SAN FRANCISCO PUBLIC UTILITIES COMMISSION

2020 RETAIL WATER CONSERVATION PLAN

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2020 Retail Water Conservation Plan

San Francisco Public Utilities Commission
Water Enterprise

March 2021

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LIST OF ACRONYMS & ABBREVIATIONS

2015 Plan	2015 SFPUC Retail Water Conservation Plan
2020 Plan	2020 SFPUC Retail Water Conservation Plan
AF	acre-feet
AMI	Advanced Metering Infrastructure
AWR	American Water Resources
BAWSCA	Bay Area Water Supply and Conservation Agency
BMP	Best Management Practices
CAP	Community Assistance Program
CCF	100 Cubic Feet
CEC	California Energy Commission
CEE	Consortium for Energy Efficiency
CII	Commercial, Industrial, and Institutional
City	City and County of San Francisco
DWR	California Department of Water Resources
FY	Fiscal year (The SFPUC uses the fiscal year from July 1 to June 31 to track financial and conservation activities. Fiscal Year 2019-2020 is presented as FY 19-20 in this plan).
GPCD	gallons per capita per day
gpf	gallons per flush
gpm	gallons per minute
HET	high-efficiency toilet
HEU	high-efficiency urinal
IWF	integrated water factor
LEED	Leadership in Energy & Environmental Design
mgd	million gallons per day
MOU	Memorandum of Understanding
MWELO	Model Water Efficient Landscape Ordinance
R-GPCD & G-GPCD	residential gallons per capita per day and gross gallons per capita per day
ROR	Retrofit on Resale
SB X7-7	Senate Bill X7-7 Water Conservation Act of 2009
SFPUC	San Francisco Public Utilities Commission
SIC	Standard Industrial Classification
SWRCB	State Water Resources Control Board
ULFT	Ultra-low flow toilet
UWMP	Urban Water Management Plan
WBIC	Weather Based Irrigation Controller
WEIO	Water Efficient Irrigation Ordinance
WF	Water Factor
WRF	Water Research Foundation
WSCP	Water Shortage Contingency Plan

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EXECUTIVE SUMMARY

The San Francisco Public Utilities Commission (SFPUC) has long been committed to conserving water. For over 30 years, the SFPUC's water conservation program has offered a variety of incentives and services, as well as educational assistance aimed at promoting efficient water use among its retail water customers. In addition, the SFPUC has helped to develop and implement local requirements that mandate water efficiency. Together, these voluntary assistance services and requirements have resulted in significant reduction of SFPUC retail water use. This *2020 Retail Water Conservation Plan* (2020 Plan) provides an overview of the retail water conservation program, the factors that shape the program, estimated water savings, and the program's effect on the overall retail water demand forecast. The main purposes of the 2020 Plan are to:

- Summarize the mix of measures that the SFPUC plans to implement, including the estimated water savings, costs, and effects on retail water demand;
- Explain the factors considered in evaluating and selecting conservation measures and recap measures implemented to date;
- Serve as a broad guidance document that helps inform annual activities, such as staffing and budget needs, both internally and for stakeholders; and
- Provide an update to the *2015 San Francisco Public Utilities Commission Retail Water Conservation Plan* (2015 Plan) as part of a five-year review cycle to assess program performance and identify the need for adjustments.

The planning horizon for the 2020 Plan spans a 25-year period from 2020 to 2045 to coincide with the planning horizon of the *2020 Urban Water Management Plan* (UWMP). The most precise analysis of the water conservation program, however, is over the next five years. Beyond this timeframe, there is less certainty regarding measure parameters, because of the difficulty in anticipating future changes in technology, customer participation rates, and codes and standards. For this reason, the SFPUC plans to continue to update its retail water conservation plan every 5 years to provide the most realistic future estimates of conservation actions and savings. The Bay Area Water Supply and Conservation Agency (BAWSCA), which coordinates conservation assistance among the SFPUC's wholesale customers, separately estimates conservation measures and savings anticipated over the next 25 years, as reflected in its *Regional Water Demand and Conservation Projections Report* and other related documents.

Following is a brief summary of each of the sections in the 2020 Plan.

About the SFPUC and Conservation Program Planning

The SFPUC's Water Resources Division is responsible for the implementation of its retail water conservation program, as well as the development of local water supplies, including groundwater, recycled water, and non-potable water. Together these programs supplement and diversify the SFPUC's portfolio of water resources and reduce demand on our regional water system.

Several SFPUC programs beyond conservation are expected to contribute to potable water savings, including recycled water facilities that reduce potable use for large landscape irrigation, stormwater management projects that use rainwater for irrigation, and the supply-side linear asset management and water loss programs that reduce water loss from breaks and leaks in SFPUC mains and pipelines. Estimated water reduction from these programs is not included in conservation program savings in the 2020 Plan, although these programs are anticipated to help lower potable water use over the next 25 years.

In 2004, the SFPUC developed its first conservation forecast model and used it to estimate three levels of potential conservation programs, choosing to pursue the most aggressive that assumed a suite of measures

implemented at the highest level of customer participation to achieve maximum savings. Over the past 15 years, the SFPUC has implemented most of the recommended measures, as well as new measures identified since then, and refined its estimate of attainable water savings through analysis of customer participation and water use, saturation studies, and industry and market data. This feasibly attainable approach now guides our program planning and is intentionally conservative to minimize over estimating water savings. For example, it assumes savings estimates over the next 5 years are more precise than those 20 years from now and it models water savings only for measures with accepted industry standards or methodologies for calculating savings. Our conservation program includes a mix of measures we model water savings for and some we do not model. While we are aware that unmodeled measures generate some water savings, they are not included in the estimated water savings in the 2020 Plan.

Conservation Goals and Progress

The SFPUC's conservation program is guided by a mix of agency and City policy directives and state and local water efficiency requirements that have evolved over time. On the state level, these shifted from meeting Best Management Practices (BMP) established by the California Urban Water Conservation Council in the 1990s (now the California Water Efficiency Partnership) to the state per capita water reduction targets set by the Water Conservation Action of 2009 (SB x7-7) to new water efficiency targets per AB 1668 and SB 606 that urban suppliers will need to meet starting in 2023 based on standards for efficient indoor, outdoor water use and supply-side water loss. Locally, San Francisco has adopted state requirements for mandating water-efficient plumbing fixtures, landscapes, and irrigation systems; sub-metering in new multi-family construction; and restrictions against outdoor water waste. The SFPUC met BMP goals for the many years those were in effect, is well below its state-imposed SB x7-7 per capita use target for 2020, and is on track to meet California's new efficiency targets.

The SFPUC regularly evaluates and adapts its conservation program to respond to changing conditions and requirements. This dynamic approach has contributed to significant reductions in water demand, despite population and job growth. Since 2005, the SFPUC's retail residential per capita water use declined by 30 percent despite a 15 percent increase in population, and at a fiscal year 2019-2020 average residential per capita of 42.9, it remains among the lowest in the state. By 2025, residential per capita is estimated to decrease to 38.4, well within industry ranges for what is considered highly efficient.

Remaining Conservation Potential

Much of the SFPUC's conservation program focuses on increasing the long-term water efficiency of existing properties and customer actions. Many regulations, codes and standards mandate water-efficiency in new construction, and the SFPUC's Onsite Water Reuse Program also requires and incentivizes water efficiency in large new commercial and mixed-use construction. Many of the retail conservation program core measures concentrate on helping customers with existing properties, which may be older and less water-efficient, in achieving long-term, permanent water savings, while measures like the Onsite Water Reuse Program focus on achieving maximum efficiency in new development. Per its Water Shortage Contingency Plan, the SFPUC also has identified and is prepared to take actions beyond the measures described in its 2020 Plan to seek short-term reductions in water use during droughts or other emergencies that restrict water supply. Drought actions are not factored into the modeled conservation water savings in this plan.

Key points the SFPUC considered in estimating remaining feasibly attainable conservation potential include our low per capita water use; Advanced Metering Infrastructure (AMI) customer engagement tools; saturation of water-efficient plumbing fixtures and appliances; customer, property, and land use characteristics; and customer participation in conservation measures.

Based on this, the following broad actions are deemed to have the most potential for remaining water savings and guide the mix of measures planned for the conservation program in 2020 and beyond:

- Maintain efficiency among customers, properties, and sites that already have water-wise use.
- Improve efficiency among residential customers with above average water use due to leaks, old fixtures, inefficient irrigation, or other forms of water waste.
- Increase commercial property compliance with requirements for efficient plumbing fixtures.
- Increase commercial customer awareness of constant and/or abnormally high-water use, with a focus on hotels, restaurants, office buildings, and schools that represent the non-residential sectors with the overall highest water use.
- Promote compliance with new efficiency standards among large landscapes served by dedicated irrigation meters.
- Explore additional opportunities for onsite reuse in new development.

Measure Evaluation Process

The SFPUC follows a thorough process to evaluate and select measures suitable for our retail service area, drawing on input from national and state water efficiency studies and experts, customers, and stakeholders. We also regularly compare our program to other water utilities with major conservation resources, including conservation measures offered by BAWSCA that serves the SFPUC's wholesale service area. The SFPUC regularly evaluates new measures and adjusts existing ones to be more effective. Since the SFPUC's 2015 Retail Water Conservation Plan, new measures underway or planned for implementation include incentives for on-demand recirculating hot water pumps and weather-based irrigation controllers (WBIC); additional leak and high usage alerts for more customer sectors; in-depth irrigation assessments for small landscapes; virtual water wise consultations; and submetering mandates for new multi-family construction.

Scope of the Conservation Program

Between 2005 and 2025, the SFPUC will have evaluated and implemented over 80 different conservation measures and mandates, providing extensive customer water-savings assistance that has played a major role in significant decline in per capita water use. These include conservation best management practices found successful by major water utilities and efficiency experts across the nation; measures that third-party studies demonstrate have water savings and customer benefits; and measures that make sense for the site conditions and characteristics unique to San Francisco water use. The 2020 Conservation Plan includes the SFPUC's Onsite Water Reuse Program among its conservation measures and in estimated water savings and effect on demand. The Onsite Water Reuse Program includes an ordinance that requires new developments of 250,000 square feet or more to install onsite water systems to treat and reuse available alternate water sources for toilet and urinal flushing and irrigation, and developments between 40,000 and 250,000 square feet to submit a water budget application and water use calculator to the SFPUC. The program also provides grant funding for projects that aren't required to install onsite reuse systems, including breweries that collect, treat, and reuse process water. Estimated 2020-2045 Onsite Water Reuse Program savings are based on existing water budget applications and water use assumptions for known onsite water reuse projects.

Moving forward, the SFPUC will continue to utilize a mix of demand-side, customer water-saving strategies, including voluntary incentives, assistance services, tools to help customers understand and manage their water use, education and outreach, and mandates that require indoor and outdoor water efficiency. See **Table 6-2** in Section 6 for a list of current conservation measures and **Table 6-3** for a list of completed and evaluated measures.

Water Savings and Cost

The SFPUC estimates its conservation program and efficient plumbing codes have a "past savings" of approximately 86,385 AF (28,149 MG or 5.5 mgd) between 2005 (the year the SFPUC developed its first conservation forecast model) and 2019. "Future savings" are estimated at 117,221 AF (38,197 MG or 4.2 mgd) between 2020 and 2045. The future savings reflect anticipated savings from modelled measures described in Section 6, including anticipated savings from the Onsite Water Reuse Program. The past and future estimates do not reflect water savings from conservation measures the SFPUC offers but does not model, or from SFPUC efforts that are not part of its conservation program but may generate potable water savings, such as its supply-side water loss program, recycled water program, and stormwater management program. Additionally, the conservation measure savings that are modeled and presented in this 2020 Plan do not reflect potential savings from short-term drought actions that could be taken if the SFPUC had to activate its Water Shortage Contingency Plan. The estimated average unit cost of water savings across all the conservation measures the SFPUC plans to implement is $906/acre foot.

Effect on Demand

Estimated water savings from the SFPUC's conservation program, onsite reuse program, and efficient plumbing codes are anticipated to help to reduce overall demand for water. **Table ES-1** below shows the effects the estimated water savings from active conservation programs and onsite reuse could have on retail water demand. The unadjusted baseline demand indicates the projected retail demand if there were no water savings from SFPUC conservation measures. Retail demand projections are from the SFPUC's Retail Demand Forecast Model prepared in 2020 for use in the SFPUC's 2020 UWMP. The adjusted retail demand is the result of subtracting the savings from SFPUC conservation and onsite reuse programs and then adding distribution system losses from the unadjusted baseline demand, which, when divided by the population, provides the estimated per capita water use for the retail system.

Table ES-1: Retail Water Demands with Water Conservation

	2020	2025	2030	2035	2040	2045
	million gallons per day (mgd)					
Unadjusted Baseline Demand	61.8	65.6	67.6	70.0	73.2	76.3
Adjustments:						
1. SFPUC Active Conservation Program Savings	0.0	-0.6	-0.7	-0.7	-0.5	-0.4
2. Onsite Water Reuse Program Savings*	-0.1	-0.3	-0.5	-0.9	-1.3	-1.3
3. Distribution System Losses	7.2	6.0	6.0	6.0	6.0	6.0
Adjusted Retail Demand	**68.8**	**70.7**	**72.4**	**74.5**	**77.4**	**80.6**
Population (1,000)**	**900**	**1,005**	**1,066**	**1,128**	**1,190**	**1,251**
Residential Population (1,000)**	**872**	**975**	**1,034**	**1,094**	**1,154**	**1,214**
Gross Per Capita Use (GPCD)	**77**	**70**	**68**	**66**	**65**	**64**
Residential GPCD (R-GPCD)	**43**	**38**	**38**	**38**	**38**	**38**

Note: Sum of demands and adjustments may not match the totals due to rounding.

** Onsite Water Reuse Program is being counted as a conservation measure for water savings purposes, but because of its size and focus on new development, it is also being called out in this table to show its effect on demand*

*** San Francisco's population estimates have increased significantly since the 2015 Plan due to new housing projections and development goals from the City. These updates are described further in Appendix D.*

For several reasons described in Chapter 8 (Conservation Effect on Retail Water Demand) of the 2020 Plan, the SFPUC's 2020 Retail Demand Model does not explicitly adjust for passive savings outputs from the Water Conservation Tracking Model. Savings from active conservation programs and the Onsite Water Reuse Program are explicitly called out in future projections, while passive savings are assumed to be captured as part of the unadjusted baseline demand. For the purpose of the 2020 Plan, the potential future passive savings are called out in **Table ES-2** below and total an estimated 5.7 mgd by 2045. The volumes shown here are normalized to 2020, meaning all passive water savings achieved prior to 2020 are inherently included in existing 2020 demands; future passive savings are projected relative to 2020 demands.

Table ES-2: Projected Passive Savings (Relative to 2020)

Sector	2020	2025	2030	2035	2040	2045
	million gallons per day (mgd)					
Single-Family	0.0	-0.6	-1.1	-1.4	-1.6	-1.8
Multi-Family	0.0	-1.0	-1.7	-2.2	-2.5	-2.8
Non-Residential	0.0	-0.3	-0.6	-0.8	-0.9	-1.1
Total Passive Savings	**0.0**	**-2.0**	**-3.3**	**-4.3**	**-5.1**	**-5.7**

Conclusions and Next Steps

The SFPUC will continue to evaluate and adapt its conservation measures to respond to changing conditions and regulations. This dynamic approach to conservation has contributed to significant reductions in water demand, despite population growth. Between now and issuance of our next 2025 Retail Water Conservation Plan, the SFPUC plans to continue to review its forecasted conservation savings against actual program activity on an annual basis. The SFPUC has committed to updating its conservation savings model and conducting a major review of implemented and potential new conservation measures every five years, coinciding with its update of its UWMP. Moving forward, the SFPUC will use this 2020 Plan and the findings as a broad guidance document to inform the implementation of conservation measures over the next five years. The levels of funding, resources, and public participation for each conservation measure will change over time; thus, the recommendations contained herein will be revisited and adapted as needed to meet the SFPUC's needs and to ensure its conservation goals are met.

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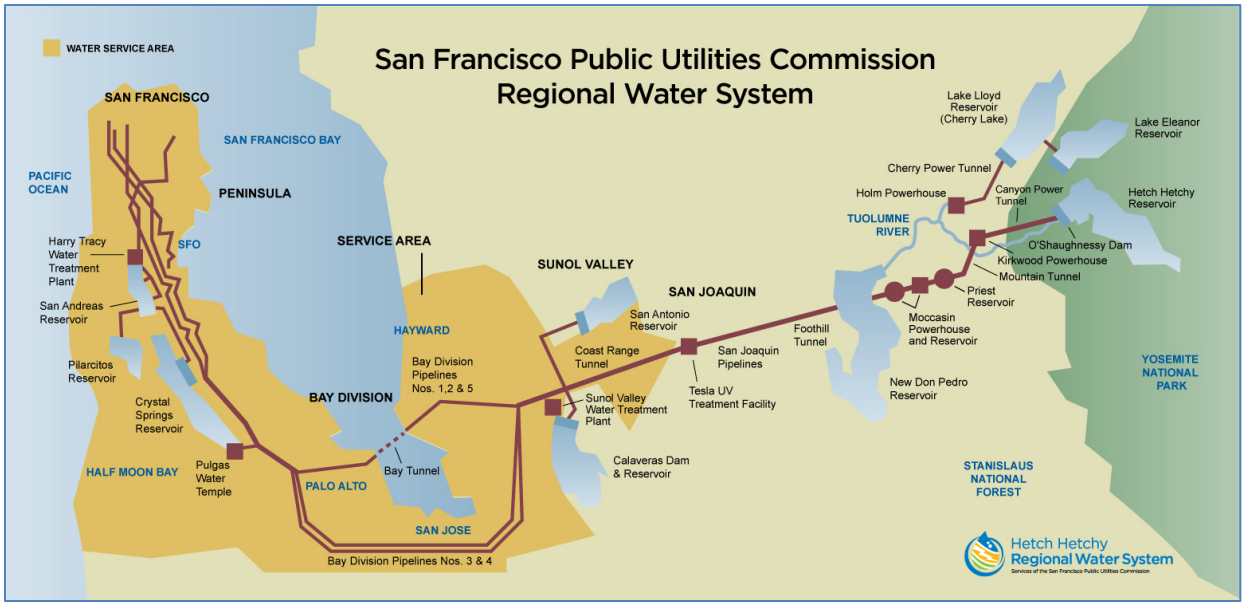
1. About the SFPUC

The San Francisco Public Utilities Commission (SFPUC), a department within the City and County of San Francisco (City or San Francisco), has been implementing a retail conservation program for over 30 years to help ensure that future water demands can be supported. The conservation program, along with development of local supplies through recycled water, groundwater, and non-potable water, and the SFPUC's program to reduce water loss in our own system due to pipe breaks and leaks are part of overall efforts to stretch water resources, increase reliability should drought or disaster interrupt regional water sources, and increase flexibility to meet the diverse needs of customers. This *2020 Retail Water Conservation Plan* (2020 Plan) presents an overview of the SFPUC's water conservation program and serves as a broad guidance document for both the SFPUC and its stakeholders. It explains the evaluation process and factors considered when designing the program, documents changes and evolution in the approach to estimating water savings, and summarizes the estimated water savings. Estimated water savings include those accumulated to date, the projected savings over the planning horizon, and the anticipated effects of water savings on the overall retail water demand.

Retail Water System and Customers

The SFPUC owns and operates the Regional Water System, a complex water supply network of pipelines and facilities that conveys high-quality drinking water from the Tuolumne River and local reservoirs in the Alameda and Peninsula watersheds to 2.7 million customers in the San Francisco Bay Area (**Figure 1-1**). Approximately one-third of this water is delivered to the residents and businesses in San Francisco and to a small number of retail customers in areas outside of the City, while two-thirds is provided through wholesale deliveries to 27 municipalities, water suppliers, and private entities in Alameda, Santa Clara, and San Mateo counties. In addition to providing water through the Regional Water System, the SFPUC has diversified its supply portfolio for retail customers by increasing use of groundwater, implementing recycled water projects that serve large irrigation customers, and an Onsite Water Reuse Program that mandates and promotes reuse in large new developments.

Figure 1-1: Regional Water System Overview

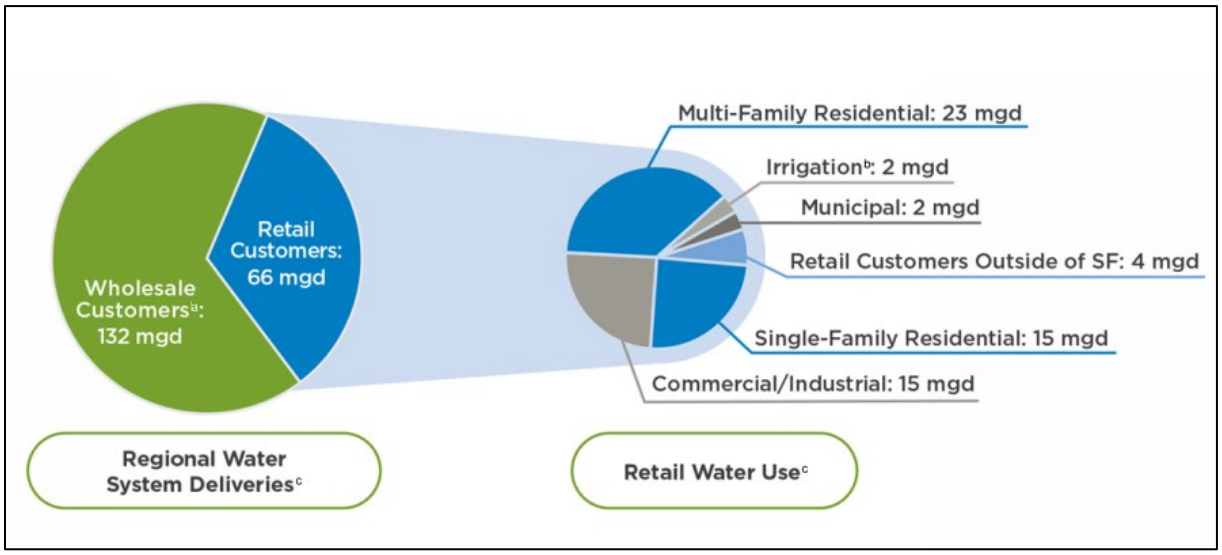


"Retail customers" refers to all residents and businesses located in San Francisco, as well as residential customers and facilities outside of the City that pay for and receive water directly from the SFPUC. These customers outside San Francisco include clusters of residential houses in Sunol, Redwood City, Daly City, Fremont, Millbrae, Castlewood, and Groveland[1]; and a number of large, non-residential facilities such as the San Francisco County Jail in San Bruno, the Sunol Valley Golf Course, the San Francisco International Airport in Millbrae, the Lawrence Livermore National Laboratory in Livermore, and the NASA Ames Research Center in Mountain View.

The SFPUC coordinates and directly manages the water conservation program for its retail customers, while BAWSCA represents the interests of the wholesale customers and coordinates water conservation assistance on their behalf. BAWSCA's Regional Water Demand and Conservation Projections Project issued in June 2020 identifies conservation measures anticipated to be implemented over the next 25 years and their estimated water savings.

Figure 1-2 below shows overall regional water system deliveries for the last complete fiscal year (FY 2019-2020) and retail water system billed consumption. While the specific delivery and consumption amounts vary from year to year, the relative breakdown of wholesale versus retail deliveries and retail consumption by customer sector remains fairly consistent.

Figure 1-2: SFPUC FY 19-20 Regional Water System Deliveries and Retail Water Use



Notes:

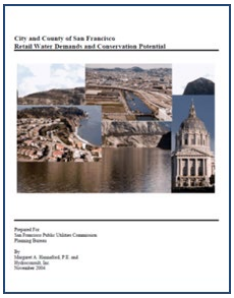
(a) Deliveries exclude 5.3 mgd delivered in lieu of groundwater to customers participating in the Regional Groundwater Storage and Recovery Project.

(b) These data are from dedicated irrigation accounts only, and do not include irrigation use from water accounts that jointly serve both indoor and outdoor demands.

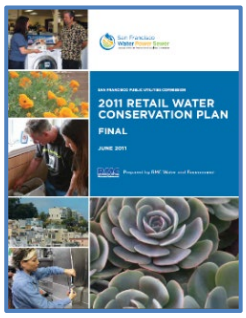
(c) The Retail Water Use chart does not reflect water used for pipe flushing, firefighting, street cleaning, and loss from supply-side main and pipe breaks. The Regional Water System Deliveries chart does include water loss.

1 Groveland Community Services District (CSD) is contractually defined as a retail customer of the SFPUC and is accounted as such in the SFPUC's previous planning documents. However, for the 2015 & 2020 Urban Water Management Plan (UWMP) Updates, SFPUC was directed by the Department of Water Resources to report Groveland CSD as a wholesale customer. For consistency, the analysis presented in this 2020 Plan also refers to Groveland CSD as a wholesale customer instead of a retail customer.

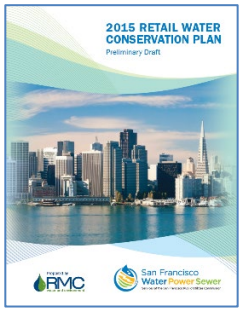
Water Conservation Program Planning



The SFPUC established its first retail water conservation program with modeled water savings and goals in 2004. The SFPUC identified three levels of water conservation options and conducted a detailed cost-benefit analysis for each option, ultimately selecting the most ambitious of the three. Details of the analysis are documented in the report *City and County of San Francisco 2004 Retail Water Demands and Conservation Potential* (2004 Plan).



In 2010, the SFPUC conducted another assessment of the retail water conservation program to account for updated demographic data and regulations that may have influenced the water use trends among the retail customers. The 2010 effort consisted of both qualitative and quantitative evaluations of over 30 conservation measures and their specifications, such as participation rates, costs, target customer sectors, and potential water savings. Details of the analysis are included in the *2011 San Francisco Public Utilities Commission Retail Water Conservation Plan* (2011 Plan). The SFPUC also set forth a five-year review cycle to reassess its program and update program plans.



In 2015, the SFPUC conducted an update to reflect new codes and regulations, transition to an econometric demand model and a separate Water Conservation Tracking Model for estimating conservation water savings and the effects on water demand, incorporation of market saturation estimates from a fixture inventory study, and refinement of various conservation measure program parameters.

Over the past 15 years, the SFPUC has refined its approach to conservation planning through analysis of customer participation and water use, saturation studies, and industry and market data to better estimate attainable savings. This feasibly attainable approach now guides our program planning and is intentionally conservative to minimize over estimating savings. For example, it assumes savings estimates over the next 5 years are more precise than those 20 years from now and it models water savings only for measures with accepted industry standards or methodologies for calculating savings. Our conservation program includes a mix of measures we model savings for and some we do not model. While we assume that unmodeled measures likely generate some water savings, we do not estimate and count water savings for them until we deem there is enough data or valid savings methodologies. For more detail about the SFPUC's conservation forecast model, see Appendix D (SFPUC Water Conservation Tracking Model Overview and Water and Energy Savings Specifications for Conservation Program Measures).

Our 2020 Plan outlines planned conservation strategies and measures over the next 25 years, and draws on a new econometric retail system demand model and an updated Water Conservation Tracking Model for estimating conservation water savings and the effects on water demand.

Key updates reflected in the 2020 Plan include:

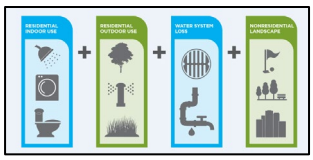
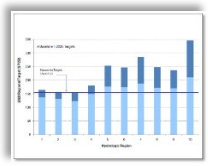
- Updated retail demand projections as modeled in the SFPUC's new Retail Demand Forecast Model
- Updated active and passive conservation water savings estimates as modeled in the SFPUC's Water Conservation Tracking Tool
- Updated goals and progress, as well as legislation and codes
- Updated market saturation and fixture estimates

- Updated suite of conservation measures planned for implementation, including measures ended or added since the 2015 Plan, and parameter adjustments to some ongoing measures
- Updated water-savings calculations for several conservation measures and added parameters for some new measures

2. Conservation Goals and Progress

The SFPUC's conservation program is guided by state water efficiency directives, local legislation and building codes, and SFPUC and rules governing water service to its customers. **Table 2-1** presents a broad snapshot of the SFPUC's progress toward meeting these goals.

Table 2-1: Conservation Goals and Progress

Conservation Goal	Progress
California New Water Efficiency Framework Urban Water Use Objective (AB 1668 and SB 606)	
 In 2018, California enacted SB 606 and AB 1668 to establish a new foundation for long-term improvements in water conservation that replaces and achieves greater water saving than SB X7-7. Starting in 2023, urban water suppliers must meet a water use objective based on efficiency standards for indoor residential water use, outdoor residential water use, dedicated irrigation account use, and water loss and performance goals for commercial, industrial, and institutional (CII) use, starting in 2023.	The SFPUC has actively participated as a stakeholder as the state develops standards and methodologies to implement these new requirements and anticipates meeting its water use objective. The SFPUC also has been evaluating and updating its residential, commercial and landscape conservation assistance measures and supply-side water loss programs to support compliance with the state's new water use targets. The SFPUC will begin reporting compliance in 2023.
California Water Conservation Act of 2009 (SB X7-7)	
 The Water Conservation Act of 2009 (SB X7-7) required that all water suppliers increase their water use efficiency by 2020 and set a per capita reduction target for each supplier.	The SFPUC's current gross per capita water use for 2020 is well below its 2020 target of 96 GPCD and the SFPUC remains in compliance with the SB X7-7 requirements.
Local Water Efficiency Requirements and Codes	
San Francisco established local ordinances to meet state requirements, including a Water Efficient Irrigation Ordinance (WEIO), residential and commercial conservation ordinances that mandate water-efficient plumbing fixtures, submetering in new multi-family construction, onsite reuse in new construction over 250,000 square feet, and local green building codes for new construction and retrofits.	The SFPUC remains actively involved in directly administering or supporting and tracking compliance with these requirements.

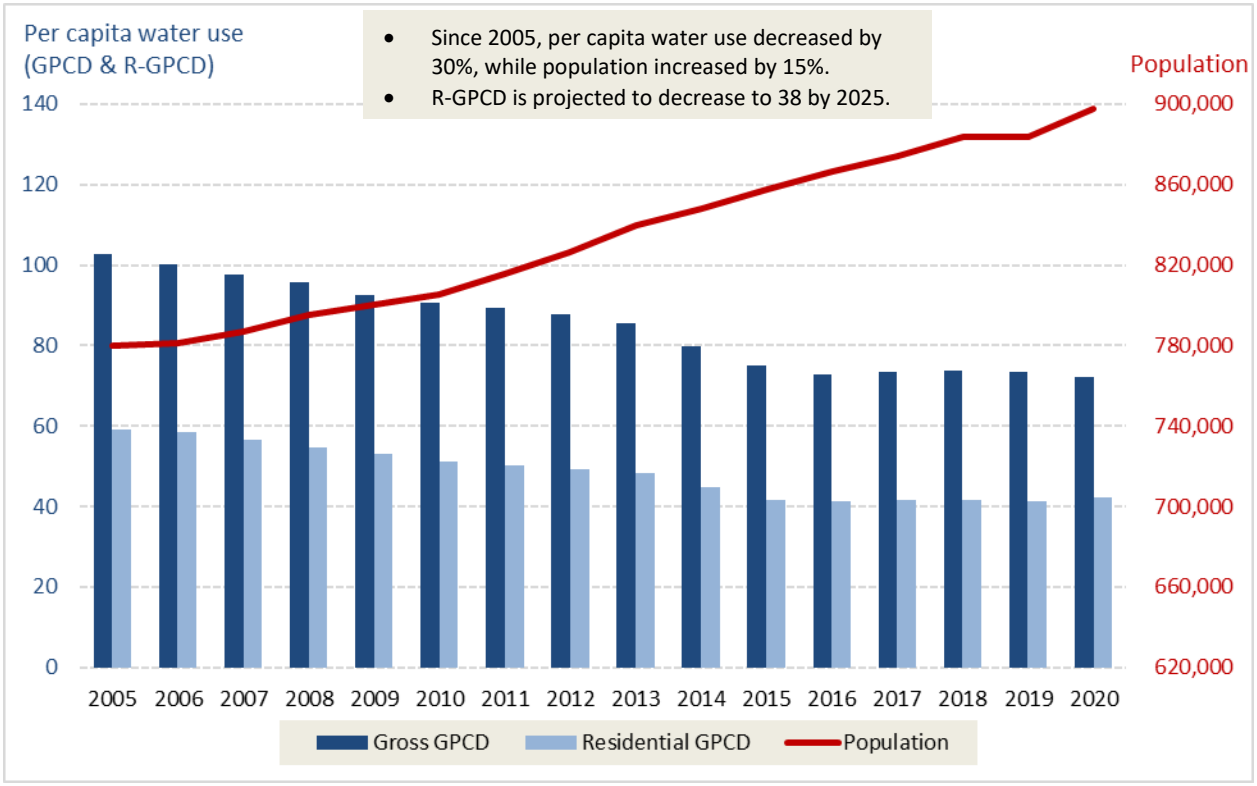
The SFPUC has provided water-saving assistance to many thousands of residential and non-residential customers. Between 2010 and 2020 highlights include:

- ✓ Conducted over 46,000 residential and commercial building and landscape evaluations
- ✓ Incentivized the replacement of over 50,000 inefficient toilets and urinals through rebate and direct install programs
- ✓ Issued over 28,000 rebates for high-efficiency residential clothes washers and commercial clothes washers
- ✓ Provided water-saving incentives and conducted evaluations of over 380 acres of irrigated landscape
- ✓ Reviewed and approved new and retrofitted landscape compliance with San Francisco's Water Efficient Irrigation Ordinance for over 260 sites, reflecting over 140 acres of irrigated landscape
- ✓ Alerted single family, multi-family, commercial and irrigation customers to over 28,000 leak incidents
- ✓ Distributed over 240,000 water-saving showerheads, aerators and other devices to customers
- ✓ Conducted more than 1,700 presentations, outreach events, field trips and classes for community members and students
- ✓ Registered over 83,000 customers for use of the SFPUC's online bill and water use tracking MyAccount portal
- ✓ Reviewed over 100 water budget applications to install onsite water reuse systems

Despite steady population and job growth in the retail service area, the SFPUC's per capita water use rate has declined and remained low, due in large part to SFPUC conservation efforts. Its FY 19-20 residential GPCD of 42.9 and gross GPCD of 72.8 are among the lowest in the state of California. **Figure 2-1** shows the decline in both gross GPCD[2] and R-GPCD[3] even as population was increasing.

[2] GPCD is total demand divided by total population, which includes people living in both households and group quarters.
[3] R-GPCD is residential demand divided by residential population.

Figure 2-1: SFPUC Retail In-City Populations and Per Capita Water Use Trends



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3. Remaining Conservation Potential

Many of the SFPUC's conservation program measures focus on increasing the long-term water efficiency of existing properties and customer actions. Various regulations, codes and standards and the SFPUC's Onsite Water Reuse Program mandate water efficiency in new construction. Per its Water Shortage Contingency Plan, the SFPUC also identifies additional actions to seek short-term reductions during droughts or other emergencies that restrict water supply.

The SFPUC draws on many sources to assess the potential for water savings in our retail service area, identify conservation measures that align with savings opportunities, and select the most feasible mix to implement. Sources include studies and information from national and state water efficiency organizations and experts, such as the Alliance for Water Efficiency, California Water Efficiency Partnership, Water Research Foundation, Water Now Alliance, and Pacific Institute; water efficiency consultants and academics; internal staff research and input; surveys of other water utilities' conservation programs; and input and suggestions from community stakeholders and customers.

Focus Areas

The SFPUC determined the following areas reflect the most feasibly attainable potential for remaining water savings within our conservation program. These areas guide the implementation strategies and specific measures planned over the next five years:

- Maintain efficiency among customers, properties, and sites that already have water-wise use.
- Improve efficiency among residential customers with above average water use due to leaks, old fixtures, inefficient irrigation, or other forms of water waste.
- Increase commercial property compliance with requirements for efficient plumbing fixtures and awareness of opportunities for equipment retrofits, reuse technologies, and efficiency audits and action plans.
- Increase commercial customer awareness of constant and/or abnormally high-water use, particularly among hotels, restaurants, office buildings, and schools that represent the non-residential sectors with the overall highest water use.
- Promote compliance with new efficiency standards among large landscapes served by dedicated irrigation meters and smaller sites with inefficient irrigation.
- Explore additional opportunities for onsite reuse in new development.

