

A REPORT FOR THE:
LOS ANGELES SUSTAINABILITY COLLABORATIVE

KEEPING WATER CONSERVATION AFLOAT

Sustainable outdoor water conservation through
progressively tiered pricing

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	3
INTRODUCTION	6
WATER CONSERVATION IN SOUTHERN CALIFORNIA	7
WATER CONSERVATION FOR THE FUTURE	9
WATER CONSERVATION IS INADVERTENTLY DISADVANTAGED	10
ENCOURAGING CONSERVATION THROUGH RATES	11
DESIGNING THE RATE STRUCTURE.	13
CONCLUSION	16

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EXECUTIVE SUMMARY

Extensive outdoor water conservation measures will allow Southern California to improve water reliability substantially, especially during drought periods. However, there are barriers to implementation. Water conservation is inadvertently disadvantaged by the indirect way in which it recoups the cost of implementation; revenue is not generated, expenses are forgone. Current rate structures allot more water to land uses that potentially waste more water outdoors (e.g., single-family homes on large lots). And most reductions will result from difficult to mandate behavioral changes. A solution is a well designed progressively tiered water rate structure, which allows for financial stability of conservation program implementation, incentivizes land uses that waste a lot of water outdoors to become more efficient, and gives consumers a strong incentive to voluntarily make decisions on how they could best reduce their consumption.

Water conservation is an important tool to improve water reliability in Southern California. Regional water agencies began to take notice of conservation possibilities in the early 1990s as the full brunt of the 1988-1992 drought highlighted the limits of local and imported water supplies. In the years that followed, there were aggressive programs to implement water efficient technologies in the home and legislation that mandated minimum water efficient devices in new, for-sale, and renovated buildings. By 2005, cities such as Los Angeles saw water consumption 15 percent below projections due to these efforts (Los Angeles Department of Water and Power, 2005).

After two decades of primarily indoor water conservation efforts, outdoor use is where most future savings will be achieved. In heavily urbanized areas, outdoor water use accounts for up to 40 percent of total use (Los Angeles Department of Water and Power, 2005), while in suburban areas dominated by single-family homes – like those in Orange County – outdoor water use can exceed 50 percent of the total (Grand Jury Orange County, 2008) The Pacific Institute estimates that up to 20 percent of outdoor water can be conserved by implementing weather-based irrigation controllers. Even more, up to 90 percent of all outdoor use can be conserved by allowing a lawn to go dormant during dry periods of the year or installing more drought resistant plants (Gleick, et al., 2003).

Presently, achieving significant outdoor water conservation is unlikely as it is inadvertently disadvantaged in three ways. First, conservation does not generate revenue to cover initial investment; instead it forgoes the expense of developing a new source or expanding an existing one. Second, conservation may reduce the water agency's overall revenues if the agency's total consumption drops without a proportional increase in rates. Finally, conservation incurs costs to encourage participation in programs that are above and beyond the more obvious costs of implementation. In addition, many water agencies with progressively tiered rate structures discourage outdoor water

Water conservation has achieved savings of 15 percent from 1990 projections in L.A.

Single-family home residential areas can use more than 50 percent of their water outdoors.

Conservation does not directly generate revenue, disadvantaging it against new supplies.

conservation by allotting more water to residences that have larger outdoor areas and to areas and seasons with higher losses to evapotranspiration.

A progressively tiered rate structure can overcome the inadvertent disadvantages and even encourage outdoor water conservation. Such a structure contains two tiers: one for operation and maintenance costs and another for expansion costs. Each tier is made up of blocks (See Figure 1). By gradually stepping up prices as a user consumes indicates to her the essentiality of the water she uses. For instance, the first block's low price refers to the fact that it is water *essential* to meeting a person's basic needs, while the second block indicates the more *inessential* nature of water that will primarily be used outdoors. Such a rate structure encourages voluntary behavioral change or investment in technical efficiency using increasing price to indicate the inessentiality of the water use.

The first pricing block is for water *essential* to basic daily needs.

