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A Saturation Study of Non-Efficient Water Closets in Key States

A Report by the
Alliance for Water Efficiency
and Plumbing Manufacturers International

Alliance for Water Efficiency

pmi PLUMBING MANUFACTURERS INTERNATIONAL ®

A SATURATION STUDY OF NON-EFFICIENT WATER CLOSETS IN KEY STATES

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Executive Summary

The Alliance for Water Efficiency (AWE) and Plumbing Manufacturers International (PMI) commissioned this study to quantify the potential water savings that can be achieved by replacing older, non-efficient toilets with water-efficient models in residential properties in five states. The "Saturation Study of Non-Efficient Water Closets in Key States" focused on Arizona, California, Colorado, Georgia and Texas – all states that have experienced serious water shortages.

This study concluded that between 90 billion and 170 billion gallons of potable drinking water could be saved per year in these five states (or 250 to 465 million gallons per day), with the higher numbers more likely if all of the non-efficient toilets in residential properties are replaced with water-efficient ones. This five-state savings can be extrapolated to an estimate of up to 360 billion gallons of potable drinking water saved nationally per year.

The five-state water savings estimate was calculated after the study's research determined that more than 13 million non-efficient toilets (with a flush volume of more than 1.6 gallons) remain installed in Arizona, California, Colorado, Georgia and Texas residences. These 13 million toilets comprise about 21 percent of all toilets installed in those states; therefore, about 79 percent of installed residential toilets are already efficient at 1.6 gpf or less.

This research produces important direction for water managers nationwide, as 40 out of 50 states anticipate water shortages in the coming years, according to a Government Accountability Office survey of state water managers published in 2013. Most of these states already experience periodic shortages. The five states researched represented 28% of the national population and 47% of all housing units in 2015, so the report examines a large part of the residential water consumption in the US. Toilet flushing is the largest indoor use of water, representing 24 percent of total use in single-family homes. Replacing non-efficient toilets with efficient ones is an important strategy to stretch available water supplies.

Acknowledgements

This study involved the contribution of many individuals, especially for gathering the needed information on incentivized toilet replacements dating from 1990 through to 2015. Because many water providers and other organizations in the five states were involved in offering incentives to replace non-efficient toilets with efficient models, the 25 years of historical data was not always readily available. As such, staff members of these organizations were required to 'dig deep' in many instances to recover and assemble data that was stored in various electronic and paper forms. For this, we are extremely grateful.

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Introduction

About

Alliance for Water Efficiency

The Alliance for Water Efficiency (AWE) is a nonprofit organization dedicated to the efficient and sustainable use of water in North America. Working with nearly 400 water suppliers, business and industry, regulatory and advocacy organizations, AWE delivers innovative tools and training to encourage cost-effective water conservation programs, cutting-edge research, and policy options necessary for a sustainable water future.

Plumbing Manufacturers International

Plumbing Manufacturers International (PMI) is a trade association of plumbing products manufacturers. Its member companies produce most of the nation's plumbing products. PMI functions as a sounding board for its members, a source for industry and market information, and as a coordinating and decision-making body for dealing with industry issues. It is active in many arenas as it helps develop and maintain standards and codes, and works closely with government agencies at all levels – federal, state and local.

Purpose

- Determine the number of non-efficient toilets (water closets)[1] that remain within the installed residential base of plumbing fixtures in five states: Arizona, California, Colorado, Georgia, and Texas.
- Determine the potential water savings that could be achieved through replacement of those non-efficient models.