To address these focus areas, the SFPUC plans to continue to: expand the use of AMI and other data for customer engagement and research, provide incentives to improve the efficiency of indoor water-using fixtures in homes and businesses, mandate and promote onsite reuse, provide direct assistance to all customer types through virtual and onsite audits, and expand outreach, training and education virtually and in person.

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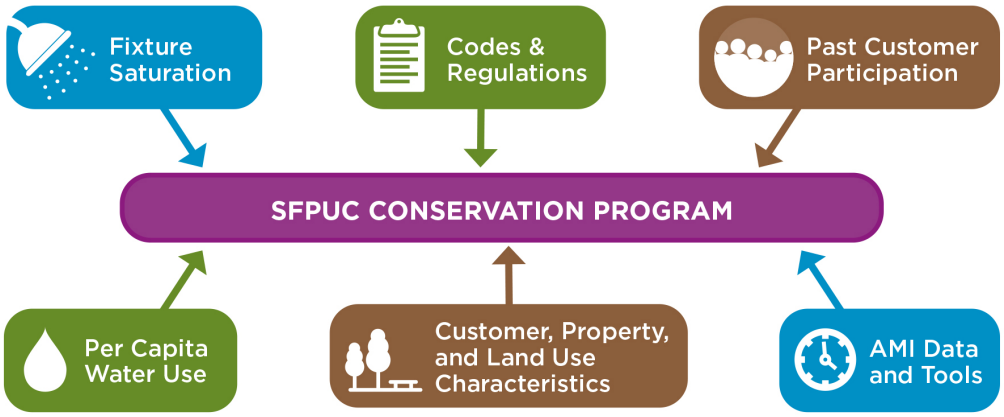
4. Factors Shaping the Conservation Program

This section covers key factors the SFPUC considers in assessing opportunities for feasibly attainable remaining water savings opportunities in existing homes, buildings, and irrigated landscapes.

Figure 4-1: Factors Shaping Remaining Conservation Potential



Per Capita Water Use

Despite steady population and job growth in the retail service area, the SFPUC's per capita water use rate has declined over 30 percent in the last 15 years and remained low, due in large part to conservation efforts. The SFPUC's average indoor/outdoor retail residential per capita and gross per capita water use is now among the lowest in California and for many of our residential customers reflects highly efficient per capita rates cited by some industry experts. While opportunities for more water savings remain, our low per capita water use means there are limits to how much more long-term residential savings can feasibly be achieved through demand-side conservation measures.

The Water Research Foundation's (WRF) 2016 Residential End Uses of Water study estimates that indoor residential per capita water use could drop below 40 gallons a per a day if all remaining inefficient plumbing fixtures were replaced and leaks addressed with additional potential savings from reuse. The SFPUC's combined indoor/outdoor average residential per capita has been in the low 40s the last two fiscal years (2018-2019 and 2019-2020) and is estimated to decrease to 38 by 2025. Studies underway by the California Department of Water Resources (DWR) to assess residential indoor use in California are expected to provide additional insights on current indoor use and help inform the state's current indoor residential standard of 55 gpcd, which will drop to 50 gpcd in 2030. As of the publication of this Plan, studies and discussions were underway that could propose future legislation to set the state indoor residential per capita standards below 50.

AMI-Enabled Customer Engagement and Research

The SFPUC was the first large California water utility to fully automate most of its meters. Over the past 5 years since the 2015 Conservation Plan, the SFPUC has greatly expanded the ways it uses daily and hourly data generated from its AMI system to help customers monitor, manage and reduce their water use. During this period, we also began using our extensive data to conduct among the first empirical studies of water savings from leak alert programs and studies of effective indicators of high or unusual water use in large multi-family and commercial properties. The SFPUC has been actively involved in state and national-level

efforts through the Alliance for Water Efficiency and California Water Efficiency Partnership to further the study of AMI water-saving benefits and has shared the results of our own research.

AMI data has enabled the SFPUC to undertake significant water-savings, customer service, and resource maintenance efforts, including:

- Expanding staff ability to help customers address water use issues remotely versus only through onsite inspections and meter reads
- Switching from bimonthly to monthly billing and adding fractional billing
- Developing an automated maintenance system to quickly locate and more efficiently repair AMI system components
- Providing customers an online platform (MyAccount) for conducting account services, accessing current and past bills, and reviewing water use down to the hourly level. **Figure 4-2** shows a typical daily water use view on MyAccount, which can help customers identify their typical water use patterns and high water use days.
- Sending constant usage alerts to customers about potential leaks

After conducting a two-year pilot program that started in 2015, the SFPUC automated its leak alert program and has continued to regularly expand it. As of March 2021, the program notifies single-family, small multi-family (2-5 dwelling units), and irrigation customers when the AMI system detects 72 hours or more of continuous water use of at least 1 cubic foot per hour, which could mean a leak is occurring. When an alert is triggered, the account holder, property owner, and occupant (if not the same as the owner) receive an email, text message, recorded phone message (if contact information is available), and a mailed letter. Notifications are sent in English, Spanish, Chinese, and Tagalog. In the spring of 2020, when many businesses and commercial properties partially or fully closed due to COVID-19 shelter-in-place restrictions, the SFPUC added notifications specifically for non-residential properties to alert them about high and constant usage that likely meant a problem was occurring.

The SFPUC also surveys all residential customers who receive alerts by email to better understand the cause of leaks, how customers repair them, and what resources are most helpful. **Figure 4-3** illustrates the distribution of customer reported causes of leaks. Information gathered from these surveys and other contact with alert recipients has provided valuable insights regarding what conservation and customer support measures are most beneficial. For example, the high prevalence of toilet leaks not only supports the value of continuing a leak alert program and leak detection guides and resources, but it also supports continuing virtual and in-person water-wise evaluations and consultations from conservation technicians, distribution of free toilet flappers and other toilet repair parts, and outreach about the importance of fixture maintenance even if already efficient.

Figure 4-2: My Account Daily Water Use Graph

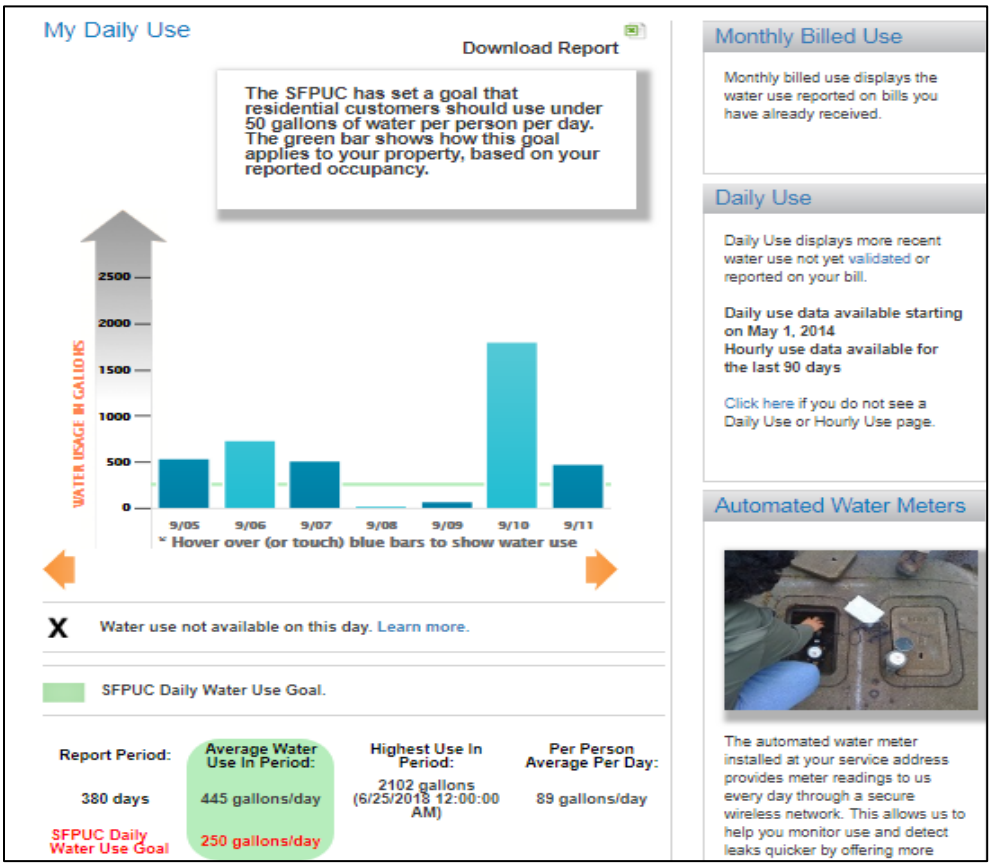
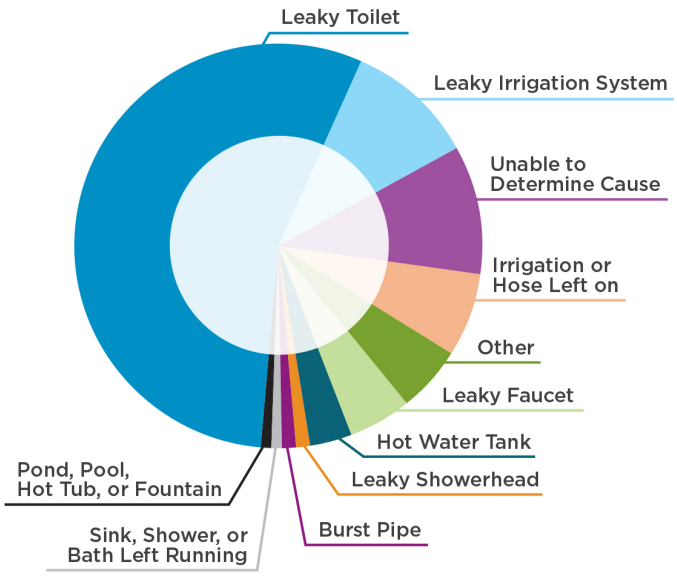


Figure 4-3: SFPUC Residential Customer Reported Causes of Leaks



Note: Based on 270 survey responses from single- and small multi-family leak participants surveyed Jan 2020-Jul 2020.

Moving forward, the SFPUC plans to update estimated water savings from its leak alert programs every few years. In 2021, the SFPUC plans to lower the 72-hour threshold for single family residential alerts to 48 hours and launch a permanent commercial and large multi-family alert program. Additionally, the SFPUC will consider alerts to irrigation customers who water during rainy periods or drought periods. The SFPUC is also evaluating expansion of digital self-service capabilities provided to its customers and replacing or enhancing its MyAccount platform, retaining and building upon current features that enable customers to track their monthly, weekly, daily, and hourly water use, as well as leaks.

Efficient Fixture Saturation

Across the country, as well as in the SFPUC's service area, average indoor water use in homes and many buildings has decreased significantly over the past 30 years due in great part to replacement of old toilets, clothes washers, faucet aerators, and showerheads with water-efficient models. The diagram below shows a breakdown of average indoor residential water use by fixture.

Figure 4-4: Indoor Residential Water Use by Fixture per 2016 WRF Residential End Uses of Water Study

Toilet	Faucet	Shower	Clothes washer	Leak	Bath	Other*	Dishwasher
24%	20%	20%	16%	13%	3%	3%	2%

**The "Other" category includes evaporative cooling, humidification, water softening, and other uncategorized indoor uses.*

In 2014, the SFPUC developed a plumbing fixture population and efficiency saturation forecast model to estimate efficient plumbing fixture and appliance saturation rates, as well as water use and savings potential by customer sector in the in-City retail service area. This saturation model, in turn, helps us determine the most cost-effective, feasible, and strategic approaches to achieve remaining saving opportunities, whether through SFPUC-issued incentives, services, or codes and mandates. In 2019, the SFPUC updated the efficiency saturation model with additional available data to help inform development of this 2020 Plan (see Appendix A and Appendix B for details). The general economic principle of the "law of diminishing returns" aptly applies to utility water conservation programs, reflecting the fact that it can take substantially greater effort and cost to incentivize inefficient fixture replacement as the population of inefficient fixtures shrinks over time. The California Urban Water Conservation Council (now the California Water Efficiency Partnership) recognized this in its Best Management Practices for conservation incentive programs by indicating programs were not required once utilities reached 75 percent efficiency saturation rates for showerheads and toilets.

The fixture population and efficiency saturation model is also the main tool the SFPUC uses to estimate passive water savings associated with plumbing codes and appliance efficiency standards. Using data from the saturation analysis, the SFPUC's conservation forecast model estimates passive savings for toilets, urinals, showerheads, and clothes washers, which represent the highest indoor water uses in most residential properties and many commercial properties. While there are water efficiency codes and requirements for other types of fixtures and appliances such as residential hot water systems and submetering, the SFPUC deemed there is not yet enough data available to reliably estimate their populations and potential effect on

water savings. The SFPUC will continue to evaluate this with future conservation plan updates and revisit if sufficient data exists to warrant adding additional fixtures, appliances, and equipment to the saturation analysis.

Key findings from the SFPUC's saturation model and assessment:

- **Toilets**: As of 2020, over 80 percent of properties are estimated to have efficient toilets, reflecting the efficacy of the SFPUC's long-running fixture replacement programs, as well as the ongoing effect of mandates and codes that require efficient fixtures in certain circumstances, such as property resale, new housing, or per "natural replacement".[4] By 2030, 90 percent of residential toilets are estimated to be efficient. These findings support the continuance of the SFPUC's financial incentive for residential toilet replacement incentives for properties that do not trigger compliance with San Francisco's Residential Conservation Ordinance until about 2025. After 2025, the focus would be on continued education and outreach through 2030 and beyond to promote compliance with mandates and to accelerate natural replacement and continued services such as water-wise evaluations and free replacement parts (i.e., toilet flappers and fill valves) that help customers maintain toilet performance and fix leaks promptly.

- **Showerheads**: As of 2020, an estimated 68 percent of properties have the most efficient showerheads with flow rates of 1.8 gpm or less, increasing to over 90 percent by 2030, which supports the SFPUC's plan to continue its free efficient showerhead distribution program over the next 10 years.

- **Clothes Washers:** As of 2020, 64 percent of washers are estimated to be efficient, which supports continuance of the SFPUC's residential and commercial washer incentive programs over the next five years and potentially to 2030 when residential washer efficiency is estimated to be close to 90 percent and over 90 percent for commercial washers. Because there are only federal water efficiency standards for clothes washers and they are considerably higher than the most efficient washers available, the SFPUC's financial incentives continue to help transform the market.

- **Urinals:** Urinals are generally found in commercial buildings and represent the smallest fixture population when compared to toilets, showerheads, and clothes washers. As of 2020, a little over 70 percent are estimated efficient, increasing to 80 percent by 2030. The SFPUC ended its financial incentives for urinal replacements in commercial properties in 2016, due to San Francisco's Commercial Conservation Ordinance requirement. The data supports the SFPUC's continued education and outreach to commercial properties to promote compliance with mandates and to accelerate natural replacement and continued services such as water-wise evaluations and free replacement parts that help customers maintain urinal performance and fix leaks promptly.

Table 4-1 shows the estimated percentage of remaining inefficient fixtures between 2020 and 2045, factoring in anticipated participation rates in SFPUC incentive measures, natural turnover rates, and projected growth in fixture populations from new development. The SFPUC uses the estimated percentages of inefficient fixtures to help determine the best strategies to seek additional water savings from replacements. Generally, using voluntary financial incentives to try to reach the last 20 percent of customers that have not made upgrades is less efficient and cost-effective than relying on natural replacement, mandates, and education to reach them. See Appendix C for more detailed estimates of fixture populations.

[4] Natural replacement is the assumption that a certain number of inefficient fixtures are replaced every year for reasons other than mandates or SFPUC incentive programs, such as to replace broken fixtures, but only efficient models can be purchased for replacement.

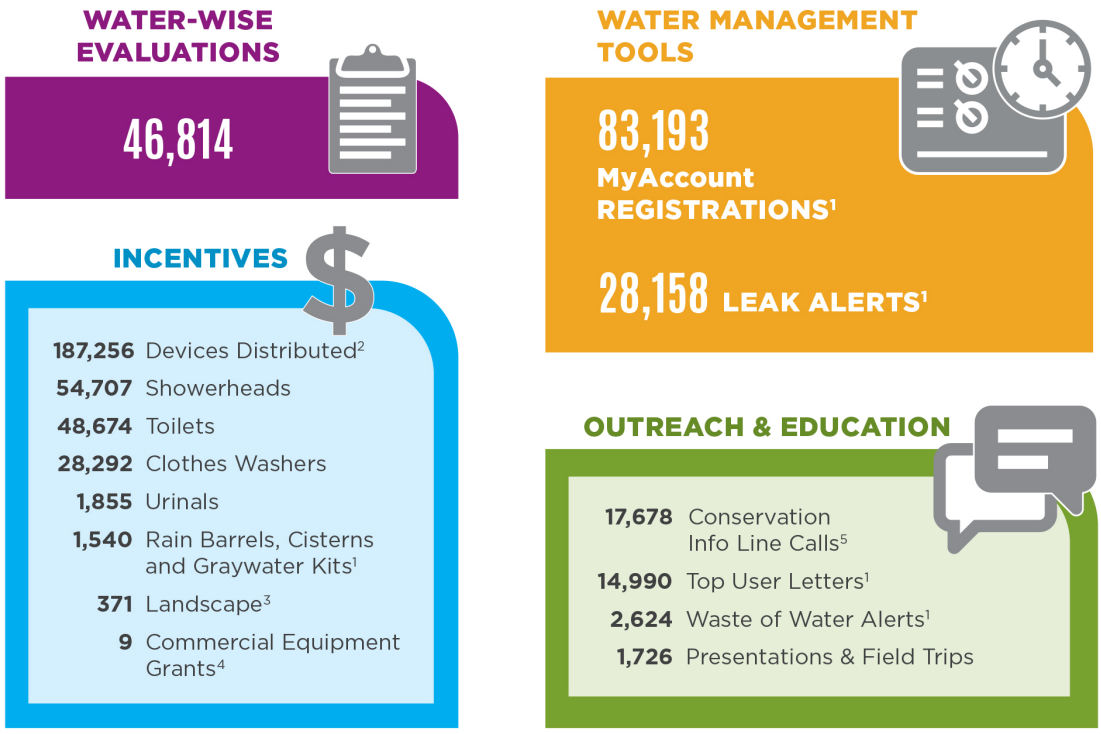
Table 4-1: Remaining Inefficient Fixture Estimates

Fixture	Class	Inefficient Is	2020	2025	2030	2035	2040	2045
Showerheads	Single Family	>1.8 gpm	26%	13%	6%	2%	1%	1%
	Multi-Family	>1.8 gpm	34%	17%	8%	4%	2%	1%
	Non-Residential	>1.8 gpm	35%	19%	10%	5%	3%	1%
Toilets	Single Family	>1.6 gpf	19%	14%	11%	8%	6%	5%
	Multi-Family	>1.6 gpf	18%	13%	10%	8%	6%	5%
	Non-Residential	>1.6 gpf	24%	21%	18%	15%	13%	11%
Urinals	Non-Residential	>1.0 gpf	28%	24%	21%	18%	15%	13%
Clothes Washers	Single Family	>6.0 WF	36%	21%	12%	7%	5%	3%
	Multi-Family	>6.0 WF	44%	27%	17%	10%	7%	4%
	Non-Residential	>6.0 WF	48%	30%	19%	12%	7%	4%

Participation in Conservation Measures

The SFPUC regularly analyzes customer participation rates in measures implemented to date. This analysis considers the most and least popular measures, customer feedback, and water use trends of customers that participated to help assess which measures will work best moving forward and to most precisely estimate anticipated future participation levels for purposes of estimating water savings, SFPUC expenditures, and resources needed. For example, the SFPUC's free device distribution measures have had high participation due to their applicability to many residential and nonresidential customers, their ease of participation, and the low cost and administrative effort by the SFPUC to implement them. Therefore, although we have seen a decline in participation since the 2014-2017 drought, we anticipate sustained participation over the next 10 years and beyond. For other measures that apply to much larger projects, have many more participation requirements, or apply to a much smaller subset of customers, participation rates may be low. It is important to note that quantity of customer participation by some key measures as reflected in **Figure 4-5** does not reflect the relative water savings of these measures. Some lower participation measures, such as large landscape retrofits and commercial equipment rebates, may have very high-water savings per project and a single project may represent more savings than a year or more of a measure with high participation. See Section 7 (Water Savings and Cost) for more details on estimated water savings by measure.

Figure 4-5: Key Conservation Measure Activity FY 2009-2010 through FY 2019-2020



1 Tracking of participation in measure started later than 2009

2 Aerators, toilet flappers, fill valves, pre-rinse spray valves, nozzles, soil moisture meters

3 Landscape includes Water Efficient Irrigation Ordinance projects, landscape audits, community irrigation grants and rebates

4 Includes ice machines, industrial dishwashers, sterilization equipment

5 Doesn't include calls to the SFPUC's Call Center regarding conservation

Customer, Property, and Land Use Characteristics

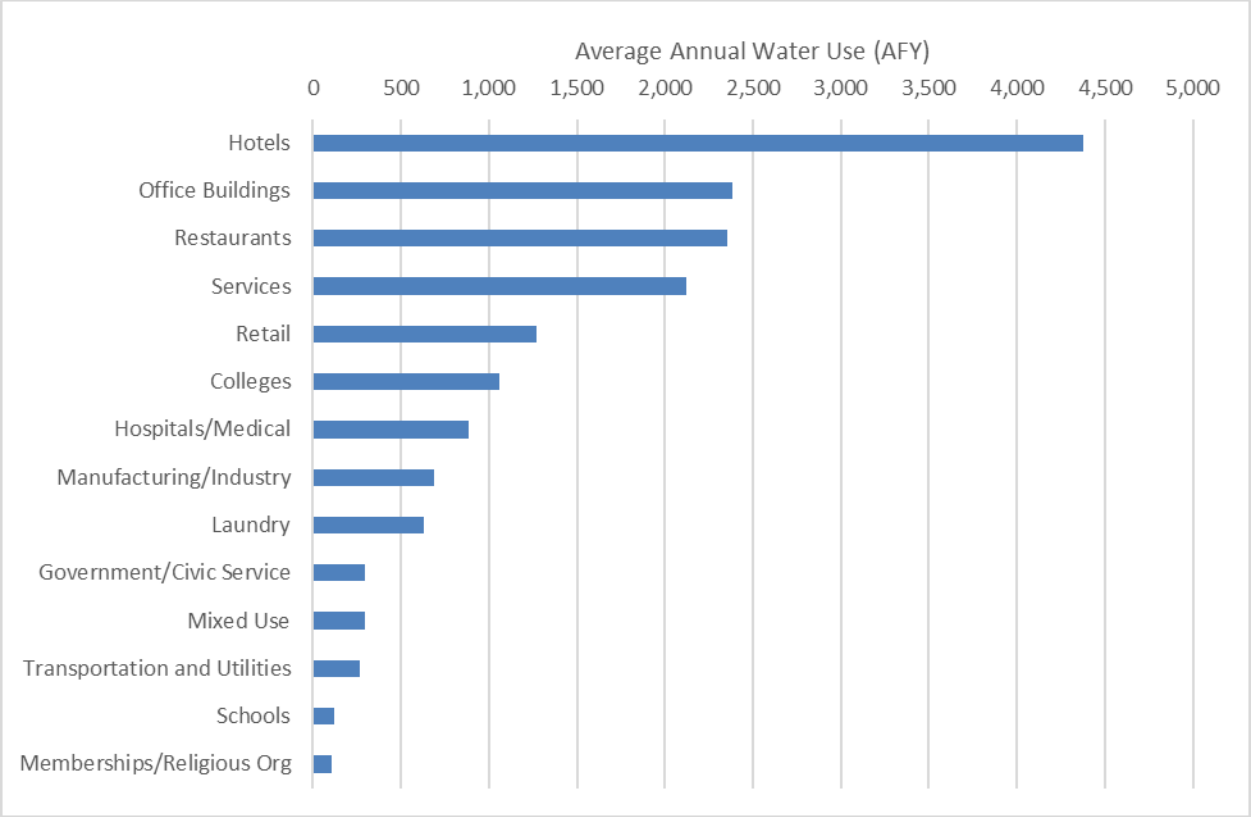
The SFPUC regularly analyzes water use by customer and business sector, as well as by characteristics of customers with higher-than-average water use for their sector or unusual increases based on their water use patterns. For example, **Figure 4-6** shows the top water-using non-residential sectors. Another overall consideration is that irrigation use represents a relatively low percentage of total retail water use.

San Francisco's high density, cool climate, minimal amount of residential landscaping, high number of multi-family dwellings, prevalence of old and pre-1994 homes and buildings, and role as an employment and tourism hub are major factors in water use trends. Additionally, because water use in newly constructed homes and buildings is anticipated to continue to decline per local, state, and federal codes and requirements that increasingly call for more water-efficient plumbing fixtures and landscaping, the SFPUC focuses its conservation program on existing sites and its Onsite Reuse Program focuses on large, new development.

These characteristics support the SFPUC's focus on tools, services, and incentives for helping customers avoid or promptly fix leaks, maintain indoor fixtures and efficient water use; cost-effective small landscape assistance programs with most financial incentives for outdoor water savings focused on the largest landscapes; providing tools, services, and assistance that promote entire building water savings in multi-family properties and efficient tenant water use; and working with non-residential business sectors with the highest water use, including hotels, office buildings, restaurants, schools, hospitals, government facilities,

and laundromats. The SFPUC will also continue outreach to the top residential water users and the top non-residential water-using sectors, while working with the organizations that represent them to promote water efficiency and provide information about the SFPUC's applicable assistance programs.

Figure 4-6: Non-Residential Sectors with Top Water Use



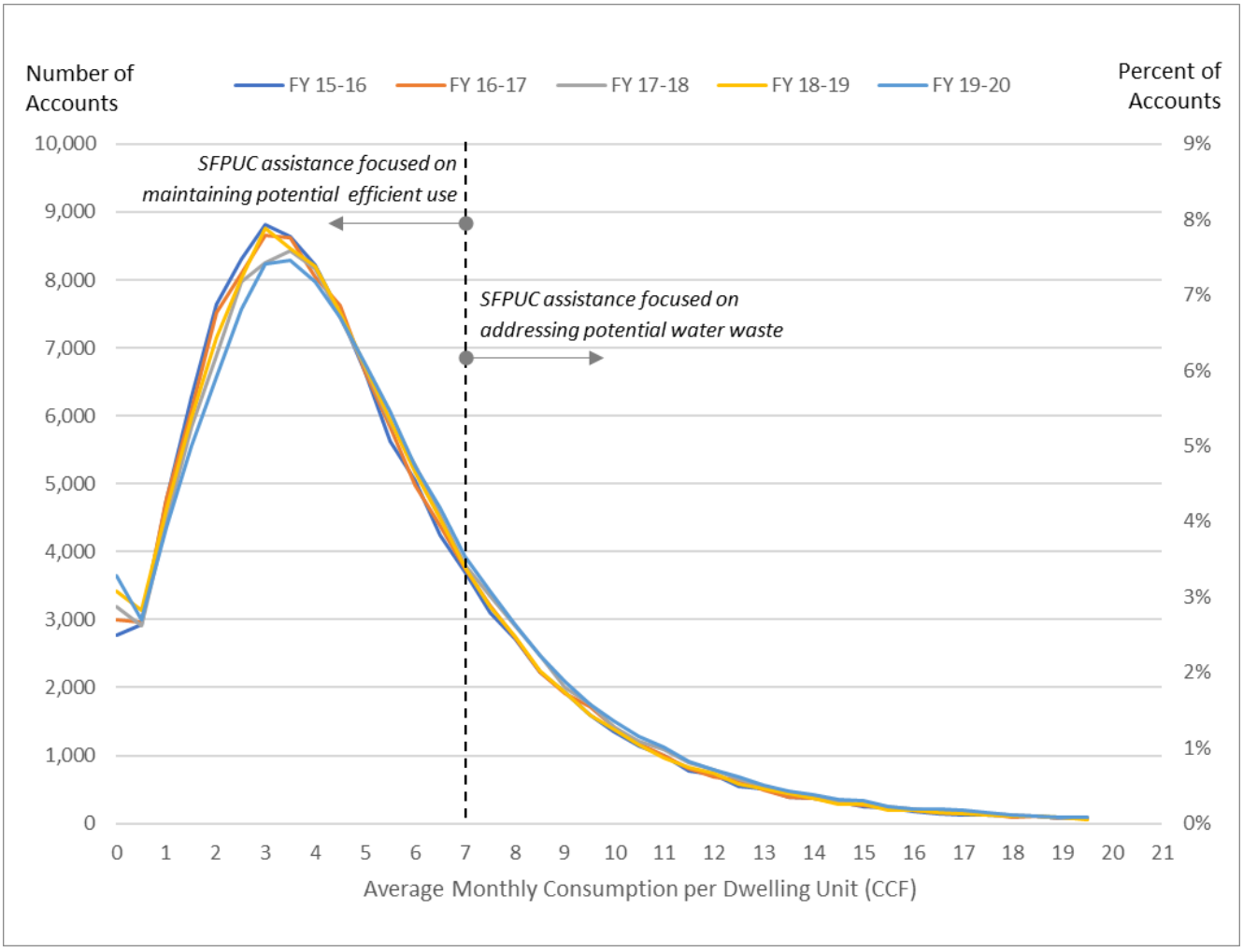
Notes: Business classifications are based on the Standard Industrial Classification (SIC) code information from the SFPUC's billing system and represent water used in 2015-2020. Data does not include most municipal department use. Data may not reflect all businesses/institutions in a particular sector, as some businesses may not have a SIC code in the SFPUC's billing system and businesses that are part of a mixed- use commercial meter do not have their own water accounts.

Analysis of residential customer water use over the past five years shows that on average monthly use is higher among single family customers than multi-family households and decreases among multi-family households in larger buildings (see **Table 4-2**). The data reflects that most single-family and multi-family household use is low compared to typical national and state residential household use. The data also highlights that a relatively small number of residential households have monthly use well over the average and the quantity of high-using households is about the same from year to year (see **Figure 4-7**). This information supports the SFPUC's continuation of outreach aimed at helping customers who may already be conserving maintain efficient use, while also providing more extensive assistance to customers with high use that may be due to inefficient fixtures, leaks, or other forms of water waste.

Table 4-2: Most Frequent Average Monthly Consumption per Dwelling Unit from FY 15-16 to FY 19-20

Class	Average Monthly Water Use per Dwelling Unit	
	CCF	*gallons*
Single Family	3.4	2,543
Multi-Family (2-5 Dwelling Units)	2.9	2,169
Multi-Family (6-10 Dwelling Units)	2.6	1,944
Multi-Family (>10 Dwelling Units	2.5	1,870

Figure 4-7: Distribution of Average Monthly Consumption for Single Family Dwelling Units



While SFPUC retail system irrigation use is generally considered low compared to other parts of the state, many residential customers have some outdoor water use and not all customers have efficient outdoor use. Analyzing single family, multi-family, and irrigation account outdoor water use trends helps SFPUC conservation staff evaluate which landscape conservation assistance measures may be most valuable and cost effective for our service area, how many customers may benefit from such assistance, and helps the SFPUC prepare for meeting California's new residential and CII outdoor water use efficiency targets.

Relevant Water Efficiency Codes, Regulations, Standards, and Laws

The SFPUC evaluates legislative codes and standards pertaining to efficiency for water-using fixtures, appliances, and devices to understand the impact of legal requirements on customer participation levels and market gaps. Generally, the SFPUC does not provide customer financial incentives for water efficiency actions that are required by law, unless the actions exceed the requirement. The SFPUC does, however, conduct outreach and education and provide information to encourage compliance with requirements. **Table 4-3** provides a summary of key applicable legislation and local codes that affect incentives and services provided by the SFPUC. The table only provides a partial list of the codes and standards affecting the SFPUC and does not represent a complete list of all national, state, and local codes and requirements related to water efficiency. For more information on water-related requirements affecting new development and retrofits in the SFPUC's retail service area, visit https://sfpuc.org/construction-contracts/design-guidelines-standards.