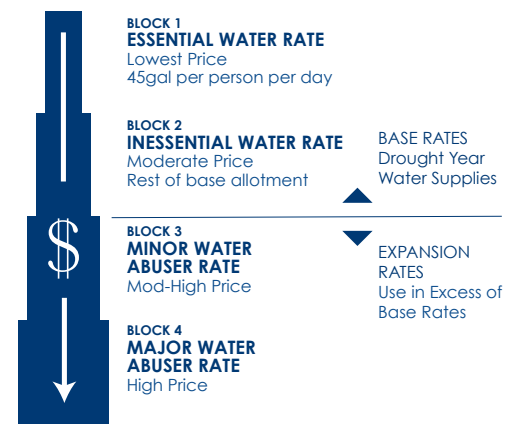


FIG 1. Progressively Tiered Rate Structure

A progressively tiered rate structure should be adapted to each water agencies specific characteristics. Though this limits the standardized implementation of a pricing structure, there are certain attributes that should be present in any pricing structure expected to reduce outdoor water consumption. They are:

- Operation and maintenance costs should receive revenue from two base rate blocks: the first of which covers *essential* indoor uses and the second which covers *inessential* indoor and outdoor uses.
- Costs for water conservation and new supplies should be provided by expansion rate blocks.
- Significant price difference should exist between each block so as to increase the likelihood a consumer will note the price increase and respond by decreasing water use.
- The base allocation for operation and maintenance costs should be based on a ten-year drought year and be held there no matter the climatic conditions; the longer the drought pricing remains the more likely a consumer will change behavior or invest in technical efficiency to reduce water consumption.
- Residences in zones with larger land areas and higher evapotranspiration rates should not receive a larger water allocation as this discourages outdoor conservation on those lawns where the greatest reductions could be achieved.

A progressively tiered rate structure following the guidelines put forth will decrease consumption through voluntary water reductions by consumers. It will provide secure financing for a water agency's operations and maintenance costs. It will generate financing to improve the reliability of existing supplies through the implementation of water conservation programs. It will assure that all households will be able to afford water *essential* to their basic needs. And, most importantly, a progressively tiered rate structure will make water conservation a more desirable alternative to water agencies.

INTRODUCTION



Conservation is an important tool to ensure future water reliability in Southern California. Water conservation rose as a tool for water agencies to combat supply reliability issues in the 1980s and entered into widespread use as a result of the 1988-1992 drought. By the mid 2000s, water conservation programs had reduced overall consumption by 15 percent in the Los Angeles Department of Water and Power service area against 1990 projections (Los Angeles Department of Water and Power, 2005). Nevertheless, a hurdle looms for future water conservation efforts; the relatively inexpensive retrofits of indoor appliances for more efficient ones reaped large reductions with little intrusion on consumers' water use habits, but have reached saturation. The next measures to achieve large reductions in water consumption will take place outdoors and will require extensive behavioral adjustment.

Water conservation measures are inadvertently disadvantaged against new supplies because they do not generate revenues to finance themselves, erode existing water agency revenues, and usually have a cost higher than is alluded to by studies of economic effectiveness. A progressively tiered rate structure can remedy many of these disadvantages. Such a rate structure is not new, but not yet ubiquitous. Furthermore, many of the current rate structures are not designed to actively encourage outdoor water conservation, and in some cases even reward outdoor water use. This paper will show in particular how a progressively tiered rate structure should be designed to encourage water conservation in general but especially outdoor residential water conservation.

The paper will progress through the following five steps.

1. I will show how water conservation has progressed in Southern California over the last 20 years.
2. I will explain where future water conservation gains will most likely be made.
3. I will show how water conservation is discouraged against new supplies.
4. I will give guidelines for a progressively tiered rate structure that encourages water conservation measures, and outdoor residential measures in particular.
5. I will emphasize those components of the proposed water rate structure that should be prioritized to achieve future gains in water conservation.



WATER CONSERVATION IN SOUTHERN CALIFORNIA

The 1988-1992 drought was the impetus for much of the current water conservation policies in Southern California.

Water conservation in Southern California is a relatively recent concept. That is not to say that people did not conserve water priorly, but water conservation as government policy did not come about in California until the early 1980s. Water policy up to this point had primarily been supply biased; supply had to meet what consumers demanded. The severe 1988-1992 drought awakened Southern California to the limitations of its local and imported supplies (Los Angeles Department of Water and Power, 2005). Subsequent climatic events, regulatory restrictions on water exportations from environmentally fragile areas, and the looming uncertainty of how severely global climate change would affect Southern California's water supplies has further put an emphasis on improved water supply reliability. The most obvious way to improve reliability is through water conservation.

