Use in Single Family Residential Sector in the City of San Diego



Source: Aquacraft, Equinox, SDUWMP

The City's projections, developed using the CWA-MAIN model for the City, illustrate single family resident demand totaling roughly **86,000 acre feet per year** by 2035. Our analysis, based on the Aquacraft findings and the future employment of the most efficient use of water provides estimates of **59,000 – 68,000 acre feet per year** by 2035. In short, our calculations lead us to believe that a minimum of **18,000 to 27,000 AF** per year can be conserved relative to the projected water use within the City of San Diego in the next 20 years, a 20-30% reduction from the City's estimate for 2035.

The Water Conservation Act of 2009, known as SBX7-7, was signed into law in the State of California and requires urban water suppliers in California to establish Municipal and Industrial (M&I) per capita water use targets that would reduce their per capita water use 20% by 2020 from a certain baseline. M&I water use includes water an individual uses in their residence as well as when they are at work, restaurants, schools, etc. Due to the nature of the original data we obtained from Aquacraft, the demand estimates developed within this report have been calculated on a per household basis for single family residences, and not on an M&I per capita basis for all types of homes within the City. Therefore it is very difficult to compare our estimates with the SBX7-7 requirements. However based on our analysis of Aquacraft data and of the targets set by water districts within the County of San Diego, we believe the region would benefit from considering policies that would go beyond the mandated requirements of SBX7-7.

We estimate a minimum of 18,000 to 27,000 Acre Feet per year can be conserved in the Single Family Home residential sector in the City of San

Diego alone, a 20-30% reduction from the City's estimates for 2035. That's about enough water to fill Lake Hodges Reservoir every year (capacity =30,000 AF) or to supply 60,000 single family homes with water for 1 year.

Based on actual consumption numbers for single family homes in the City (62,367 AF as of 2010) this means that just by using existing available technologies and some minor behavioral changes, we could essentially keep total demand flat in that sector over the next 25 years.

In fact, we believe these estimates are rather conservative for several reasons:

- Every home (within a 20 year time frame) will have replaced older plumbing fixtures and appliances – at least once – with ones that are more efficient. The average life of a clothes washer or toilet is anywhere between 10 -20 years. Even if a household purchases a HEW today, that household will certainly need to replace that one by 2035, a 20 year time period when technological advancements in appliance efficiency may continue to improve (much like they have over the past two decades).

- In order to accommodate future growth on fewer and fewer acres of developable land, housing lots will invariably have to be smaller, on average, than the existing housing stock and a 10% reduction in irrigable area seems reasonable.

- Only minor behavioral modifications were included in the above estimates. In a recent paper, *Behavior Studies of Water Conservation*, Professor Wesley Schultz of Cal State, San Marcos researched a variety of non-price strategies to assess their effect on water conservation. His review suggested that feedback and other social information can be as effective as or more effective than traditional non-price strategies like information campaigns. His paper cites a study (Willis et al 2010) where shower monitors were installed that conveyed flow rate, temperature, and duration of showers to customers. The study reported a 27% decrease in showering time in response to the device. Behavioral changes could increase the scale of water conservation further when combined with the technologies presented above.

- We have not accounted for the significant potential savings from the transition to Automated Meter Reading (AMR) or "smart meters" technology. A recent study in the Coachella Valley District provided evidence of significant demand reductions by consumers and district level savings as well. The study showed those homes equipped with smart meters reduced their overall water consumption by 17% compared to the control group. These reductions, based on behavioral responses to water use inconsistencies found through the smart meters, translated to savings of approximately 5,000 gallons per household per month. Likewise, a pilot study conducted in 2009 by Wesley Schultz at Cal State San Marcos in cooperation with the Olivenhain Water District found that homes equipped with smart meters reduced water consumption by 20% compared to 10% in a control group. Several water agencies in San Diego County are effectively using automated meters to help conserve water. It should be noted, however, that a recent survey of water districts in San Diego County by the San Diego Taxpayers Educational Foundation found that some variables such as topography diminish the value of adopting AMR technology.