Table 4-3: Summary of Codes and Standards

Code/Standard/Law	Effective Date or Last Update	Affected Sector	Requirements
Federal: Energy Conservation Standards for Residential Clothes Washers	2018	Residential customers	• Front-Loading Clothes Washer: Integrated Water Factor (IWF) ≤ 4.7 • Top-Loading Clothes Washer: IWF ≤ 6.5
Federal: Energy Star High Efficiency Washer Standards	2015	Residential and commercial customers	• Residential Clothes Washer Standard Top Loading: Water Factor (WF) ≤ 4.3 • Commercial Clothes Washer: WF ≤ 4.5 • Most Efficient Standard Front Loading: Integrated WF ≤ 3.7
Federal: Other WaterSense Fixtures & Appliances	2019	Residential and commercial customers	• Toilets: ≤ 1.28 gpf • Urinals: ≤ 0.5 gpf • Showerheads: ≤ 2.0 gpm • Faucets: 1.5 gpm • Pre-rinse Spray Valves: ≤ 1.28 gpm • Irrigation controller: able to meet watering needs of a landscape without overwatering • Residential dishwashers: 3.1 gallons/cycle for compact and 3.5 gallons/cycle for standard
California: Conservation Framework (AB 1668, SB 606)	Legislation 2018; Standards 2023	Urban Water Suppliers	• Meet a new urban water use objective based on efficiency standards for indoor residential water use, outdoor residential water use, dedicated irrigation account use, and water loss and performance goals for commercial, industrial, and institutional (CII) use
California: Water Conservation Act of 2009 (SB X7-7)	2009 through 2020	Urban Water Suppliers	• Reduce gross per capita water use to below GPCD target established for supplier by 2020 • SFPUC's 2020 target is 96 GPCD for the retail service area

Code/Standard/Law	Effective Date or Last Update	Affected Sector	Requirements
California: SB 555		Urban Water Suppliers	• Conduct an annual supply-side water loss audit and system component analysis • Meet performance standards for volume of water losses to be determined by the State Water Resources Control Board
California: Assembly Bill 715 (AB 715)	2014	Any building installing new fixtures in California	All toilets and urinals (other than blow-out) sold or installed must be: • Toilets: 1.28 gallons per flush (gpf) or less • Urinals: 0.125 gpf or less
California: Senate Bill 407 (SB 407)	Single Family: 2017 Others: 2019	All customer sectors by deadlines noted; before then, when customers undergo alterations or improvements	All plumbing fixtures must comply with current plumbing code standards.
California: Title 24, Building Standards Code	2016	Any building installing new fixtures in California	• Plumbing, residential, energy, and green building standards sections • Toilets: ≤ 1.28 gpf • Urinals: ≤ 0.125 wall mounted; 0.5 for floor mounted • Residential Kitchen Faucets: ≤ 1.8 gpm • Commercial Lavatory Faucets: ≤ 0.5 gpm • Residential Lavatory Faucets: ≤ 1.2 gpm • Showerheads: ≤ 1.8
California Title 24 Recirculating Hot Water Requirements	2016	New residential development	• Requires new residential development to include efficient hot water on demand systems. Systems reduce hot water waiting times.
San Francisco: Residential Water Conservation Ordinance – SF Building Code (Based on State's SB 407)	At time of sale or transfer of title or upon major improvement	Existing single family and multi-family properties, and residential hotels	Existing fixtures must be replaced if they do not meet or exceed the following water use requirements: • Showerheads: 2.5 gallons per minute (gpm) • Faucets: 2.2 gpm • Toilets: 1.6 gpf (≤ 1.28 gpf per plumbing code) • Leak Repair

Code/Standard/Law	Effective Date or Last Update	Affected Sector	Requirements
San Francisco: Commercial Water Conservation Ordinance – SF Building Code (Based on State's SB 407)	January 1, 2017 or upon major improvement	Commercial properties	Existing fixture must be replaced if they do not meet or exceed the following water use requirements: • Showerheads: 2.5 gpm • Faucets: 2.2 gpm • Toilets: 1.6 gpf (≤ 1.28 gpf per plumbing code) • Urinals: 1.0 gpf (≤ 0.125 gpf per CEC water appliance standards) • Leak Repair
San Francisco: Water Efficient Irrigation Ordinance (Based on State's Model Water Efficient Landscape Ordinance – MWELO)	January 1, 2011	New or renovation projects with landscaped areas ≥ 500 square feet (ft^2)	• Water-efficient landscape design and practices. Requirements vary depending on project size.
San Francisco: Submetering for New Multi-Family Construction (Based on State Water Code, Division 1, Chapter 8, Article 5, Sections 537 per SB 7)	January 1, 2018	New multi-family construction	• Requires buildings to submeter each dwelling unit and to bill tenants in apartment buildings accordingly for their water use.
San Francisco: Water Waste Restrictions (Based on Executive order B-37 that directed SWRCB to permanently prohibit practices that waste potable water	2016	All single family, multi-family and non-residential sites and customers in SFPUC retail service area	• Section E, Rule 12 of SFPUC Rules and Regulations Governing Water Service to its customers permanently bans water waste from runoff from irrigation and hardscape cleaning, irrigating right after rainfall, use of single pass cooling systems and water features, use of hoses without shutoff nozzles, and other practices
San Francisco: Water Shortage Contingency Plan	2015, expected update 2021	All customers in SFPUC retail service area	• California Water Code Section 10632 requires urban water suppliers to prepare a Water Shortage Contingency Plan (WSCP) as part of the 2020 UWMP process. The WSCP outlines actions the water supplier could impose on its customers to reduce water use during declared water shortages.
San Francisco: Green Building Ordinance (Based on State's CalGreen)	Varies (LEED 1994)	New construction or renovated buildings	• LEED building certification includes a section for water conservation techniques

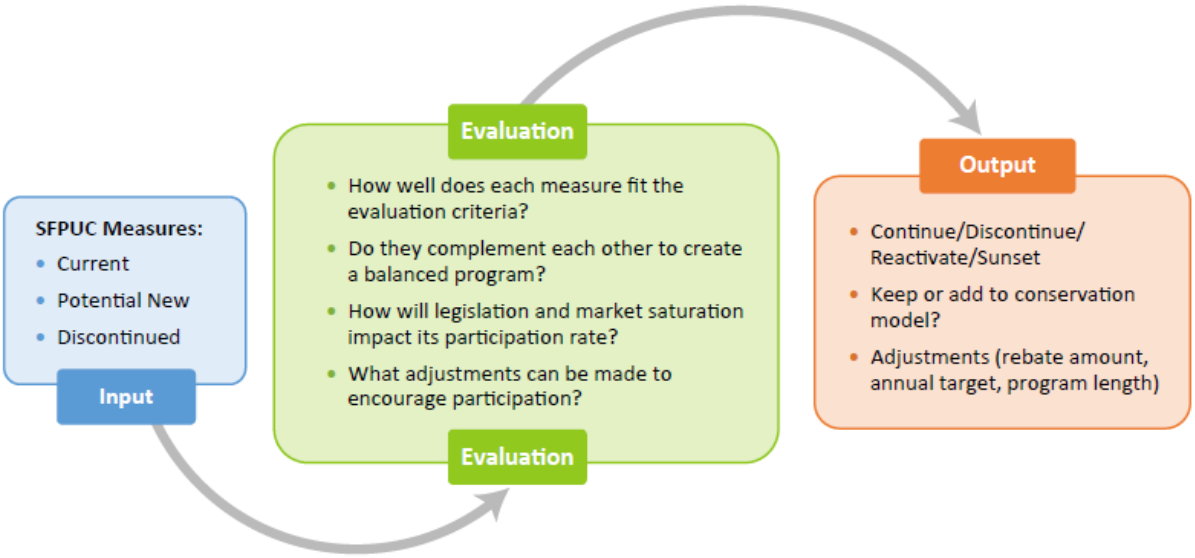
Code/Standard/Law	Effective Date or Last Update	Affected Sector	Requirements
San Francisco: Non-Potable Reuse Ordinance	2015	Commercial, multi-family, and mixed use over 250,000 square feet	• All new buildings of 250,000 ft^2 or more of gross floor area must be constructed, operated, and maintained using available alternate water sources for toilet and urinal flushing and irrigation • All new buildings in San Francisco of 40,000 ft^2 or more of gross floor area must prepare water budget calculations
San Francisco: Stormwater Management Ordinance	2010, updated 2016	Projects that create or replace ≥ 5,000 square feet of impervious surface in separate and combined sewer areas or ≥ 2,500 square feet of impervious surface in separate sewer areas	• Requires new and redevelopment projects to manage stormwater using green infrastructure (i.e., stormwater controls or best management practices) and to maintain that green infrastructure for the lifetime of the project

5. Evaluation Process

Since the 2004 development of its original conservation potential and demand forecast model, the SFPUC has evaluated a wide range of over 80 measures, including financial and educational assistance programs and mandates. For details on current measures and measures previously implemented or evaluated, see the following tables in Section 6: **Table 6-2 (**SFPUC Conservation Strategies and Measures Planned for 2020-2025) and **Table 6-3 (**SFPUC Conservation Measures Completed before 2020 or Not Implemented).

During its conservation plan updates in 2011, 2015, and 2020, the SFPUC conducted a thorough analyses of all current measures implemented at the time of each plan, potential new measures the agency had not implemented before, and measures previously offered and discontinued. **Figure 5-1** below illustrates the general measure evaluation and review process.

Figure 5-1: Conservation Measure Evaluation Process



The SFPUC considers several criteria to determine which measures most effectively provide the greatest benefit and work best together as a balanced conservation program that serves all customer sectors. While the SFPUC's overall focus is on measures that deliver the greatest water savings, measures with a lower water savings potential may be valuable for the purposes of researching new or emerging technologies or providing a high level of customer service.

Table 5-1: Criteria for Evaluating Conservation Measures

Criteria	Description
Water savings potential	Amount of water a measure could save over its lifespan
Certainty of water savings	Likelihood actual water savings will be achieved
Implementation feasibility	Ease with which a measure could be implemented
Customer receptivity & customer service value	Degree to which customers like or want a measure and will participate, and customer service value of the measure to the SFPUC
Adaptability	Ease with which a measure could be scaled to react to a changing market
Research benefits	To what degree measure enables research and analysis of an emerging technology
Cost	How cost effective the measure is per acre foot of water saved
Other program co-benefits	To what extent the measure benefits programs other than conservation
Staff resources needed	What level of staffing resources are needed to administer the program and to what extent the measure utilizes the SFPUC's conservation field technician team

6. WATER CONSERVATION PROGRAM

The SFPUC's retail water conservation program has historically consisted of a mix of financial incentives, technical assistance, water management tools, education, outreach, and mandates. These offerings are planned to continue over the next five years and beyond.

Between 2005 and 2025, the SFPUC will have evaluated and implemented over 80 different conservation measures and mandates, providing extensive customer water-savings assistance that has played a major role in this significant decline in water use. These include conservation best management practices found successful by major water utilities and efficiency experts across the nation; measures that third-party studies demonstrate have water savings and customer benefits; and measures that make sense for the site conditions and characteristics unique to San Francisco water use. The measures also include the SFPUC's Onsite Reuse Program. In September 2012, the City of San Francisco adopted the Onsite Water Reuse for Commercial, Multi-family, and Mixed Use Development Ordinance, commonly known as the Non-potable Water Ordinance. It was added to the San Francisco Health Code and allows for the collection, treatment, and use of alternate water sources for non-potable applications. The ordinance requires new developments of 250,000 square feet or more to install onsite water systems to treat and reuse available alternate water sources for toilet and urinal flushing and irrigation, and developments between 40,000 and 250,000 square feet to submit a water budget application and water use calculator to the SFPUC. The ordinance also established the SFPUC's Onsite Water Reuse Program, which provides grant funding for projects that aren't required to install onsite reuse systems. The grant program provides funding to non-mandated projects that replace at least 450,000 gallons of potable water through onsite reuse, as well as to breweries that collect, treat, and reuse process water (e.g. water used in the brewing process for applications such as rinsing bottles and cleaning equipment) generated onsite. The grant program also includes water quality, treatment, and monitoring standards for brewery process water reuse systems.

The SFPUC regularly reviews the water-saving measures and strategies undertaken by other water utilities in California and other states and reviews information on advancements in conservation best management practices provided by national and state water-efficiency experts, including the Alliance for Water Efficiency, California Water Efficiency Partnership, Water Research Foundation, and others. **Table 6-1** shows how the SFPUC aligns with 17 other water utility conservation programs the SFPUC reviewed in 2019. Overall, it shows that the SFPUC offers the same core measures, with expected variations among agencies in how measures are structured and implemented. The SFPUC also offers additional measures beyond those noted in the table.

Table 6-1: How the SFPUC Conservation Measures Compare to Other Water Utilities

Measure	# of Agencies that Offer Measure	Currently Offered by SFPUC?
Devices	17	Yes
Education & Training	16	Yes
Turf Replacement	15	Yes, for irrigated landscapes over 10,000 square feet
Audits	15 outdoor 14 indoor	Yes
Clothes Washers	13	Yes
Toilets	14 (11 rebates, 1 DI)	Yes
Commercial Equipment	14	Yes
Irrigation System Components	13	Yes, for irrigated landscapes over 10,000 SF and launching WBICs in 2021 for any size site
Urinals	13	Yes
Non-Potable Reuse	13 for irrigation, 0 for indoor	Yes, for indoor and outdoor
Pools (Covers)	5	No
Mulch	5	No
Water Use Reports & Online Portals	4	Yes
Leak Alerts	4	Yes
Dishwashers	3	Yes, for large commercial systems
Hot Water On Demand Systems	3	Yes, launching in 2021
Pressure Reducing Valves	3	No
Submeters (Indoors)	1	Yes, mandated for new MF construction

Agencies Surveyed:

1. *Alameda County Water District*
2. *Austin Water Utility*
3. *Bay Area Water Supply and Conservation Agency*
4. *City of San Diego Public Utilities Department*
5. *Contra Costa Water District*
6. *East Bay Municipal Water District*
7. *Irvine Ranch Water District*
8. *Los Angeles Department of Water and Power*
9. *Marin Municipal Water District*
10. *Metropolitan Water District of Southern California*
11. *Municipal Water District of Orange County*
12. *San Diego County Water Authority*
13. *Santa Clara Valley Water District*
14. *Sonoma County Water Agency*
15. *Soquel Creek Water District*
16. *South Florida Water Management District*
17. *Southern Nevada Water Authority*

The SFPUC's conservation measures can be broadly characterized as foundational customer assistance measures and water efficiency mandates that the SFPUC anticipates continuing through the 2045 planning horizon with no definite end date. Examples include evaluations, site usage reports and tools, free devices, education and outreach, and mandates or incentive-based measures that have specific and varying end dates, depending on factors such as plumbing code impacts and market saturation rates. Collectively, the measures proposed for 2020 and beyond support the SFPUC's strategies for tapping into anticipated remaining water-saving opportunities, specifically:

- Maintaining efficiency among customers, properties, and sites that already have water-wise use.
- Improving efficiency among residential customers with above average water use due to leaks, old fixtures, inefficient irrigation, or other forms of water waste.

- Increasing commercial property compliance with requirements for efficient plumbing fixtures and awareness of opportunities for equipment retrofits, reuse technologies, and efficiency audits and action plans.
- Increasing commercial customer awareness of constant and/or abnormally high-water use, with focus on hotels, restaurants, office buildings, and schools that represent the non-residential sectors with the overall highest water use.
- Promoting compliance with new efficiency standards among large landscapes served by dedicated irrigation meters and smaller sites with inefficient irrigation.
- Maximizing opportunities for onsite reuse in new development.

Moving forward, the SFPUC will continue to utilize a mix of demand-side, customer water-saving strategies, including voluntary incentives, assistance services, tools to help customers understand and manage their water use, education and outreach, and mandates that require indoor and outdoor water efficiency. **Table 6-2** below notes the conservation measures the SFPUC already is implementing or plans to start implementing within the next five years and which ones are modeled for water savings. Measures marked as "New" have been added since the 2015 Plan. The SFPUC only models water savings for measures with established water-savings methodologies, engineering calculations or enough empirical data of our own to meet a sufficient level of confidence in the estimates. The SFPUC implements several measures that are not modeled but are likely to generate some water savings and also several programs beyond conservation that likely contribute to reductions in potable water use, including its supply-side water loss, recycled water facility, and stormwater management programs. Additionally, per its Water Shortage Contingency Plan, the SFPUC also has identified and is prepared to take actions beyond the measures or level of effort described in its 2020 Plan to seek short-term reductions in water use during droughts or other emergencies that restrict water supply. For example, these could include voluntary calls for reduction or mandatory rationing, irrigation restrictions, and other actions. Drought actions are not factored into the modeled conservation water savings in this 2020 Plan.

For detailed information about how water savings are calculated for each modeled conservation measure, see Appendix D.

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Table 6-2: SFPUC Conservation Strategies and Measures Planned for 2020-2025

Measure	Markets Served	Description	Are Water Savings Modeled?	Model Reference Number **
INCENTIVES				
Toilet and urinal direct installations	SF, MF	Free replacement (installation and fixture) of existing 3.5 gpf-plus toilets and existing 1.0 gpf-plus urinals with toilets 1.28 gpf or less and urinals 0.125 or less.	Yes	S8, M7
Rebates for residential and commercial clothes washers	SF, MF, NR	Rebates for installation of Energy Star Most Efficient residential washers in single family and multi-family and commercial properties, and rebates for installation of coin-operated commercial washers in common areas of multi-family properties and laundromats.	Yes	S12, M10, N21
Discounts for rain barrels and cisterns	SF, MF, NR	Discount off purchase cost of rain barrel or cistern.	Yes	S16a, S16b
Discounts and rebates for laundry to landscape and simple graywater systems	SF, MF	Discount off kit of parts and free training for laundry to landscape graywater systems in up to 2-unit residential homes, and rebate for obtainment of building permit for installation of simple branched drain graywater system.	No	
Grants for large landscape & irrigation upgrades	MF, NR, IRR	Grants to existing, irrigated landscape sites over 10,000 square feet that provide funding up to 50% of project design and construction for landscape and irrigation system component upgrades that reduce potable water use by 25 percent or more.	Yes	N22a, N22b
Rebates for large commercial equipment	MF, NR	Rebates for up to 50% of purchase cost for installed equipment in existing sites that saves over 200 ccf annually for customized projects or equipment with predictable water savings, such as water efficient ice machines and connectionless food steamers.	Yes	N24, N25
Grants for irrigation meters and backflow devices for community gardens	IRR	Waiver of SFPUC fees for installation of a dedicated irrigation meter for community gardens and rebate off the purchase cost of installed backflow devices. Participants receive monthly water budget report from the SFPUC.	No	

Measure	Markets Served	Description	Are Water Savings Modeled?	Model Reference Number **
Onsite Water Reuse Program (Grants)	MF, NR	Grant funding for non-mandated projects that replace at least 450,000 gallons of potable water through onsite reuse, as well as to breweries that collect, treat, and reuse process water (e.g. water used in the brewing process for applications such as rinsing bottles and cleaning equipment) generated onsite.	Yes	N/A**
Rebates for weather-based irrigation controllers and sensors (NEW, slated to launch in FY 2021-2022)	SF, MF, IRR	Rebates off the purchase cost of installed weather-based irrigation controllers and sensors for small to medium-sized landscapes between approximately 250 – 5,000 square feet and that have between approximately 2 to 20 irrigation zones to be programmed.	Yes	S18, M17
Rebates for recirculating hot water pumps (NEW; slated to launch in FY 2020-2021)	SF, MF	Rebates off the cost of installed, on-demand recirculating hot water pumps used to reduce hot water wait time in single family and small multi-family properties.	No	
Free water-saving devices	SF, MF, NR	Free distribution or direct install of water-efficient devices, including showerheads, faucet aerators, pre-rinse spray nozzles, garden spray hose nozzles, toilet flappers, toilet fill valves, soil moisture meters.	Yes	S4, S5, S20, M4, M5, M20, N7, N8, N9, N27
Insurance for water lateral replacements * (NEW; started in FY 19-20)	SF, MF	SFPUC has an agreement with American Water Resources (AWR) that enables them to offer water (and sewer) lateral coverage that pays for the cost of replacing broken or damaged laterals in single family and small multi-family properties up to 4 dwelling units. Broken water laterals can be a source of extensive water loss and high bills.	No	
Grants for installation of green infrastructure for stormwater management *	SF, MF, NR, IRR	Grants provide financing toward planning, design, and construction of green stormwater management facilities, including projects that harvest and use rainwater, remove impervious surfaces, install vegetated roofs, or implement other green infrastructure like bioswales and rain gardens.	No	
Bill reductions for leak repair *	SF, MF, NR	To encourage prompt repairs of leaking pipes or fixtures, the SFPUC's Customer Service Bureau grants allowances for excessive bills resulting from leakage beyond the meter.	No	

Measure	Markets Served	Description	Are Water Savings Modeled?	Model Reference Number **
ASSISTANCE SERVICES				
Onsite indoor and outdoor water-wise evaluations and reports	SF, MF, NR, IRR	Free site consultation that reviews consumption history, checks plumbing fixtures and irrigation system components for leaks, determines fixture flow rates, recommends improvements, identifies fixtures eligible for replacement through rebate programs, provides standard repair parts for faulty toilets and free water-saving devices and materials, and provides a report of findings and recommendations.	Yes	S2, M1, M2, N1, N2, N3, N4, N5
Virtual evaluations and consultations (NEW)	SF, MF, NR, IRR	Free consultations by phone and/or video that review consumption history, provide input on plumbing fixture and irrigation system efficiency and potential eligibility for incentives, and provide general guidance on ways to reduce water use and waste from leaks.	No	
WATER MANAGEMENT TOOLS				
MyAccount online platform for viewing water use	SF, MF, NR, IRR	Online portal where customers can view their bills, perform account service, and view and download hourly, daily, weekly, and monthly water use. Residential customers can compare their use to the SFPUC's goal to keep residential use under 50 GPCD and can compare household water use to the previous year. Drought targets can be added during water shortages.	No	
Irrigation account monthly water use budgets	NR/IRR	Informational monthly report indicates how water use compares with the estimated amount allotted for their site based on state calculations for efficiency.	Yes	A3
Leak and high usage alerts	SF, MF, NR, IRR	Alerts sent by text, email, phone, mail, and door hanger to customers with constant water use, which could indicate leaks.	Yes	S3a, M3
MANDATES				
Retrofit on Resale (ROR)	SF, MF	Existing residential properties are required to replace inefficient plumbing fixtures upon sale.	Yes	N/A

Measure	Markets Served	Description	Are Water Savings Modeled?	Model Reference Number **
Onsite Water Reuse Program (Ordinance)	MF, NR	New development projects of 250,000 square feet or more of gross floor area are required to install and operate an onsite non-potable water system to treat and reuse available graywater, rainwater, and foundation drainage for toilet and urinal flushing and irrigation. New development projects of 40,000 square feet or more of gross floor area are required to prepare water budget calculations assessing the amount of available rainwater, graywater, and foundation drainage, and the demands for toilet and urinal flushing and irrigation.	Yes	N/A**
EDUCATION & OUTREACH				
School presentations and field trips	SF, MF	In-person and virtual presentations about the SFPUC's water supply, local water program and conservation to K-12, and virtual and in-person field trips to a water efficiency demonstration garden.	No	
Demonstration garden and adult landscape trainings	SF, MF	Maintenance of publicly accessible demonstration garden with educational signage about water efficient plants, irrigation and rainwater harvesting, and in-person and virtual adult classes conducted on site.	No	
Waste of water notifications and outreach	SF, MF, NR, IRR	Inclusion of waste of water in San Francisco's 311 public complaint reporting system and program of escalating letters, warnings, calls, and inspector dispatch to sites of reported water waste.	No	
Top user notifications and outreach	SF, MF	Periodic (approximately annual) issuance of letters to single family customers with top water usage and multi-family customers with highest average usage per dwelling unit.	No	
Social media, direct customer notification, community events	SF, MF, NR, IRR	Regular notifications and outreach through multiple platforms and means to promote conservation services and assistance.	No	

**SFPUC programs funded/implemented outside the conservation program and their estimated water savings not reflected in this Conservation Plan.*
SF - single family; MF - multi-family; NR - non-residential; IRR – irrigation.
*** Refers to the reference number assigned to measures modeled for water savings in the Conservation Tracking Model; these reference numbers are noted in Appendix D: Updated SFPUC Water Conservation Tracking Model Overview and Water and Energy Savings Specifications for Conservation Program Measures (2020). Water savings for the Onsite Water Reuse Program are estimated outside of the Conservation Tracking Model but are included in water savings and effect on demand presented in this 2020 Conservation Plan.*

Table 6-3 summarizes the conservation measures the SFPUC implemented or evaluated since 2005 and terminated by 2020 or has not offered.

Table 6-3: SFPUC Conservation Measures Completed before 2020 or Not Implemented

Measure	Description	Status	Model Reference No.
SINGLE FAMILY MEASURES			
Mandatory CAP Audits	Free site evaluation required for single family residents to participate in the Community Assistance Program (CAP) for discounted water and sewer rates.	**Completed.** Measure provided 2009-2019.	S1
HET Rebates (Tank-Style)	Up to $125 rebate to replace old toilets (≥ 3.5 gpf) with approved high-efficiency toilets (HETs) (1.28 gpf or less).	**Completed.** Rebate program provided until 2017. Replaced by toilet direct install program that started in 2016 and continues as of 2020. Before HET rebates, between approximately 1997 and 2000, the SFPUC provided $10 fixture sales and rebates to replace high-flow toilets with 1.6 gpf toilets. These earlier toilet incentives are not counted as active conservation measures in the SFPUC's conservation forecast models.	S6
CAP Direct Install thru SFPUC Funding	Free installation of HETs for single family CAP participant residents.	**Completed.** Measure provided 2010-2015. Replaced by new direct install program that started in 2016 open to all eligible single-family customers and as of 2020 continues.	S7
HET Vouchers	A voucher issued to eligible residents to replace their older toilets with HETs.	**Completed.** Measure provided 2010-2015. Replaced by new direct install program that started in 2016 open to all eligible single-family customers and as of 2020 continues.	S9
CEE Tier 2 Rebates	Rebate from the Consortium for Energy Efficiency (CEE) for clothes washers with a Water Factor (WF) of ≤ 4.5. Measure recently discontinued.	**Completed.** Measure replaced by rebate for Energy Star Most Efficient to continue to drive market for most efficient clothes washers.	S11
Custom Water Use Reports	Provides customers a home and site-specific water use report to provide better understanding of water use patterns and trends.	**Evaluated, not offered.** The SFPUC currently provides customers reports and information on home water use through its My Account portal for those who sign up, as part of water-wise evaluations, and to customers receiving leak alerts.	S3b

Measure	Description	Status	Model Reference No.
HET/Fixture Install thru On-Bill Financing	On-bill financing is an alternative means to provide direct installation of water-saving fixtures such as toilets and showerheads that recovers some of agency's costs over time. The customer finances the project through water bill savings.	**Evaluated, not offered.** Single family market already served by SFPUC's extensive former rebate and current direct install programs. On-bill financing could potentially be considered after all SFPUC's HET incentives expire if the remaining estimated quantity of inefficient fixtures warrants it.	S10
High- Efficiency Dishwasher Rebates	Rebate for high-efficiency dishwasher.	**Evaluated, not offered.** Very low potential to save water. Dishwashers represent approximately 1.4% of residential indoor water use with estimated use of 1 gallon per capita per day. Most are already energy- and water-efficient.	S13
Turf Removal Incentive	A per-square-foot rebate to replace turf with drought appropriate plants.	**Evaluated, not offered.** Limited opportunity and high cost per potential water savings. SFPUC instead continues to provide educational materials, trainings, and onsite assistance through water-wise evaluations and plans to start a WBIC rebate program to help customers improve small landscape water efficiency.	S17
Irrigation Nozzle Distribution	Free irrigation nozzles for eligible customers.	**Evaluated, not offered.** Limited opportunity and high cost per potential water savings. SFPUC instead continues to provide educational materials, trainings, and onsite assistance through water-wise evaluations and plans to start a WBIC rebate program to help customers improve small landscape water efficiency	S19
Flow Sensor Incentives	Devices that strap on to meters or on/in house pipes that provide customers "real-time" water use dashboards available through apps, including high usage and leak alerts.	**Evaluated, not offered.** Currently several technologies such as FLUME are being piloted by some water agencies that do not have AMI and the ability to provide customers daily and hourly water use info. The SFPUC already provides water use information through the previous day on MyAccount and courtesy leak alerts, though neither of these provide "real-time" data or alarms. Potential issues with inaccurate data or data that does not match SFPUC records. The SFPUC will continue to evaluate and monitor this emerging field.	N/A
Pressure Reducing Valve Incentives	Devices installed in-flow in house pipe that reduces pressure to home and could be beneficial to leak-prone homes in known areas of high pressure.	**Evaluated, not offered.** May require a permit to install in-flow. Few water agencies offer such rebates and unclear how any water-savings could be attributed or measured. The SFPUC will continue to evaluate as data on homes located in potentially high-pressure areas becomes available and in conjunction with SFPUC's City Distribution Division.	N/A

Measure	Description	Status	Model Reference No.
MULTI-FAMILY MEASURES			
HET Rebates	Cash rebates of up to $125 per tank-style HET or up to $500 per flushometer HET to replace a high-flow toilet (≥ 3.5 gpf).	**Completed.** Offered until 2017. Replaced by toilet direct install program that started in 2016 and continues as of 2020. Before HET rebates, between approximately 1997 and 2000, the SFPUC provided $10 fixture sales and rebates to replace high-flow toilets with 1.6 gpf toilets. These earlier toilet incentives are not counted as active conservation measures in the SFPUC's conservation forecast models.	M6
HET Voucher	A voucher issued to eligible residents to replace their older toilets with HETs.	**Completed.** Offered 2010-2017. Replaced by new direct install program that started in 2016 open to all eligible multi- family customers and as of 2020 continues.	M8
CEE Tier 2 Rebates	Rebate for clothes washer with WF of ≤ 4.5 or lower.	**Completed.** Measure replaced by rebate for Energy Star Most Efficient to continue to drive market for most efficient clothes washers.	M10
Custom Water Use Reports	Provides customers a site-specific water use report to provide better understanding of water use patterns and trends.	**Evaluated, not offered.** The SFPUC instead provides customers reports and information on site water use through its My Account portal for those who sign up, and as part of water-wise evaluations and leak alert notifications.	M3b
HET/Fixture Install thru On-Bill Financing	On-bill financing is an alternative means to provide direct installation of water-saving fixtures such as toilets and showerheads that recovers some of agency's costs over time. The customer finances the project through water bill savings.	**Evaluated, not offered.** Multi-family market already served by SFPUC's extensive former rebate and current direct install programs. On-bill financing could potentially be considered after all SFPUC's HET incentives expire if the remaining estimated quantity of inefficient fixtures warrants it.	M9
Submetering Incentives for Multi-Family Dwelling Units	Rebate for cost of submeters installed per dwelling unit, assuming the building maintains a master meter. Submeters to be installed by the building owner, working with the California Department of Food and Agriculture, Division of Measurement Standards, with water billing conducted by a third party.	**Evaluated, not offered.** Effective 2018, California law now requires installation of submeters in all new multi-family construction and the SFPUC administers this requirement locally and because it is mandated, incentives do not apply. For existing buildings, the SFPUC continues to provide assistance with fixture and equipment replacement, maintenance and leak detection and report, as well as assistance with water use monitoring through existing tools that are easier and more economical ways for existing buildings to reduce water use.	M12, M13

Measure	Description	Status	Model Reference No.
Turf Removal Incentive	A per-square-foot rebate to replace turf with regionally appropriate plants.	**Evaluated, not offered as an independent measure.** Turf removal is provided through the SFPUC's Large Landscape Grant measure open to multi-family customers with irrigated landscapes over 10,000 square feet. Additionally, the SFPUC continues to provide educational materials, trainings, and onsite assistance through water-wise evaluations and plans to start a WBIC rebate program to help improve small landscape water efficiency.	M16
Irrigation Nozzle Distribution	Provide free irrigation nozzles to customers, such as homeowners associations and multi-family properties.	**Evaluated, not offered as an independent measure.** Nozzles are provided through the SFPUC's Large Landscape Grant measure open to multi-family customers with irrigated landscapes over 10,000 square feet.	M18
NON-RESIDENTIAL MEASURES			
HET Rebates – CII	Rebate up to $125 per tank-style toilet and up to $500 per flushometer toilet for replacing high-flow toilets (≥ 3.5 gpf) with approved HET models (≤ 1.28 gpf).	**Completed.** Offered until 2017. Ended due to Commercial Conservation Ordinance requirements for efficient fixtures. Before HET rebates, the SFPUC provided rebates to replace high-flow toilets with 1.6 gpf toilets. These earlier toilet incentives are not counted as active conservation measures in the SFPUC's conservation forecast models	N10
HET Rebates – Schools, Hotels, Muni	Rebate up to $125 per tank-style toilet and up to $500 per flushometer valve toilet for replacing high-flow toilets (≥ 3.5 gpf) with approved HET models (≤ 1.28 gpf).	**Completed.** Offered until 2017. Ended due to Commercial Conservation Ordinance requirements. Before HET rebates, the SFPUC provided rebates to replace high-flow toilets with 1.6 gpf toilets. These earlier toilet incentives are not counted as active conservation measures in the SFPUC's conservation forecast models	N11
HET Direct Install – CII	Free installation of HETs for non-residential customers. **Prerequisite:** Direct Install Audit (Measure N2).	**Completed.** SFPUC provided HET direct install programs from 2010 through 2016. Ended due to Commercial Conservation Ordinance requirements.	N12
HET Direct Install – School/Hotel	Free installation of HETs for schools or hotels in San Francisco. **Prerequisite**: Direct Install Audit (Measure N2).	**Completed.** SFPUC provided HET direct install programs that also included urinals (see N18) from 2010 through 2016. Ended due to Commercial Conservation Ordinance requirements.	N13

Measure	Description	Status	Model Reference No.
HET Voucher – CII	A voucher for HET purchase.	**Completed.** Provided between 2010 and 2015. Ended due to Commercial Conservation Ordinance requirements.	N14
HET Voucher – School/Hotel	A voucher for HET purchase.	**Completed.** Provided between 2010 and 2015. Ended due to Commercial Conservation Ordinance requirements.	N15
HEU Rebates	Rebate up to $500 per urinal for eligible commercial businesses when high-flow urinals (≥ 1.5 gpf) are replaced with HEUs.	**Completed.** Offered until 2017. Ended due to Commercial Conservation Ordinance requirements.	N17
HEU Direct Install	A program for replacing 1.5-gpf HEUs with pint-flush urinals.	**Completed.** SFPUC provided urinal direct install programs from 2010 through 2016. Ended due to Commercial Conservation Ordinance requirements.	N18
Urinal Retrofit	A turnkey program for the replacement of the flush valve only. Free product and free installation of HEU flush valves.	**Completed.** SFPUC provided urinal retrofit program from 2015 to 2017. Ended due to Commercial Conservation Ordinance requirements.	N19
Coin-Op CEE Tier 2 (WF 4.5) Rebate	Rebates for commercial high-efficiency clothes washers with a WF of ≤ 4.5. Measure discontinued.	**Completed.** Measure replaced by rebate for Energy Star Most Efficient to continue to drive market for most efficient clothes washers.	N20
Custom Water Use Reports	Provides customers a site-specific water use report to provide better understanding of water use patterns and trends.	**Evaluated, not offered.** The SFPUC instead provides customers reports and information on site water use through its My Account portal for those who sign up, and as part of water-wise evaluations and leak alert notifications.	N6b
HET/Fixture Install thru On-Bill Financing	On-bill financing is an alternative means to provide direct installation of water-saving fixtures such as toilets and showerheads that recovers some of agency's costs over time. The customer finances the project through water bill savings.	**Evaluated, not offered.** Non-residential market already extensive served by SFPUC's long-running rebate and direct install programs. On-bill financing could potentially be considered if the remaining estimated quantity of inefficient fixtures warrants it.	N16
Dipper Well Incentives	Dipper wells are small countertop sinks that use a constant flow of water to clean utensils like scoops and thermometers used in ice cream parlors, coffee shops, restaurants, cafeterias, etc.	**Evaluated, not offered.** Water utilities are beginning to study potential replacement technologies that do not use continuous flow. More study needed to confirm compliance with health requirements and what if any permits might be required.	N/A

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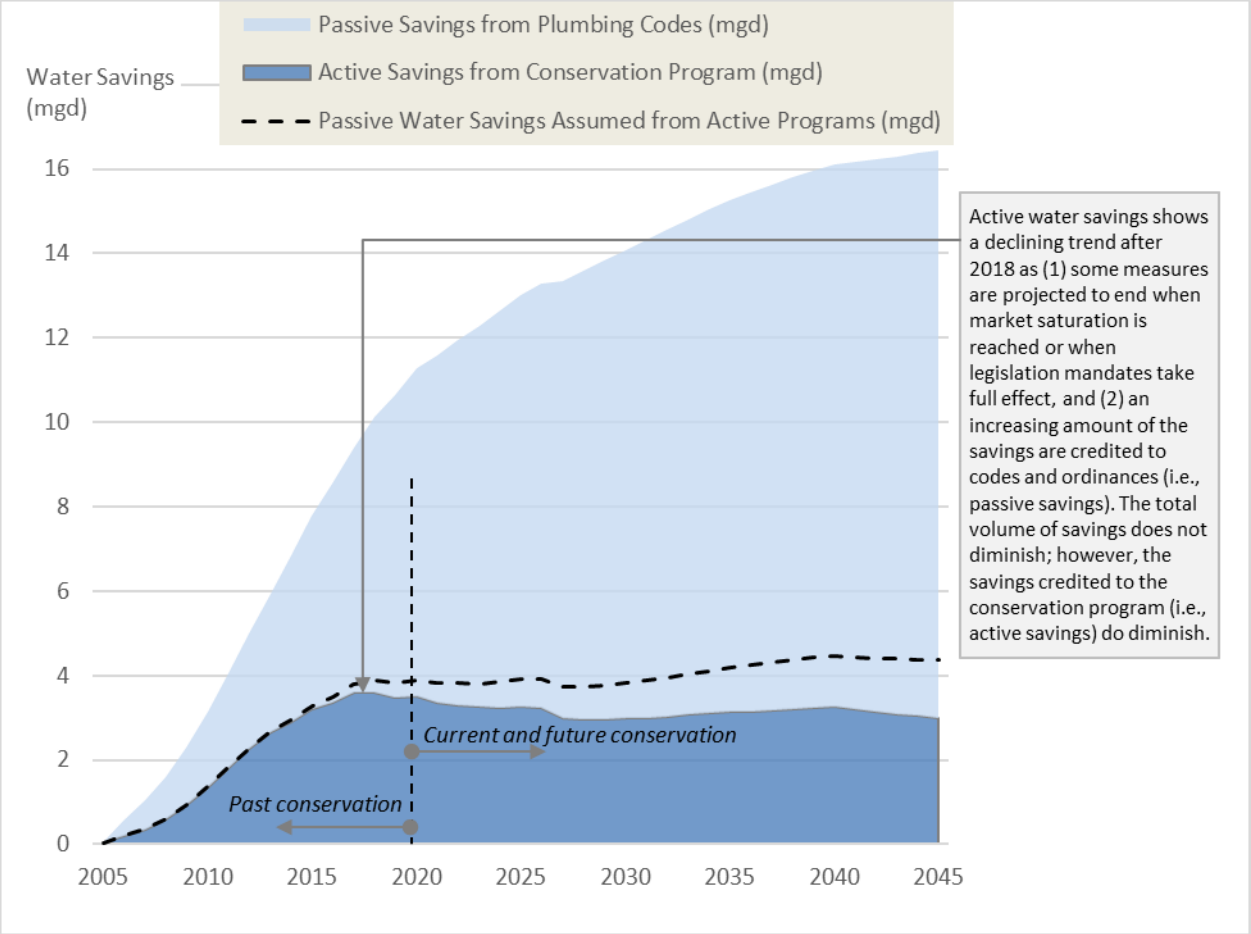
7. WATER SAVINGS AND COST

The SFPUC uses its Water Conservation Tracking Model (Conservation Model), a customization of the Alliance for Water Efficiency's (AWE's) Water Conservation Tracking Tool to estimate and project water conservation program activity, water savings, and the costs and benefits of conservation measures summarized in this *2020 Retail Water Conservation Plan*. As noted earlier in this document, the SFPUC only models water savings for measures with sufficient empirical data or industry-accepted engineering calculations for which there is a reasonable level of confidence. The SFPUC implements a number of measures that do not have modeled water savings and also implements other programs beyond conservation, including supply-side water loss and stormwater management programs that are estimated to reduce potable water use but whose savings are not included in the Conservation Model or reflected in the following savings estimates. Estimated 2020-2045 water savings for the Onsite Water Reuse Program are based on existing water budget applications and water use assumptions for known onsite water reuse projects. These estimates were determined outside of the Conservation Model, but are included in water savings and effect on demand presented in this section and Section 8. They are likely conservative estimates of future savings, because they do not include savings from future unknown onsite reuse projects. More information about the onsite reuse water budget application and water use calculator tools can be found on the SFPUC's program website: https://www.sfpuc.org/construction-contracts/design-guidelines-standards/onsite-water-reuse.