Technical efficiency is water conservation through water efficient technologies.

Water conservation is the management of water demand. Typically, demand management is implemented in one of two ways: through technical efficiency or behavioral change. Much of Southern California's success in reducing per capita water demand is the result of more efficient technologies replacing older less efficient ones. Water agencies, politicians and the public prefer technical efficiency because it conserves water with minimal intrusion on the lifestyles of those who implement water efficient devices. A good representation is the replacement of an older clothes washer with a new high-efficiency model; the household reduces their water consumption while washing the same quantity of clothing as frequently as before.

Behavioral change requires a person to alter their water use habits to conserve water.

Water conservation through behavioral change relies on a change in a person or society's way of being. Until recently, behavioral change (e.g., taking a shorter shower, changing a lawn's biological composition) has remained a secondary method to reduce water demand; many water agencies and government institutions remain hesitant to force a behavioral change upon their constituents and most water users do not want others to decide for them how they should use "their" water. As a result, water agencies have achieved only limited water conservation savings through voluntary behavioral practices¹. Consequently, the lack of past water reductions through behavioral changes means that it offers great promise for large future savings.

As mentioned, most water conservation achievements implemented since the 1988-1992 drought have been through water efficient technologies. Two of the most successful programs were those encouraging replacement of ultra

¹ An exception is during severe drought times. Residents working together to avert what is seen as a short-term challenge can drastically reduce water use. This can be noted under the current drought. The LADWP has imposed mandatory water restrictions upon their consumers and have seen largely cooperation reducing water consumption by 17 percent in July 2009 when compared with July 2008 (Office of Mayor Antonio Villaraigosa, 2009).

low-flow toilets (ULFTs) and low-flow showerheads².

Technical efficiency accounts for most of conservation to date.

An example of a water agency that vigorously implemented an ULFT and low-flow showerhead program is the LADWP. The LADWP implemented its first toilet rebate programs in 1990 replacing 7, 5, and 3.5 gallon per flush (gpf) toilets with ULFTs. The program began including free installation of toilets, low flow showerheads, faucet aerators, and new toilet flappers in 2003 (Los Angeles Department of Water and Power, 2005). By 2005 the program had installed more than 1.2 million toilets at an average cost of \$315 per acre-foot of water saved (Los Angeles Department of Water and Power, 2005). Due to near saturation – the LADWP estimates that they converted 90 percent of all toilets in their service area to ULFTs – the LADWP ended the program in 2006 though it is still possible to get a rebate through the Metropolitan Water District's (MWD) program (Los Angeles Department of Water and Power, 2009). The savings from the installation of ULFTs alone are more than 40,000 acre-feet annually (Los Angeles Department of Water and Power, 2009). Regional and state efforts have produced similar results in most of Southern California's water agencies (Metropolitan Water District of Southern California, 2005).

Other programs that have had smaller but significant impacts on overall water use are rebates for water efficient dishwashers and clothes washers. More recently, there has been extensive focus on outdoor water efficiency with rebates to implement irrigation controllers that automatically adjust watering based on daily climatic conditions and to replace grass turf with artificial turf or the implementation of drought resistant plants.

Governments have used legislation to passively implement widespread water conservation.

Other than the active implementation of water efficient devices, state and local governments have passively encouraged conservation through legislation, codes, and regulations. The State of California mandated in the early 1990s that all toilets sold in the state must be ULFTs. Also, three significant legislative bills have indirectly pushed forward water conservation; SB 901, SB 610, SB 221. SB 901 was a 1995 bill that first required planning agencies to take into account water supply information when ruling on developments (Water Task Force, 2009). In 2001, SB 610 passed requiring that new large scale developments that are subject to the California Environmental Quality Act have a specified water supply assessment by the public water agency (Water Task Force, 2009). In the same year, SB 221 passed requiring any subdivision with more than 200 units³ show proof of a water source for the life of the project to receive approval (Mannion, 2001).

Local governments have also passed many ordinances to assure that water efficient devices are installed. The City of Los Angeles, for example, updated

2 An ULFT is a toilet that uses at most 1.6 or fewer gallons per flush (gpf). A low-flow showerhead uses at most 2.5 gallons per minute (gpm) of water at a pressure of 80 pounds per square inch, though many jurisdictions have modified these to be 1.28 gpf for ULFTs and 2.0 gpm for low-flow showerheads.