BENEFITS OF IMPROVING EFFICIENCY

Financial savings: Theoretically if water users are consuming less water, their water bills would be reduced. As we showed above, investments in more efficient technologies such as High Efficiency Washers or more efficient irrigation systems generally have a payback period of 1-3 years. As most products have an expected life span of 20 years, that generally means the consumer that installs more efficient equipment is saving money on water use as a result of that product for 17-19 years, after he or she has recouped his/her initial investment. However, for a variety of reasons, this sometimes is not the case due to reasons outlined below in the challenges section.

When less water is being used for landscape purposes, the amount of runoff and pollution that reaches local rivers and bays and beaches is reduced.

Environmental benefits: Studies show that when less water is being consumed in homes, particularly for landscape purposes, the amount of runoff and pollution that reaches local rivers, bays and beaches is reduced. Further afield, if we can flatten our demand for imported water, we will contribute less to some of the environmental challenges occurring in northern California and the Colorado River Basin. Those issues will ultimately require funds from the state and even from our local region to ameliorate if conditions do not improve. In addition, saving water means saving energy, both in the home but also as a region. Tremendous energy is expended in transporting and treating water. Reducing water consumption, and thus energy consumption, will help improve air quality, reduce greenhouse gas emissions and assist the region in meeting its climate goals.

Economic growth: Using water more efficiently in the residential sector in particular can support economic growth because it stretches our existing supplies further to help ensure our businesses that need it will have an adequate and reasonably priced supply. In addition, a focus on conservation and efficiency, particularly in retrofitting older homes with more efficient technologies, can spur new businesses, clean technologies and clean jobs.

CHALLENGES

As important as water efficiency is to our region, there are a number of challenges associated with using water resources more efficiently.

Business models of water utilities: As mentioned above, water storage, transport, and treatment in California has generally involved massive infrastructure investments (reservoirs, piping, pump stations, treatment facilities) especially in semi-arid regions like ours, where local supplies are not readily available. Therefore, water managers are tasked with recovering, not only the variable costs associated with facility operation and maintenance (payroll, chemicals for treatment, system upkeep), but the upfront capital costs as well (facility construction and the interest on those investments). Traditionally, this has led to a business model that promotes greater output and delivery of water. In other words, more users consuming more water helps the utility recover costs of a facility more quickly and also reduces the overall costs of service per customer. Since per capita costs decrease with greater water delivery, there may be less incentive to conserve water (from the utility's financial perspective). Water utilities need to cover their fixed capital costs to replace infrastructure and to pay off finance charges for past investments. If water utilities are selling less water, in order to cover their significant capital costs they often have to increase the per unit cost of water to make ends meet.

Cash Flow: Another challenge with conservation programs and investments in efficient technologies that reduce overall demand is that the short term cost savings from demand reductions are often *smaller* than the corresponding reductions in revenue to the utility, resulting in a cash flow shortfall to the utility. Revenue variability is a serious concern to water utilities. In order to smooth the effect of revenue shortfalls, utilities are often faced with either reducing short run variable costs like payroll and maintenance or increasing rates to consumers – both of which can be disincentives to further implementation of meaningful conservation programs and water efficiency programs.

Peak Demand: The uncertainty and reliability of future peak demand estimates may compel utilities to overestimate supply to cushion the future variability of demand. This methodology is similar to a city planning department setting out minimum standards for off-street parking – in order to provide an adequate number of spaces for customers during peak periods and to mitigate congestion issues.

An oversupply of any resource creates economic inefficiencies and sends the wrong price and behavioral signals to consumers.

An oversupply of any resource (water or parking) creates economic inefficiencies and sends the wrong price and behavioral signals to consumers. While an under-utilized surface parking lot can be easily converted to some other use for future purposes, a reservoir cannot be easily converted. That is why it is imperative to understand and characterize present demand and develop reasonable expectations of future demand.

The inefficiencies of oversupply and the long term *avoided* costs that can be captured through increases in water conservation and productivity are critically important to consumers and society as a whole moving forward.