The Conservation Model contains the individual measures for which there are modeled water savings that the SFPUC has implemented in the past, is planning to implement as part of its overall current 2020 conservation program and is considering implementing in the future through 2045. The model estimates the water savings associated with each measure as a product of the estimated water savings per unit of activity and the amount of activity completed. The savings are then adjusted based on parameters such as the useful life of fixtures, annual decay, and plumbing code interaction over time. See Appendix D (SFPUC Conservation Tracking Model Water and Energy Savings Specifications for Conservation Measures) for the specific data sources and assumptions used to generate the water savings and plumbing code specifications for each measure. Some measures, such as school education programs, do not have well-defined water savings and are therefore not included in the model.

The most meaningful way to assess the overall impact of a conservation program is to consider both "active" water savings from conservation measures implemented by the utility and "passive" savings from plumbing codes. **Figure 7-1** shows the SFPUC's estimated active and passive water savings from modeled conservation measures since 2005 when we began to use a forecast model and through 2045. The key takeaway is that overall water savings continue to increase over time; active water savings show a declining trend after 2018 due to the SFPUC's conservative approach of not estimating water savings for some measures anticipated to be offered over the next 25 years but are not yet defined enough to calculate reliable savings estimates and to the fact more savings are attributed to code.

Figure 7-1: Conservation Water Savings Forecast



Note: "Active Savings" includes savings from Onsite Reuse Program.

Table 7-1 shows the estimated passive water savings by customer sector since 2005.

Table 7-1: Estimated Passive Savings (Cumulative Since 2005)

	2005 (model start year)	2010	2015	2020	2025	2030	2035	2040	2045
				million gallons per day (mgd)					
Single-Family	0.0	0.6	1.4	2.2	2.9	3.3	3.6	3.8	4.0
Multi-Family	0.0	1.0	2.5	4.2	5.2	5.9	6.4	6.8	7.1
Non-Residential	0.0	0.3	0.7	1.3	1.6	1.9	2.1	2.2	2.4
Total Passive Savings	**0.0**	**1.8**	**4.6**	**7.8**	**9.7**	**11.1**	**12.1**	**12.9**	**13.4**
				Acre-Feet per Year (AF/Yr)					
Single-Family	0	627	1,520	2,509	3,206	3,694	4,045	4,306	4,506
Multi-Family	0	1,090	2,806	4,748	5,879	6,655	7,203	7,603	7,901
Non-Residential	0	292	820	1,458	1,822	2,103	2,326	2,505	2,652
Total Passive Savings	**0**	**2,010**	**5,146**	**8,715**	**10,908**	**12,452**	**13,574**	**14,414**	**15,059**

The following tables **Table 7-2** through **Table 7-4** show the estimated active water savings by customer sector for modeled conservation measures. For ease of presentation, some measures are grouped together in a single savings estimate. The tables depict the "active" component of water savings (i.e., the amount of water savings that can be directly attributed to a conservation measure). For some measures—notably those related to toilets, urinals, and clothes washers—active water savings per unit of activity diminish over time because new fixtures are required to adhere to plumbing codes and appliance standards. In the absence of active conservation measures, these codes and standards would eventually generate some or all of the water savings created by the measures. The measures accelerate water savings so that their benefits can be realized sooner than would have otherwise been the case; however, over the long term, the codes and standards would have eventually achieved the same effect, which is why the active water savings for toilets, urinals, and washers shown in the figure decrease over time. The rate of decrease depends on the turnover rate for fixtures and appliances. Thus, the rate of decrease is faster for clothes washers than for toilets because clothes washers are normally replaced more frequently than toilets.[5]

[5] The average useful life of a clothes washer is 12 to 14 years, whereas the average useful life of a toilet is 25 to 30 years.

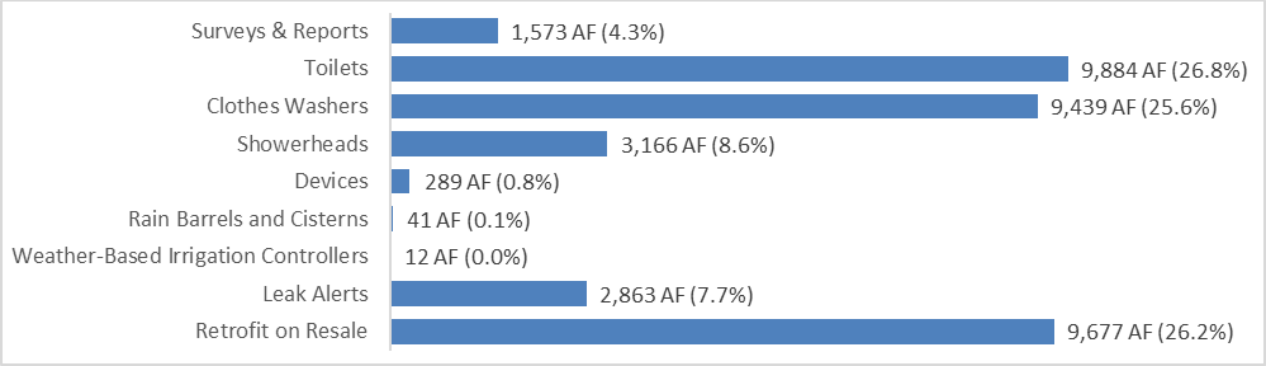
Table 7-2: Single Family Annual and Cumulative Water Savings Projection

Measure Category	Annual Water Savings in Selected Years (AF/Yr)									2005-2045 Cumulative Savings (AF)
	Past Savings			*Future Savings*						
	2005 (model start year)	2010	2015	2020	2025	2030	2035	2040	2045	
ASSISTANCE SERVICES										
Surveys & Reports	0	41	68	31	33	33	33	33	33	**1,573**
INCENTIVES										
Toilets	0	128	334	352	323	278	239	205	176	**9,884**
Clothes Washers	0	407	654	576	145	47	27	11	0	**9,439**
Showerheads	0	143	283	73	40	42	42	16	0	**3,166**
Devices	0	0	0	2	12	12	12	12	12	**289**
Rain Barrels and Cisterns	0	0	1	1	2	2	1	1	1	**41**
Weather-Based Irrigation Controllers	0	0	0	0	1	1	0	0	0	**12**
WATER MANAGEMENT TOOLS										
Leak Alerts	0	0	89	90	91	92	94	95	95	**2,863**
MANDATES										
Retrofit on Resale (ROR)[1]	0	68	190	266	305	319	317	305	287	**9,677**
Total Annual Savings (AF/Yr) [2]	**0**	**787**	**1,620**	**1,393**	**952**	**826**	**764**	**677**	**604**	**36,944**
Total Annual Savings (mgd) [2]	**0.00**	**0.70**	**1.44**	**1.24**	**0.85**	**0.74**	**0.68**	**0.60**	**0.54**	

(1) Although ROR is related to local plumbing codes, it is included as an active conservation measure in the SFPUC's conservation forecast model. Other mandates and code related to toilets, urinals, showerheads, and clothes washers are counted into plumbing code savings and are not called out as active measures. Additional standards such as requirements for efficient residential hot water systems and submetering that may generate some water savings are not factored into active or passive plumbing code changes due to insufficient data or established methodology to estimate savings.

(2) 1 mgd equals 1,121 AF/Yr. Values may show a difference of 1 AF/Yr or 0.1 mgd due to rounding.

Figure 7-2: Single Family Conservation Measures Cumulative Water Savings Projection



Note: 1 mgd equals 1,121 AF/Yr. Values may show a difference of 1 AF/Yr or 0.1 mgd due to rounding.

Table 7-3: Multi-Family Annual and Cumulative Water Savings Projection

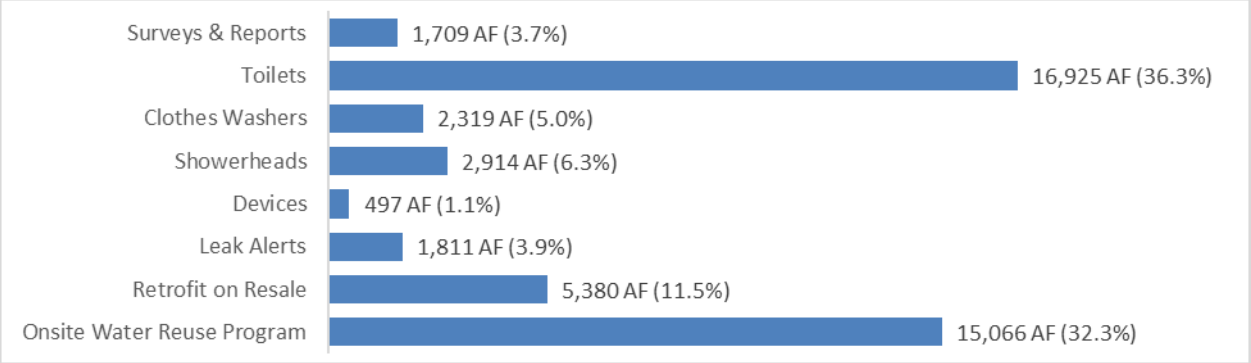
Measure Category	Annual Water Savings in Selected Years (AF/Yr)									2005-2045 Cumulative Savings (AF)
	Past Savings			*Future Savings*						
	2005 (model start year)	2010	2015	2020	2025	2030	2035	2040	2045	
ASSISTANCE SERVICES										
Surveys & Reports	0	7	147	76	22	20	20	20	20	**1,709**
INCENTIVES										
Toilets	0	153	549	616	571	490	421	361	310	**16,925**
Clothes Washers	0	2	42	81	117	124	74	30	0	**2,319**
Showerheads	0	18	194	173	63	65	65	24	0	**2,914**
Devices	0	0	0	4	21	21	21	21	21	**497**
WATER MANAGEMENT TOOLS										
Leak Alerts	0	0	0	61	65	68	72	75	75	**1,811**
MANDATES										
Retrofit on Resale (ROR)[1]	0	37	104	146	168	177	178	173	164	**5,380**
Onsite Water Reuse Program[3]	0	0	0	78	235	392	706	1,020	1,020	**15,066**
Total Annual Savings (AF/Yr) [2]	**0**	**217**	**1,035**	**1,237**	**1,262**	**1,358**	**1,557**	**1,725**	**1,610**	**46,621**
Total Annual Savings (mgd) [2]	**0.00**	**0.19**	**0.92**	**1.10**	**1.13**	**1.21**	**1.39**	**1.54**	**1.44**	

(1) Although ROR is related to local plumbing codes, it is included as an active conservation measure in the SFPUC's conservation forecast model. Other mandates and code related to toilets, urinals, showerheads, and clothes washers are counted into plumbing code savings and are not called out as active measures. Additional standards such as requirements for efficient residential hot water systems and submetering that may generate some water savings are not factored into active or passive plumbing code changes due to insufficient data or established methodology to estimate savings.

(2) 1 mgd equals 1,121 AF/Yr. Values may show a difference of 1 AF/Yr or 0.1 mgd due to rounding.

(3) Onsite Water Reuse Program estimated savings covers projects that are required to comply and projects that voluntarily comply, as well as voluntary projects that receive SFPUC grant bunding, but for ease of presentation is included under the Mandates category.

Figure 7-3: Multi-Family Conservation Measures Cumulative Water Savings Projection



Note: 1 mgd equals 1,121 AF/Yr. Values may show a difference of 1 AF/Yr or 0.1 mgd due to rounding.

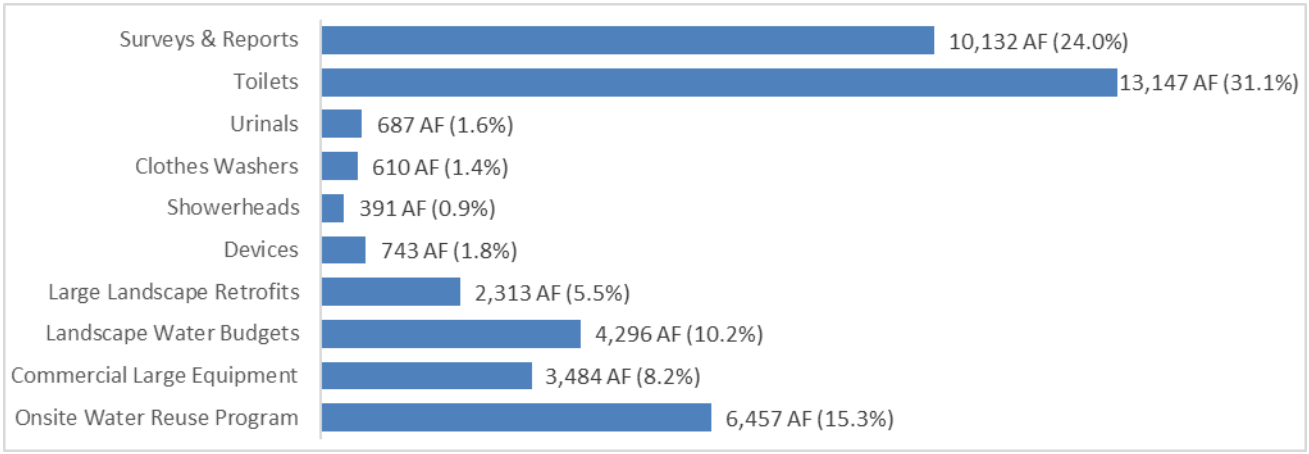
Table 7-4: Non-Residential Annual and Cumulative Water Savings Projection

Measure Category	Annual Water Savings in Selected Years (AF/Yr)									2005-2045 Cumulative Savings (AF)
	Past Savings			*Future Savings*						
	2005 (model start year)	2010	2015	2020	2025	2030	2035	2040	2045	
ASSISTANCE SERVICES										
Surveys & Reports	5	291	289	236	262	262	262	262	262	**10,132**
INCENTIVES										
Toilets	0	164	484	486	417	358	308	264	227	**13,147**
Urinals	0	3	20	26	23	20	18	17	15	**687**
Clothes Washers	0	16	27	29	21	20	11	4	0	**610**
Showerheads	0	0	0	3	18	24	24	9	0	**391**
Devices	10	10	37	58	7	9	9	7	5	**743**
Large Landscape Retrofits	35	35	61	77	81	81	55	38	0	**2,313**
Landscape Water Budgets	0	0	0	8	200	200	200	200	200	**4,296**
Commercial Large Equipment	0	0	10	330	324	9	9	9	9	**3,484**
MANDATES										
Onsite Water Reuse Program[2]	0	0	0	34	101	168	303	437	437	**6,457**
Total Annual Savings (AF/Yr) [1]	**50**	**518**	**929**	**1,285**	**1,454**	**1,152**	**1,199**	**1,248**	**1,156**	**42,260**
Total Annual Savings (mgd) [1]	**0.04**	**0.46**	**0.83**	**1.15**	**1.30**	**1.03**	**1.07**	**1.11**	**1.03**	

(1) 1 mgd equals 1,121 AF/Yr. Values may show a difference of 1 AF/Yr or 0.1 mgd due to rounding.

(2) Onsite Water Reuse Program covers projects that are required to comply and projects that voluntarily comply, but for ease of presentation is included under the Mandates category.

Figure 7-4: Non-Residential Conservation Measures Cumulative Water Savings Projection



Note: 1 mgd equals 1,121 AF/Yr. Values may show a difference of 1 AF/Yr or 0.1 mgd due to rounding.

Unit Costs of Water Savings

Table 7-5 shows the estimated total cost to the SFPUC to implement each measure (Present Value Cost), the estimated lifetime water savings from each measure in acre feet (Discounted Savings) and each measure's cost per acre foot of water saved (Unit Cost). Present value is a typical measurement that indicates the total cost of the program in today's dollars, while unit cost indicates the present cost per unit of water. Present value and unit cost calculations assume a nominal discount rate of 5 percent and a long-term inflation rate of 3 percent.

The unit cost is defined as an unvarying price which if applied to the volume of saved water over the life of the forecast would exactly recover the present value cost of generating the water savings. Algebraically this price (or unit cost) can be determined by discounting project costs to their present value, discounting water savings to their present value, and then dividing the former by the latter. The unit cost is analogous to a fixed mortgage payment on a loan which is calculated so that it exactly recovers the present value of the loan over the loan's repayment period.

To provide an accurate estimate of the cost of program water savings, the present value of program costs is divided by the discounted cumulative water savings. The average unit cost of water savings across all the SFPUC's retail measures is **$906/AF**. The average unit cost is $546/AF for single family residential measures, $428/AF for multi-family residential measures, and $2,027/AF for non-residential measures. These estimates do not reflect the Onsite Water Reuse Program.

Table 7-5: Unit Costs by Conservation Measure and Customer Sector

Conservation Measure Category	Present Value Cost ($1,000)	Discounted Savings (AF)	Unit Cost ($/AF)
Single Family Residential			
ASSISTANCE SERVICES			
Surveys & Reports	$1,920	1,149	$1,671
INCENTIVES			
Toilets	$4,467	7,703	$580
Clothes Washers	$3,960	7,524	$526
Showerheads	$175	2,489	$70
Devices	$297	180	$1,651
Rain Barrels	$327	29	$11,259
Weather-Based Irrigation Controllers	$64	8	$8,039
WATER MANAGEMENT TOOLS			
Leak Alerts	$183	1,790	$102
All Single-Family Measures:	**$11,392**	**20,872**	**$546**
Multi-Family Residential			
ASSISTANCE SERVICES			
Surveys & Reports	$1,009	1,291	$782
INCENTIVES			
Toilets	$5,878	13,148	$447
Clothes Washers	$539	1,530	$352
Showerheads	$142	2,126	$67
Devices	$511	309	$1,653
WATER MANAGEMENT TOOLS			
Leak Alerts	$254	1,068	$237
All Multi-Family Measures:	**$8,332**	**19,472**	**$428**
Non-Residential			
ASSISTANCE SERVICES			
Surveys & Reports	$2,077	7,139	$291
INCENTIVES			
Clothes Washers	$341	442	$771
Showerheads	$21	238	$88
Devices	$667	563	$1,184
Large Landscape Retrofits	$20,816	1,637	$12,716
Landscape Water Budgets	$6,351	2,443	$2,600
Commercial Large Equipment	$120	2,529	$47
All Non-Residential Measures:	**$30,392**	**14,991**	**$2,027**
All Measures:	**$50,116**	**55,335**	**$906**

The unit costs for a measure do not necessarily mean the SFPUC spends more on a yearly basis to implement that particular measure compared to measures with lower unit costs, and a higher unit cost does not necessarily mean the measure does not have as much value as one with a lower unit cost. For example, single family audits typically generate savings in conjunction with other measures, particularly the replacement of plumbing fixtures, and the water savings are primarily captured through these latter measures. Additionally, residential rainwater and graywater measures have a higher unit cost due to limited data available on water savings. The SFPUC, however, issues a much lower volume of these incentives than toilet and washer incentives and as such spends less a year administering the reuse incentives. The reuse measures also add value in aligning with the SFPUC's mission of diversifying the conservation program and encouraging the use of non-potable water for irrigation needs and helping with the collection of cost and water savings data for use in evaluating similar types of projects in the future.

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8. Conservation Effect on Retail Water Demand

The SFPUC used demand projections generated from its Retail Demand Model that was prepared in 2020 for its 2020 UWMP for the demand numbers presented in this 2020 Plan. The retail water demand forecast shows the effect of active conservation savings on water use over time and helps the SFPUC assess its compliance with GPCD targets. As shown in the tables and figures in this section, the SFPUC's retail per capita water use is expected to decline and remain low despite steady population and employment growth, which is due in large part to its water conservation efforts.

Table 8-1 presents the water demand projections for each of the three customer sectors and for the in-city retail service area. There are four projections included in the table:

1. **Unadjusted Baseline Demand:** This is the gross retail water demand forecast and does not include reductions in demand due to SFPUC active conservation measures. This forecast is driven by population growth, employment growth, and various socioeconomic factors. Passive savings from plumbing codes and appliance standards are assumed to be included in this value (see detailed explanation below).

2. **SFPUC Program Adjustment:** This is the forecast of future water savings from SFPUC-initiated water conservation programs (i.e., active conservation savings). The adjustment is presented as a negative value, indicating a deduction from the Unadjusted Baseline Demand.

3. **Onsite Water Reuse Program Adjustment:** This is a forecast of future water savings from buildings with onsite water reuse systems. The adjustment, like the SFPUC Program Adjustment, is presented as a negative value, indicating a deduction from the Unadjusted Baseline Demand.

4. **Adjusted Demand:** This is the water demand after accounting for both active water savings from SFPUC program adjustments and the Onsite Water Reuse Program.

The table below also includes distribution system losses, which represents the unallocated water in the distribution system. The SFPUC annually conducts water loss audits to estimate its distribution system losses, in accordance with the DWR guidelines. 2020 system water losses presented in the table were taken from the SFPUC's FY 19-20 water loss audit to DWR; projected water losses are based on the anticipation of leaks and breaks due to aging infrastructure and active management of losses.

The adjusted demand divided by the corresponding population projection is the gross per capita water use of the in-city retail system, or GPCD. It is used to assess the SFPUC's expected compliance with the conservation goals set forth by SB X7-7 and progress toward meeting its urban water efficiency targets that will become effective in 2023.

The SFPUC also tracks its residential per capita water use in addition to the overall gross per capita water use. Residential per capita water use, or R-GPCD, is calculated by dividing residential demand by residential population, whereas the gross per capita water use, or GPCD, is calculated by dividing total demand by total population, which includes people living in both households and group quarters.

Earlier chapters of this 2020 Plan describe the effect of historical and future water savings from plumbing codes and appliance standards (i.e., passive conservation savings). The SFPUC's 2020 Retail Demand Model does not explicitly adjust for passive savings using outputs from the Conservation Model. Instead, the Retail Demand Model estimates the relationship between water use and various demand factors (primarily price, weather, and presence of drought) using a regression analysis with account-level fixed effects. In a regression analysis, changes in the explanatory variable—customer water use—are explained by the dependent variables, such as rates, climate, and macro-economic factors. While savings from active conservation programs and the Onsite Water Reuse Program are explicitly modeled, passive savings are

assumed to be accounted for in the econometric analysis of changes in water demand in response to factors like price and weather. There are always inherent challenges in adjusting for and projecting conservation effects on demands. Specifically, care needs to be taken not to double-count savings from conservation programs with consumers' responses to rates, drought, and climate. Whether passive savings are explicitly modeled or not, there is the potential for some level of over- or under-estimation of passive savings. To be conservative for water planning purposes, the Retail Demand Model estimation of passive savings is likely on the lower end (i.e., not over-projecting).

After adding in active conservation and Onsite Water Reuse Program historical savings to historical demands, the 2020 Retail Demand Model arrives at an estimate of "pre-conservation" demand, which describes what demand would have been but-for SFPUC's conservation programs. The statistical demand model predicts future demand based on this "pre-conservation" data. In the last step of the Retail Demand Model, active conservation savings and Onsite Water Reuse Program savings are added back in to generate the final demand estimates. **Table 8-1** summarizes the outputs of the 2020 Retail Demand Model.

Table 8-1: SFPUC In-City Retail Water Demands for 2020-2045

	2020	2025	2030	2035	2040	2045
Single-Family	million gallons per day (mgd)					
Unadjusted Baseline Demand	14.45	13.83	13.63	13.60	13.63	13.65
Adjustments:						
SFPUC Conservation Program	0.00	-0.15	-0.18	-0.17	-0.13	-0.11
Adjusted Demand	**14.45**	**13.68**	**13.45**	**13.43**	**13.49**	**13.54**
Multi-Family						
Unadjusted Baseline Demand	22.92	24.04	26.15	28.66	31.33	34.00
Adjustments:						
SFPUC Conservation Program	0.00	-0.15	-0.20	-0.18	-0.11	-0.06
Onsite Reuse Program[4]	-0.07	-0.21	-0.35	-0.63	-0.91	-0.91
Adjusted Demand	**22.85**	**23.68**	**25.60**	**27.85**	**30.31**	**33.03**
Non-Residential						
Unadjusted Baseline Demand	14.89	17.49	17.57	17.73	18.17	18.62
Adjustments:						
SFPUC Conservation Program	0.00	-0.28	-0.30	-0.30	-0.28	-0.23
Onsite Reuse Program[4]	-0.03	-0.09	-0.15	-0.27	-0.39	-0.39
Adjusted Demand	**14.86**	**17.12**	**17.11**	**17.16**	**17.51**	**18.00**
Total Adjusted Demand	**52.15**	**54.47**	**56.16**	**58.44**	**61.31**	**64.57**
Municipal Demand[5]	2.60	2.50	2.50	2.30	2.30	2.30
Landscape Demand[5]	3.40	3.30	3.30	3.30	3.30	3.30
Water Loss	7.18	6.00	6.00	6.00	6.00	6.00
Total In-City Retail Demand	**65.33**	**66.27**	**67.96**	**70.04**	**72.91**	**76.17**
In-City Retail Population (1,000)	**898**	**1,003**	**1,064**	**1,126**	**1,188**	**1,249**
In-City Residential Population (1,000)	**870**	**973**	**1,033**	**1,092**	**1,152**	**1,212**
Gross Per Capita Use (GPCD)	**73**	**66**	**64**	**62**	**61**	**61**
Residential GPCD (R-GPCD)	**43**	**38**	**38**	**38**	**38**	**38**

Notes:

(1) System losses for 2016-2040 are estimated based on historical losses and will be updated upon completion of the water loss study.

(2) Active savings from the SFPUC conservation program was zero in 2005, the starting year of the model. The table does not reflect the savings achieved from conservation activities prior to 2005.

(3) Sum of demands and adjustments may not match the totals due to rounding.

(4) While the Onsite Water Reuse Program is considered a measure in the SFPUC's overall conservation program for purposes of water savings, to highlight its size and focus on new development, it is separately highlighted in this table.

(5) "Landscape" includes all dedicated irrigation accounts across sectors. "Municipal" includes all standard, combination, fire, and otherwise non-irrigation accounts for municipal departments.

Table 8-2 summarizes the various water uses by in-city and suburban retail customers to provide another perspective on the breakdown of the retail demands. Historical water billing data and census data were used to estimate the suburban water use and population, respectively.

Table 8-2: Retail Water Demand Projections with Water Conservation

	2020	2025	2030	2035	2040	2045
Adjusted In-City Retail Demands			million gallons per day (mgd)			
Single Family Residential	14.5	13.7	13.5	13.4	13.5	13.5
Multi-Family Residential	22.9	23.7	25.6	27.9	30.3	33.0
Non-Residential	14.9	17.1	17.1	17.2	17.5	18.0
Municipal	2.6	2.5	2.5	2.3	2.3	2.3
Landscape	3.4	3.3	3.3	3.3	3.3	3.3
Water Loss (1)	7.2	6.0	6.0	6.0	6.0	6.0
In-City Retail Demand Subtotal (2)	**65.3**	**66.3**	**68.0**	**70.0**	**72.9**	**76.2**
Suburban Retail Demands(3)						
Single Family Residential	0.1	0.1	0.1	0.1	0.1	0.1
Non-Residential	3.1	4.0	4.0	4.0	4.0	4.0
Other	0.3	0.3	0.3	0.3	0.3	0.3
Suburban Retail Demand Subtotal (2)	**3.5**	**4.4**	**4.4**	**4.4**	**4.4**	**4.4**
Total Retail Demand (2)	**68.8**	**70.7**	**72.4**	**74.5**	**77.4**	**80.6**
Combined Retail Population (1,000)	**900**	**1,005**	**1,066**	**1,128**	**1,190**	**1,251**
Combined Retail Residential Population (1,000)	**872**	**975**	**1,034**	**1,094**	**1,154**	**1,214**
Gross Per Capita Use (GPCD)	**77**	**70**	**68**	**66**	**65**	**64**
Residential GPCD (R-GPCD)	**43**	**38**	**38**	**38**	**38**	**38**

Notes:

(1) System losses for 2021-2040 are estimated based on the anticipation of leaks and breaks due to aging infrastructure and active management of losses.

(2) Sum of demands may not match the totals due to rounding.

(3) Large facilities and residential houses outside of San Francisco that receive water from and are billed directly by the SFPUC.

Figure 8-1 graphically illustrates the effect of the SFPUC's water conservation program on the overall retail water demand. Demand reflects projected water use and includes all retail customers within and outside of San Francisco. Projections show that water savings from conservation will not outpace anticipated population and job growth; thus, demand is forecasted to increase. In the absence of active water conservation program efforts, retail demand is projected to increase by 19 percent over the next 25 years, from 68.9 mgd in 2020 to 82.3 mgd in 2045. However, after accounting for the projected savings from water conservation, the retail demand would only increase by about 17 percent, from 68.8 mgd in 2020, to 80.6 mgd in 2045.

Figure 8-1: Effect of Water Conservation on Retail Water Demand

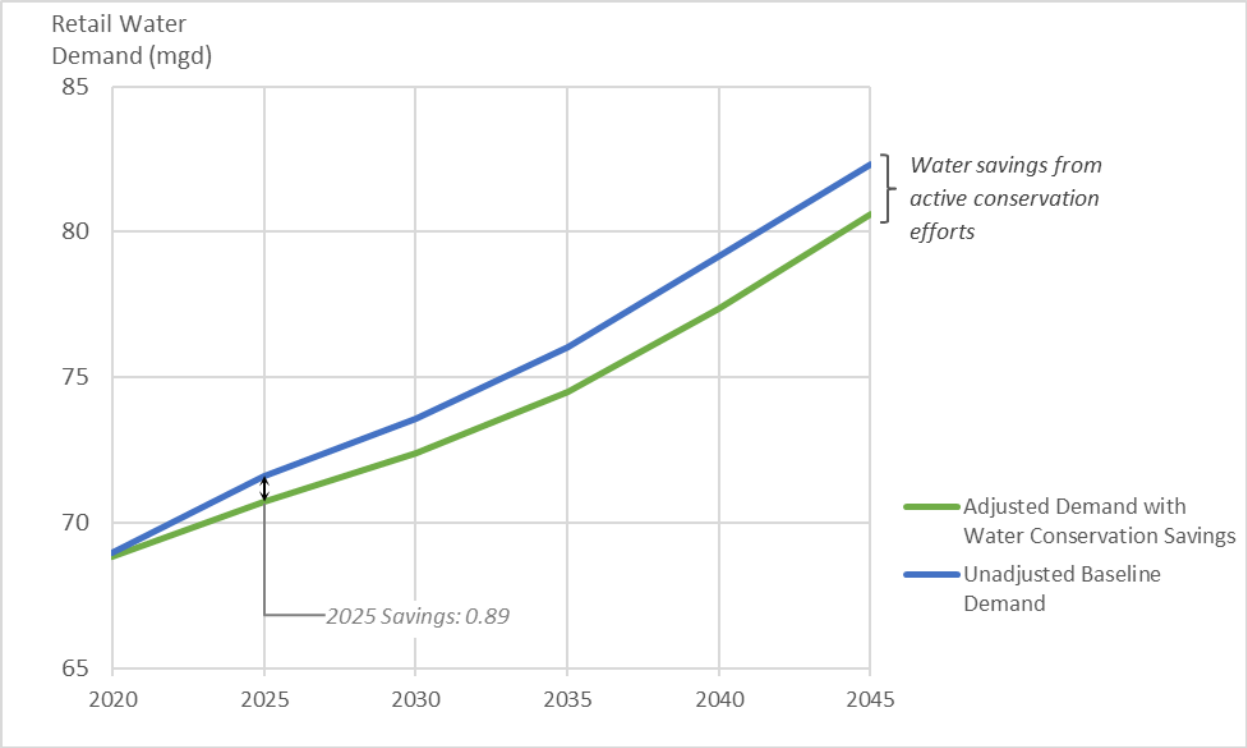
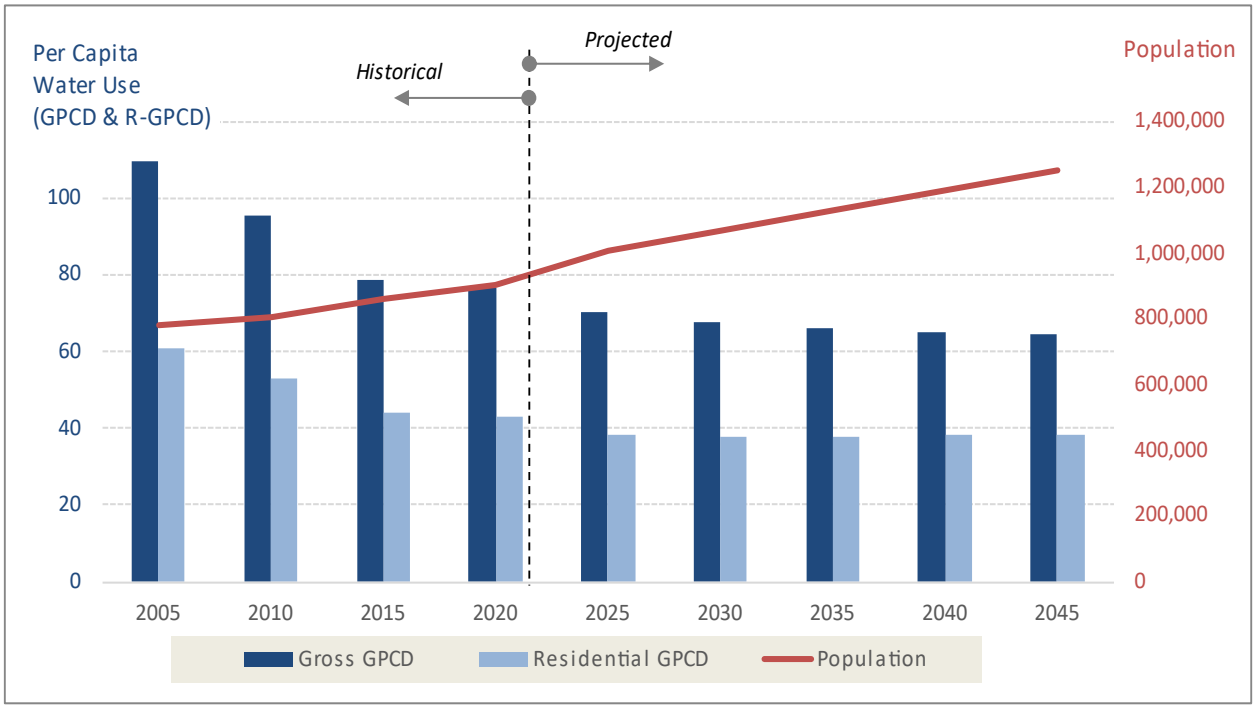


Figure 8-2 shows the effect of the SFPUC's water conservation effort in terms of per capita water use. Like the previous figure, this figure reflects actual water use and historical population estimates for years through 2020 and projected water use and population for years after 2020.

Figure 8-2: Historical and Projected Population and Per Capita Water Use Trends



While the SFPUC's retail service area population is expected to grow by over 39 percent over the next 25 years (from 899,700 in 2020 to 1,251,200 in 2045), the retail per capita water use is estimated to decrease and remain low. The SFPUC's retail residential per capita water use for FY 19-20 is 42.9 R-GPCD, which is one of the lowest in the state of California. Through continuous aggressive conservation efforts, the SFPUC expects to maintain low residential water usage.