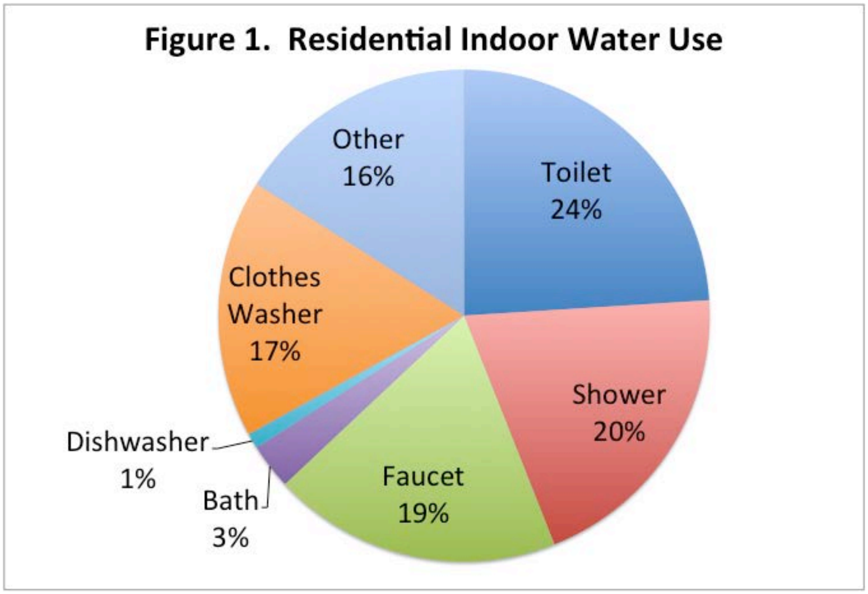
Scope

These five key states have demonstrated water supply or infrastructure issues leading to government proposals or actions[2] directed at aggressive water conservation. Each of these five states (or major jurisdictions within those states) has implemented or proposes to implement codes or standards that reduce maximum flush volumes for toilet fixtures below that of Federal law (or, in some cases, below that of the U.S. EPA WaterSense program). Each state has a sufficient inventory of installed residential toilets to warrant an assessment of the non-efficient portion of that base. The scope was limited to residential installations.

[1] The term 'non-efficient water closets' is defined as inclusive of all water closets with rated flush volumes greater than 1.6 gallons per flush (gpf), nominally rated at 3.5 gpf, 5.0 gpf and above. Also known as 'legacy fixtures'.
[2] Including legislation, regulations, programs, or other actions directed at toilet replacement in the built environment.

Background

Over the years, there has been a range of studies directed at identifying opportunities for water use reductions in residential dwellings. Included within those studies have been estimates of the average indoor water demand associated with the various appliances, fixtures, and other equipment[3] within the home. Figure 1 displays the most recent distribution of indoor water use.[4]



Clearly, toilet flushing is a major component of indoor water use. In those geographic areas where water supply and infrastructure issues were of critical importance, such water demand information became very important. It led to the development of initiatives and incentives by water providers, manufacturers, government agencies and others directed at removing the older, water-wasting products and installing newer, water-efficient replacements.

In the 1980s, water conservation programs and legislative actions focused on new product designs and several fixture/appliance replacement programs were launched in the U.S. Because toilet flushing represented a significant segment of water use in the home, a large number of those programs and actions focused on replacing older 5.0 and 3.5 gallons per flush (gpf) models with the newly available 1.6 gpf products (deemed “low flow” or “low flush”). At the same time, some programs began requiring them in new construction.

Recognizing the need to reduce water demands and defer infrastructure investments, four of these states and one municipality adopted legislation setting the maximum flush volume for toilets at 1.6 gpf prior to any Federal action:

[3] Includes appliances (clothes washers, dishwashers) plumbing fixtures and fixture fittings.
[4] Water Research Foundation, 2016. *Residential End Uses of Water, Version 2, Executive Report.*

Table 1. Early Legislation Setting Pre-EPAct92 Maximum Toilet Fixture Flush Volumes at 1.6 gpf[5]

State/Locality	Effective Date of Legislation
Arizona	January 1, 1993
California	January 1, 1992
Georgia	April 1, 1992
Texas	January 1, 1992
Denver, Colorado	March 1, 1992

These state and local mandates setting 1.6 gpf as a maximum were ultimately followed by the Federal mandate of Environmental Policy Act of 1992 (EPAct92), which established a new national maximum water use threshold for toilets at 1.6 gpf.[6] EPAct92 also pre-empted any actions by states or other jurisdictions to adopt regulations "More stringent than Federal regulation concerning the water use or water efficiency…".[7] This included the legislation noted above in Table 1.