3 The requirement does not apply to urban-infill developments.

its plumbing code in July 2009 requiring all new buildings and renovations of all existing buildings have ULFTs of no more than 1.28 gallons per flush, showerheads that use no more than 2.0 gallons per minute, and dishwashers that use no more than 5.8 gallons per cycle (Moschos, 2009). Santa Monica has a retrofit-upon-sale that requires that homes have water efficient devices installed to receive certificate of sale (Santa Monica Office of Sustainability and the Environment, 2009).



WATER CONSERVATION FOR THE FUTURE

Water conservation has taken on a significant importance in Southern California and, as a result, significant results have been achieved, but there is also great potential for further conservation. Several studies, including the Pacific Institute's 2003 "Waste Not, Want Not: The Potential for Urban Water Conservation in California," predict that water use could be greatly reduced from current levels (Gleick, et al., 2003).

Current water use in Los Angeles is about 65 percent indoor and 35 percent outdoor (Los Angeles Department of Water and Power, 2005). Residential use accounts for around 65 percent of all water use of which single-family homes account for more than 35 percent (Los Angeles Department of Water and Power, 2005). In more suburban areas with larger amounts of land devoted to single-family homes (e.g., like in much of Orange County) outdoor water use is more than 50 percent of total use (Grand Jury Orange County, 2008).

The Pacific Institute states that consumers could reduce indoor water use by 33 percent from 2000 levels with current technologies. For residential uses they predict a conservation potential of 39 percent indoors and 32.5 percent outdoors (Gleick, et al., 2003). Based on interviews with Southern California water agencies, much of the indoor reductions have been achieved in their jurisdictions since 2000 and they repeatedly mention that large future gains will be outdoors (Sanchez & Likens, 2009; Wildermuth, 2009). Though indoor water use has been substantially reduced since the 1980s there are still areas where significant savings can be made. The City of Los Angeles has reported near saturation of ULFTs and low-flow showerheads (the two largest uses of indoor water), however recent technological improvements have made these devices an additional 20 percent more efficient⁴ (Moschos, 2009).

Outdoor water use, at more than half of residential consumption in suburban areas, exists primarily to maintain an aesthetic. Furthermore, outdoor water use increases in periods when water supplies are most restricted; the dryer

Single-family homes often use more than 50 percent of their water outdoors.

Future water savings will require significant outdoor use reductions.

4 ULFTs now use only 1.28 gpf instead of 1.6 gpf and showerheads use only 2.0 gpm over 2.5 gpm. Though the more efficient low-flow showerhead may be 20 percent more efficient, bathers may actually spend more time in the shower meaning that actual water savings will not equal 20 percent.

Outdoor water use has a higher average marginal cost than indoor water.

and hotter the weather the more water is needed to maintain lawns, keep swimming pools full, and clean off the grime that accumulates on surfaces, but this is also when precipitation is lowest. The marginal cost of providing water in the dry season is higher than during the wet season due to increased storage costs. Since outdoor water use makes up a more significant quantity during the dry time per year than the wet periods it is more likely to consist of more expensive water than basic water needs.

Ninety percent of outdoor water could be conserved.

Since native plants can survive with no water added, swimming pools are a luxury for those who can afford them, and cleaning the walk does not require a pressure washer, outdoor water use is inessential and could be saved. Compare this with essential indoor water uses like bathing, cooking, drinking and using a toilet. More practically, studies have found that more than 20 percent of outdoor water use could be saved by properly installing and setting a weather-based irrigation controller (Gleick, et al., 2003). Estimates show that up to 40 percent could be saved at a cost no greater than \$200 per acre-foot of water saved by properly educating home owners on how to manage their lawn (Gleick, et al., 2003). And even 90 percent could be saved by letting a lawn go dormant during the dry months or changing the lawn composition to Southern California native plants (Gleick, et al., 2003).



WATER CONSERVATION IS INADVERTENTLY DISADVANTAGED

Water conservation does not generate revenue to pay for implementation, but forgoes expenses.