9. NEXT STEPS

The SFPUC plans to continue implementing a robust conservation program and meeting conservation goals established under SB X7-7, the AB 1668/SB 606 new state urban water efficiency targets, other local and state water efficiency requirements, and the SFPUC's own level of service goals for efficient water use. The conservation program outlined in this 2020 Retail Water Conservation Plan includes an extensive mix of incentives, services, and tools that serves all customer sectors, as well as foundational customer assistance measures, such as water evaluation surveys, site usage reports and tools, free devices, and public education and outreach. These foundational measures will continue to be offered with no definite end date. Fixture incentive measures for toilets are expected to be phased out by 2025 because of codes, as well as high market saturation rates.

The SFPUC will continue to evaluate and adapt its conservation measures to respond to changing conditions and regulations. This dynamic approach to conservation has contributed to significant reductions in water demand, despite population growth. As a result, the SFPUC currently has one of the lowest residential water use levels in the state of California. In 2005, gross per capita water use was 102.8 gallons per capita per day (GPCD) and residential per capita water use was 59.1 R-GPCD. In 2020, these figures dropped to 76.3 GPCD and 42.9 R-GPCD due in large part to increasingly more efficient plumbing fixtures and are expected to remain much lower than the statewide average. These figures indicate that the SFPUC is already in compliance with its SB X7-7 target for 2020 and well positioned to meet its new urban water efficiency targets that become effective in 2023.

Between now and issuance of the 2025 Retail Water Conservation Plan, the SFPUC plans to continue to review its forecasted conservation savings against actual program activity on a quarterly and annual basis. The SFPUC has committed to updating its conservation savings model and conduct a major review of implemented and potential new conservation measures every five years, coinciding with its update of its UWMP. Moving forward, the SFPUC will use this 2020 Plan and the findings as a broad guidance document to inform the implementation of conservation measures over the next five years. The levels of funding, resources, and public participation for each conservation measure will change over time; thus, the recommendations contained herein will be revisited and adapted as needed to meet the SFPUC's needs and to ensure its conservation goals are met.

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APPENDIX A

SFPUC Plumbing Fixture Population and Efficiency Saturation Estimates - 2019 Update

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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

5358 MILES AVENUE
OAKLAND, CA 94618
PH: 510-547-4369
FX: 510-547-3002
MITCHELL@MCUBED-ECON.COM

Date: **August 19, 2019**

To: **Julie Ortiz and Kevin Galvin, SFPUC**
Fr: **David Mitchell, M.Cubed**
Cc: **Chris Hewes, Woodard & Curran**

Re: **Review of Recent Evidence on Plumbing Fixture Ownership, Turnover, and Saturation**

I. Introduction

This memo summarizes the results of research and analysis conducted by M.Cubed for the purpose of updating SFPUC's plumbing fixture population and efficiency saturation forecast model. SFPUC uses this model to estimate plumbing fixture water use and savings potential. This memo addresses subtasks 2.1-2.5 in our Scope of Work. Collectively, these subtasks entailed:

- Review and analysis of data on plumbing fixture ownership, turnover, and saturation, with a focus on data and research published since 2014 when the current fixture population and efficiency saturation forecast model was developed.
- Review and analysis of residential and commercial property affidavit and inspection data related to administration and enforcement of San Francisco's residential and commercial water conservation ordinances.
- Preparation of a technical memorandum summarizing findings and recommendations for updating the plumbing fixture population and efficiency saturation forecast model.

Multiple reports and data sources were reviewed for this analysis. Key among these were:

- 2019 U.S. WaterSense Market Penetration Report
- 2016 Residential End Uses of Water Study
- 2015 and 2017 American Housing Survey public use files
- US Census American Community Survey data
- AWE Saturation Study of Non-Efficient Water Closets in Key States (2017)
- LADWP Water Conservation Potential Study (2017)
- CEC Analysis of Standards Proposal for Toilets & Urinals Water Efficiency (2013)
- EBMUD Water Conservation Market Penetration Study (2002)
- Orange County Saturation Study (2002)
- San Francisco Residential and Commercial Water Conservation Ordinances affidavit and inspection data

Analytical findings are divided into three broad categories according to whether they are germane to:

- Estimation of the stock of plumbing fixtures

- Turnover/replacement rates of plumbing fixtures
- Estimation and benchmarking the market penetration of efficient plumbing fixtures

II. Estimation of Plumbing Fixture Stocks

This section presents findings germane to the estimation of the stock of residential and commercial plumbing fixtures.

A. Residential Toilets

The plumbing fixture population and efficiency saturation forecast model calculates the stock of residential toilets by multiplying a forecast of single- and multi-family housing units by estimates of the mean number of toilets per housing unit. The estimates currently used in the model are 2.21 and 1.38 toilets per housing unit for single- and multi-family housing, respectively. These estimates were derived from 2011 American Housing Survey (AHS) summary tables (M.Cubed 2014).

A problem with the 2011 AHS was that it top-coded the number of bathrooms per housing unit in its summary tables. That is, rather than fully enumerating the distribution of housing units by number of bathrooms, it grouped housing units according to whether they had one bathroom, one and half bathrooms, or two or more bathrooms. Homes in the first two categories can reasonably be assumed to have one and two toilets, respectively. However, it was not possible to infer the mean number of toilets for homes with two or more bathrooms. We dealt with this by assuming that the mean number of toilets was 2.75 for homes in this category, though this was largely conjecture on our part.

For this update, we use individual response data available with the 2015 and 2017 AHS to test the validity of this assumption. The individual response data also are top-coded but at the higher threshold of four bathrooms. Respondents with four or more bathrooms account for only two percent of the sample. Thus top-coding is much less of an issue. Additionally, whereas we previously applied the 2.75 assumption to both single- and multi-family households, the individual response data allows us to deal with top-coded response data separately for single- and multi-family households.

As before, the estimates are for the San Francisco-Oakland-Hayward statistical area. Table 1 compares our estimates using the 2015 and 2017 individual response data to our previous estimates. We find a close correspondence between the original and updated single-family estimate but not the multi-family estimate. The original multi-family estimate is about 10% greater and falls outside of the updated estimate's 95% confidence interval. This occurs because the original multi-family estimate assumed 2.75 toilets in households with two or more toilets whereas the 2015/17 individual response data indicate the true value is about 2.15 toilets.

Updating the plumbing fixture population and efficiency saturation forecast model with the new estimates would reduce the forecast of the stock of multi-family toilets by approximately 10%.

Table 1. Updated and Original Estimates of Mean Number of Toilets per Housing Unit

	Updated	Original
Single-Family	2.22 [2.19 to 2.24]	2.21
Multi-Family	1.26 [1.24 to 1.28]	1.38
Note: Updated estimates estimated with 2015 and 2017 AHS public use file individual response data. Original estimates estimated with 2011 AHS summary table data. 95% confidence interval in brackets. Estimates are for the San Francisco-Oakland-Hayward statistical area.		

B. Residential Clothes Washers

The plumbing fixture model calculates the stock of residential in-unit clothes washers by multiplying a forecast of single- and multi-family housing units by estimates of the ownership rate of in-unit clothes washers. Ownership rates currently used in the model are 92.2% and 40.9% for single- and multi-family housing, respectively. These estimates were derived from 2011 American Housing Survey (AHS) and American Community Survey (ACS) summary data (M.Cubed 2014).

We use individual response data available with the 2015 and 2017 AHS to test the accuracy of these estimates. Results are provided in Table 2. The single-family estimates are within two percent of each other. However, the multi-family estimates differ by almost 20%.

Updating the plumbing fixture model would reduce the stock of multi-family in-unit clothes washers by about 20%.

Table 2. Updated and Original Estimates of In-Unit Clothes Washer Ownership Rates

	Updated	Original
Single-Family	0.937 [0.928 to 0.946]	0.922
Multi-Family	0.343 [0.321 to 0.365]	0.409
Note: Updated estimates estimated with 2015 and 2017 AHS public use file individual response data. Original estimates estimated with 2011 AHS summary table data. 95% confidence intervals in brackets. Estimates are for the San Francisco-Oakland-Hayward statistical area.		

The plumbing fixture model also estimates the stock of multi-family common area washers. The estimate is based on laundry room equipment guidelines published by the Multi-Family Laundry Association as described in M.Cubed (2014). Our review did not uncover any new information that would enable us to improve on this estimate.

The plumbing fixture model combines the ownership rate for in-unit multi-family washers with the prevalence of common area washers to estimate the average number of washers per multi-family housing unit. The estimate currently used in the model is 0.47 washers per multi-family housing unit. Updating the multi-family in-unit clothes washer ownership rate would result in a combined estimate of

0.41. Overall, then, updating the multi-family estimates would reduce the stock of multi-family clothes washers by approximately 13%.

C. Non-residential Toilets

The stock of non-residential toilets in the plumbing fixture model is calculated using the CUWCC CII toilet count methodology, as described in M.Cubed (2014). The estimate for 2018 is 162,450, which corresponds to roughly 9.2 toilets per *meter*.[1] DBI affidavit and inspection data show, on average, 13.5 toilets per *building*. We expect toilets per building to be greater than toilets per meter since some buildings have multiple meters. Associating the buildings in the DBI dataset with the meters serving these buildings would allow us to cross-check our toilet per meter assumption. However, this data is not currently available to us.

D. Non-residential Urinals

The plumbing fixture model currently uses a urinal-to-toilet ratio of 0.25 to estimate the number of urinals. The ratio is taken from Koeller (2006). The CEC used this ratio in its analysis of proposed standards for toilets and urinals water efficiency (CEC 2013). DBI's commercial conservation ordinance affidavit and inspection data, however, suggest the ratio for San Francisco buildings is 0.15.[2] This is actually the assumption that was used in the original Retail Demand Model. However, the basis for that assumption was unknown and therefore it was updated to 0.25 to be consistent with Koeller (2006) and CEC (2013).

EBMUD and SCVWD inspected samples of non-residential buildings in the early 2000s (EBMUD 2001, SCVWD 2008). These surveys did not utilize sample designs that allow reliable inferences for the general population of non-residential buildings. It is nonetheless useful to compare the observed ratios of urinals to toilets in these samples to the DBI data. The ratio for the SCVWD sample is 0.14 while for the EBMUD survey it is 0.29. The SCVWD data are in alignment with the DBI data while the EBMUD data are not.

Overall the evidence is mixed, but we are inclined to give more weight to the DBI data since it is specific to San Francisco and encompasses a large sample of the total building stock. Updating the plumbing fixture model with this estimate would reduce the forecast of the stock of urinals by 40%.

E. Non-residential Clothes Washers

The plumbing fixture model's stock of non-residential clothes washers is based on an estimates of the number of laundromats in San Francisco and the average number of washers per laundromat. Our review did not identify new information that would enable us to improve this estimate.

III. Turnover/replacement Rates of Plumbing Fixtures

This section presents findings germane to assumptions about the turnover/replacement rates of plumbing fixtures.

A. Residential Toilets

There are three ways in which existing inefficient toilets are replaced in the plumbing fixture model: (1) SFPUC toilet replacement programs, (2) the residential water conservation ordinance via resale of

[1] The SFPUC 2018 Water and Wastewater Cost of Service Study reports 17,585 CII meters.
[2] The mean estimate is 0.15; 95% CI [0.12 to 0.17].

residential property, and (3) natural replacement (e.g. bathroom remodels, replacement of broken toilets, etc.). The first is determined by historical and forecast program participation. The second is governed by an assumption about the average rate of resale of residential property. The third is governed by an assumption about the average rate of natural replacement.

a) Natural Replacement Rate

The plumbing fixture model currently assumes a 3.1% natural replacement rate for single- and multi-family toilets. This rate is the average rate of replacement from two empirical studies of toilet replacement in the Bay Area, one done for EBMUD and the other done for SCVWD.

We use individual response data from the 2015 and 2017 AHS to test the validity of this assumption. The AHS asks respondents if a bathroom has been remodeled in the last two years. The proportion of households answering yes is shown in Table 3. We infer the annual remodel rate by dividing these estimates by two. This annual rate is consistent with the model's 3% assumption for single-family but not for multi-family homes.

Previous research has found that broken toilets are the most common reason given for replacing a toilet in multi-family households while bathroom remodels are the most common reason given in single-family households (MWD 2002). This suggests the toilet replacement rate in multi-family would be greater than the bathroom remodel rate.

It is uncertain, however, that higher rates of replacement of broken toilets would equilibrate the rates for single- and multi-family homes. Earlier research has generally concluded that multi-family toilet replacement rates are 20 to 35% lower than single-family replacement rates (M.Cubed 2004, MWD 2002). This suggests a lower toilet replacement rate than 3% for multi-family homes may be a better assumption for the model – perhaps a rate in the neighborhood of 2.5%.

Table 3. Proportion of households remodeling bathroom within last two years

Housing Type	Last 2 Years	Inferred Annual Rate
Single-family	0.051 [0.043 to 0.060]	0.026 [0.022 to 0.030]
Multi-family	0.013 [0.009 to 0.020]	0.007 [0.005 to 0.010]
All housing types	0.036 [0.031 to 0.042]	0.018 [0.016 to 0.021]
Note: Estimated with 2015 and 2017 AHS public use file individual response data. 95% confidence intervals in brackets. Estimates are for the San Francisco-Oakland-Hayward statistical area.		

b) Resale Rate

The plumbing fixture model currently assumes a resale rate of 2.4% for single-family and 1.1% for multi-family. The single-family rate is derived from 2008-2012 sales data and estimates of the housing stock from the American Community Survey (ACS). Similar data was not available for multi-family. The multi-family rate is assumed to be half the single-family rate.

We updated the single-family estimate with sales and ACS data for 2013-2017. The mean estimate of 2.8% is not statistically different from the previous estimate of 2.4%.[3] Thus we do not find strong evidence to revise the resale parameter values based on these data.

[3] The 95% CI of the new estimate is 2.1-3.5%.

We also calculated the single-family resale rate based on the tabulated number of DBI resale inspections. The mean rate based using this data is 1.7%.[4] However, note that the number of annual inspections averages just 58% of the number of resales in San Francisco estimated with Multiple Listing Service (MLS) and ACS data. We suspect the DBI data undercount the number of property resales and therefore do not recommend changing the resale rate assumption based on this data.

B. Residential Clothes Washers

The plumbing fixture model assumes that 7.1% of stock of residential clothes washers is replaced each year. We looked at the validity of this assumption in two ways. First, we compared it to the average rate of turnover derived from household survey data collected for the 2016 Residential End Uses of Water Study (WRF 2016). Second, we compared the model's forecast of the proportion of households with high-efficiency clothes washers to the estimate from the 2016 Residential End Uses of Water Study derived from data-logging. These comparisons are shown in Table 4. The household survey data imply an annual turnover rate of 6.1 to 6.4%, suggesting the model's assumption of 7.1% may be too high. On the other hand, the two estimates of the proportion of homes with high-efficiency clothes washers closely match, which indicates the turnover assumption is approximately correct. Since the model closely corresponds to the data-logging evidence, we see no compelling reason to revise the clothes washer replacement rate assumption.

Table 4. Residential Clothes Washer Turnover Estimates

	REUWS 2016	Model Forecast
Surveyed households saying they had replaced washer in last 10 years	62% [61 to 64%] n = 4612	71%
Implied annual rate of turnover	6.1 to 6.4%	7.1%
Proportion of data-logged households with high-efficiency clothes washer in 2012	51.6% [47.7 to 55.4%] n = 673	51.5%
Note: 95% confidence intervals in brackets. Data logging occurred primarily in the fourth quarter of 2012. Some logging spilled into January of 2013. Thus logging results indicate the level of saturation at the end of 2012 was about 52%, which corresponds almost exactly to the model's estimate for the same period. Also note that the reus2016 report states that washer saturation is 46% in 2012. This estimate, however, does not square with the actual data-logging event data that was distributed with the study. The event data show that saturation is 55% if outlier observations are included and 52% if they are removed.		

C. Non-residential Toilets and Urinals

The plumbing fixture model assumes a natural replacement rate of 3% for non-residential toilets and urinals, which matches the assumption used for residential toilets. Other studies have assumed different rates of replacement, as summarized in Table 5. None of the estimates have a strong empirical basis. They are generally based on assumptions about average fixture life. The AWE, SCVWD, and CEC reports, for example, assume average fixture life of 25, 20, and 12.5 years, respectively. The PMI

[4] The 95% CI is 1.3-2.1%.

estimate is a weighted average of fixture life for the installed base of toilets and urinals across eleven building types where the fixture lives range from 15 to 50 years.[5]

Table 5. Non-residential toilet and urinal replacement rates assumed in other studies

Study	Toilets	Urinals
PMI (2019)	3%	3%
AWE (2017)	4%	4%
CEC (2013)*	8%	8%
SCVWD (2008)	5%	5%
* Estimate is from D&R International (2005), Plumbing Fixtures Market Overview: Water Savings Potential for Residential and Commercial Toilet and Urinals.		

EBMUD and SCVWD surveyed non-residential toilets in the early 2000s. These studies provide some insight into non-residential plumbing fixture turnover/replacement rates as described next. However, they are based on small and non-representative samples which greatly limit the ability to make valid inferences to the general population.

EBMUD (2002) inspected 1,745 toilets and 346 urinals at 536 non-residential sites. A tabulation of this data is provided in Table 6. These data show that at least 47% of inspected toilets were rated 1.6 gpf or less and 23% of inspected urinals were rated 1 gpf or less at the time of the survey in 2001. Note, however, that flush rating was not determined for a large proportion of the sample, especially in the case of urinals. If, for example, half of the urinals with unknown flush rating were 1 gpf or less, then the proportion of high-efficiency urinals in the sample would be similar to that of toilets.

Table 6. EBMUD (2002) Sample Frequencies for Inspected Toilets and Urinals

Toilet Rated Flush Volume	Freq.	Percent	Cum.
1.6 gpf or less	831	47.59	47.59
3.5 gpf	367	21.04	68.62
More than 3.5 gpf	247	14.17	82.79
Unknown	300	17.21	100.00
Total	1,745	100.00	
Urinal Rated Flush Volume	Freq.	Percent	Cum.
1 gpf or less	80	23.12	23.12
1-2 gpf	71	20.52	43.64
2-3 gpf	14	4.05	47.69
More than 3 gpf	9	2.60	50.29
Unknown	172	49.71	100.00
Total	346	100.00	

If we assume this sample is representative of the general population of non-residential toilets, the 95% confidence interval for the proportion of non-residential toilets that were ULF compliant is 44 to 51% in

[5] Average fixture life for each building type are based on interviews with leading plumbing fixture manufactures.

2001. The SFPUC model estimates 32% saturation in 2001 given a 3% natural replacement rate. Increasing the rate to 5% changes the saturation estimate to 46%, which falls within the above range.

SCVWD (2008) inspected 731 toilets in 220 non-residential buildings in 2004. Sixty percent of the toilets flushed less than 2 gallons, suggesting they were ULF compliant. If we assume this sample is representative of the general population of non-residential toilets, the 95% confidence interval for the proportion of non-residential toilets that were ULF compliant is 56 to 64% in 2004. The SFPUC model estimates 39% saturation in 2004 given a 3% natural replacement rate. Increasing the rate to 5.25% changes the saturation estimate to 56%, which falls within the above range.

Thus a natural replacement rate in the neighborhood of 5% yields ULF toilet saturation estimates that are consistent with both the EBMUD and SCVWD survey results. This provides some evidence that the current 3% assumption may be too low. However, as noted above inferences based on these data should be interpreted with caution since sample sizes are relatively small and may not be representative of the overall population of non-residential buildings.

D. Non-residential Clothes Washers

The plumbing fixture model assumes that 7.1% of stock of non-residential clothes washers is replaced each year. This rate was selected to match the assumption used for residential clothes washers. We note that other models assume commercial washers have a shorter useful life than residential washers. For example, models used by the Energy Department for the analysis of federal commercial clothes washer energy and water efficiency standards assume a useful life of 7.5 years, equivalent to a replacement rate of 13.3%. The AWE conservation tracking tool uses a 9 year useful life (11.1%), which is the average reported in FEMP (2000) and Coin Laundry Association (2008).

IV. Benchmarks of Market Penetration of Efficient Plumbing Fixtures

This section reviews plumbing fixture model estimates of saturation to available empirical estimates.

A. Residential Toilets

We compare the plumbing fixture model saturation forecast for 2012 to Residential End Uses of Water Version 2 (WRF 2016) estimates in Table 1.[6] The model forecast falls within the 95% confidence interval for surveyed California households. Note that the model also closely tracked saturation benchmarks for 1997 and 2005 (M.Cubed 2014).

LADWP conducted telephone surveys of a statistically representative random sample of single-family customers and site-inspections for a sub-sample of these households to gather data on the penetration of high-efficiency plumbing fixtures (LADWP 2017). It also fielded an on-line survey to multi-family building owners and managers. Saturation estimates from these surveys are compared to the plumbing fixture model forecast. We expect saturation rates in LA to be higher than in San Francisco due to the large number of toilets that were replaced in LA through utility rebate programs in the 1990s and early 2000s. Results are shown in Table 8.

Overall we conclude that the model forecast is consistent with available empirical benchmarks.

[6] Surveys and data-logging for the end use study took place primarily in 2012.

Table 7. Proportion of Single-Family Toilets that are High-Efficiency in 2012

Source of estimate	Proportion of toilets that were high-efficiency in 2012
SFPUC model	0.67
2016 end uses of water study household survey	
Full North America sample (n = 5,796)	0.58 [0.57 to 0.60]
California sample (n = 416)	0.64 [0.59 to 0.68]
Note: 95% confidence intervals in brackets.	

Table 8. Los Angeles Saturation of High-Efficiency Toilets circa 2017

	Single-family	Multi-family
SFPUC model	0.79	0.80
LADWP Surveys		
Single-family (n = 615)	0.88 [0.86 to 0.91]	
Multi-family (n = 4,025)		0.86 [0.85 to 0.87]
Note: 95% confidence intervals in brackets.		

B. Residential Clothes Washers

The model's predicated saturation of high-efficiency clothes washers in single-family homes closely matches saturation estimates from the 2016 residential end uses of water study, as shown in Table 9.[7] The model also tracks the saturation estimate from the LADWP single-family household survey, as shown in Table 10.[8]

While multi-family households were asked if they had an energy star labeled clothes washer in the 2011 AHS, this question was dropped from the 2015 and 2017 AHS. Our review did not find other recent empirical estimates of saturation of high-efficiency clothes washers in multi-family housing so we are unable to compare the model's forecast to empirical benchmarks for this sector.

[7] Single-family homes were data logged in ten locations throughout North America. No homes in California were data logged in this study, however.

[8] The onsite inspections found a lower proportion of high-efficiency clothes washers than reported by households through the telephone survey, indicating that some households answered the high-efficiency washer question incorrectly. We note, however, that the telephone survey's saturation estimate is consistent with what we would expect based on the 2016 end uses of water study's data logging results which are not subject to this type of survey response bias.

Table 9. Proportion of Single-Family Clothes Washers that are High-Efficiency in 2012

Source of estimate	Proportion of Clothes Washers that are high-efficiency in 2012
SFPUC model	0.52
2016 end uses of water data-logged households (n = 673)	0.52 [0.48 to 0.55]
Note: 95% confidence intervals in brackets. Data logging occurred primarily in the fourth quarter of 2012. Some logging spilled into January of 2013. Thus logging results indicate the level of saturation at the end of 2012 was about 52%, which matches the model's estimate for the same period. Also note that the reus2016 report states that washer saturation is 46% in 2012. This estimate, however, does not square with the actual data-logging event data that was distributed with the study. The event data show that saturation is 55% if sample outlier observations are included and 52% if they are excluded.	

Table 10. Proportion of Single-Family Clothes Washers that are High-Efficiency in 2017

Source of estimate	Proportion of Clothes Washers that are high-efficiency in 2017
SFPUC model	0.67
LADWP single-family survey (n = 615)	0.62 [0.58 to 0.66]
Note: 95% confidence intervals in brackets.	

C. Non-residential Toilets and Urinals

SFPUC's and LADWP's estimates of the saturation of high-efficiency toilets in non-residential buildings are similar: 77 versus 81% circa 2017. LADWP used data from previous studies and interviews with CII industry experts to construct its estimate. Our review did not uncover other recent empirical estimates of saturation of high-efficiency non-residential toilets and urinals.

D. Non-residential Clothes Washers

Our review did not uncover any recent empirical estimates of saturation of high-efficiency non-residential clothes washers.

V. Summary of Findings

This section summarizes our principal findings.

A. Estimation of Plumbing Fixture Stocks

- The current parameterization of the model may result in an overestimate of the stock of multi-family toilets by approximately 10% based on data from the two most recent AHS surveys. This issue does not extend to the single-family sector where the current parameterization is in agreement with AHS data.

- Data from the two most recent AHS surveys suggest the current parameterization of the model may result in an overestimate of multi-family clothes washers by approximately 13%.

- No new information was uncovered that would support revising the estimate of the stock of non-residential toilets. However, if the number of meters associated with buildings in the DBI dataset could be determined, we could cross-check model assumptions with the DBI data.

- The current parameterization of the model may overestimate of the stock of urinals in non-residential buildings by as much as 40%. The model currently assumes there is one urinal for every four non-residential toilets (0.25). This assumption is based on Koeller (2006) and also used in CEC (2013). DBI data, however, suggest the ratio for San Francisco buildings is one urinal for every 6.67 non-residential toilets (0.15).

- Our review did not uncover new data supporting revision to the estimate of the stock of non-residential clothes washers.

B. Turnover/replacement Rates of Plumbing Fixtures

- The current parameterization of the model may overestimate the rate of natural replacement of toilets in multi-family housing. The current model assumes turnover rates are the same for single- and multi-family housing. However, lower turnover rates in multi-family housing were reported in previous studies (M.Cubed 2004, MWD 2002). AHS data also show lower bathroom remodel rates in multi-family housing compared to single-family housing. Together, these data suggest the toilet replacement rate may be lower in multi-family than in single-family housing.

- The single-family resale rate assumption in the model is consistent with available data on the single-family property turnover in San Francisco.

- Our review did not uncover new data supporting revision to the estimate of residential natural replacement of clothes washers.

- The current parameterization of the model may underestimate the rate of natural replacement of toilets and urinals in non-residential buildings. The evidence is mixed, however. On the one hand, data from surveys conducted by EBMUD and SCVWD in the early 2000s imply a replacement rate of 5% instead of 3%. On the other hand, the current model specification yields toilet saturation estimates that match recent estimates developed for Los Angeles.

- The current parameterization of the model may underestimate the turnover rate of non-residential clothes washers. Currently the model assumes turnover rates are the same for residential and non-residential clothes washers. However, other studies have assumed that non-residential washers turnover more frequently. Whereas the model currently assumes a turnover rate of 7.1%, the AWE conservation tracking tool assumes 11.1% and models used by the Department of Energy assume 13.3%. Because the estimated stock of non-residential

washers in the model is very small, modifying the current assumption would have a negligible impact on overall model results.

C. Benchmarks of Market Penetration of Efficient Plumbing Fixtures

- On balance, we find the model closely aligns with available empirical and model-based estimates of plumbing fixture saturation levels:
    - The model's forecast of residential toilet and clothes washer saturation levels closely aligns with evidence from recent household surveys and data logging (WRF 2016, LADWP 2017).
    - It also closely aligns with model-based estimates of non-residential toilet saturation in Southern California (LADWP 2017).
    - Its performance with respect to non-residential clothes washers remains uncertain, since we did not find any recent empirical estimates of saturation for this sector.

D. Impact of Model Parameter Adjustments on Model Estimates

The impact on fixture saturation and plumbing code water savings due to model parameter adjustments are summarized in this section. Based on the forgoing, the following parameter adjustments were made to the model:

- SFR and MFR toilet ownership rates were updated to 2.22 and 1.26, per Table 1.
- SFR and MFR washer ownership rates were updated to 0.937 and 0.410, per Table 2 and supporting text.
- The ratio of urinals to non-residential toilets was reduced from 0.25 to 0.15, per Section II.D.
- CII washer turnover rate was increased from 7.1% to 12.2%, per Section III.D. This is the average of the turnover rates assumed by AWE (11.1%) and DOE (13.3%).

Table 11 provides a before/after comparison of toilet population and efficiency saturation estimates.

Table 13 provides a before/after comparison of urinal population and efficiency saturation estimates.

Table 13 provides a before/after comparison of washer population and efficiency saturation estimates.

Table 14 provides a before/after comparison of plumbing code adjustments to In-City Retail Demands

Table 11. Toilet Population and Efficiency Saturation Estimates Before/After Toilet Parameter Update

Before Update

			Year / Tally													
			2015		2018		2020		2025		2030		2035		2040	
Fixture	Class	Values	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)
Toilets	Single Family	Quantity	64,698	186,600	52,968	200,168	47,232	207,129	35,736	221,724	27,038	233,560	20,457	243,316	15,478	251,509
		%	26%	74%	21%	79%	19%	81%	14%	86%	10%	90%	8%	92%	6%	94%
	Multi Family	Quantity	85,909	264,149	70,769	287,394	63,637	299,929	49,357	334,344	38,282	366,432	29,692	395,195	23,029	422,923
		%	25%	75%	20%	80%	18%	82%	13%	87%	9%	91%	7%	93%	5%	95%
	Non Residential	Quantity	51,092	108,398	43,911	118,538	41,240	123,183	35,414	135,667	30,411	147,719	26,115	159,618	22,426	171,286
		%	32%	68%	27%	73%	25%	75%	21%	79%	17%	83%	14%	86%	12%	88%
Toilets Quantity			201,699	559,147	167,648	606,101	152,109	630,241	120,507	691,736	95,731	747,710	76,264	798,129	60,933	845,718
Toilets %			27%	73%	22%	78%	19%	81%	15%	85%	11%	89%	9%	91%	7%	93%

Notes: Efficient toilets = 1.6 gpf or less. Total numbers of fixtures per year includes existing and projected fixture growth.

After Update

			Year / Tally													
			2015		2018		2020		2025		2030		2035		2040	
Fixture	Class	Values	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)	Inefficient (3.5+ gpf)	Efficient (<= 1.6 gpf)
Toilets	Single Family	Quantity	65,058	187,328	53,272	200,960	47,504	207,958	35,942	222,633	27,193	234,532	20,575	244,340	15,567	252,576
		%	26%	74%	21%	79%	19%	81%	14%	86%	10%	90%	8%	92%	6%	94%
	Multi Family	Quantity	77,059	241,536	63,170	262,802	56,773	274,117	44,034	305,182	34,153	334,187	26,489	360,210	20,545	385,326
		%	24%	76%	19%	81%	17%	83%	13%	87%	9%	91%	7%	93%	5%	95%
	Non Residential	Quantity	51,092	108,398	43,911	118,538	41,240	123,183	35,414	135,667	30,411	147,719	26,115	159,618	22,426	171,286
		%	32%	68%	27%	73%	25%	75%	21%	79%	17%	83%	14%	86%	12%	88%
Toilets Quantity			193,208	537,263	160,353	582,300	145,517	605,258	115,389	663,482	91,757	716,437	73,179	764,168	58,538	809,188
Toilets %			26%	74%	22%	78%	19%	81%	15%	85%	11%	89%	9%	91%	7%	93%

Notes: Efficient toilets = 1.6 gpf or less. Total numbers of fixtures per year includes existing and projected fixture growth.

Table 12. Urinal Population and Efficiency Saturation Estimates Before/After Urinal Parameter Update

Before Update

			Year		Tally											
			2015		2018		2020		2025		2030		2035		2040	
Fixture	Class	Values	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)
Urinals	Non Residential	Quantity	35,307	4,565	31,962	8,650	30,073	11,033	25,825	16,946	22,177	22,356	19,044	27,390	16,354	32,074
		%	89%	11%	79%	21%	73%	27%	60%	40%	50%	50%	41%	59%	34%	66%
Urinals Quantity			35,307	4,565	31,962	8,650	30,073	11,033	25,825	16,946	22,177	22,356	19,044	27,390	16,354	32,074
Urinals %			89%	11%	79%	21%	73%	27%	60%	40%	50%	50%	41%	59%	34%	66%

Notes: Efficient urinals = 0.5 gpf or less. Total number of fixtures per year includes existing and projected fixture growth.

After Update

			Year		Tally											
			2015		2018		2020		2025		2030		2035		2040	
Fixture	Class	Values	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)	Inefficient (> 0.5 gpf)	Efficient (<= 0.5 gpf)
Urinals	Non Residential	Quantity	20,596	3,328	18,535	5,832	17,440	7,223	14,976	10,686	12,861	13,859	11,044	16,816	9,484	19,573
		%	86%	14%	76%	24%	71%	29%	58%	42%	48%	52%	40%	60%	33%	67%
Urinals Quantity			20,596	3,328	18,535	5,832	17,440	7,223	14,976	10,686	12,861	13,859	11,044	16,816	9,484	19,573
Urinals %			86%	14%	76%	24%	71%	29%	58%	42%	48%	52%	40%	60%	33%	67%

Notes: Efficient urinals = 0.5 gpf or less. Total number of fixtures per year includes existing and projected fixture growth.

Table 13. Washer Population and Efficiency Saturation Estimates Before/After Washer Parameter Update

Before Update

			Year / Tally													
			2015		2018		2020		2025		2030		2035		2040	
Fixture	Class	Values	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)
Clothes Washers	Single Family	Quantity	39,616	65,191	37,283	68,291	34,499	71,585	23,817	83,560	16,442	92,243	11,351	98,659	7,836	103,514
		%	38%	62%	35%	65%	33%	67%	22%	78%	15%	85%	10%	90%	7%	93%
	Multi Family	Quantity	57,482	61,832	54,522	67,555	49,810	74,110	34,387	96,395	23,739	114,205	16,389	128,431	11,314	140,686
		%	48%	52%	45%	55%	40%	60%	26%	74%	17%	83%	11%	89%	7%	93%
	Non Residential	Quantity	2,718	3,150	2,484	3,384	2,186	3,682	1,509	4,359	1,042	4,826	719	5,149	497	5,371
		%	46%	54%	42%	58%	37%	63%	26%	74%	18%	82%	12%	88%	8%	92%
Clothes Washers Quantity			99,816	130,174	94,289	139,229	86,495	149,377	59,713	184,314	41,223	211,274	28,459	232,239	19,647	249,571
Clothes Washers %			43%	57%	40%	60%	37%	63%	24%	76%	16%	84%	11%	89%	7%	93%

Notes: Efficient clothes washers = WF 6.0 or less. Total number of fixtures per year includes existing and projected fixture growth.

After Update

			Year / Tally													
			2015		2018		2020		2025		2030		2035		2040	
Fixture	Class	Values	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)	Inefficient (> 6 WF)	Efficient (<= 6 WF)
Clothes Washers	Single Family	Quantity	40,650	65,875	38,250	69,054	35,379	72,444	24,424	84,713	16,862	93,605	11,641	100,172	8,036	105,139
		%	38%	62%	36%	64%	33%	67%	22%	78%	15%	85%	10%	90%	7%	93%
	Multi Family	Quantity	49,923	53,747	47,330	58,741	43,223	64,448	29,839	83,794	20,600	99,256	14,221	111,609	9,818	122,251
		%	48%	52%	45%	55%	40%	60%	26%	74%	17%	83%	11%	89%	7%	93%
	Non Residential	Quantity	2,419	3,449	2,214	3,654	1,843	4,025	962	4,906	502	5,366	262	5,606	137	5,731
		%	41%	59%	38%	62%	31%	69%	16%	84%	9%	91%	4%	96%	2%	98%
Clothes Washers Quantity			92,992	123,071	87,794	131,449	80,445	140,917	55,226	173,413	37,963	198,228	26,124	217,388	17,991	233,122
Clothes Washers %			43%	57%	40%	60%	36%	64%	24%	76%	16%	84%	11%	89%	7%	93%

Notes: Efficient clothes washers = WF 6.0 or less. Total number of fixtures per year includes existing and projected fixture growth.