However, as reported in 2000 by the U.S. General Accounting Office (GAO), the water savings impact of this significant action was difficult to estimate…

"… because some use of low-flow fixtures would likely occur for other reasons—that is, even in the absence of the standards. These reasons include (1) state and local laws that preceded the national standards and (2) incentives, such as rebate programs sponsored by local governments, that encourage the replacement of less efficient fixtures."[8]

The result of Federal action (EPAct92) was to effectively eliminate the 3.5 and 5.0 gpf toilet models from the marketplace. It did not, though, address the many millions of these non-efficient models already installed in residential dwellings throughout the country.

[5] United States General Accounting Office, Report to Congressional Requesters, August 2000. *Water Infrastructure, Water-Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows.* GAO/RCED-00-232
[6] With limited exceptions, applies to tank-type toilets manufactured after January 1, 1994. Flushometer valve toilets, rare in residential settings, were not required to meet the 1.6-gallons-per-flush standard until January 1, 1997.
[7] On December 22, 2010, the U.S. Department of Energy (DOE) waived pre-emption; some states and local jurisdictions immediately began implementing even more stringent flush volume limits for toilet fixtures.
[8] United States General Accounting Office, Report to Congressional Requesters, August 2000. *Water Infrastructure, Water-Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows.* GAO/RCED-00-232

Saturation Methodology

The first step in determining the existing installed base of non-efficient residential toilets was to begin with an inventory of the installed base of toilets just prior to when the state and local legislation (as noted in Table 1) effectively banned the further sale of non-efficient toilet models.

Housing Units

Population and housing data for 1990 and 1995 is readily available from the U.S. Census Bureau for each of the five states:

Table 2. Housing Unit Counts – 1990 and 1995[9]

State	1990 Housing Units (millions)	1995 Housing Units (millions)
Arizona	1.659	1.924
California	11.183	11.699
Colorado	1.477	1.643
Georgia	2.638	2.960
Texas	7.009	7.584

Bathroom Counts

Next, by applying bathroom (toilet) counts provided in multiple American Housing Surveys from the U.S. Census Bureau, it is possible to estimate the number of non-efficient toilet fixtures installed in residential dwellings as of the effective date of legislation listed in Table 1.[10]

Table 3. Bathrooms (toilets) per Dwelling Unit[11]

State	Toilet count per d.u.- 1992-1993
Arizona	1.799
California	1.652
Colorado	1.693
Georgia	1.757
Texas	1.705
NATIONAL	***1.505***

Interestingly, the national average just 10 years later (2003) had increased to 1.66 toilets per housing unit, due largely to new construction. By 2003, for example, the average for newly constructed housing was 2.47 toilets per dwelling unit.[12]

[9] U.S. Census Bureau, Population Division, May 2016. Annual Estimates of Housing Units for the United States, Regions, Divisions, States, and Counties: April 1, 2010 to July 1, 2015
[10] We recognize that a certain number of 1.6 gpf toilet models were already installed as of the dates in Table 1. However, these numbers are considered to be a very small percentage of the total installations since the availability of 1.6 gpf 'low flow' toilets was very limited in the late 1980s and early 1990s and, in most cases, there were no incentive programs existing to encourage the replacement of older 3.5 and 5.0 gpf models.
[11] U.S. Census Bureau, American Housing Surveys for the United States (various), 1970 through 2003
[12] U.S. Census Bureau, Characteristics of New Housing, at: http://www.census.gov/const/www/charindex.html.

Toilet Counts

Using the data shown above, the approximate number of non-efficient toilets at the time of legislation can be calculated as presented in Table 4.