Water conservation is inadvertently disadvantaged in three primary ways against new supplies. First, water conservation does not generate revenue; instead it forgoes the expense of developing a new source or expanding an existing one. As a consequence, the cost of implementing a water conservation program must come from existing revenues, though, many times all the water agency's revenues are already dedicated to existing expenses. Thus the primary ways that agencies must fund conservation is through fickle outside grants or self-financing by increasing revenues through raised water rates. But, raising water rates across the board without delivering additional water reflects poorly on the water agency; customers take notice of paying more per unit while being asked to use less⁵. Contrast this with a new water supply; bonds fund the project, which are either recouped through property taxes or more commonly nowadays through the revenues of selling the new water; the new source generates its own revenues⁶.

5 In many cases there is a public perception that water is a right and thus should be relatively cheap. Such a mindset is furthered by the long tradition of ample water supply at cheap prices for the population of water scarce Southern California.

6 Water prices may still need to be raised as the new water will most likely have a higher per unit cost than existing supplies. The price increase is understood by the consumer as the necessary cost of acquiring the new supply.

Water conservation reduces water sales lowering agency revenues if rates are not increased.

Second, water conservation reduces the water agency's overall revenues if total water consumption decreases without a proportional increase in water rates (Zito, 2009). Water agency revenues are directly tied by law to the cost of administering water delivery (Colantuono, 2006). A reduction in water sold due to water conservation efforts without increasing unit rates means less revenue for the agency. The cost of operating and maintaining the system does decrease, but not to the extent that water revenues do (Zito, 2009). This is a result of the fact that most water systems have high fixed costs (e.g., personnel and infrastructure) and only minimal variable costs (e.g., electricity use for pumping).

The water agency incurs a program cost on top of the cost of implementing a conservation device.

Third, water conservation incurs costs to the water agency to encourage participation in programs that are above and beyond the economic cost of implementation; successful water conservation programs require that the water agency convince possibly hundreds of thousands of constituents to take notice and partake in a program. Although the cost of implementing a new technology may seem fairly finite and the returns on investing in it are favorable, still the consumer may choose not to implement the water efficient device. Reasons may be that the consumer lacks complete information and does not realize that savings could be incurred or the relatively low cost of water makes the savings potential too low to garner priority in a consumer's busy life.⁷ To get consumer participation, the water agency may need to incentive the adoption of the device through rebates, education programs, or other means.



ENCOURAGING CONSERVATION THROUGH RATES

The design of a water rate structure can greatly encourage water conservation and especially, as is the focus here, outdoor water conservation. But, a poor design could achieve the opposite.

For a water rate structure to successfully achieve outdoor water conservation in a fair and equitable manner it should:

- Assure that a quantity of water sufficient for basic needs is sold at a price affordable to all;
- Assure a base rate that guarantees a water agency financial stability for

⁷ For example, the average single family home in Santa Monica uses 416 gallons daily. This translates into a monthly water bill at Santa Monica's current water rates of \$33 monthly or about \$400 annually. At the same time the 2008 median household income for Santa Monica was estimated to be \$70,084 (Census, 2008). The water bill is a mere half percent of income. The 2008 median income used is for all households. Many of Santa Monica's households are condo owners or apartment renters who would most likely have a smaller water bill and lower income than single-family home households. Thus, the water bill is likely to be less than ½ percent of total household income for a single-family home. For comparison, median household income for families is \$100,802 and for married-couple families is \$127,101 in Santa Monica.

operating and maintaining the existing system;

- Assure that there is funding for water conservation and new supplies when water is in excess of current supplies;
- Incentivize the millions of water consumers to use their water more sensibly without mandating behavioral change; and
- Discourage profligate outdoor water use by not allocating the cheapest water to geographic locales and land uses that tend to waste the most water outdoors.

Rate increases inelastically affect water consumption.

Understanding how different water rates affect consumption is necessary to create an effective rate structure. Water rate increases reduce water consumption inelastically. This means that a ten percent increase in price will create a less than ten percent decrease in consumption. Olmstead et al. studied 124 examples of the effects of price change on demand and found that the mean price elasticity was -0.51 (Olmstead, Hanemann, Michael, & Stavins, 2007). This means that for a 10 percent increase in price there will be a corresponding 5.1 percent decrease in water consumption. They also found that in the short run, the median price elasticity was -0.38 and in the long run it was -0.64 meaning that by maintaining a rate increase for a long time period or permanently will cause a significantly greater decrease (70 percent) in consumption over the same price increase held for a short time period. Such claims substantiate that drought pricing would improve water conservation savings if it was permanent no matter the expected duration of a drought; the current practice of ending drought pricing once climatic conditions improve signals to consumers that the drought conditions were a climatic anomaly and not a regular pattern that should be planned for. As a consequence, the full water conservation potential of the higher drought rates goes unrealized, undermining gains in water reliability during future drought events.