Table 14. Plumbing Code Adjustment to In-City Retail Demand Before/After Toilet Parameter Update

Before Update

In-City Retail	2005	2010	2015	2020	2025	2030	2035	2040
Adjustments								
Plumbing Code	-3.8	-4.9	-6.9	-9.5	-12.5	-14.9	-17.0	-18.9
SFPUC Programs	-0.1	-1.2	-2.6	-2.7	-1.7	-1.2	-1.0	-0.9
Total Adjustments	-3.9	-6.1	-9.5	-12.1	-14.2	-16.2	-18.1	-19.8

After Update

In-City Retail	2005	2010	2015	2020	2025	2030	2035	2040
Adjustments								
Plumbing Code	-3.8	-4.9	-6.9	-9.4	-12.4	-14.8	-16.9	-18.7
SFPUC Programs	-0.1	-1.2	-2.6	-2.7	-1.7	-1.2	-1.0	-0.9
Total Adjustments	-3.9	-6.1	-9.5	-12.1	-14.1	-16.0	-17.9	-19.6

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APPENDIX B

SFPUC Plumbing Fixture Population and Efficiency Saturation Estimates - 2014 Base Study

POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

5358 MILES AVENUE
OAKLAND, CA 94618
PH: 510-547-4369
FX: 510-547-3002
MITCHELL@MCUBED-ECON.COM

TO: WINOLA CHEONG

FROM: DAVID MITCHELL

SUBJECT: SFPUC PLUMBING FIXTURE POPULATION AND EFFICIENCY SATURATION ESTIMATES

DATE: JANUARY 13, 2014

I. SUMMARY OF RESULTS

Estimates of fixture populations and percentage of remaining inefficient fixtures are summarized in Table 1. Population estimates in Table 1 have been rounded to the nearest thousand. The data and methods used to develop these estimates are presented in the remainder of this memorandum.

Table 1. Summary of Fixture Population and Percentage Inefficient

Fixture	Fixture Population* Circa 2012	Percentage Inefficient	Inefficient Population*
Toilets			
Single-Family	252,000	33%	83,000
Multi-Family	321,000	32%	103,000
CII	154,000	40%	62,000
Urinals	39,000	75%	29,000
Washers			
Single-Family	105,000	49%	52,000
Multi-Family In-Unit	95,000	54%	51,000
Multi-Family Common Laundry	15,000	No Estimate	
Coin-Op	1,000	No Estimate	
*Fixture population estimates rounded to nearest thousand.			

II. INTRODUCTION

Fixture population and efficiency saturation estimates are developed for the following categories of plumbing fixtures:

- Single Family Residential Toilets
- Multi Family Residential Toilets
- Single Family Residential Clothes Washers
- Multi Family Residential In-Unit Clothes Washers
- Multi Family Residential Common Laundry Clothes Washers
- CII Toilets

- CII Urinals
- CII Coin-Op Clothes Washers

The population estimates represent the estimated total number of devices within each fixture category as of 2012. The efficiency saturation estimates represent the fraction of the estimated population of devices estimated to be high-efficiency fixtures. High-efficiency fixtures within each fixture category are defined as follows:

- Toilets: flush rating of 1.6 gpf or less
- Urinals: flush rating of 0.5 gpf or less
- Clothes Washers: Energy Star designation

Where possible, the efficiency saturation estimates are benchmarked against estimates from other independent sources of information.

III. SINGLE-FAMILY RESIDENTIAL TOILETS

A. FIXTURE POPULATION

We estimate of the number of single family toilets as the product of the number of single family dwelling units for the City and County of San Francisco and the average number of toilets per single family dwelling unit.

The number of single family dwelling units in 2012 is taken from the American Community Survey (ACS) 1-Year Estimates for 2012. For the purposes of this analysis, single family dwelling units are taken to be 1-unit detached and 1-unit attached (e.g. condominiums) dwelling units. The estimated total number of such dwelling units in 2012 is 113,878.
The average number of toilets per single family dwelling unit is estimated using bathroom count data from the 2011 American Housing Survey (AHS) for the San Francisco, San Mateo, Redwood City survey region. The AHS estimates the percentage of dwelling units with 0, 1, 1.5, or 2 or more bathrooms. For purposes of this analysis, a bathroom is assumed to have one functioning toilet. For dwelling units with 2 or more toilets, it is necessary to estimate the average number of toilets, since this is left undefined by the survey. We assume most dwelling units in the city would have either 2 or 3 toilets and a much smaller percentage would have 4 or 5 toilets. We use the distribution in Table 2 to estimate the average. This yields an average of 2.75 toilets per dwelling unit for households with 2 or more toilets.

Table 2. Assumed Distribution of Toilets in Single-Family Dwelling Units with 2 or More Toilets

Number of Toilets in Dwelling Units with 2 or More	% of Dwelling Units
2	45%
3	40%
4	10%
5	5%

The distribution of dwelling units by number of bathrooms is then used to calculate the average number of toilets per dwelling unit for 1-unit detached and 1-unit attached dwelling units, as shown in Table 3.

Table 3. Average Toilets Per 1-Unit Detached and 1-Unit Attached Dwelling Units

		% of Dwelling Units	
# Bathrooms	# Toilets	1, detached	1, attached
0	0	0.0%	0.2%
1	1	20.1%	31.9%
1.5	2	9.9%	19.0%
2 or more	2.75	70.0%	49.0%
Total		100.0%	100.0%
Average # Toilets		2.32	2.04

Lastly, the weighted average number of toilets for single-family dwelling units is calculated using the proportion of 1-unit detached and 1-unit attached dwelling units from the 2012 ACS data, as shown in Table 4. This yields as estimate of 2.21 toilets per single-family dwelling unit.

Table 4. Average Toilets Per Single-Family Dwelling Unit

Dwelling Unit	Avg. Toilets Per Unit	% of Units	Weighted Toilets
1, detached	2.32	59.5%	1.383
1, attached	2.04	40.5%	0.827
Single-Family (rounded)			2.210

Table 5 shows the resulting population estimate of single-family toilets in 2012 and compares it to the estimated population currently in the Retail Demand Model. We estimate the current stock of single-family toilets in San Francisco is 251,720 toilets, or rounding, about 252,000 toilets. The estimate exceeds the Retail Demand Model estimate by about 38,000 toilets. There are two reasons for the difference.

- First, the Retail Demand Model currently uses an average of 2 toilets per single-family unit whereas the 2012 ACS and 2011 AHS data suggest the average is somewhat greater than this, at 2.21 toilets per unit.

- Second, the Retail Demand Model does not adjust the stock of single-family housing units over time. Rather it sets it to the estimated number of units in 2005 and holds it there. This is a legacy model issue and it is not clear why an assumption of a static housing stock was adopted by SFPUC when the model was first developed. According to the 2005 ACS there were approximately 110,494 occupied single-family housing units in 2005, whereas in 2012 there were 113,878, a difference of 3,384 units. The Retail Demand Model uses an estimate of 106,722 single-family dwelling units, which is lower than the 2005 ACS estimate.

Table 5. Estimated Population of Single-Family Toilets in 2012

Variable	Value
Single-Family Units in 2012	113,878
Avg. Toilets Per Unit (rounded)	2.21
Total Single-Family Toilets in 2012	251,720
Retail Demand Model Single-Family Toilet Estimate	213,444

B. PERCENTAGE OF EFFICIENT TOILETS

We use a model of toilet turnover to estimate the percentage of single-family toilets in 2012 that have a flush rating of 1.6 gpf or less. The model operates on an annual time-step and runs from 1990 to 2012. The model assumes that all toilets in 1990 were rated 3.5 gpf or more.[1] It then estimates the replacement of existing toilets and the addition of new toilets (due to growth in the housing stock) over the 1991-2012 period based on four factors, as follows:

- **Toilets in new housing**. Starting in 1991, the model assumes toilets installed in new housing have a flush rating of 1.6 gpf or less, consistent with plumbing code requirements that went into effect in California in 1991. The distribution of housing units by year built, as reported in the 2012 ACS, is used to estimate the stock of single-family housing units in 1990 as well as the addition of new housing units in years after 1990.

- **SFPUC toilet replacement programs**. The model uses data reported to the CUWCC to adjust the stock of 3.5+ toilets for toilet conversions by SFPUC toilet replacement programs. The CUWCC data show that 41,559 single-family toilets were replaced by SFPUC programs between 1995 and 2012.

- **Retrofit on resale ordinance**. Starting in 2009, the model adjusts the stock of 3.5+ gpf toilets in response to the City's adoption of its retrofit-on-resale ordinance. The model uses an average single-family resale rate of 2.4%. The resale rate is derived from estimates of the single-family housing stock for the years 2009-2012 and the number of existing single-family units sold annually over this period, as reported by The Real Estate Market Trends Report website. The model assumes that efficient and non-efficient toilets are equally likely to be involved in a property resale. The model estimates that the ordinance resulted in the conversion of 9,561 3.5+ toilets over the period 2009-2012.

- **Natural replacement.** The model assumes that in any given year the residual stock of 3.5+ toilets (i.e., 3.5+ toilets not converted by SFPUC toilet programs or the retrofit on resale ordinance) may convert to an efficient toilet for other reasons, such as bathroom remodeling, device failure, etc. The model assumes a rate of natural replacement of 3.0%. This rate is the average rate of replacement from two empirical estimates of toilet replacement rate in the Bay Area, one done for EBMUD and the other done for SCVWD. The model estimates that natural replacement converted 103,896 3.5+ toilets over the period 1991-2012.

[1] Low-flow toilets were in existence prior to 1990 and a small percentage of toilets had likely already been converted to low-flow in 1990. However, the vast majority of toilets had not yet converted and we adopt the zero conversion assumption for modeling convenience.

Model results are summarized in Table 6, which shows the estimated percentage of 3.5+, ULFT, and HET toilets in each year. As of 2012, the model estimates that 2 out of every 3 toilets in single-family dwelling units are efficient. One-third of existing toilets are estimated to be 3.5+ gpf. Thus, of the estimated 251,720 single-family toilets, we estimate 83,184 have flush ratings of 3.5 gpf or more.

Table 6. Percentage of Single-Family Toilets by Efficiency Level

Year	3.5+ gpf	ULFT	HET	Total
1990	100%	0%	0%	100%
1991	97%	3%	0%	100%
1992	93%	7%	0%	100%
1993	90%	10%	0%	100%
1994	87%	13%	0%	100%
1995	84%	16%	0%	100%
1996	79%	21%	0%	100%
1997	74%	26%	0%	100%
1998	70%	30%	0%	100%
1999	66%	34%	0%	100%
2000	63%	37%	0%	100%
2001	60%	40%	0%	100%
2002	58%	42%	0%	100%
2003	55%	45%	0%	100%
2004	53%	47%	0%	100%
2005	51%	49%	0%	100%
2006	49%	51%	0%	100%
2007	47%	53%	0%	100%
2008	45%	54%	0%	100%
2009	42%	57%	1%	100%
2010	39%	59%	2%	100%
2011	36%	61%	3%	100%
2012	33%	63%	4%	100%

The model estimates closely correspond to empirical saturation estimates for 1997 and 2005 developed by the Residential End Uses of Water (REUWS) studies. This is shown in Table 7. The 1997 REUWS estimate is the average saturation of efficient toilets for three California cities -- Las Virgenes, Lompoc, and San Diego -- included in the national REUWS study. The two 2005 estimates are for California and San Francisco. The correspondence between the model and the REUWS estimates provides strong evidence the model estimates are reasonably accurate.

Table 7. Comparison of Model Results to REUWS Estimates

	Percentage of Efficient Toilets[1]			
Year	**Model**	**REUWS National Study[2]**	**REUWS California Study**	**REUWS San Fran. Study**
1997	26%	28%		
2005	49%		46%	47%
1. Efficient toilets are toilets with a flush rating of 1.6 gpf or less. 2. Avg. saturation for cities of Lompoc, Las Virgenes, and San Diego.				

IV. MULTI-FAMILY RESIDENTIAL TOILETS

A. FIXTURE POPULATION

As with the single-family estimate, 2012 ACS and 2011 AHS data are used to estimate the number of multi-family toilets in 2012. For the purposes of this analysis, multi-family dwelling units are defined as dwelling units in buildings with 2 to 4, 5 to 9, 10 to 19, 20 to 49, or 50 or more dwelling units per structure (excluding condominiums). The ACS data show there were 232,004 dwelling units meeting these criteria in 2012, as shown in Table 8.

Table 8. Multi-Family Dwelling Units in 2012

Units in Structure	Number of Units
2 to 4	71,046
5 to 19	72,366
20 to 49	34,916
50 or more	53,676
Grand Total	232,004

Bathroom count data from the 2011 AHS are then used to estimate the average number of toilets, as shown in Table 9.

Table 9. Average Toilets per Dwelling Unit by Number of Units per Structure

		% of Dwelling Units by Number of Units Per Structure			
# Bathrooms	**# Toilets**	**2 to 4**	**5 to 19**	**20 to 49**	**50 or more**
0	0	1.9%	0.9%	4.7%	4.7%
1	1	63.3%	77.2%	73.9%	71.4%
1.5	2	11.2%	7.7%	3.6%	1.5%
2 or more	2.75	23.6%	14.3%	17.8%	22.4%
Total		100.0%	100.0%	100.0%	100.0%
Average Toilets		1.51	1.32	1.30	1.36

Lastly, the weighted average number of toilets for multi-family dwelling units is calculated using the distribution of dwelling units by number of units per structure from Table 8 and the toilet averages from Table 9. This calculation, shown in Table 10, yields an estimate of 1.38 toilets per multi-family dwelling unit.

Table 10. Average Toilets Per Single-Family Dwelling Unit

Dwelling Unit	Avg. Toilets Per Unit	% of Units	Weighted Toilets
2 to 4	1.51	30.62%	0.46
5 to 19	1.32	31.19%	0.41
20 to 49	1.30	15.05%	0.20
50 or more	1.36	23.14%	0.31
Multi-Family (rounded)			1.38

Table 11 shows the resulting population estimate of multi-family toilets in 2012 and compares it to the estimated population currently in the retail demand model. We estimate the current stock of multi-family toilets in San Francisco is 320,903 toilets, or rounding, about 321,000 toilets. The estimate exceeds the Retail Demand Model estimate by about 118,000 toilets. As with the single-family population estimate, there are two reasons for the difference.

- First, the Retail Demand Model currently uses an average of 1 toilet per multi-family unit whereas the 2012 ACS and 2011 AHS data suggest the average is significantly greater than this, at 1.38 toilets per unit.

- Second, the Retail Demand Model does not adjust the stock of multi-family housing units over time. Rather it sets it to the estimated number of units in 2005 and holds it there. As with the single-family model, this is a legacy issue and it is not clear why an assumption of a static housing stock was adopted by SFPUC when the model was first developed. According to the 2005 ACS there were approximately 211,611 occupied multi-family housing units in 2005, whereas in 2012 there were 232,004, a difference of 20,393 units. The Retail Demand Model uses an estimate of 202,898 multi-family dwelling units, which is lower than the 2005 ACS estimate.

Table 11. Estimated Population of Single-Family Toilets in 2012

Variable	Value
Multi-Family Units in 2012	232,004
Avg. Toilets Per Unit (rounded)	1.38
Total Multi-Family Toilets in 2012	320,903
Retail Demand Model Multi-Family Toilet Estimate	202,898

B. PERCENTAGE OF EFFICIENT TOILETS

We use the same approach for estimating the percentage of efficient toilets that we used for single-family dwelling units. In the case of multi-family units, the four drivers are as follows.

- **Toilets in new housing**. As for the single-family model, we assume that all units constructed after 1991 are fitted with toilets that have flush ratings of 1.6 gpf or less.

- **SFPUC toilet replacement programs**. The model uses data reported to the CUWCC to adjust the stock of 3.5+ toilets for toilet conversions by SFPUC toilet replacement programs. The CUWCC data show that 47,306 toilets were replaced by SFPUC programs between 1995 and 2012.

- **Retrofit on resale ordinance**. Starting in 2009, the model adjusts the stock of 3.5+ gpf toilets in response to the City's adoption of its retrofit-on-resale ordinance. We do not have data on multi-family property resale rates, so we use the assumption from the Retail Demand Model of 1.1%. The model estimates that the ordinance resulted in the conversion of 5,187 3.5+ toilets over the period 2009-2012.

- **Natural replacement.** As with the single-family model, we use a natural replacement rate of 3%.

Model results are summarized in Table 12, which shows the estimated percentage of 3.5+, ULFT, and HET toilets in each year. As of 2012, the model estimates that 68% of toilets in multi-family dwelling units are efficient. 32% of existing toilets are estimated to be 3.5+ gpf. Thus, of the estimated 320,903 multi-family toilets, we estimate 102,931 have flush ratings of 3.5 gpf or more.

The saturation estimate for ULFT/HET toilets corresponds very closely to the saturation estimate based on SFPUC inspections of 158 multi-family properties. The estimate from these inspections is 69%. While the inspected properties are all affordable housing units and therefore not necessarily representative of the overall population of multi-family housing in the City, it is reassuring that the two estimates correspond so closely.

Table 12. Percentage of Multi-Family Toilets by Efficiency Level

Year	3.5+ gpf	ULFT	HET	Total
1990	100%	0%	0%	100%
1991	96%	4%	0%	100%
1992	93%	7%	0%	100%
1993	90%	10%	0%	100%
1994	87%	13%	0%	100%
1995	83%	17%	0%	100%
1996	79%	21%	0%	100%
1997	74%	26%	0%	100%
1998	70%	30%	0%	100%
1999	65%	35%	0%	100%
2000	60%	40%	0%	100%
2001	57%	43%	0%	100%
2002	54%	46%	0%	100%
2003	51%	49%	0%	100%
2004	49%	51%	0%	100%

2005	47%	53%	0%	100%
2006	45%	55%	0%	100%
2007	43%	56%	0%	100%
2008	41%	58%	1%	100%
2009	39%	60%	1%	100%
2010	37%	62%	1%	100%
2011	35%	64%	2%	100%
2012	32%	65%	3%	100%

V. SINGLE-FAMILY CLOTHES WASHERS

A. FIXTURE POPULATION

The 2011 AHS for the San Francisco-San Mateo-Redwood City survey region found that 92.2% of owner-occupied housing units have clothes washing machines. This installation percentage is applied to the 2012 population of single-family dwelling units to estimate the population of single-family clothes washers, as shown in Table 13. Unlike for residential toilets, the estimate based on the 2011 AHS and 2012 ACS data is close to the estimate used in the Retail Demand Model, differing only by about 5%.

Table 13. Estimated Population of Single-Family Washers in 2012

Variable	Value
Single-Family Units in 2012	113,878
% of Owner-Occupied Units with Washers	92.189%
Total Single-Family Washers in 2012	104,983
Retail Demand Model Single-Family Toilet Estimate	111,299

B. PERCENTAGE OF HIGH EFFICIENCY WASHERS

The 2011 AHS reports that the percentage washers in owner-occupied and renter-occupied dwelling units that were Energy Star was 54.6% and 40.6%, respectively. Based on these penetration rates, we estimate that 50.9% of single-family washers are Energy Star, as shown in Table 14.

Table 14. Percentage of Energy Star Clothes Washers by Single-Family Residential Tenure

Tenure Status	Owner-Occupied	Renter-Occupied	Total
Dwelling Units	83,484	30,394	113,878
% with washers	92.2%	92.2%	
Clothes washers	76,963	28,020	104,983
% Energy Star	54.6%	40.6%	50.9%
Energy Star	42,046	11,372	53,418

The REUWS for San Francisco estimated that circa 2005, 32% of single-family washers were efficient.[2] This suggests there has been a significant increase in the share of efficient washers since the time of that analysis. We used a washer replacement model to test the plausibility of this increase in saturation. The model runs on an annual time-step from 2005 to 2012. The model assumes that 32% of washers in 2005 were efficient. In subsequent years, the model assumes the following:

- 91.4% of washers in new construction are rated Energy Star. This estimate comes directly from the 2011 AHS.[3]
- 60% of washer purchases (other than new construction) are rated Energy Star. This estimate comes from EPA.
- 8.3% of the existing washer inventory is replaced each year. This estimate is based on a 12-year average life for clothes washers.

Based on these assumptions, the model estimates that 52% of washers in 2012 would be efficient, which corresponds closely with the estimate of about 51% in Table 14 derived AHS and ACS data. Thus, we conclude the 2005 REUWS saturation estimate is consistent with the current estimated saturation rate.

VI. MULTI-FAMILY IN-UNIT CLOTHES WASHERS

A. FIXTURE POPULATION

As with single-family washers, the population estimate for in-unit clothes washers in multi-family dwelling units is derived from 2011 AHS and 2012 ACS data. Based on this data, we estimate as of 2012 there were 94,746 in-unit clothes washers in multi-family dwelling units, as shown in Table 15. It is not possible to compare this estimate to the Retail Demand Model since that model does not include in-unit multi-family clothes washers.

Table 15. Estimated Population of In-Unit Multi-Family Washers in 2012

Tenure Status	Owner-Occupied	Renter-Occupied	Total
Dwelling Units	40,817	191,187	232,004
% with washers	92.2%	29.9%	
Clothes washers	37,629	57,118	94,746
Retail demand model estimate for 2012			NA

B. PERCENTAGE OF HIGH EFFICIENCY WASHERS

Based on the AHS Energy Star penetration rates for owner- and renter-occupied dwelling units, we estimate that 46.2% of multi-family in-unit washers are Energy Star, as shown in Table 16.

[2] Based on water volume per load statistics.
[3] New construction for the 2011 AHS was defined as units constructed between 2007-11.

Table 16. Percentage of Energy Star Clothes Washers by Multi-Family Residential Tenure

Tenure Status	Owner-Occupied	Renter-Occupied	Total
Dwelling Units	40,817	191,187	232,004
% with washers	92.2%	29.9%	
Clothes washers	37,629	57,118	94,746
% Energy Star	54.6%	40.6%	46.2%
Energy Star	20,557	23,182	43,739

VII. MULTI-FAMILY COMMON LAUNDRY CLOTHES WASHERS

A. FIXTURE POPULATION

The population of common laundry area washers in multi-family units is based on laundry room equipment guidelines published by the Multi-Family Laundry Association. The guidelines recommend the number of washer/dryer pairs per unit based on the residential profile of the multi-family complex, as shown in Table 17.

Table 17. Recommended Washer/Dryer Pairs by Resident Profile

Resident Profile	Number of Dwelling Units per W/D Pair
Families	8-12
Young working adults	10-15
Older working adults	15-20
Students	25-40
Senior citizens	25-40

Using the mid-point of the dwelling unit ranges and assigning the weights shown in Table 18, we estimate, on average, there are 15.75 dwelling units per common laundry washer/dryer pair. The average number of washer/dryer pairs per dwelling unit is the reciprocal of this estimate – 0.0635 washer/dryer pairs per dwelling unit. Multiplying by the number of multi-family dwelling units yields an estimate of 14,730 common laundry clothes washers.

The Retail Demand Model uses an estimate of 17,410 common laundry washers for 2012, which is about 18% greater than the estimate in Table 18. There are two reasons for the difference.

- First, the Retail Demand Model assumes an average of 14 dwelling units per common area washer whereas the Table 18 estimate uses 15.75.

- Second, the Retail Demand Model estimate uses a larger dwelling unit estimate – about 244,000 versus 232,000.

Table 18. Multi-Family Common Laundry Washer Population Estimate

Resident Profile	Mid-Point Dwelling Units per W/D Pair	Assumed Distribution of Dwelling Units (Weight)
Families	10	50%
Young working adults	12.5	20%
Older working adults	17.5	10%
Students	32.5	10%
Senior citizens	32.5	10%
Weighted Avg. Dwelling Units Per W/D Pair		15.75
Estimated Washers per Dwelling Unit		0.0635
Number of Renter-Occupied Multi-Family Dwelling Units		232,004
Estimated Common Laundry Washers		14,730

B. PERCENTAGE OF HIGH EFFICIENCY WASHERS

Other than the 2011 AHS, we did not find any estimates of high-efficiency washer saturation for multi-family. The AHS applies to in-unit washers, not common laundry washers, and therefore is not directly applicable. Because common laundry washers are frequently leased from a vendor rather than owned by the facility, the penetration rate could differ from what the AHS estimated for in-unit washers.

VIII. CII TOILETS

A. FIXTURE POPULATION

We use the CUWCC's CII toilet count methodology to estimate the number of CII toilets from 1992 to 2012. The CUWCC methodology is described in the CUWCC's CII ULFT Savings Study (2001). Toilet populations are calculated separately for commercial and industrial buildings (other than hotels), hotels, schools, and government sector buildings.

For commercial and industrial buildings (other than hotels) the coefficients in Table 19 are used with County Business Patterns (CBP) data to estimate the number of toilets. The CBP data give the count of establishments within each CII sector by employment size category. These counts are multiplied by the coefficients in Table 19 to estimate the number of toilets for each CII sector.

In the case of hotels, the CUWCC method is based on the number of hotel rooms. The toilet count coefficient is 1.05 toilets/hotel room. Hotel room counts for 1985, 2009, and 2012 are from City planning department reports. For other years, hotel room counts are interpolated.

For schools, the CUWCC method is based on the number of K-8 and 9-12 students. The toilet count coefficients are 0.028571 toilets/student for K-8 and 0.036364 toilets/student for 9-12. Multiplying these coefficients by the number of students yields the toilet population estimate for the school sector. Student body counts for public and private schools are from the California Department of Education.

Table 19. CII Toilet Coefficients

CII Sector	Industry Classification System		Employment Size				
	NAICS	SIC	1 to 9	10 to 19	20 to 49	50 to 99	100+
Industrial	31-33	20-39	2.0	2.6	4.8	8.0	18.0
Retail/Wholesale	42,44,45	50-57,59,72,75,76	2.0	2.4	5.3	9.0	13.1
Eating/Drinking	722	58	2.0	2.5	4.3	7.7	11.6
Office	52-56, 81 (not 81311)	60-67,73,81,86 (not 866), 87-89	2.0	3.4	8.1	18.1	32.6
Health Care	62	80	2.2	6.3	15.0	32.4	65.2
Church	81311	866	3.1	9.1	21.6	21.6	21.6
Other		All other SIC codes	2.0	2.3	5.7	12.7	19.4

The toilet populations for commercial/industrial, hotels, and schools developed using the CUWCC method are shown in Table 20. A problem with the CUWCC method is the way in which the estimates fluctuate with the business cycle. This happens because the method assumes the relationships between number of employees (and students) and number of toilets are fixed, whereas in reality they fluctuate. This causes the method to undercount toilets during low employment periods -- e.g. 1992 -- and over count toilets during high employment period -- e.g. 2000. To address this problem, we smooth the estimates using linear regression. The smoothed estimates are shown in the last column of Table 20.

Table 20. CUWCC Method CII Toilet Population Estimates

Year	Comm./Ind.	Hotels	Schools	Total Unsmoothed	Total Smoothed
1992	103,547	29,917	2,913	136,377	144,120
1998	115,221	31,509	2,762	149,492	145,817
1999	115,010	31,782	2,756	149,548	146,100
2000	118,674	32,058	2,739	153,470	146,383
2001	118,216	32,336	2,733	153,285	146,666
2002	109,884	32,616	2,697	145,197	146,949
2003	108,431	32,900	2,651	143,981	147,232
2004	107,890	33,185	2,606	143,680	147,514
2005	108,871	33,473	2,589	144,932	147,797
2006	110,630	33,763	2,570	146,963	148,080
2007	112,306	34,056	2,562	148,924	148,363
2008	113,812	34,352	2,526	150,690	148,646
2009	110,927	34,650	2,493	148,070	148,929
2010	110,411	34,876	2,470	147,757	149,212
2011	111,385	35,104	2,447	148,935	149,494
Avg Growth	0.38%	0.85%	-0.91%	0.46%	0.19%

The CUWCC method for estimating toilets in the government sector could not be implemented because it requires data from Dunn and Bradstreet which would have to be purchased and could not be obtained in time for this study. To estimate the number of toilets in the government sector, we use a previous estimate of government sector toilets in San Francisco in 1992 prepared by the CUWCC and then escalate it using the average rate of growth for the other sectors. The estimated population of CII toilets, including the government sector, is shown in Table 21.

Table 21. Estimated Population of CII Toilets

Year	CII (excl. Gov't)	Gov't	Total
1992	144,120	4,000	140,377
1993	144,403	4,008	141,018
1994	144,686	4,015	141,663
1995	144,969	4,023	142,310
1996	145,252	4,031	142,960
1997	145,534	4,039	143,614
1998	145,817	4,046	144,270
1999	146,100	4,054	144,929
2000	146,383	4,062	145,592
2001	146,666	4,070	146,257
2002	146,949	4,078	146,926
2003	147,232	4,086	147,598
2004	147,514	4,093	148,272
2005	147,797	4,101	148,950
2006	148,080	4,109	149,631
2007	148,363	4,117	150,315
2008	148,646	4,125	151,003
2009	148,929	4,133	151,693
2010	149,212	4,141	152,387
2011	149,494	4,149	153,084
2012	149,777	4,157	153,784

The estimated population of CII toilets in 2012 is 153,784 toilets. The CII toilet population estimate in the Retail Demand Model is 81,174 toilets in 2005, which is about half the estimate based on the CUWCC method. The Retail Demand Model estimate is based on an average of 6 toilets per non-residential account and 13,529 non-residential accounts in 2005. Both of these are legacy assumptions from when the model was first developed by SFPUC.

B. PERCENTAGE OF EFFICIENT TOILETS

We use the same approach for estimating the percentage of efficient toilets that we used for single- and multi-family dwelling units. In the case of CII toilets, there are only three drivers as follows.

- **Toilets in new construction**. We assume new buildings after 1991 are fitted with toilets that have flush ratings of 1.6 gpf or less.

- **SFPUC toilet replacement programs**. The model uses the toilet program history in the Retail Demand Model and data reported to CUWCC on CII toilet replacement to adjust the stock of 3.5+ toilets for toilet conversions by SFPUC toilet replacement programs. These data show that 14,533 CII toilets were replaced by SFPUC programs between 1995 and 2012.

- **Natural replacement.** As with the single- and multi-family models, we use a natural replacement rate of 3%.

Model results are summarized in Table 22, which shows the estimated percentage of 3.5+, ULFT, and HET toilets in each year. As of 2012, the model estimates that 60% of CII toilets are efficient. 40% of existing toilets are estimated to be 3.5+ gpf. Thus, of the estimated 153,784 CII toilets, we estimate 61,500 have flush ratings of 3.5 gpf or more.

Table 22. Percentage of CII Toilets by Efficiency Level

Year	3.5+ gpf	ULFT	HET	Total
1992	97%	3%	0%	100%
1993	94%	6%	0%	100%
1994	90%	10%	0%	100%
1995	87%	13%	0%	100%
1996	84%	16%	0%	100%
1997	81%	19%	0%	100%
1998	77%	23%	0%	100%
1999	74%	26%	0%	100%
2000	72%	28%	0%	100%
2001	69%	31%	0%	100%
2002	67%	33%	0%	100%
2003	65%	35%	0%	100%
2004	62%	38%	0%	100%
2005	60%	40%	0%	100%
2006	58%	42%	0%	100%
2007	54%	45%	1%	100%
2008	52%	47%	2%	100%
2009	49%	48%	2%	100%
2010	46%	50%	4%	100%
2011	44%	52%	4%	100%
2012	40%	53%	7%	100%

IX. CII URINALS

A. FIXTURE POPULATION

Koeller (2006) estimated that there is one urinal for every four toilets in California.[4] Using this ratio with the CII toilet population estimate in Table 21 gives a urinal population estimate of 38,500 (rounded).

The Retail Demand Model currently uses a ratio of 3 urinals to every 20 toilets (15%), which gives a population estimate that is 40% smaller than the population estimate based on Koeller (2006). The urinal to toilet ratio used in the Retail Demand Model is a legacy assumption from when the model was first developed by SFPUC.

B. PERCENTAGE OF EFFICIENT URINALS

We did not identify data that would improve the Retail Demand Model's saturation estimates. Under current assumptions, the Retail Demand Model estimates that 25% of urinals have flush ratings of 0.5 gpf or less in 2012. Using the population estimate based on Koeller (2006), this implies that there remain 28,875 non-efficient urinals in use circa 2012.

X. COMMERCIAL COIN-OPERATED WASHERS

A. FIXTURE POPULATION

The population of commercial coin-operated washers is San Francisco is estimated using CBP data on the number of coin-operated establishments in the City and an average of 36 washers per establishment. The average number of washers per establishment is based on a sample of California coin-operated laundries reported in Sutter, Pope, and Walther (2006).[5] CBP reported 26 coin-operated laundries in San Francisco in 2011. This yields an estimated 936 coin-operated washers.

B. PERCENTAGE OF EFFICIENT WASHERS

We did not find any estimates of high-efficiency washer saturation for coin-operated laundries. However, the low number of coin-operated washers and the prevalence of equipment leasing does not make this sector an attractive target for washer rebate programs.

[4] Koeller, J. (2006). *A Report on Potential Best Management Practices: Year Two Annual Report.* Sacramento: California Urban Water Conservation Council.
[5] Sutter, M., T. Pope, and E. Walther, "Estimating Commercial Clothes Washer Use in California Coin Laundry Stores." ACEE Summer Study on Energy Efficiency in Buildings.

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APPENDIX C

Detailed Table of Fixture Populations and Saturation Rates 2020 - 2045)

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Table C-1: Estimated Fixture Population and Percentage of Efficient and Inefficient Fixtures

	2020		2025		2030		2035		2040		2045	
	Inefficient Fixtures	Efficient Fixtures	Inefficient Fixtures	Efficient Fixtures	Inefficient Fixtures	Efficient Fixtures	Inefficient Fixtures	Efficient Fixtures	Inefficient Fixtures	Efficient Fixtures	Inefficient Fixtures	Efficient Fixtures
Toilets												
Single Family	47,220	200,758	35,139	212,840	26,586	221,392	20,115	227,863	15,219	232,759	11,515	236,464
	19%	81%	14%	86%	11%	89%	8%	92%	6%	94%	5%	95%
Multi-Family	56,345	264,486	42,840	277,991	33,227	287,604	25,771	295,060	19,988	300,843	15,503	305,328
	18%	82%	13%	87%	10%	90%	8%	92%	6%	94%	5%	95%
Non-Resi.	41,240	130,812	35,414	136,637	30,411	141,640	26,115	145,936	22,426	149,626	19,258	152,794
	24%	76%	21%	79%	18%	82%	15%	85%	13%	87%	11%	89%
Total	144,805	596,055	113,392	627,469	90,224	650,637	72,001	668,860	57,633	683,228	46,276	694,585
	20%	80%	15%	85%	12%	88%	10%	90%	8%	92%	6%	94%
Clothes Washers												
Single Family	37,220	67,445	22,086	82,579	12,642	92,023	7,702	96,963	4,806	99,859	2,999	101,666
	36%	64%	21%	79%	12%	88%	7%	93%	5%	95%	3%	97%
Multi-Family	46,325	58,072	28,604	75,793	17,546	86,851	10,899	93,498	6,802	97,596	4,244	100,153
	44%	56%	27%	73%	17%	83%	10%	90%	7%	93%	4%	96%
Non-Resi.	2,788	3,080	1,740	4,128	1,086	4,782	678	5,190	423	5,445	264	5,604
	48%	52%	30%	70%	19%	81%	12%	88%	7%	93%	4%	96%
Total	86,334	128,596	52,431	162,499	31,274	183,656	19,279	195,651	12,031	202,900	7,507	207,423
	40%	60%	24%	76%	15%	85%	9%	91%	6%	94%	3%	97%
Urinals												
Total	7,194	18,614	6,177	19,630	5,305	20,503	4,555	21,252	3,912	21,896	3,359	22,448
	28%	72%	24%	76%	21%	79%	18%	82%	15%	85%	13%	87%
Showerheads												
Single Family	38,886	110,794	19,201	130,479	8,875	140,805	3,454	146,226	1,816	147,865	955	148,726
	26%	74%	13%	87%	6%	94%	2%	98%	1%	99%	1%	99%
Multi-Family	104,301	203,798	52,999	255,100	25,999	282,101	11,786	296,313	6,206	301,893	3,268	304,831
	34%	66%	17%	83%	8%	92%	4%	96%	2%	98%	1%	99%
Non-Resi.	12,048	21,952	6,358	27,642	3,355	30,645	1,771	32,229	935	33,065	493	33,507
	35%	65%	19%	81%	10%	90%	5%	95%	3%	97%	1%	99%
Total	155,236	336,544	78,559	413,221	38,230	453,551	17,011	474,769	8,957	482,824	4,717	487,064
	32%	68%	16%	84%	8%	92%	3%	97%	2%	98%	1%	99%

Note: Total numbers of fixtures per year includes existing and projected fixture growth. Efficient toilet equals 1.6 gpf or less, efficient showerhead equals 1.8 gpm or less, efficient clothes washer equals WF 6.0 or less, and efficient urinal equals 1.0 gpf or less.