Table 4. Non-Efficient Toilets as of Legislation Date – Residential Housing

State	Year	Total installed base of non-efficient residential toilets (millions)
Arizona	1993	3.38
California	1992	19.90
Colorado	1992	2.67
Georgia	1992	4.93
Texas	1992	12.50
5 State Total	***1992-93***	***43.38***
NATIONAL	***1991***	***157.12***

Incentivized Replacement

Various water providers in each of the five states implemented incentivized toilet replacement programs directed at homeowners and multi-family housing managers. In most cases, the programs took the form of rebates paid directly to the utility customer or multi-tenant building owner. Some program incentives took the form of what is known as 'direct installation', wherein the water utility contracts a qualified plumber or plumbing contractor to complete the replacement of non-efficient toilets in single- or multi-family dwellings. In these latter cases, both the toilet fixture and its installation are provided to the utility customer, who usually bears little cost, if any.

We surveyed a number of individuals associated with water utilities in the five states to determine the number of incentivized replacements of toilet fixtures made since 1990. While it was not possible to contact and obtain historical information from all of the thousands of water providers in those states,[13] we were able to connect with the largest purveyors and develop a reliable approximation of such replacements over the 26 years from 1990 to 2015 inclusive (Table 5).

Table 5. Incentivized Replacements of Non-Efficient Residential Toilets - 1990 to 2015

State	Estimate of Incentivized Replacements[14] (millions)
Arizona	0.09
California	3.80
Colorado	0.18
Georgia	0.13
Texas	0.45
5 State Total	***4.65***

In 2003, the new construction average of 2.47 was comprised of multi-family at 1.73 toilets per housing unit and single-family at 2.83 toilets per housing unit.

[13] Staff turnover, loss of records, and privacy issues were among the reasons why some data was unavailable.

[14] Data gathered and aggregated from numerous sources and used to develop a statewide estimate.

Natural Replacement

The installed base of non-efficient toilets shown in Table 4 was gradually depleted naturally over the ensuing 20-25 years as these toilets were replaced with efficient models (1.6 gpf or less), irrespective of any incentives by the water providers to homeowners to do so. The most common natural replacement rate adopted by economists developing water use projections is four (4) percent per year, equivalent to an average toilet life cycle of 25-years.[15] Some economists will assume a different life cycle for single- and multi-family installations.[16] This analysis assumes a natural replacement rate of four percent annually of the remaining installed stock each year of non-efficient fixtures, or a total replacement of approximately 64 percent over a 25-year period.

Table 6. Natural Replacements of Non-Efficient Residential Toilets – 1992-93 to 2015 at 4% annually

State	Estimate of Natural Replacements (millions)
Arizona	2.03
California	11.11
Colorado	1.57
Georgia	3.04
Texas	7.65
5 State Total	***25.40***

Total Replacements and Saturation

The combination of incentivized replacement and natural replacement represents the estimated reduction in non-efficient toilet fixtures over the 26-year span. Tables 7 and 8 summarize the saturation results.

Table 7. Changes in Non-Efficient Residential Toilets - 1992-93 to 2015 (millions)

State	Installed base of non-efficient residential toilets - 1992-93 (Table 4)	Incentivized replacement 1992 to 2015 (Table 5)	Natural replacement 1992 to 2015 (Table 6)	Remaining installed base Year-end: 2015
Arizona	3.38	0.09	2.03	1.26
California	19.90	3.80	11.11	4.99
Colorado	2.67	0.18	1.56	0.93
Georgia	4.93	0.13	3.04	1.76
Texas	12.50	0.45	7.65	4.36
5 State Total	***43.38***	***4.65***	***25.40***	***13.30***

[15] Whereas many plumbing professionals will claim the physical life of a toilet is over 50 years, the useful or economic life of a toilet fixture is generally much less, and is governed by many external factors other than physical durability. These include the tendency to remodel or re-equip an existing bathroom, a desire for a different design, need for achieving a higher level of water efficiency, and other influences. It is important to note that the assumed 25-year life cycle is an average value, with some toilets replaced more frequently and some remaining in place for a much longer period. In its Water Conservation Tracking Tool, the Alliance for Water Efficiency uses four (4) percent annually for natural replacement of residential toilet fixtures:
Alliance for Water Efficiency, July 2016. *Water Conservation Tracking Tool*, *version 3.0, User Guide*, page 56

[16] California has historically used a four (4) percent natural replacement rate for all residential toilets (http://www.cuwcc.org/Research-Portal/Natural-replacement-rates), however, a recent analysis for Colorado used 2.8 percent, Texas used 2.0 percent, and Austin, Texas used 4.0 percent for single-family and 2.0 percent for multi-family housing.