Existing Capital Costs: Another issue is that revenue collected from current water consumption is not only paying for new system upgrades and service enhancements, but for infrastructure investments already made in the past (both principal and interest). Reductions in demand could help the region and consumers avoid future costs, but costs already incurred in the past still need to be paid for somehow.

This paper does not address these issues in detail, though preliminary research already developed by the Equinox Center in its 2009 *Water Pricing Primer* outlines how well-developed water pricing structures can help mitigate against revenue shortfalls on existing capital assets when there is a reduction in demand.

SUMMARY

Based on our research and data presented above, we find that a more efficient water use scenario for San Diego is possible, using existing technologies and minor behavioral changes. Our analysis points to the conclusion that in the single family residential sector just in the City of San Diego alone, overall we could use 20-30% less water than current projections estimate.

Proper pricing structures, incentives and rebates, coupled with more effective and coordinated communication with consumers about their water usage, likely could result in even more opportunity to conserve. Likewise, there are opportunities in the multi-family residential sector as well as the commercial and agricultural sectors here in San Diego County that this report does not address.

Potential reductions in demand are critical to our regional conversation about a safe and reliable future water supply. Given the values apparent in the region from recent surveys, the staggering upfront capital costs of new supply infrastructure, the potential risks of supply disruptions brought about by climate change or other natural disasters like earthquakes and wild fires, and the political turmoil and costs associated with meeting demand for an ever increasing customer base throughout the West, improving how efficiently we use water remains a critical method of water resource management. Despite the potential savings that could translate to financial savings for ratepayers and utilities in the long run, and which could result in improved ecosystems both locally and closer to our water sources, hurdles remain to advance these savings due to the current business and regulatory models for water.

Possible Solutions and Areas for Exploration and Research

Our policy recommendations include:

1) Water retailers and wholesalers need to ensure that future demand estimates at the local and regional level include all new green building codes that will require buildings to have more water efficient technologies installed.

2) Water districts and policy makers should prioritize implementing water pricing structures that incentivize conservation and discourage waste. There is evidence that steeply tiered and budget- based pricing structures do this and also help water utilities keep their revenue and rates more stable during times of drought. Additional research is needed to better understand the opportunities with this kind of pricing, and how to convey its complexities to ratepayers. The SDCWA and other regional non-profits could help facilitate this research and approach.

3) After exploring the long term costs and benefits, water districts should consider setting more aggressive targets than those laid out in SBX7-7 by using rebates, incentives, pricing and other methods to increase water efficiency in the residential sector.

4) Coordinate water consumer education campaigns within the county using the latest research from social psychology about the effectiveness of various messages to consumers on thoughtful water use. The SDCWA and regional non-profit organizations could work to develop public-private partnerships (such as the one the SDCWA has developed with Home Depot to promote low water plants) and help facilitate this coordination.

5) Water retailers should use and invest in billing and data collection systems that can help water managers better assist the small percentage of single family residential homes that are over watering or have significant leaks, rather than scattershot outreach approaches.

6) Elected officials and water utility leaders should explore the possibility of working with other water utilities throughout the state to support research on whether/how the sale of water could be decoupled from water efficiency services as is done in the electric utility industry.

7) Water managers, regional nonprofits and others should engage with a wide range of stakeholders in the region, including the considerable intellectual and financial assets of the private sector, those from the energy industry, land use planners and others in a regional dialogue to weigh the options of what our future water portfolio should look like.

8) Regional water managers and/or regional non profit or academic institutions should conduct research better documenting the costs and benefits of conservation measures versus the costs of new infrastructure projects, and exploring the issue of who pays for such measures and how. More research is also needed to understand how demand hardening would affect water management efforts in times of drought if more aggressive long term water conservation methods were put in place.

APPENDIX 1 - SOURCE DATA AND METHODOLOGY

Information about the Aquacraft Study

120 single family residences within San Diego County participated in the *California Single Family Water Use Efficiency Study* end use study. Each home was outfitted with a data logger that provided information regarding indoor water usage. Outdoor water usage, based on landscape characteristics, lot size, and irrigable area, was estimated through GIS software and site visits.