The longer the duration of a rate increase, the greater the decrease in consumption.

A progressively tiered rate structure⁸ increases water conservation more significantly than a single uniform marginal rate⁹. Olmstead et al. modeled a progressively tiered rate structure against a single uniform marginal rate and found that the price elasticity was -0.59 for the tiered rate structure and -0.33 for the uniform, though the result was not statistically significant. This means that a rate hike will decrease water consumption greater in a progressively tiered rate structure than under a single uniform marginal rate, though less than 95 percent of the statistical sample followed this trend. They also found that in a tiered structure 40 percent of demand was within five percent of a

8 A progressively tiered rate structure consists of specific allotments of water sold at unique unit prices. For example, a water agency sells the first 1000 gallons used at a rate of \$0.05 per gallon, and the second thousand gallons at a rate of \$0.10 per gallon, and for all use over 2,000 gallons at \$0.15 per gallon. Figure 1 on page 14 gives a visual of such a structure.

9 A uniform marginal rate is when water is sold at a single price per unit no matter the quantity sold. For example, if a water agency sold water at a rate of \$0.05 per gallon, it would sell all water sold to a household at this price.

Progressively tiered rates generate more conservation than a uniform rate.

price change, showing that consumers note rate increases and adjust their consumption accordingly (Olmstead, Hanemann, Michael, & Stavins, 2007). These findings show that a progressively tiered rate structure with well-placed tier breaks can reduce water consumption more effectively than a uniform rate.

DESIGNING THE RATE STRUCTURE



When developing the rubric for a progressively tiered rate structure, the operation and maintenance cost of the existing water infrastructure should be separated from the cost of expanding the system to meet demand in excess of current needs. The separate costs should be each financed by separate pricing tiers, the base rates and expansion rates. The base rates should provide sufficient revenue to cover the cost of receiving water from existing infrastructure. The expansion rates should provide revenues for water conservation programs or supply expansion.

Both the base and expansion rates should be divided into progressive

blocks with distinct prices and allotment quantities (See Figure 1). The number of blocks and the prices and allotments under each one will vary by jurisdiction. However, four are used in this paper for consistency purposes – two base rate blocks and two expansion rate blocks. The structure functions in the following manner: a water user consumes from the first block at a particular price, once the first block's quantity has been consumed, the user will begin consuming the second block at its higher price, and so on.

The base rates pay for the operation and maintenance costs of the existing system.

The expansion rates pay for the costs of expanding the system, which includes water conservation.

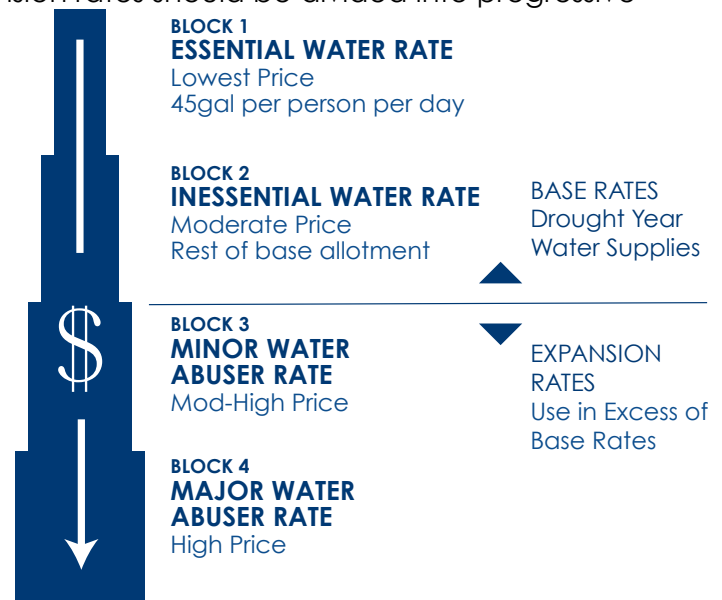


FIGURE 1. Progressively Tiered Rate Structure

The base rates have an allotment of water determined by what the existing system can deliver. However, the existing system's capacity for many water agencies in Southern California is largely determined by the Metropolitan Water District's (MWD) allotment for them. The MWD determines its annual base allotments on the "maximum annual amount of firm delivery purchased from Metropolitan [MWD] in the 13 years ending June 30, 2002" (Metropolitan Water