Table 8. Non-Efficient Residential Toilet Saturation – 2015

State	Total installed base of ALL residential toilets Year End-2015 (millions)	Remaining installed base of non-efficient residential toilets Year-End 2015 (millions)	Percent saturation of non-efficient residential toilets remaining in the installed base
Arizona	5.80	1.26	21.7%
California	24.36	4.99	20.5%
Colorado	4.19	0.93	22.2%
Georgia	8.59	1.76	20.5%
Texas	20.42	4.36	21.4%
5 State Total	***63.36***	***13.30***	***21.0%***

Potential Water Savings

The prediction of water savings that might accrue when replacing a residential toilet fixture is influenced by a number of variables, most of which are of unknown quantity and must be estimated with the best available information. For example:

- **The actual 'real world' consumption of the non-efficient toilet fixtures being replaced is generally unknown**.
  Experience tells us that many older 3.5 or 5.0 gpf-rated toilet installed in the 1980s or prior tend to flush with more than their rated volume. Field studies have shown the water savings achieved by replacing these fixtures with efficient models is usually greater than might be expected from a simple engineering calculation. This 'additional' savings is due largely to older non-efficient toilets flushing with higher-than-rated volumes and to the elimination of leakage. Water savings will vary depending upon the fixture being replaced.

- **The flush volume of the replacement high-efficiency toilet (HET)**.[17]
  Flush volumes of HETs vary from a maximum of 1.28 gpf to as low as 0.8 gpf today. Over 200 models currently in the marketplace are rated at 1.1 gpf or less. As such, the water savings profile is also dependent upon the replacement toilet model chosen by the consumer or building owner.

- **The use profile of the homeowner/renter**.
  It is common practice to attribute an average count of 5.0 flushes per day per person in the home.[18] However, for many users, this number of flushes per day at home may either be higher or lower.

For the purpose of this analysis, we have conservatively assumed the replaced non-efficient toilet to be a 3.5 gpf model, the flush volume of the replacement HET to be 1.28 gpf, and the use profile to be 5.0 flushes per person per day.

Also to be considered is the average occupancy density of the dwelling units (i.e., persons per household) where the toilets are being replaced. In this case, such information is readily available on a statewide basis from national and state sources:

[17] Four of the five states (excluding Arizona) now limit sales of residential toilet fixtures to HETs and, in most cases, also limit toilet installations to HETs as well.
[18] Water Research Foundation, 2016. *Residential End Uses of Water, Version 2, Executive Report.* Page 9.

Table 9. Persons per Household - 2015[19]

State	Persons per household
Arizona	2.69
California	2.96
Colorado	2.55
Georgia	2.73
Texas	2.84
NATIONAL	***2.54***

The estimate of water savings likely to be achieved by replacing toilet fixtures is frequently based exclusively upon a simple 'engineering estimate'. That is, the analyst assumes the savings is equal to the 'delta' in flush volume between the old (non-efficient) fixture and the new (efficient) fixture multiplied by the number of times the new toilet is flushed per day (Table 10).

Table 10. Engineering Calculation: Gallons/Day Savings per Replacement Toilet

	Toilets per Dwelling Unit (1992-93) (Table 3)	Persons/ Household (2015) (Table 9)	Persons/ Toilet (2015)	Flushes per Person per Day	Engr. Calculation of Savings at 2.22 gpf (gal/toilet/day)
Arizona	1.799	2.69	1.495	5.0	16.6
California	1.652	2.96	1.792	5.0	19.9
Colorado	1.693	2.55	1.506	5.0	16.7
Georgia	1.757	2.73	1.554	5.0	17.2
Texas	1.705	2.84	1.666	5.0	18.5
NATIONAL	***1.505***	***2.54***	***1.688***	***5.0***	***18.7***