Equinox Center's analysis focuses on water demand from single family residential homes within the City of San Diego, which participated in the study, for 3 main reasons:

- 50 % of the county sample (60 homes) were located within the City of San Diego jurisdiction while the rest were evenly distributed throughout 4 other water districts in the county (Helix, Otay, Rincon, and Sweetwater). We obtained indoor and outdoor data from the 60 City of San Diego single family homes, 58 of which, provided valid results (Aquacraft). Given the small sample size and lack of specific outdoor data for each of the other water districts, they were omitted from the analysis.

- The City of San Diego accounts for more than 1.3 million people and supplies approximately 274,000 metered service connections within its jurisdictional boundaries. Likewise, the city covers more than 200 square miles of developed land and is situated within several microclimates. The significant population totals and the diversity of topography and climate found within the city boundaries provide a good (though not perfect) cross-section of the region as whole; a cross-section that may be instructive to other municipalities and water districts.

- In 2010, residential water use accounted for roughly 60% of total water consumed within the City of San Diego[1], compared to 18% consumed by commercial and industrial facilities. Efficiency gains at the household level could translate to significant reductions in overall water demand for the region as a whole.

The 58 single family residences in the City of San Diego that were ultimately chosen to participate in the study were randomly selected from a much larger surveyed group (842 homes). The surveyed group was assembled using customer billing data that mirrored actual annual per household usage at the population level. While water usage, and not

[1] Single family residential household demand accounted for roughly 38% of total demand. Multi-family dwelling accounted for 22 %.

geographic heterogeneity, was the criterion for sample selection, the 58 homes ended up being spread out over the service area.

The table below provides baseline estimates of residential water demand for the City of San Diego in gallons per household per day (GPHD). The first column is actual delivery to single family households in 2008 and the second column is from the Aquacraft sample. The average household within the city of San Diego was consuming 322 GPHD and the average household within the sample, 324 GPHD – which are almost identical. Since the numbers are so close, we believe the Aquacraft data accurately represents average usage in single family homes during the sampling time.

City of San Diego	Population Annual Use 2008	AQ Sample Annual Use 2007
GPHD	322	324
# of Accounts	217,983	58

The indoor water use data from the Aquacraft report were collected through devices and software programs that were installed at the 58 City of San Diego sample households. These devices tracked how much water each appliance or plumbing fixture was using and the length of time (for showers or faucet events) and number of events per day (flushes per day, clothes washer loads per day, etc).

The numbers related to gallons per flush of toilets are averages for the home –many homes have more than 1 toilet and in its study findings, Aquacraft recognized that some ultra low flush toilets may have been poorly adjusted, meaning that a 1.6 GPF ULF was registering at 2 or 2.2 GPF). To account for potential adjustment errors, when calculating additional potential savings, we used a 2.2 GPF threshold to represent 1.6 GPF toilets and a 1.6 GPF threshold to represent 1.28 GPF toilets.

Aquacraft relied on the data logger to determine indoor demand and subtracted that from total annual water usage to estimate outdoor usage. Homes were determined to be using outdoor water for irrigation purposes through GIS mapping and site visits to determine lot size, irrigable area, irrigation requirements based on plant types, local net evapotranspiration rates (EV) and the relative efficiencies of household irrigation systems. Aquacraft used the methods below to estimate the application ratio, which is the *actual* application of water for irrigation purposes compared to the *theoretical* irrigation demand. An application ratio of 1 would be ideal. This means that households with well maintained irrigation systems are providing their plants and turf with *exactly* the correct amount of water. An application ratio of greater than 1 represents too much water being applied to the specific landscape.

The following calculations for outdoor usage are based on the California Department of Water Resources Model Landscape Ordinance. The equation below estimates the water required (theoretical) for a given landscape.