District of Southern California, 2005, pp. 11-26), Using a maximum amount of water delivered does not inspire water conservation among users. Even more, maximum use years happen to be those first dry years of a drought before water agencies become worried about severely depleting overall reserves. By the time the agency recognizes the drought severity and they put emergency water conservation measures (i.e. drought pricing) in place, the drought is two or three years along. Once the drought ends, the agency removes the emergency conservation measures soon thereafter. Such an emergency reaction and minimization of the drought discourages water conservation; the longer drought pricing remains in effect the more a consumer will implement water efficiency and behavioral change measures. To improve water reliability during drought years and encourage conservation, water agencies should predicate their base rate allotment on the driest year that occurs every decade – the same period mandated by the State of California for submission of the Urban Water Management Plan – instead of letting it move variably based on water storage levels.

The base rates' allotment should be that of a 10 year drought-year.

Now that the base rates' allotment has been determined, it should be divided into two further blocks: *essential* and *inessential* water. The initial block termed *essential* water should include the basic indoor per capita water needs of a household, which in a conserving household – one with efficient appliances – is about 45 gallons per person per day (Vickers, 2001). This *essential* water should be priced relatively cheaply so that all in society may affordably consume sufficient quantities for their basic daily needs.

Essential water is for basic daily needs; approximately 45 gallons per person per day.

The second base rate block should encompass *inessential* water above the basic needs block and up to the total dry year allotment for the water agency. The water will mostly be outdoor and excessive indoor use. The *inessential* water rate should be high enough to assure that total revenue from the two base rate blocks is enough to cover the operations and maintenance costs for the existing infrastructure. The lower the price for the first block, the higher the price for the second block; the *inessential* water provides a subsidy for the *essential* water.

Inessential water is all water used in excess of basic daily needs; primarily outdoor use.

Each block's allotment should vary by household characteristics. The *essential* water household allotment requires data on the number of residents. However, this data is often not actively kept by a water agency or is very difficult to verify. Since poverty is many times linked with larger household sizes, care needs to be taken to assure that all households are able to afford sufficient water for their basic daily needs. At the same time, the city does not want to reward homes that average one or two residents with plentiful cheap water while larger households pay more just to obtain basic needs water (since the poor generally live in significantly larger households than the wealthy, a water rate with equal allotments to all households would be very regressive). A way to moderate a regressive water rate would be to use occupancy data for neighborhoods or census tracts. For example, the City of Los Angeles neighborhood with the highest occupancy rate is Pacoima at 4.3 persons per

The *essential* household water allotment should take into account household size.

household, far above the citywide average of 2.9 (Los Angeles Times, 2000). Many other neighborhoods have a significantly lower level like Westwood with 2.0 persons per household and Venice with 1.9 persons per household (Los Angeles Times, 2000). If the Pacoima neighborhood was rounded up to 5 persons per household then they would require 6,750 gallons or 9 hundred cubic feet¹⁰ of *essential* water per month per household. Nine hundred cubic feet is less than half of the entire base allotment for the LADWP¹¹ (Los Angeles Department of Water and Power, 2009) and one more billing unit than the basic needs allotment for Pasadena Water & Power¹² (City of Pasadena, 2009). The Westwood and Venice neighborhoods require only 40 percent Pacoima's quantity of *essential* water per household.

The *inessential* household water allotment should not vary by lot size or climate conditions.

The base rates allotment (*essential* and *inessential* water) currently varies by not only household size, but also lot size, local climate, and land use. In the City of Los Angeles, as in many Southern California cities, the current base rates allotment favors outdoor water consumption; households and seasons with higher evapotranspiration rates and larger lots receive larger allotments than others (Los Angeles Department of Water and Power, 2009). So, the very households that will likely waste the most water outdoors are allotted more, reducing their incentive to become more efficient. The rate structure should encourage a reduction in outdoor water waste by giving households regardless of lot size and climate similar allotments.