While this intuitive approach appears to be reliable, it fails to account for 'real world' measurements of water use reductions obtained from field studies of replacement programs. For example, field study findings from recent years show reported average savings in excess of 30 gallons per replacement:

Table 11. Measured Water Savings per Residential Replacement Toilet (Field Studies)

Source	Gallons per Toilet per Day
AWE Water Conservation Tracking Tool[20]:	
Metropolitan Water District of Southern California	38.0
Canada Mortgage and Housing Corporation	32.6
California Urban Water Agencies[21]	31.2 to 37.9
Compilation of Field Studies (see Appendix Table)	39.0

For the purpose of this analysis and to develop a range of savings, we applied both the very conservative engineering calculations shown for each of the five states in Table 10 and what we believe to be a more realistic 35 gallons per toilet per day, based upon field study findings.

[19] http://www.census.gov/quickfacts/table/PST045216/00
[20] Alliance for Water Efficiency Water Conservation Tracking Tool, v.3.0, *User Guide*
[21] California Urban Water Agencies (CUWA), April 13, 2015. *CUWA Phase 1 Water Savings Study.*

Table 12 summarizes the resulting range of water savings potential of replacing non-efficient toilets in each of the five states assuming the minimum gallons per toilet per day savings estimates identified in Table 10 and the expected average savings of 35 gallons per toilet per day. Table 13 provides the same values but on an annual basis.

Table 12. Summary Comparison - Estimated Daily Water Savings

State	Remaining installed base of non-efficient residential toilets Year-end 2015 (Table 8)	Estimate of Potential Water Use Reduction: Replacing ALL Non-efficient Residential Toilets (MILLIONS of gallons per day)	
		Determined By Engineered Calculation	**Determined By Field Study Data**
Arizona	1.26	20.9	44.1
California	4.99	99.2	174.7
Colorado	0.93	15.5	32.5
Georgia	1.76	30.4	61.6
Texas	4.36	80.6	152.6
5 State Total	***13.30***	***246.6***	***465.5***

Table 13. Summary Comparison - Estimated Annual Water Savings

State	Remaining installed base of non-efficient residential toilets Year-end 2015 (Table 8)	Estimate of Potential Water Use Reduction: Replacing ALL Non-efficient Residential Toilets (BILLIONS) of gallons per year	
		Determined By Engineered Calculation	**Determined By Field Study Data**
Arizona	1.26	7.6	16.1
California	4.99	36.2	63.7
Colorado	0.93	5.7	11.9
Georgia	1.76	11.1	22.5
Texas	4.36	29.4	55.7
5 State Total	***13.30***	***90.0***	***169.9***[22]

[22] Equal to approximately 520,000 acre-feet of water.

Conclusions

At the end of 2015, it is estimated that slightly more than 13 million non-efficient residential toilet fixtures (approximately 21% of the installed base) remained installed in Arizona, California, Colorado, Georgia, and Texas. Conversely, one can conclude that 79 percent of the installed base is comprised of efficient fixtures (1.6 gpf or less).

Based upon field experience from completed toilet replacement projects, we estimate the potential net potable water demand reductions to be achieved through replacement of these non-efficient fixtures ranges between 250 and 465 million gallons per day, or about 90 to 170 billion gallons annually. It is our opinion that the higher number is more likely.

Reaching and replacing the remaining 21 percent non-efficient toilets would undoubtedly be more difficult for the water provider incentive programs than was the case for past incentive programs and it may not be a cost-effective process. Given time, it is probable that most of the 21 percent will disappear through the natural replacement process, e.g., at the four (4) percent annual replacement rate, savings of half of the 170 billion gallons could be achieved by the year 2032.