Landscape water = (ETo) * (.62) * (irrigable area) * (ETAF)

where:
ETo = reference evapotranspiration (in)

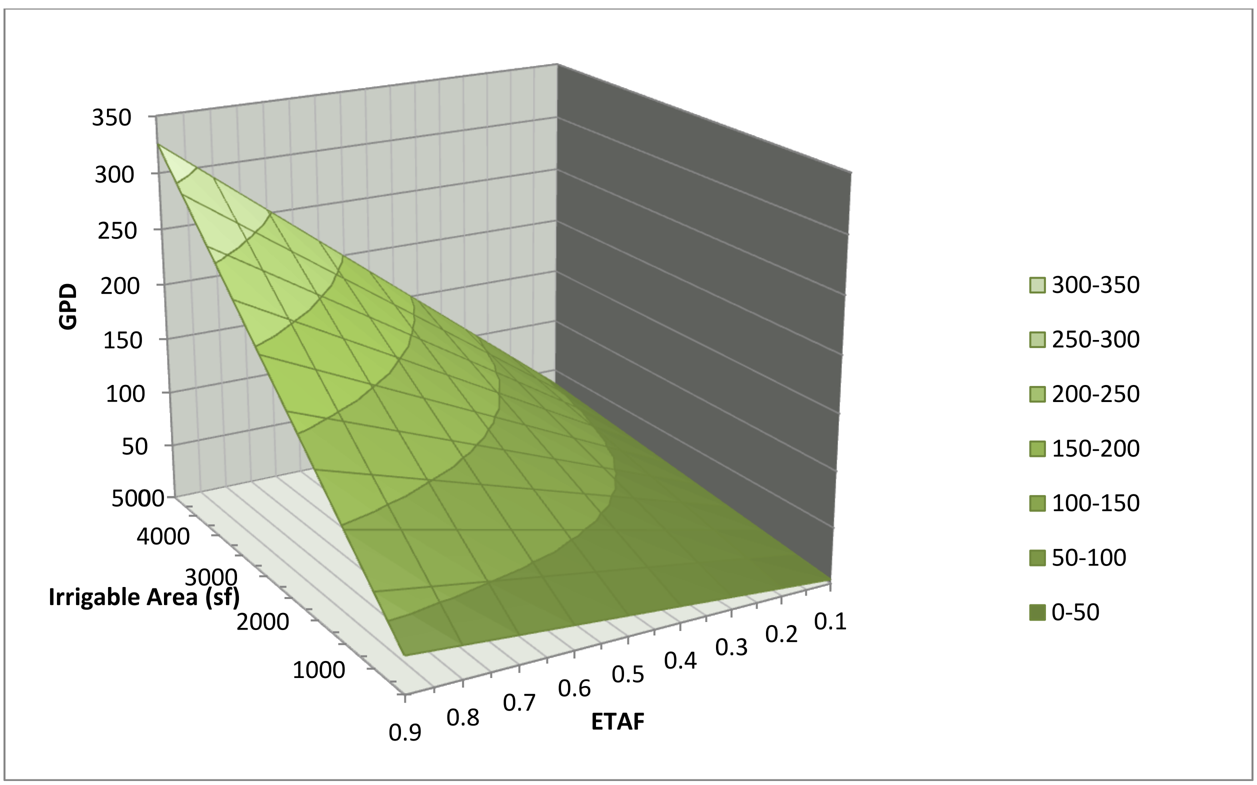
.62 = conversion factor for gallons
Irrigable area = square footage of landscaping
ETAF = PF/IE evapotranspiration adjustment factor (includes specific plant type and irrigation efficiency)

PF = plant factor
IE = Irrigation Efficiency

Outdoor Water Use		Definition
ETo	42.58	Average from 4 CIMIS stations – 150, 153, 173 and 184
Conversion Factor	0.62	Gallon conversion
Irrigable Area (sf)	3672	Mean irrigable area from AQ report
ETAF (yr. round turf)	0.8	PF of .8 and IE of 1 (perfect irrigation)
ETAF (mix turf)	0.65	PF of .65 and IE of 1 (perfect irrigation)
ETAF (xeriscape)	0.3	PF of .3 and IE of 1 (perfect irrigation)

The table above displays the specific parameters that define the theoretical landscape requirements, based on the characteristics of the San Diego region and different landscape types.

In order to provide meaningful estimates of landscape water demand, the figure below conveys estimates of landscape water requirements based on varying landscape design types and overall square footage of irrigable area.



Source: Equinox Center, 2012

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