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APPENDIX D

Updated SFPUC Water Conservation Tracking Model Overview and Water and Energy Savings Specifications for Conservation Program Measures (2020)

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SFPUC Conservation Tracking Model

Water and Energy Savings Specifications for Conservation Program Measures

David Mitchell, M.Cubed

Last Updated: 03-08-2021

Overview

The SFPUC Conservation Tracking Model is a tool developed to track conservation program activity, water savings, and costs and benefits for SFPUC's retail service area conservation programs. The model is a customized version of the Alliance for Water Efficiency's (AWE) Water Conservation Tracking Tool, an Excel-based water conservation tracking model with more than four hundred registered water utility users throughout North America. In 2014, the SFPUC customized the AWE Conservation Tracking Tool for its retail service area and began using it to forecast water savings from conservation measures.

The purpose of this Water and Energy Savings Specifications for Conservation Program Measures Technical Memorandum is to document the assumptions and methodologies used to estimate water savings for every measure in the SFPUC's Conservation Tracking Model and key updates made over time. This document reflects all measures with modeled water savings included in the Conservation Tracking Model, including measures the SFPUC implements now or plans to in the next five years, implemented in the past, and ones SFPUC has evaluated and not implemented and may or may not do so in the future. It does not reflect conservation measures the SFPUC provides or provided in the past that don't have established or sufficient water-savings methodologies.

History of SFPUC Conservation Forecast Modelling

The SFPUC developed its first model in 2004 to forecast both in-City retail water demands and water savings from conservation measures. The SFPUC used estimated conservation water savings generated by this model to develop its 2004 and 2011 conservation plans. The SFPUC migrated from using this combined demand/forecast model in 2014, and started using a separate econometric demand model developed by Brattle Group to estimate retail demands and to the SFPUC Conservation Tracking Model to estimate water savings from conservation measures. In 2020, the SFPUC updated its econometric demand model for its retail service area for use in preparing its 2020 Urban Water Management Plan and for providing updated demand estimates for its 2020 Retail Conservation Plan.

Model Structure

The Conservation Tracking Model is an Excel-based model with an extensive Visual Basic backend. Using the model requires completing Model Setup, Program Specification, and Annual Activity data input tasks. Each data input task is contained on a separate worksheet in the model.

Model Setup consists of providing the model with the baseline forecasts of population, housing units, and water demand, as well as other basic system information the model uses to calculate the costs and benefits of conservation programs. The baseline water demand forecast comes from the Brattle Group econometric demand models. The baseline population forecast is from the Association of Bay Area Governments (ABAG).

Program Specification consists of parameterizing the conservation programs in the model. The model can hold up to 75 separate programs. The model can be extended to hold more than 75 programs if needed. Program parameters are grouped into five categories: water saving parameters, utility cost parameters, participant cost parameters, participant non water benefits parameters, and plumbing code parameters. The latter are used to specify interaction effects with plumbing codes to avoid double counting water savings jointly produced by plumbing codes and conservation programs. In terms of forecasting conservation program water savings, the most important parameters are the water savings parameters and the plumbing code interaction parameters.

Annual Activity is simply the number of units of activity that have been done (in the case of historical years) or are expected to be done (in the case of future years). The user enters historical and projected annual activity for each conservation program that was specified during the Program Specification step. For toilets, urinals, and clothes washers, the model includes fixture inventory modules to keep track of how many fixtures have been converted to efficient fixtures due to plumbing codes and conservation programs to ensure the user does not specify levels of fixture replacement that are physically infeasible.

Once the three data input tasks have been completed the model results can be reviewed. Model results are summarized into three categories: (1) program water savings, (2) retail water demand, and (3) costs and benefits.

- Program water savings are the projected annual water savings from each specified conservation program through 2045. Results can be grouped by program category and customer class or shown individually.

- Retail demand results summarize the baseline annual demand forecast with plumbing code and conservation program adjustments through 2045. It is grouped by customer class and shown separately for the in-city and suburban parts of SFPUC's retail service area. Results can be shown in MGD or acre-feet. Gross per capita and residential per capita water use are also reported. In addition, projected per capita water use is compared to per capita water use targets under SBx7-7 and the MOU.

- Costs and benefits of conservation are reported for the utility and program participant perspectives. Unit costs, net present value, and benefit-cost ratios can be reported for the totality of all programs, for individual program categories (e.g. toilet replacement programs), or for individual programs. In addition to financial benefits and costs, the model calculates expected reductions in associated energy use and greenhouse gas emissions.

Model inputs can be saved as scenarios. This allows the model to simultaneously hold more than one set of data inputs. For example, a user could specify scenarios for alternative baseline population and demand forecasts or for alternative levels of conservation program investment. There is no practical limit to the number of scenarios the model can hold.

Summary of Key Updates since 2015

2015 Updates
The conservation program savings presented in SFPUC's 2011 Conservation Plan were developed with the SFPUC's original Retail Demand Model not the Conservation Tracking Model. While the Conservation Tracking Model can be calibrated to replicate the 2011 estimates, the final estimates developed for the 2015 Conservation Plan, which were developed with the Conservation Tracking Model, were generally lower after 2020 than what was presented in the 2011 Plan for three main reasons:

- The SFPUC undertook a review of the water saving estimates and assumptions and made several adjustments, including to savings estimates for clothes washers and toilets, both of which were lowered to account for new efficiency standards affecting the long-term savings potential of these programs.

- The 2015 Plan updated the end dates for toilet and clothes washer incentives due to high fixture saturation levels.
- The 2015 Plan focused mainly on the next five years, reflecting that beyond that horizon, there is much less certainty regarding what conservation programs SFPUC will find most beneficial and cost-effective to implement.

2020 Updates
In 2020, the SFPUC made the following changes to the model:

- Revised future participation levels for several measures to better reflect current trends.
- Added several new conservation measures.
- Adjusted the water savings assumptions of several existing measures.
- Updated the water savings module for clothes washer efficiency standards to align it with the approach used in Version 4 of the Alliance for Water Efficiency's Water Conservation Tracking Tool.
- Incorporated the City of San Francisco Planning Department's current population and housing estimates and projections.
- Removed the calculation of plumbing code water savings for new development (post 2020) because they are already embedded in SFPUC's updated retail demand projections.

These updates were based on analysis of historical program participation, updated fixture saturation rates, and new empirical and other water-savings studies and data available since 2015. This document reflects the assumptions and specifications used in the SFPUC's Conservation Tracking Model for purposes of estimating water savings for the SFPUC's 2020 Retail Conservation plan.

Updated Population and Housing Projections

Both population and housing estimates have changed since the 2015 version of the conservation model due to new assumptions about growth in the City of San Francisco. The City has a goal of increased housing development on the order of 5,000 new units per year. However, as described elsewhere in this TM, SFPUC expects new construction to be built at code and generate no additional passive savings. All future passive savings will come from existing stock. As such, population and housing estimates for 2020 were updated, as described below, and then held constant for the remainder of the planning horizon.

Population Projection Update

The City of San Francisco Planning Department provided an updated 2020 population of 941,269. Residential population in 2020 was estimated from total population by subtracting 3%, which represents population housed in group quarters. This value is based on historical estimates from 2011-2020 from Department of Finance E-5 Housing and Population Estimates (dated May 2020), as well as P-4 Household Projections for California Counties for 2020-2030 (dated June 2020).

The conservation model's original and updated population projections are shown in Table 1. As shown in this table, the population stops growing after 2020 to reflect no additional passive savings to be generated from future growth.

Table 1: Population Projection Update

Year	Total Population			Residential Population		
	2015 Model	2020 Model	% Difference	2015 Model	2020 Model	% Difference
2005	780,187	780,187	0.0%	756,678	756,678	0.0%
2010	805,235	805,235	0.0%	780,971	780,971	0.0%
2015	857,508	857,508	0.0%	831,995	831,995	0.0%
2020	890,400	941,269	5.7%	863,800	913,031	5.7%
2025	934,800	941,269	0.7%	906,800	913,031	0.7%
2030	981,800	941,269	-4.1%	952,500	913,031	-4.1%
2035	1,032,500	941,269	-8.8%	1,000,800	913,031	-8.8%
2040	1,085,700	941,269	-13.3%	1,051,100	913,031	-13.1%
2045	1,085,700	941,269	-13.3%	1,051,100	913,031	-13.1%
2050	1,085,700	941,269	-13.3%	1,051,100	913,031	-13.1%

Source: 2020 total population from San Francisco Planning Department, adjusted to residential population based on 3% group quarters (DOF E-5 and P-4)

Household Projection Update

The City of San Francisco Planning Department provided an estimate of total housing units as of 2020 to the SFPUC in October 2020. This value is assumed to be a projection of total constructed housing units as opposed to occupied housing units.

Occupied single-family housing units in 2020 were set equal to the number of single-family residential accounts in the SFPUC's billing system as of August 2020. This includes the number of accounts with the service agreement type residential single family (RES-SWTR), regardless of dwelling unit count, and the service agreement type of residential combination service (COMBO-R) with 1 dwelling unit. Occupied single-family housing units for 2025 and beyond were kept the same as 2020.

Total 2020 housing units from the Planning Department were adjusted to estimate occupied housing units using a vacancy rate of 8.26%, which is an average of the last five estimates provided by the ACS 5-year estimates for the City of San Francisco from 2015-2019 (ranging 7.7% to 8.9%). Total occupied multi-family housing units in 2020 were estimated by subtracting the number of occupied single-family housing units in 2020 from the total 2020 occupied housing units.

2015 housing units for both single- and multi-family were interpolated between values used previously for 2010 and the updated inputs for 2020.

The conservation model's original and updated projections for total, single-, and multi-family housing units are shown in Table 2. As shown in this table, the 2020 housing units stop growing after 2020 to reflect no additional passive savings to be generated from future growth.

Table 2: Housing Projection Update

Year	Total Occupied Housing Units			Occupied Single-Family Housing Units			Occupied Multi-Family Housing Units		
	2015 Model	2020 Model	% Difference	2015 Model	2020 Model	% Difference	2015 Model	2020 Model	% Difference
2005	335,054	335,054	0.0%	109,500	109,500	0.0%	225,554	225,554	0.0%
2010	345,811	345,811	0.0%	110,759	110,759	0.0%	235,052	235,052	0.0%
2015	366,540	356,070	-2.9%	113,687	111,231	-2.2%	252,853	244,840	-3.2%
2020	377,684	366,330	-3.0%	115,073	111,702	-2.9%	262,611	254,628	-3.0%
2025	393,630	366,330	-6.9%	116,475	111,702	-4.1%	277,155	254,628	-8.1%
2030	410,227	366,330	-10.7%	117,894	111,702	-5.3%	292,333	254,628	-12.9%
2035	426,235	366,330	-14.1%	119,331	111,702	-6.4%	306,904	254,628	-17.0%
2040	442,905	366,330	-17.3%	120,785	111,702	-7.5%	322,120	254,628	-21.0%
2045	442,905	366,330	-17.3%	120,785	111,702	-7.5%	322,120	254,628	-21.0%
2050	442,905	366,330	-17.3%	120,785	111,702	-7.5%	322,120	254,628	-21.0%

Source: 2020 total housing units provided by San Francisco Planning Department and adjusted to account for occupancy using average vacancy rate from ACS 5-year estimates from 2015-2019. Count of single-family units equal to 2020 count of SFPUC single-family water accounts served with remainder allocated to multi-family units.

Calculation of Plumbing Code Water Savings

The Conservation Tracking Model calculates the water savings associated with plumbing codes and appliance efficiency standards using models of fixture inventory coupled with usage assumptions. These savings are commonly referred to as passive water savings because they occur regardless of actions taken by the utility. The Tracking Model includes passive savings models for residential toilets, showerheads, and clothes washers, and non-residential toilets, urinals, hotel showerheads, and coin-op clothes washers.

It is important to emphasize that the passive savings estimates do not actually impact the model's estimates of final water demand. This is because the Brattle Group's baseline demand forecasts used in the Tracking Model are net of passive water savings. However, the Brattle forecast does not generate an explicit forecast of passive water savings because the adjustment for passive savings is enacted through the model's trend term. Because SFPUC desired explicit estimates of passive water savings, modules for estimating these savings were included in the Conservation Tracking Model. These estimates are added to the Brattle Group's baseline forecast before it is used in the model so that they can be represented explicitly. It is the Brattle Group's baseline forecast adjusted for passive savings that is entered on the Model Setup worksheet. The adjusted baseline forecast is:[1]

Adjusted Baseline Forecast = Brattle Baseline Forecast + Passive Water Savings

The final demand forecast generated by the Conservation Tracking Model is then:

[1] The passive water savings adjustment also includes water savings expected to be realized after 2015 from the historical implementation of SFPUC conservation programs prior to the start of the Brattle Group's baseline forecast. This is done to prevent the model from double counting these water savings.

Final Demand Forecast = Adjusted Baseline Forecast – Passive Water Savings – Program Water Savings

This is also equal to:

Final Demand Forecast = Brattle Baseline Forecast – Program Water Savings

This means the only determinants of the final demand forecast are the Brattle Baseline Forecast and the forecast of programmatic water savings from future implementation of SFPUC conservation programs. While the passive savings forecast is useful because it provides an estimate of how much demand reduction can be ascribed to plumbing codes and appliance standards, it does not actually affect the final estimate of future demand.

Following are descriptions of how passive savings are calculated for each fixture/appliance category. The SFPUC Plumbing Fixture Population and Efficiency Saturation Estimates Technical Memorandum issued on January 13, 2014 and included in Appendix A of the 2015 Retail Conservation Plan and the updated saturation estimates memo dated August 19, 2019, and included in appendices of the 2020 Retail Conservation Plan provide more details on fixture population and saturation estimates.

Residential Toilets

The population of residential toilets is based on SFPUC's forecasts of single and multi-family housing units. These forecasts are multiplied by the average number of toilets per dwelling unit, which are estimated from recent American Housing Survey data. The model uses an average of 2.22 and 1.26 toilets per dwelling unit for single and multi-family housing, respectively. Toilets installed in new housing constructed between 1991 and 2013 are assumed to be ULFT (1.6 gpf). Toilets installed in new housing constructed after 2013 are assumed to be HET (1.28 gpf). Toilets in existing housing constructed before 1991 are assumed to have an average flush volume of 3.5 gpf. Toilets in existing housing are assumed to be replaced at an annual rate of 3.1% per year. This is the average rate of residential toilet replacement reported in studies done by EBMUD and SCVWD. Existing toilets replaced between 1991 and 2013 are assumed to be replaced by ULFTs. Existing toilets replaced after 2013 are assumed to be replaced by HETs. Using this information, the model calculates the average flush volume for the inventory of new and existing toilets for each year between 1990 and 2064. Water savings per flush is calculated relative to the average flush volume in 1990. Average savings per flush is equal to the average flush volume in 1990 less the average flush volume in each year after 1990. Average savings per flush is multiplied by the estimated number of flushes per year to estimate annual water savings. The estimated number of flushes per year is equal to the residential population multiplied by the average daily per capita flush rate multiplied by 365. The residential population is derived from SFPUC's service area population forecasts. The average daily per capita flush rate of 4.8 is taken from the San Francisco Residential End Uses of Water Study.

Non-Residential Toilets

The population of non-residential toilets for the period 1990-2012 is taken from the Fixture Saturation Task Memo. The population of non-residential toilets for the period 2013-2064 is a linear extrapolation based on the forecast of service area population. The same assumptions used for residential toilets regarding flush volume of new toilets and replacement rate of existing toilets are used for non-residential toilets. The average flush volume of the toilet inventory and the water savings per flush relative to 1990 are calculated the same way as for residential toilets. Average savings per flush is multiplied by the estimated number of flushes per year to estimate annual water savings. Vickers (2001)

estimates annual flushes by multiplying daily flushes by a 260-day work year. Male workers are assumed to flush toilets (as opposed to urinals) an average of one time per day while female workers are assumed to flush toilets an average of three times per day. Male workers are assumed to comprise 54% of the labor force, per City of San Francisco (2009). Total employment is taken from SFPUC's employment forecast.

Non-Residential Urinals

Based on an analysis of DBI data, the ratio of urinals to toilets is estimated to be 0.15. This ratio is applied to the estimated stock of non-residential toilets to estimate the stock of urinals. Urinals installed before 1992 are assumed to have an average flush volume of 2 gpf. Urinals installed between 1992 and 2013 are assumed to have an average flush volume of 1 gpd. Urinals installed in 2014 are assumed to have a flush volume of 0.5 gpf. Urinals installed after 2014 are assumed to have a flush volume of 0.125 gpf. Urinals are assumed to have the same replacement rate as toilets. The average flush volume of the urinal inventory and the water savings per flush relative to 1990 are calculated the same way as for residential and commercial toilets. Average savings per flush is multiplied by the estimated number of flushes per year to estimate annual water savings. To calculate total flushes per year, male workers are assumed to have a daily flush rate of 2, per Vickers (2001). Male workers are assumed to comprise 54% of the labor force, per City of San Francisco (2009). Total employment is taken from SFPUC's employment forecast.

Residential Showerheads

The population of residential showerheads is based on SFPUC's forecasts of single and multi-family housing units. These forecasts are multiplied by the average number of showerheads per dwelling unit, which are estimated from recent American Housing Survey data. The model uses an average of 1.34 and 1.21 showerheads per dwelling unit for single and multi-family housing, respectively. Showerheads installed in new housing constructed before 2005 are assumed to have an average flow rate of 2.3 gpm. Showerheads installed in new housing constructed between 2005 and 2017 are assumed to have an average flow rate of 2.0 gpm. Showerheads installed after 2017 are assumed to have an average flow rate of 1.8 gpm. Showerheads in existing housing are assumed to be replaced at an annual rate of 12% per year, per the Alliance for Water Efficiency. Using this information, the model calculates the average showerhead flow rate for the inventory of new and existing showerheads for each year between 2005 and 2064. Average savings per minute is equal to the average flow rate in 2005 less the average flow rate in each year after 2005. Annual water savings is calculated as the product of the average flow rate and the annual number of minutes for showering. The annual number of minutes for showering is equal to the average number of shower events per household per day multiplied by the average shower duration in minutes multiplied by the number of households multiplied by 365. An average of 2 shower events per day and an average duration of 9 minutes per shower event are taken from the San Francisco Residential End Uses of Water Study.[2] The number of residential housing units is taken from SFPUC's housing forecast.

Hotel Showerheads

The population of hotel showerheads is based on an estimate of the total number of hotel rooms in San Francisco. The model assumes one showerhead per room. Showerheads installed before 2005 are

[2] The estimate of average number of shower events per day from the San Francisco Residential End Uses of Water Study is used directly in the single-family residential calculation. For the multi-family calculation, it is scaled by the ratio of multi-family to single-family persons per household to take into account the lower density in multi-family housing.

assumed to have an average flow rate of 2.5 gpm. Showerheads installed between 2005 and 2017 are assumed to have an average flow rate of 2.2 gpm. Showerheads installed after 2017 are assumed to have an average flow rate of 1.8 gpm. Showerheads are assumed to be replaced at an annual rate of 12% per year, per the Alliance for Water Efficiency. Using this information, the model calculates the average showerhead flow rate for the inventory of new and existing showerheads for each year between 2005 and 2064. Average savings per minute is equal to the average flow rate in 2005 less the average flow rate in each year after 2005. Annual water savings is calculated as the product of the average flow rate and the annual number of minutes for showering. The annual number of minutes for showering is equal to the average number of shower events per occupied room per day multiplied by the average shower duration in minutes multiplied by the number of occupied rooms multiplied by 365. An average of 1.34 shower events per day per occupied room and an average duration of 10 minutes per shower event are taken from the AWWARF Commercial End Uses of Water Study. The average hotel occupancy rate is based on a review of various estimates published on the internet of hotel occupancy in San Francisco.

Residential Clothes Washers

The stock of residential clothes washers is based on SFPUC's housing forecast and the average number of washers per dwelling unit. The average number of washers per dwelling unit is 0.937 for single-family and 0.41 for multi-family. The multi-family estimate includes both in-unit and common room washers. Existing washers are replaced at an annual rate of 9%, which is equivalent to assuming washers have an average useful life of 11 years, which is consistent with industry estimates. When a washer is replaced, it is replaced with either a conventional or high-efficiency (Energy Star) washer according to a forecast of market shares informed by market analyses done to support the setting of federal efficiency standards for washers. Water factors for new conventional and high-efficiency washers change over time in the model. Water factors for conventional washers are based on federal energy standards while water factors for high-efficiency washers are based on EPA Energy Star specifications. The average water factor for the stock of residential washers adjusts over the course of the forecast based upon the rate at which existing washers are replaced and new washers are added to the inventory. The model's accuracy in predicting water use by clothes washers is checked against water use benchmarks for 1997, 2007, and 2012 taken from residential end use studies. Washer utilization in single-family households is drawn from the San Francisco End Use of Water Study. Washer utilization in multi-family households scales down the single-family estimate to account for smaller average household size. Water savings are calculated relative to 2005 and are equal to the difference in water use assuming average washer efficiency in 2005 versus average washer efficiency in the forecast year.

Coin-op Clothes Washers

Estimates of passive water savings for coin-op clothes washers use the same methodology used for residential clothes washers. The natural replacement rate for coin-op washers is the average of estimates developed by the Alliance for Water Efficiency (11.1%) and the Department of Energy (13.3%). The stock of coin-op clothes washers is based on an internet search of coin-op washer facilities in San Francisco. The average number of washers per coin-op facility is taken from the Fixture Saturation Task Memo. The average number of loads per day is taken from a PG&E study of coin-op washer water and energy consumption. The water factors for new and replaced washers are based on existing federal efficiency regulations for commercial clothes washers.

Calculation of Programmatic Water Savings

The Conservation Tracking Model calculates the water savings associated with a program as the product of the estimated water savings per unit of activity and the amount of activity completed. These savings are commonly referred to as active water savings because they result from the utility's direct investment in conservation programs intended to reduce demand. In other words, the savings result from the utility's active pursuit of demand reduction.

In the Tracking Model, the user specifies a starting unit water savings for each program. The behavior and duration of the unit savings overtime can then be adjusted with the useful life, annual decay, and plumbing code interaction parameters. When the annual decay and plumbing code interaction parameters are both set to 0, annual savings is equal to the product of the initial unit savings and the amount of activity. Annual savings accrue until the measure's useful life is reached, after which annual savings are assumed to be zero. Thus given initial unit savings S_0, measure useful life u, and activity of A_s in year s, water savings in any year t ≥ s are:

$$S_t = A_s S_0 \; if \; t - s + 1 \leq u, 0 \; otherwise$$

When the annual decay parameter takes a value d in the range (0, 1], annual water savings in any year t ≥ s are:

$$S_t = A_s S_0 (1-d)^{t-s} \; if \; t - s + 1 \leq u, 0 \; otherwise$$

When the plumbing code interaction parameter takes a value p in the range (0, 1] and the plumbing code is in effect for any year t ≥ v, annual water savings in any year t ≥ s are:

$$S_t = \begin{cases} A_s S_0 \; if \; u \geq t - s + 1 \; and \; t < v \\ A_s (1-p)^{t-s} S_0 \; if \; t - s + 1 \leq u \; and \; t \geq v \\ 0 \; if \; t - s + 1 > u \end{cases}$$

When the plumbing code interaction parameter takes a value p in the range (0, 1], the plumbing code is in effect for any year t ≥ v, and the annual decay parameter takes a value d in the range (0, 1], annual water savings in any year t ≥ s are:

$$S_t = \begin{cases} A_s S_0 (1-d)^{t-s} \; if \; t - s + 1 \leq u \; and \; t < v \\ A_s (1-p)^{t-s} S_0 (1-d)^{t-s} \; if \; t - s + 1 \leq u \; and \; t \geq v \\ 0 \; if \; \; t - s + 1 > u \end{cases}$$

The specification of these parameters are based on current state and federal plumbing codes and appliance standards and findings from empirical evaluations of conservation program performance, as compiled by the California Urban Water Conservation Council (CUWCC) and Alliance for Water Efficiency (AWE). The specific data sources and assumptions used to create the water savings and plumbing code specifications for each program are provided in the remainder of this document.

The model's toilet fixture inventory modules for single- and multi-family toilets also estimate water savings from the City's toilet retrofit-on-resale ordinance that started in 2009. These estimates rest on two simplifying assumptions: (1) 3.5+ gpf toilets are uniformly distributed across the housing stock and

(2) each housing unit is equally likely to be put on the market for sale each year. Given these two assumptions, ROR toilet replacements in any year t ≥ 2009 are calculated as:

(Stock of 3.5+ gpf toilets at beginning of year – SFPUC toilet replacements) x housing resale rate

The model assumes ROR toilets are replaced with ULFTs prior to 2014 and HETs thereafter.

Program Water Savings Specifications

The remainder of this document presents the water savings specifications for each conservation measure included in the Conservation Tracking Model. Program specifications are grouped first by customer class and second by programs type.

Confidence in Estimates

The program water savings specifications utilize the best available information on water savings. Only measures with a sufficient level of confidence in the approach to estimating water-savings are included in the Tracking Model. The SFPUC implements a number of measures that are not included in the model that are likely to generate some water savings but for which there are insufficient empirical studies or standard engineering estimates to generate estimates with a reasonable level of confidence. For the measures included in the model there is a range of reliability of savings estimates. While all measures in the tool meet a base level of confidence, for established and widely deployed measures – e.g. toilet replacements -- there is strong empirical evidence on water savings from multiple empirical program evaluations. In other cases, less data is available or the program is so new that empirical performance data is limited or nonexistent. In these cases, the water savings estimates may be based on results of a single evaluation done elsewhere or they may be built up from utilization and flow rate assumptions – commonly referred to as engineering estimates.

A confidence score of 1, 2 and 3 is assigned to each program specification to indicate the level of confidence in the water savings specification. The confidence scores are subjective in the sense that they rely on professional judgement as to the quality and applicability of the data underlying the water savings specification.

Confidence Score	**Criteria**
1	Savings are based on well-designed empirical evaluations of program performance. The program is widely deployed by other water suppliers and water savings have been evaluated in multiple locations and contexts. Savings estimates are directly applicable or can reasonably be re-scaled to be applicable to SFPUC's service area.
2	Savings are based on simple empirics of program performance (e.g. a simple difference in means or difference-in-differences analysis). The program may not be widely deployed by other water suppliers and may not have been evaluated in multiple locations and contexts.
3	Empirical estimates of program performance are not available or are limited in their applicability to SFPUC's service area. Savings are based on engineering estimates relying on general

assumptions about water use with and without the program intervention

Measure Summary Tables

The following tables summarize the measures in the model at the time of this update (August 2020). The tables provides:

- A brief description of each measure
- The unit savings estimate for the measure
- The basis for the estimate
- The expected annual water savings at the planned level of activity
- The confidence score for the water savings estimate

Link to Detailed Specifications

The measure IDs in the summary tables are hyperlinked to the measure's detailed specification. Ctr-clicking the specification ID will take the reader to the measure's detailed specification. Ctr-clicking the ID the detailed specification will take the reader back to the summary table.

Basis for Savings Estimates

The basis for the savings estimate is either:

Empirical Program Evaluations – the savings estimate is based on results from one or more empirical evaluations of water savings for similar programs. The empirical estimate may be adjusted to account for differences between the location(s) where the empirical evaluation was completed and SFPUC's service area. Such adjustments are explained in the measure's detailed specification.

Engineering Estimate – the savings estimate is based on assumptions about fixture/device utilization and the water-using properties of the existing and new fixture/device. Engineering estimates are generally less reliable than estimates based on empirical program evaluations.

Annual Savings Estimates

The annual savings estimates show the expected water savings from one year of planned annual activity. These savings would be expected to persist over the useful life of the measure. Savings for most measures are assumed to be stationary, meaning the model does not assume the savings will change significantly over its useful life. However, this assumption is not adopted for every measure. For example, the model assumes savings from surveys are not constant, but rather decrease with time. The estimates in the summary tables do not reflect these adjustments. Therefore, the estimates should be viewed as upper-bounds for measures whose savings are expected to decrease over time.

Single-Family Measures

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
S1	Mandatory CAP Audit	Free site evaluation required for single-family residents to participate in the SFPUC's Community Assistance Program (CAP) for discounted water and sewer rates. Identify inefficient plumbing fixtures and leaks and suggest improvements.	17.5 gpd	0	NA	Empirical Program Evaluations	Savings assumed to decay by 20% per year	2
S2	WaterWise Evaluation	Free indoor and outdoor site consultation: review consumption history, check plumbing fixtures and irrigation system components for leaks, determine fixture flow rates, recommend improvements, identify fixtures eligible for replacement through rebate programs, and provide standard repair parts for faulty toilets and free water-saving devices and materials. Customized report of findings sent to customer after visit.	17.5 gpd	500	9.8	Empirical Program Evaluations	Savings assumed to decay by 20% per year	2
S3a	Leak Alerts	SFPUC uses its AMI data to flag accounts that trigger continuous usage thresholds and alerts customers if a leak is suspected. SFPUC provides alerted customers with information on	0.7 gpd	109,000	85.5	Empirical Program Evaluations	Unit savings is per active Single-Family account	1

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
		how to check for and repair common leaks						
S3b	Custom Water Use Report	Report with customers' water use information, comparison of water to similar properties, and customized information on ways to save.	8.4 gpd	0	NA	Empirical Program Evaluations	Multiple empirical evaluations have found home water reports reduce water use by 5-6%. The model assumes 5.5%.	1
S4	1.5 GPM Showerhead Distribution	Up to two free showerheads (as part of measure S2 or in-person pickup from SFPUC) per household.	6.8 gpd	500	3.6	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018. Assumes 54% installation rate	2
S5	1.5 GPM Showerhead Direct Install	Provides free installation of 1.5 gpm showerheads to single family residents. WaterWise Evaluation (S2) is a pre-requisite to this measure.	12.6 gpd	100	1.4	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018	1

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
S6	HET Rebate	Cash rebates of up to $125 to replace old toilets (3.5 gpf or more) with approved HETs (1.28 gpf or less).	20.9 gpd	0	NA	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018. Direct install savings reduced by 25% to account for rebates used to replace ULF toilets and program free-riders	2
S7	CAP Direct Install thru SFPUC Funding	Free installation of HETs (1.28 gpf) for single-family residents who are also CAP participants. Only 3.5 gpf toilets replaced except a small number of old, poorly performing 1.6s. **Pre-requisite:** Mandatory CAP Audits (Measure S1).	27.8 gpd	0	NA	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018	1
S8	HET Direct Install (Non-CAP)	Same as measure S7 but is open to single-family residents who are not a CAP participant. Program did not start until 2016	27.8 gpd	206	6.4	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit	1

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
							programs completed in 2018	
S9	HET Voucher	A voucher issued to eligible residents to replace their older toilets with HETs.	20.9 gpd	0	NA	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018. Direct install savings reduced by 25% to account for rebates used to replace ULF toilets and program free-riders	2
S11	CEE Tier 3 Washer Rebate (WF 4.0)	Up to $100 rebate from SFPUC and $50 rebate from PG&E for a combined $150 rebate for a washer with 4 WF or lower.	10.2 gpd	0	NA	Engineering Estimate	Engineering estimate based on limited data on clothes washer market shares	3
S12	Energy Star Most Efficient Washer	Up to $100 rebate from SFPUC and $50 rebate from PG&E for a combined $150 rebate for a washer with 3.5 WF or lower.	11.6 gpd	80	1.0	Engineering Estimate	Engineering estimate based on limited data on clothes	3

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
	Rebate (WF 3.5)						washer market shares	
S16a	Rain Barrel Rebate	Subsidy program that discounts the purchase cost of rain barrel and provides training.	0.8 gpd	30	0.03	Engineering Estimate	60 gal capacity. Estimated with AWE Rain Barrel Harvest & Application Model	3
S16b	Rain Cistern Rebate	Subsidy program that discounts the purchase cost of cisterns and provides training.	2.4 gpd	15	0.04	Engineering Estimate	205 gal capacity. Estimated with AWE Rain Barrel Harvest & Application Model	3
S18	Weather-Based Irrigation Controller Rebate	Financial rebate towards purchase and installation of a weather-based irrigation controller that uses site specific data and adjusts the irrigation time depending on the local weather.	3.7 gpd	50	0.2	Empirical Program Evaluations	Estimate is based on review of empirical evaluations of WBIC savings in Southern and Northern CA	2
S20	Device Distribution	Various water-efficient fixtures: bathroom aerators (0.5/1.0/1.5 gpm), kitchen/bathroom laminar (1.5 gpm), kitchen aerators (1.5/2.2 gpm), utility aerators (1.5/2.0/2.2), pre-rinse spray nozzles, garden spray hose nozzles, toilet flappers, toilet fill valves, and soil moisture meters.	3.3 gpd	1600	5.9	Engineering Estimate	Based on review of end use studies and engineering estimates of savings potential of	3

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
							aerators and other devices	

Multi-Family Measures

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
M1	WaterWise Direct Installation Evaluation	Free, required site evaluation for multi-family residents to participate in the SFPUC's HET/Urinal Direct Install Program). Identify inefficient plumbing fixtures and leaks and suggest improvements.	10.6 gpd	206	2.4	Empirical Program Evaluations	Equal to indoor savings for S1 and S2. Savings assumed to decay by 20% per year	2
M2	WaterWise Evaluation	Free site consultation: review consumption history, check toilets for leaks, determine fixture flow rates, recommend improvements, identify fixtures eligible for replacement through rebate programs, provide standard repair parts for faulty toilets and free water-saving devices and materials.	10.6 gpd	500	5.9	Empirical Program Evaluations	Equal to indoor savings for S1 and S2. Savings assumed to decay by 20% per year	2
M3	Leak Alert	SFPUC uses its AMI data to flag 2-5 dwelling unit multi-family accounts that trigger continuous usage thresholds and alerts customers if a leak is suspected. SFPUC provides alerted customers with information on how to check for and repair common leaks	2 gpd	27,000	60.5	Empirical Program Evaluations	Unit savings applies to all Multi-Family customers with 2-5 dwelling units	1
M4	Showerhead Distribution	Buildings with 10 or less units are limited to one showerhead per unit. These buildings can pick up showerheads at the customer service counter. Also includes	6.8 gpd	700	5.3	Empirical Program Evaluations	Based on empirical evaluation of bathroom	2

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
		buildings that receive showerheads that are not installed during a Water Wise Evaluation. Buildings with over 10 units must schedule a WaterWise Evaluation (measure M2) in order to receive the free devices					retrofit programs completed in 2018. Assumes 54% installation rate	
M5	Showerhead Direct Install	Free installation of showerheads. **Pre-requisite:** WaterWise Direct Install Evaluations (Measure M1)	12.6 gpd	200	2.8	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018	1
M6	HET Rebate	Cash rebates of up to $125 per tank-style HET or up to $300 per flushometer valve HET to replace a high-flow toilet (3.5 gpf or more).	30 gpd	0	NA	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018. Direct install savings reduced by 25% to account for rebates used to replace ULF toilets and	2

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
							program free-riders	
M7	HET Direct Install	Free installation of tank-style (T) or flushometer valve (F) HETs. **Pre-requisite:** WaterWise Direct Install Evaluation (Measure M1)	38.6 gpd	300	13.0	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018	1
M8	HET Voucher	A voucher issued to eligible residents to replace their older toilets with HETs	30 gpd	0	NA	Empirical Program Evaluations	Based on empirical evaluation of bathroom retrofit programs completed in 2018. Direct install savings reduced by 25% to account for rebates used to replace ULF toilets and program free-riders	2
M9	HET Install thru On-Bill Financing	Partner with third-party vendors to find customers with remaining savings opportunity, sell them the	38.6 gpd	0	NA	Empirical Program Evaluations	Based on empirical evaluation of	1

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
		program, and conduct the installation. The customer pays for the program through savings received through their water bill.					bathroom retrofit programs completed in 2018	
M10	CEE Tier 3 Washer Rebate (WF 4.0)	Rebate for coin-op, common area clothes washer with WF of 4 or lower. (multi-family in-unit residential style washers are covered under SF measure)	126 gpd	80	11.3	Engineering Estimate	Engineering estimate based on limited data on clothes washer market shares	3
M20	Device Distribution	Various water-efficient fixtures: bathroom aerators (0.5/1.0/1.5 gpm), kitchen/bathroom laminar (1.5 gpm), kitchen aerators (1.5/2.2 gpm), utility aerators (1.5/2.0/2.2), pre-rinse spray nozzles, garden spray hose nozzles, toilet flappers, toilet fill valves, and soil moisture meters.	3.3 gpd	2750	10.2	Engineering Estimate	Based on review of end use studies and engineering estimates of savings potential of aerators and other devices	3