Appendix

Summary of Residential Water Savings Studies - Toilet Fixture Replacement Projects

Project Name	**Fountain View Apts**	**U.C. Irvine-Student Housing Retrofit Project**		**Sun Prarie Apts**	**Kenco Apts - Waverly Manor**	**Univer-sity Place Apts**	**HET Direct Install Program**		**HET Direct Install Program**		**Mendelsohn House**	**Embedded Energy in Water Studies**		**HET Direct Insall Program**		**Residential End Use Studies (Aquacraft)**			**Water Matrix Case Studies (Canada)**			
Geographic Location	**Long Beach CA**	**Irvine CA**		**West Des Moines, IA**	**Norcross GA**	**Columbia MO**	**Santa Clara Valley CA**		**Sonoma County CA**		**San Francisco CA**	**PG&E/ Santa Clara Valley, CA**	**SCE/ Irvine Ranch Water District, CA**	**Elsinore Valley Water District, CA**	**Eastern Municipal Water District, CA**	**East Bay Municipal Utility District, CA (2003)**	**Seattle Public Utilities, WA (2000)**	**Tampa Water Dept., FL (2004)**	**Capreit, Toronto**	**St. David's Tower Corp., Toronto**	**Haven-brook Realty Co., Toronto**	**Gold Seal Mgt. Toronto**
Type of residential application	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	SF	MF	SF	SF	SF	SF	SF	MF	MF	MF	MF
Date of replacement	Mar-12	Jul-09			Jul-10		Jul-07 to May-11		2009-10		Apr-May 2010	2008-09		2nd qtr, 2010		2001-2003	1999-2000	2001-2003				
Toilets replaced:																						
Flush volume (gal)	3.5	1.6	3.5		3.5	5.0	3.5	5.0	1.6	3.5	3.5	3.2 avg	3.5	1.6	3.5	3.88	3.61	3.51	1.6	3.5	1.6	1.6
Number of toilets replaced and evaluated	250	88	500		118	174	2412	831	523		192	40	74	34	24				340	60	372	186
Replacement Toilets:																						
Flush volume	0.8	0.8	0.8	0.8	0.8	0.8	1.28	1.28	1.1	1.1	1.0	1.28	1.2	0.8	0.8	1.6	1.6	1.6	0.8	0.8	0.8	0.8
Showerhead replaced?	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No
Aerator replaced?	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No
Water Savings (gal/toilet/day)	**43.7**	**13.7**	**60.8**	Toilet replacement performed concurrent with clothes washer replacement; data on savings is not parsed for toilets only	**75.6**	Insufficient data to draw water savings conclusions	**39.5**	**33.7**	**27.1**	**41.8**	**56.0**	**36.3**	**31.2**	**25.0**	**97.0**				**60.6**	**40.4**	**63.5**	**89.4**
Water Savings (gal/capita/day)	**No occu-pancy data**	**3.23**	**7.48**		**No occu-pancy data**		**No occupancy data**		**No occupancy data**		**28.0**	**11.1**	**20.8**	**14.0**	**14.0**	**10.1**	**10.9**	**10.1**	**No occu-pancy data**	**No occu-pancy data**	**No occu-pancy data**	**No occu-pancy data**
														21.0	***40.0***							
Comments & information sources	L.B. email	IRWD powerpoint			Waverly billing records		Final Project Report		Final Project Report		*(seniors apt complex)* K&C Final Project Rpt-Aug 2011	CPUC Final Report by ECONorthwest - March 2011		*(When per toilet savings are ajusted to avg. CA household occupancy, due to extraordinary housing density in project area)* Stealth study of 2011		**Source: Individual Aquacraft reports**			**Source: Water Matrix data**			

SUMMARY by type of replacement	**No. of toilets replaced**	**Average savings per toilet per day**	**Notes**
3.5-0.8	952	57.8	868 of the 952 replacements also included showerheads & aerators
1.6-0.8	1020	61.5	868 of the 952 replacements also included showerheads & aerators
COMBINED (10 projects)	**1972**	**59.7**	
3.5-1.1	527	45.5	No showerhead or aerator replacements
1.6-1.1	262	27.1	No showerhead or aerator replacements
3.5-1.28	2412	39.5	No showerhead or aerator replacements
3.2-1.28	40	36.3	No showerhead or aerator replacements
5.0-1.28	831	33.7	No showerhead or aerator replacements
All 3.5 to HET	**3810**	**39.03** (weighted avg)	