Significant price change should occur between tiers so the consumer takes notice.

Expansion rates are more difficult to set than base rates. We will consider two blocks, one for minor water abusers and another for major water abusers. The rates need to be closely tied with the program costs to reduce demand by the amount used in excess of the basic allotment.¹³ The cost of such programs will vary by each individual water agency and the plan they would like to implement and so the tiers will need to be set based on each water agency's individual characteristics. However, as a guideline, the expansion tiers' rates should be significantly different to assure that the consumer notices the increase in their water usage, compared to the relatively cheap price of water in general.

Progressively tiered rate structures have effectively reduced water consumption and stabilized water agency finances in Southern California, though without a

10 A hundred cubic feet or HCF is the common billing unit for most water agencies. It is equal to 748 gallons.

11 The LADWP has only a single base rate pricing block

12 The average household size may be smaller in Pasadena than for the Los Angeles neighborhood used in the example.

13 Proposition 218 requires water agencies to notify all ratepayers of a rate increase with a "45 days mailed notice" and "an old-fashioned majority protest proceeding in which silence is consent" (Colantuono, 2006). Also, it requires that the water agency must be revenue neutral; all rate revenues must be tied to specific costs. A block rate system allows the water agency to do this, but it may cause the need to fluctuate the overall rate so as to coincide with variable expenses. For example, the electricity rate to pump water fluctuates, sometimes severely. An electricity component of the water rate may need to fluctuate as the electricity rate does so.

Irvine Ranch Water District has had great success with their progressively tiered rate structure.

specific encouragement of outdoor water conservation. Irvine Ranch Water District (IRWD) became a pioneer upon implementation of their progressively tiered rate structure in 1991. The implementation came about due to the agency's desire to maintain financial wellbeing after the drastic conservation measures required due to the severity of the 1988-1992 drought. In 1989 the average residential household in the IRWD used 120 gallons per person per day. In 2008, this had been reduced to 90 gallons per person per day (Sanchez & Likens, 2009). The majority of the decrease occurred between 1991 (the year of implementation) and 1992. Use has decreased gradually since 1992. Though other factors like the implementation of water efficient devices may have caused some of the decrease in residential water consumption, the IRWD credits much of the decrease to the implementation of the progressively tiered rate structure (Sanchez & Likens, 2009). Additionally, IRWD's finances have stabilized; since implementation of the new rate structure they have continuously supported more water conservation measures, while weathering the current drought in good financial health.



CONCLUSION

Water conservation is an integral part to achieving water reliability in Southern California, especially with uncertain future supplies due to climate change, regional growth, and legislative and judicial rulings.

Twenty years of successful indoor water conservation measures has reduced future potential for large savings in the home. However, the relative absence of large outdoor reductions and the inessential nature of such uses make outdoor water conservation promising for substantial future gains. The behavioral nature of outdoor use makes a progressively tiered rate structure an effective way to achieve significant voluntary reductions.

A progressively tiered rate structure should be adapted to each water agency's specific characteristics. Though this limits the rate structures ability to be standardized, there are certain attributes that are significant towards achieving successful reductions in outdoor water consumption. They are:

- Operation and maintenance costs should be provided by two base rate blocks: the first of which covers *essential* indoor uses and the second which covers *inessential* indoor and outdoor uses.
- Costs for water conservation and new supplies should be provided by expansion rate blocks.
- Significant price difference should occur between each pricing block so as to increase the likelihood a consumer will note the price increase and respond by decreasing water use.
- The base allocation for operation and maintenance costs should be based

on a ten-year drought year and be held there no matter the climatic conditions; the longer the drought pricing remains the more likely a consumer will change behavior or invest in technical efficiency to reduce water consumption.

- Residences in zones with larger land areas and higher evapotranspiration rates should not receive a larger water allocation as this discourages the very outdoor water conservation on those lawns where the greatest benefits could be achieved.

A progressively tiered rate structure following the guidelines put forth will decrease consumption through voluntary water reductions by consumers. It will provide secure financing for a water agencies operations and maintenance costs. It will generate financing to improve the reliability of existing supplies through the implementation of water conservation programs. It will assure that all households will be able to afford water *essential* to their basic needs. Most importantly, a progressively tiered rate structure will make outdoor water conservation more desirable for water agencies.



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