Non-Residential Measures

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
N1	WaterWise Evaluations for Commercial Buildings	Free site consultation: review consumption history, check toilets for leaks, determine fixture flow rates, recommend improvements, identify fixtures eligible for replacement through incentive programs, provide standard repair parts for faulty toilets and free water-saving devices and materials. Customized report of findings sent after visit.	215 gpd	50	12.0	Empirical Program Evaluations	Based on empirical evaluations of CII surveys done in Southern California in the 1990s	3
N2	Commercial Direct Install Audits	Free site consultation similar to measure N1. Required for commercial buildings that applied for direct install programs.	215 gpd	0	NA	Empirical Program Evaluations	Based on empirical evaluations of CII surveys done in Southern California in the 1990s	3
N3	Surveys – Hospitals, Hotels, Schools	Free site consultation for hospitals, hotels, and schools	837 gpd	16	15.0	Empirical Program Evaluations	Based on empirical evaluations of CII surveys done in Southern California in the 1990s	3
N4	Surveys – Large Landscape by Contractors	Free landscape survey provided to eligible customers (0.5 acres or more of irrigated landscapes) under the Landscape Technical Assistance Program. Survey	161 gpd	30	5.4	Engineering Estimate	Unit savings per acre surveyed. Assumes 10% reduction in average landscape	3

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
		will evaluate the water delivery system to check for inefficiencies that lead to water losses, Surveyors will also determine the site's water budget by cataloguing plant type and will create site-specific recommendations and a cost estimate for improving irrigation efficiency.					site water use of 1.8 AF/Acre	
N5	Surveys – CII Facilities by Contractors	Free site consultation for other types of non-residential customers provided by third-party consultant or other funding sources.	5120 gpd	3	17.2	Engineering Estimate	SFPUC staff estimate of water savings from consultant audits	2
N7	1.5 GPM Showerhead Giveaway	Provides free, high-efficiency 1.5 gpm showerheads for San Francisco businesses.	5.6 gpd	300	1.9	Engineering Estimate	Based on review of hotel end use studies and engineering estimates of hotel showerhead savings potential. Assumes 54% installation rate	3
N8	1.5 GPM Showerhead Direct Install	Free installation of high-efficiency 1.5 gpm showerheads for San Francisco businesses. **Pre-requisite:** Direct Install Audit (Measure N2)	10.4 gpd	100	1.2	Engineering Estimate	Based on review of hotel end use studies and engineering estimates of hotel showerhead savings potential.	3
N9	Device Distribution	Various water-efficient fixtures: bathroom aerators (0.5/1.0/1.5 gpm),	3.3 gpd	700	2.6	Engineering Estimate	Based on review of end use studies and	3

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
		kitchen/bathroom laminar (1.5 gpm), kitchen aerators (1.5/2.2 gpm), utility aerators (1.5/2.0/2.2), pre-rinse spray nozzles, garden spray hose nozzles, toilet flappers, toilet fill valves, and soil moisture meters.					engineering estimates of savings potential of aerators and other devices	
N10	HET Rebate	Cash rebates of up to $125 per tank style toilet and up to $300 per flushometer valve toilet for replacing high-flow toilets (3.5 gpf or more) with approved HET models (1.28 gpf or less).	28.4 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC CII Toilet Savings Study. Estimate scales-up ULFT savings to account for improved efficiency of HET	2
N11	HET Rebate – Schools, Hotels, Muni	Cash rebates of up to $125 per tank style toilet and up to $300 per flushometer valve toilet for replacing high-flow toilets (3.5 gpf or more) with approved HET models (1.28 gpf or less).	20.6 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC CII Toilet Savings Study. Estimate scales-up ULFT savings to account for improved efficiency of HET	2
N12	HET Direct Install	Free installation of High-Efficiency Toilets for businesses in SF **Pre-requisite:** Direct Install Audit (Measure N2)	29 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC CII Toilet Savings Study. Estimate scales-up ULFT savings to account for improved efficiency of HET	2

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
N13	HET Direct Install – Schools, Hotels	Free installation of HETs for schools or hotels in SF. **Pre-requisite:** Direct Install Audit (Measure N2)	19.6 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC CII Toilet Savings Study. Estimate scales-up ULFT savings to account for improved efficiency of HET	2
N14	HET Voucher	A voucher for HET purchase.	28.4 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC CII Toilet Savings Study. Estimate scales-up ULFT savings to account for improved efficiency of HET	2
N15	HET Voucher – Schools, Hotels	Same as N14 but directed at schools and hotels	17.8 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC CII Toilet Savings Study. Estimate scales-up ULFT savings to account for improved efficiency of HET	2
N16	HET Install thru On-Bill Financing	Partner with third-party vendors to find customers with savings opportunity, sell them the program, and conduct the installation. The customer pays for the program through savings received through their water bill.	29 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC CII Toilet Savings Study. Estimate scales-up ULFT savings to account for improved efficiency of HET	2

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
N17	HEU Rebate	Cash rebates of up to $300 per urinal for eligible commercial businesses when high flow urinals (1.5 gpf or more) are replaced with High-Efficiency Urinal (HEU) models that are 0.125 gpf or less.	16.2 gpd	0	NA	Empirical Program Evaluations	Based on CUWCC Urinal Savings Potential PBMP Study	3
N18	HEU Direct Install	A program for replacing 1.5 gallons per flush (gpf) high efficiency urinals with pint flush urinals.	16.2 gpd	0	NA	Engineering Estimate	Based on CUWCC Urinal Savings Potential PBMP Study	3
N20	Energy Star Washer Rebate (WF 4.5)	Measure has been discontinued. Cash rebates for commercial high-efficiency clothes washers with a water factor of 4.5 or below.	39 gpd	0	NA	Engineering Estimate	Engineering estimate based on limited data on clothes washer market shares and coin-op washer utilization rates	3
N21	Energy Star Washer Rebate (WF 4)	Cash rebates of up to $200 for commercial high-efficiency clothes washers with a water factor of 4.0 or below. For any business where 10 or more washers are being installed, a pre-purchase inspection must be scheduled.	45 gpd	40	2.0	Engineering Estimate	Engineering estimate based on limited data on clothes washer market shares and coin-op washer utilization rates	3
N22	Landscape Grants	Under Landscape Grant Program, landscapes with over 0.5 acre of irrigated areas are eligible to receive funding to implement retrofits and install	446 gpd/acre	11.2 acres (2 projects per year)	5.6	Empirical Program Evaluations	Based on SFPUC staff estimates of water savings for 11 large	2

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
		fixtures to facilitate water conservation.					landscape grant projects	
N24	Equipment Retrofit Rebate	Incentives to businesses to upgrade indoor equipment. Projects must achieve an annual water savings of 200 ccf or more to qualify. SFPUC will provide qualifying projects incentives of $0.50 per ccf over a 10-year lifespan up to 50% of the equipment costs. Program includes customized incentives as well as standard incentives for equipment with predictable water savings, such as water efficient ice machines, and connectionless food steamers.	2 gpd per dollar of grant funding	1 project (200 ccf/yr)	0.5		Minimum required savings per $1 of grant funding – e.g. if $100K awarded, expected savings would be 200,000 gpd	1
N25	Custom Equipment Retrofit Rebate	Similar to Measure N24, but allows applicants to create customized project tailored toward their specific business needs and water use patterns.	2 gpd per dollar of grant funding	1 project (200 ccf/yr)	0.5		Minimum required savings per $1 of grant funding – e.g. if $100K awarded, expected savings would be 200,000 gpd	1
N27	Kitchen Low Flow Spray Valves	Rebate or giveaway of high-efficiency kitchen spray valves used primarily by dishwashing stations	30 gpd	10	0.3	Empirical Program Evaluations	Based on multiple empirical evaluations of savings from kitchen spray-valve retrofits. Estimate assumes 50%	1

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings (AF)	Basis for Savings Estimate	Notes on Savings Estimate	Water Savings Estimate Confidence Score
							installation/retention rate	

Measures Applicable to All Customers

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings	Notes on Savings Estimate	Water Savings Estimate Confidence Score
A3	Irrigation Customer Large Landscape Budget	The SFPUC calculates how water use for irrigated landscape sites that received an irrigation or landscape grant or were required to comply with San Francisco's Water Efficient Irrigation Ordinance (WEIO) compares to the maximum allowable water use (MAWA) recommended for the plant types per state calculations. Staff are exploring how to potentially expand the program to all sites served by dedicated irrigation meters	357 gpd	TBD	Engineering Estimate	Unit savings per acre surveyed. Assumes 10% reduction in average pre-grant water use of 4 AF/Acre for 9 large landscapes enrolled in SFPUC landscape grant program	3
S16a	Rain Barrel Rebate	Subsidy program that discounts the purchase cost of rain barrel and provides training.	0.8 gpd	See Single-Family Table	Engineering Estimate	Originally specified as a single-family measure, multi-family and non-residential customers also can participate in the program. Currently single-family customer account for about 80% of program participants with the	3

ID	Measure Name	Measure Description	Expected Unit Water Savings (GPD)	Planned Annual Activity Level	Annual Water Savings	Notes on Savings Estimate	Water Savings Estimate Confidence Score
						other 20% split more or less evenly between multi-family and non-residential customers	
S16b	Rain Cistern Rebate	Subsidy program that discounts the purchase cost of cisterns and provides training.	2.4 gpd	See Single-Family Table	Engineering Estimate	See previous note	3

Measure Specifications

This section contains the water savings specification for each measure used in the conservation savings model. The specifications are grouped by customer class: (1) single-family, (2) multi-family, and (3) non-residential.

Single Family Measures

ID	Name	Class	Category
S1	Mandatory CAP Audit	Single Family	Audits & Reports

Water Savings: Average of savings from residential survey savings reported by Whitcomb (2000), A&N Technical Services (1994b), and Chesnutt, et al. (1995) is 33.9 gpd. Whitcomb (2000) reported 60% of savings are from outdoor uses and 40% are from indoor uses. Single family irrigation area in SFPUC retail service is approximately 34% of state average reported by DeOreo and Mayer (2010). Estimate based on combination of behavioral and fixture retrofits induced by survey recommendations. Savings from showerheads removed from indoor component to avoid double counting savings from S11 and S12. The 3 gpd estimate for showerheads assumes half the site visits get a direct install showerhead and half get a showerhead left for owner-installation, in which 50% are installed.

Water savings = (0.4 x 33.9 gpd – 3 gpd) + 0.6 x 0.34 x 33.9 gpd = 17.5 gpd (6,388 gpy)

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: 20%. Lower-end of decay rate range reported in CUWCC (2005).

Useful Life: 5 yrs. Based on typical useful life of survey savings reported in CUWCC (2005).

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year, 80% of outdoor savings occur in peak period. Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 0.42 x (0.4 x 33.9 gpd – 3 gpd) + 0.8 x 0.6 x 0.34 x 33.9 gpd)/17.5 = 57%

Unit Sewer Savings: Sewer savings = 0.4 x 33.9 gpd – 3 gpd = 10.6 gpd (3,869 gpy)
Wastewater to water savings ratio = 0.606

Unit Electricity Savings: NA

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006), that hot water comprises 67% of shower/faucet flow - per DOE (2006) – that half of indoor water savings involve reductions in shower/faucet flow, and that indoor savings comprise 66% of total survey savings.

Gas savings = 0.0072 therms/gal x 0.67 x 0.5 x 0.66 = 0.0016 therms/gal

Confidence Score: 2

ID	Name	Class	Category
S2	WaterWise Evaluations	Single Family	Audits & Reports

All assumptions same as S1.

ID	Name	Class	Category
S3a	Leak Alerts	Single Family	Audits & Reports

Water Savings: Detailed empirical analysis of SFPUC's Single-Family Customer Leak Alert Program concluded:

- The Program reduced the mean duration of leak events lasting 72 or more hours by 31.5%, from 313.0 hours to 214.5 hours.
- The Program reduced the frequency of leak events lasting 72 or more hours by 39.5%, from 0.000425 to 0.000257 leaks per customer-day.
- The mean leak flow rate before the Program was 1.30 CF per hour. This increased 10.8% to 1.44 CF per hour with the Program.
- Given a base of 109,000 meters, the expected annual water loss without the Program is 51.5 MG and with the Program is 23.6 MG, a decrease of 54%.

This translates to an expected annual water savings rate of 256 gpy per single-family meter enrolled in the leak alert program.

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 1 year.

Peak Period Savings Percent: We assume the same savings pattern as S1 and S2 – where outdoor savings comprise 34% of total savings and 80% of outdoor savings occur in the peak period.

Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 0.42 x 0.66 + 0.8 x 0.34 = 55%

Unit Sewer Savings: We do not have data on how leakage is distributed between indoor and outdoor water uses. We assume the same distribution as indoor and outdoor water use.
Sewer savings = 0.66 x 256 gpy per meter = 169 gpy per meter
Wastewater to water savings ratio = 0.66

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 1

ID	Name	Class	Category
S3b	Custom Water Use Report	Single Family	Audits & Reports

Water Savings: Average water savings are 5.5% of single family daily use, per Mitchell and Chesnutt (2014). Multiple other empirical estimates of water use report savings have measured average saving rates of 4-6% (https://www.watersmart.com/resources/). Median single family water use in SFPUC's retail service area (circa 2005) is 153 gpd, per DeOreo and Mayer (2010a).

Water savings = 0.055 x 153 gpd = 8.4 gpd (3,066 gpy)

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 1 year.

Peak Period Savings Percent: Evaluations of water use reports have not had sufficient data to detect seasonal effects (Mitchell and Chesnutt, 2014). For now we assume the same savings pattern as S1 and S2 – where outdoor savings comprise 34% of total savings and 80% of outdoor savings occur in the peak period.

Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = (0.42 x 0.66 x 8.4 gpd + 0.8 x 0.34 x 8.4 gpd) ÷ 8.4 = 55%

Unit Sewer Savings: Evaluations of water use reports have not had sufficient data to determine indoor and outdoor savings as a share of total (Mitchell and Chesnutt, 2014). For now we assume the same savings pattern as S1 and S2 – where indoor savings comprise 66% of total savings

Sewer savings = 0.606 x 8.4 gpd = 5.09 gpd (1,858 gpy)
Wastewater to water savings ratio = 0.606

Unit Electricity Savings: NA

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006), that hot water comprises 67% of shower/faucet flow - per DOE (2006) – that half of indoor water savings involve reductions in shower/faucet flow, and that indoor savings comprise 66% of total savings.

Gas savings = 0.0072 therms/gal x 0.67 x 0.5 x 0.66 = 0.0016 therms/gal

Confidence Score: 1

ID	Name	Class	Category
S4	1.5 GPM Showerheads Distributions	Single Family	HESH

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Mean savings for showerheads installed in single-family households was 12.6 gpd. Field studies of retrofit kit distributions in Irvine (A&N Technical Services 1992d) and Los Angeles (A&N Technical Services 1991) have found initial installation probabilities that range from 49% to 59%. We assume a 54% installation probability.

Water savings = 0.54 x 12.6 gpd = 6.8 gpd (2482 gpy)

Plumbing Code Savings: Zero. SB 407 mandates showerheads have a maximum capacity of 2.5 gpm. Currently, the average flow rate of showerheads in SFPUC's retail service area is 1.95, per DeOreo and Mayer (2010a).

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 8 yrs, per Alliance for Water Efficiency (2014).

Peak Period Savings Percent:
Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 6.8 gpd (2482 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006) and that hot water comprises 67% of shower/faucet flow - average of DOE (2006) and Aquacraft (1999). Gas savings = 0.0072 therms/gal x 0.67 = 0.0048 therms/gal

Confidence Score: 2

ID	Name	Class	Category
S5	1.5 GPM Showerheads Direct Install	Single Family	HESH

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Mean savings for showerheads installed in single-family households was 12.6 gpd (4599 gpy).

Unit Sewer Savings: Sewer savings = 12.6 gpd (4599 gpy)
Wastewater to water savings ratio = 1.000

All other assumptions same as S4.

Confidence Score: 1

ID	Name	Class	Category
S6	HET Rebates (Tank)	Single Family	HET

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Installed HETs had flush rates of 1.1 gpf or less. Mean savings for HETs installed in single-family households was 27.8 gpd (10147 gpy). Direct installation programs can more effectively screen out the replacement of ULF toilets than can rebate programs. Nearly all the toilets replaced in the direct installation programs evaluated by M.Cubed and A&N Technical Services were older non-ULFT toilets. Rebate programs may inadvertently issue rebates for the replacement of ULF toilets. To account for this possibility, mean daily savings estimated for the direct installation programs is reduced by 25%.

Water savings = 27.8 gpd x 0.75 = 20.9 gpd (7629 gpy)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency. Period of savings attributed to program does not exceed useful life of toilet. On average savings are counted for 25 years, the average useful life of the toilet.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 20.9 gpd (7629 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
S7	CAP Direct Install thru SFPUC Funding	Single Family	HET

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Installed HETs had flush rates of 1.1 gpf or less. Mean savings for HETs installed in single-family households was 27.8 gpd (10147 gpy).

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency. Period of savings attributed to program does not exceed useful life of toilet. On average savings are counted for 33 years, the average useful life of the toilet.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 27.8 gpd (10147 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 1

ID	Name	Class	Category
S8	HET Direct Install (Non-Cap)	Single Family	HET

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Installed HETs had flush rates of 1.1 gpf or less. Mean savings for HETs installed in single-family households was 27.8 gpd (10147 gpy).

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency. Period of savings attributed to program does not exceed useful life of toilet. On average savings are counted for 33 years, the average useful life of the toilet.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 27.8 gpd (10147 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 1

ID	Name	Class	Category
S9	HET Vouchers	Single Family	HET

All assumptions same as S6.

ID	Name	Class	Category
S11	CEE Tier 3 Rebate (WF 4.0)	Single Family	HEW

Water Savings: Assumes participant in market for washer. Without rebate, participant will purchase either top- or front-load washer. Current market share (circa 2012) of top-load washers is 52%, per DOE (2012). Current Energy Star market share (circa 2012) is 50%, per DOE (2012). Maximum allowed WF for Energy Star washer after 2011 is 6. Maximum allowed WF for non-Energy Star washer is 9.5, per National Appliance Standard. (National Appliance Standard changes in 2015 to 4.5 WF for front-load and 8.0 WF for top-load, and again in 2018 to 6.0 WF for top-load). Average WF of new washer is:

Avg WF of New Washer Without Rebate = 0.5 x 6.0 + 0.5 x 9.5 = 7.75 (note this will overstate avg WF after 2015 due to nat'l appl stdrd)

Average washer loads per day for single family households in SFPUC retail service area is 0.91, per DeOreo and Mayer (2010a). Average volume of new clothes washer is 3 cubic feet, per DOE (2012).

Water savings = (7.75 – 4.0) x 3 x 0.91 = 10.2 gpd (3,723 gpy)

Plumbing Code Savings: Effective Jan 1, 2015, appliance standard is 4.5 WF for front-load and 8.0 WF for top-load. Given current front- and top-load market shares and Energy Star market share, average WF under appliance standard in 2015 is:

2015 Avg WF under Nat'l Appl Std = 0.52 x (0.5 x 8.0 + 0.5 x 6.0) + 0.48 x 4.5 = 5.8

Effective Jan 1, 2018, appliance standard is 4.5 WF for front-load and 6.0 for top-load. Average WF under appliance standard in 2018 is:

2018 Avg WF under Nat'l Appl Std = 0.52 x 6.0 + 0.48 x 4.5 = 5.3.

For modeling conservation program benefits, we use the average of these two water factors – 5.6 -- and start the standard in 2015. Plumbing code savings starting in 2015 are:

Plumbing code savings = (7.75 – 5.6) x 3 x 0.91 = 5.9 gpd (2,154)

Plumbing Code NRR: 7.1%. Based on average washer life of 14 years, per DOE (2012).

Annual Decay Rate: NA

Useful Life: 14 years, per DOE (2012)

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 10.2 gpd (3,723 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: 0.0036 KWh/gal. Based on high efficiency washer electricity savings reported in FEMP (2000).

Unit Gas Savings: 0.0035 therms/gal. Based on high efficiency washer gas savings reported in FEMP (2000).

Confidence Score: 3

ID	Name	Class	Category
S12	Energy Star Most Efficient (WF 3.5) Washer Rebate	Single Family	HEW

Water Savings: See S11 for details.

Water savings = (7.75 – 3.5) x 3 x 0.91 = 11.6 gpd (4,234 gpy)

Unit Sewer Savings: Sewer savings = 11.6 gpd (4,234 gpy)
Wastewater to water savings ratio = 1.000

All other assumptions same as S11.

Confidence Score: 3

ID	Name	Class	Category
S16a, S16b	Rain Barrels and Cisterns	Single Family, Multi Family, Non-Residential	Grants

Water Savings: Savings based on M.Cubed Rain Barrel Harvest & Application Model (rainbarrel_harvest_and_application_model.xlsx)

60 gal barrel = 302 gpy (assumes 100 sqft irr area)
205 gal cistern = 887 gpy (assumes 300 sqft irr area)

The rain barrel water savings model simulates rain barrel catchment, filling, and application of stored water using daily rainfall and ETO data for the period 2/5/2001 to 10/22/2014. Daily weather data are from the Union City CIMIS weather station. The 60 gallon barrel savings estimate assumes a catchment area of 1000 square feet, irrigation area of 100 square feet, and landscape crop water coefficient (KL) of 0.25. The 205 gallon cistern savings estimate assumes irrigation area is 300 square feet. The other model assumptions are the same. Daily application of stored water is equal to the lesser of daily irrigation requirement and stored water. Daily irrigation requirement in cubic feet is equal to irrigation area x KL x net ETO ÷ 12.

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 15 years. Assumed

Peak Period Savings Percent: 24%. Calculated with M.Cubed Rain Barrel Harvest & Application Model for a 100 gal. barrel. Peak period savings % increases with barrel size, since more water can be stored for use in peak season.

Unit Sewer Savings: NA

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 3

ID	Name	Class	Category
S18	WBIC	Single Family	Grants

Water Savings: Several empirical program evaluations of WBIC performance have been completed since the early 2000s. A good summary of these studies can be found on the Cal WEP website. The following table summarizes findings from these studies.

Study	% Reduction in Outdoor Water Use	% Reduction in Total Household Water Use	Mean Reduction in Gal/Day	Sample Size
Orange County 2001	16-24%	7-10%	37-57	40 SF Homes
Orange County 2004	No estimate	10%	41	97 SF Homes
No & So Cal, 2009	7%	No estimate	58	1,987 SF Homes
Orange County 2010	10%	7%	37	899 SF Homes
Orange County 2011	No estimate	9%	49	70 SF Homes

The mean percentage reduction in outdoor water use estimated by these studies range from 7 to 24%. We are inclined to give more weight to the 2009 and 2010 studies that had large sample sizes. The mean percentage reduction in outdoor water use was 7-10%. We use the lower end of the range to be conservative.

Median single family water use in SFPUC's retail service area (circa 2005) is 153 gpd, per DeOreo and Mayer (2010a). On average, outdoor water use is assumed to be 34% of total water use. Expected WBIC savings are thus: 153 x 0.34 x 0.07 = 3.7 gpd or 1,351 gpy.

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 10 years. Assumed

Peak Period Savings Percent: 100% of savings assumed to occur in peak season.

Unit Sewer Savings: NA

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
S20	Device Distribution	Single Family	Grants

Water Savings: Water savings are a quantity-weighted average of devices distributed by SFPUC. The devices, quantity weights, and annual savings are shown in the following table.

Devices	Annual Quantity	Savings (GPY)	
1.5 gpm bathroom aerator	8229	210	
1.0 gpm bathroom aerator	0	361	
0.5 gpm bathroom aerator	1537	511	
1.5 gpm kitchen laminar	0	210	
1.5 gpm bathroom laminar	0	210	
2.2 gpm kitchen aerator	265	0	
1.5 gpm kitchen aerator	4641	210	
1.5 utility aerator	54	210	
2.0 utility aerator	54	60	
2.2 utility aerator	16	0	
Garden spray hose nozzle	295	0	No reliable estimates
Toilet flapper	3603	1212	
Toilet fill valves	1819	1212	Assumed to be same as flapper savings
Soil moisture meter	7	0	No reliable estimates
Total	20520		
Weighted Avg Savings		491	

Annual savings for aerators are based on the following data and assumptions:

- Median SFR faucet use is 29 gpd (source: Aquacraft SFPUC End Use Study).
- An average of 4 faucets per household is assumed.
- Average use per faucet is 7.25 gpd. The calculation assumes uniform faucet usage, which while unlikely to be true is necessary given lack of data on faucet use.
- Aerators reduce free flowing faucet water consumption. It is assumed half of faucet use is for free flowing uses (e.g. brushing teeth or washing vegetables) and half is for fixed volume uses (e.g. filling pots or getting a drink of water). Free flowing faucet use is therefore 3.63 gpd.
- Average faucet flow is assumed to be 2.2 gpm. Therefore, faucets average 1.6 minutes of free flowing use per day.
- It is assumed half of distributed faucets are installed.

Given these assumptions, savings by aerator flow rate are:

Aerator flow rate (gpm)	Avg Use GPD	Potential Savings (GPD)	Install %	Actual Savings (GPD)	Actual Savings (GPY)
2.2	3.63	0.00	50%	0.00	0
2.0	3.30	0.33	50%	0.16	60
1.5	2.47	1.15	50%	0.58	210
1.0	1.65	1.98	50%	0.99	361
0.5	0.82	2.80	50%	1.40	511

Annual savings for flappers and fill valves are based on the following data and assumptions:

- Median SFR leakage rate is 8.3 gpd, per Aquacraft SFPUC End Use Study.
- According to 2004 CUWCC Toilet Flapper Study and 1999 Residential End Use Study most household water leaks can be attributed to toilets. It is assumed toilet leaks account for 80% of the median leakage rate, or 6.64 gpd.
- It is assumed replacing flapper or fill valves will eliminate toilet-related leakage.
- It is assumed half of distributed flappers and fill valves are installed.

Given these assumptions, water savings are 3.32 gpd, or 1212 gpy.

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 5 years

Peak Period Savings Percent:

Unit Sewer Savings: Same as water savings

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 3

Multi Family Measures

ID	Name	Class	Category
M1	WaterWise Direct Install Evaluations	Multi Family	Audits & Reports

Water Savings: Assumes same as indoor share of savings for S1 and S2

Water savings = 10.6 gpd (3,869 gpy)

Plumbing Code NRR: NA

Annual Decay Rate: 20%. Same as S1 and S2. Lower-end of decay rate range reported in CUWCC (2005).

Useful Life: 5 yrs. Same as S1 and S2. Based on typical useful life of survey savings reported in CUWCC (2005).

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 10.6 gpd (3,869 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006), that hot water comprises 67% of shower/faucet flow - per DOE (2006) – that half of indoor water savings involve reductions in shower/faucet flow, and that indoor savings comprise 100% of total survey savings.

Gas savings = 0.0072 therms/gal x 0.67 x 0.5 x 1.00 = 0.0024 therms/gal

Confidence Score: 2

ID	Name	Class	Category
M2	WaterWise Evaluations	Multi Family	Audits & Reports

All assumptions same as M1.

ID	Name	Class	Category
M3	Leak Alerts	Multi Family	Audits & Reports

Water Savings: Detailed empirical analysis of SFPUC's Multi-Family Customer Leak Alert Program concluded:

- The Program reduced the mean duration of leak events lasting 72 or more hours by 23%, from 325.1 hours to 249.5 hours.
- The Program reduced the frequency of leak events lasting 72 or more hours by 31%, from 0.00139 to 0.00096 leaks per customer-day.
- The Program had no effect on the mean flow rate of leaks, which was 1.29 CF/Hr for both the pre- and post-program periods.
- Given a base of 27,000 meters, the expected annual water loss without the Program is 43 MG and with the Program is 23 MG, a decrease of 47%.

This translates to an expected annual water savings rate of 741 gpy per multi-family meter served.

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 1 year.

Peak Period Savings Percent: We assume leaks are more or less distributed uniformly across the year.

Peak period runs from May 1 to Sep 30, representing 42% of days.

Unit Sewer Savings: We do not have data on how leakage is distributed between indoor and outdoor water uses. We assume multi-family water use is dominated by indoor water uses and so too are water savings from leak alerts.
Sewer savings = 0.9 x 741 gpy per meter = 667 gpy per meter
Wastewater to water savings ratio = 0.9

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 1

ID	Name	Class	Category
M4	Showerheads Distributions	Multi Family	HESH

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Mean savings for showerheads installed in multi-family households was 12.6 gpd. Field studies of retrofit kit distributions in Irvine (A&N Technical Services 1992d) and Los Angeles (A&N Technical Services 1991) have found initial installation probabilities that range from 49% to 59%. We assume a 54% installation probability.

Water savings = 0.54 x 12.6 gpd = 6.8 gpd (2482 gpy)

Plumbing Code Savings: Zero. SB 407 mandates showerheads have a maximum capacity of 2.5 gpm. Currently, the average flow rate of showerheads in SFPUC's retail service area is 1.95, per DeOreo and Mayer (2010a).

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 8 yrs, per Alliance for Water Efficiency (2014).

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 6.8 gpd (2482 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006) and that hot water comprises 67% of shower/faucet flow - average of DOE (2006) and Aquacraft (). Gas savings = 0.0072 therms/gal x 0.67 = 0.0048 therms/gal

Confidence Score: 2

ID	Name	Class	Category
M5	Showerheads Direct Install	Multi Family	HESH

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Mean savings for showerheads installed in multi-family households was 12.6 gpd (4599 gpy).

Unit Sewer Savings: Sewer savings = 12.6 gpd (4599 gpy)

All other assumptions same as M4.

Confidence Score: 1

ID	Name	Class	Category
M6a	HET Rebate (Tank)	Multi Family	HET

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Installed HETs had flush rates of 1.1 gpf or less. Mean savings for HETs installed in multi-family households was 38.6 gpd (14089 gpy). Direct installation programs can more effectively screen out the replacement of ULF toilets than can rebate programs. Nearly all the toilets replaced in the direct installation programs evaluated by M.Cubed and A&N Technical Services were older non-ULFT toilets. Rebate programs may inadvertently issue rebates for the replacement of ULF toilets. To account for this possibility, mean daily savings estimated for the direct installation programs is reduced by 25%.

Water savings = 38.6 gpd x 0.75 = 30.0 gpd (10950 gpy)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 30.0 gpd (10950 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
M6b	HET Rebate (Flushometer)	Multi Family	HET

All assumptions same as M6a.

ID	Name	Class	Category
M7a	HET Direct Install (Tank)	Multi Family	HET

Water Savings: M.Cubed and A&N Technical Services (2018a, 2018b) estimated toilet, showerhead, and aerator water savings from direct installation bathroom retrofit programs in Bakersfield, Torrance, and East Los Angeles targeting both single- and multi-family bathrooms. Installed HETs had flush rates of 1.1 gpf or less. Mean savings for HETs installed in multi-family households was 38.6 gpd (14089 gpy).

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 38.6 gpd (14089 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 1

ID	Name	Class	Category
M7b	HET Direct Install (Flushometer)	Multi Family	HET

All assumptions same as M7a.

ID	Name	Class	Category
M8	HET Voucher	Multi Family	HET

All assumptions same as M6a.

ID	Name	Class	Category
M9	HET/Fixture Install thru On-Bill Financing	Multi Family	HET

All assumptions same as M7a.

ID	Name	Class	Category
M10	CEE Tier 3 Rebate (WF 4.0)	Multi Family	HEW

Water Savings: Assumes rebates are for common area laundry rooms, not individual apartments. Without rebate, participant will purchase either top- or front-load washer. Current market share (circa 2012) of top-load washers is 52%, per DOE (2012). Current Energy Star market share (circa 2012) is 50%, per DOE (2012). Maximum allowed WF for Energy Star washer after 2011 is 6. Maximum allowed WF for non-Energy Star washer is 9.5, per National Appliance Standard. (National Appliance Standard changes in 2015 to 4.5 WF for front-load and 8.0 WF for top-load, and again in 2018 to 6.0 WF for top-load). Average WF of new washer is:

Avg WF of New Washer Without Rebate = 0.5 x 6.0 + 0.5 x 9.5 = 7.75 (note this will overstate avg WF after 2015 due to nat'l appl stdrd)

Average washer loads per day is 8.4, per M.Cubed (2014). Average volume of new clothes washer for common area use is assumed to be 4 cubic feet.

Water savings = (7.75 – 4.0) x 4 x 8.4 = 126 gpd (45,990 gpy) [Get energy star commercial list]

Plumbing Code Savings: Effective Jan 1, 2015, appliance standard is 4.5 WF for front-load and 8.0 WF for top-load. Given current front- and top-load market shares and Energy Star market share, average WF under appliance standard in 2015 is:

2015 Avg WF under Nat'l Appl Std = 0.52 x (0.5 x 8.0 + 0.5 x 6.0) + 0.48 x 4.5 = 5.8

Effective Jan 1, 2018, appliance standard is 4.5 WF for front-load and 6.0 for top-load. Average WF under appliance standard in 2018 is:

2018 Avg WF under Nat'l Appl Std = 0.52 x 6.0 + 0.48 x 4.5 = 5.3.

For modeling conservation program benefits, we use the average of these two water factors – 5.6 -- and start the standard in 2015. Plumbing code savings starting in 2015 are:

Plumbing code savings = (7.75 – 5.6) x 4 x 8.4 = 72 gpd (26,280)

Plumbing Code NRR: 7.1%. Based on average washer life of 14 years, per DOE (2012).

Annual Decay Rate: NA

Useful Life: 14 years, per DOE (2012)

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 126 gpd (45,990 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: 0.0036 KWh/gal. Based on high efficiency washer electricity savings reported in FEMP (2000).

Unit Gas Savings: 0.0035 therms/gal. Based on high efficiency washer gas savings reported in FEMP (2000).

Confidence Score: 3

ID	Name	Class	Category
M20	Device Distribution	Multi Family	Grants

Water Savings: Water savings are a quantity-weighted average of devices distributed by SFPUC. The devices, quantity weights, and annual savings are shown in the following table.

Devices	Annual Quantity	Savings (GPY)	
1.5 gpm bathroom aerator	8229	210	
1.0 gpm bathroom aerator	0	361	
0.5 gpm bathroom aerator	1537	511	
1.5 gpm kitchen laminar	0	210	
1.5 gpm bathroom laminar	0	210	
2.2 gpm kitchen aerator	265	0	
1.5 gpm kitchen aerator	4641	210	
1.5 utility aerator	54	210	
2.0 utility aerator	54	60	
2.2 utility aerator	16	0	
Garden spray hose nozzle	295	0	No reliable estimates
Toilet flapper	3603	1212	
Toilet fill valves	1819	1212	Assumed to be same as flapper savings
Soil moisture meter	7	0	No reliable estimates
Total	20520		
Weighted Avg Savings		491	

Annual savings for aerators are based on the following data and assumptions:

- Median SFR faucet use is 29 gpd (source: Aquacraft SFPUC End Use Study).
- An average of 4 faucets per household is assumed.
- Average use per faucet is 7.25 gpd. The calculation assumes uniform faucet usage, which while unlikely to be true is necessary given lack of data on faucet use.
- Aerators reduce free flowing faucet water consumption. It is assumed half of faucet use is for free flowing uses (e.g. brushing teeth or washing vegetables) and half is for fixed volume uses (e.g. filling pots or getting a drink of water). Free flowing faucet use is therefore 3.63 gpd.
- Average faucet flow is assumed to be 2.2 gpm. Therefore, faucets average 1.6 minutes of free flowing use per day.
- It is assumed half of distributed faucets are installed.

Given these assumptions, savings by aerator flow rate are:

Aerator flow rate (gpm)	Avg Use GPD	Potential Savings (GPD)	Install %	Actual Savings (GPD)	Actual Savings (GPY)
2.2	3.63	0.00	50%	0.00	0
2.0	3.30	0.33	50%	0.16	60
1.5	2.47	1.15	50%	0.58	210
1.0	1.65	1.98	50%	0.99	361
0.5	0.82	2.80	50%	1.40	511

Annual savings for flappers and fill valves are based on the following data and assumptions:

- Median SFR leakage rate is 8.3 gpd, per Aquacraft SFPUC End Use Study.
- According to 2004 CUWCC Toilet Flapper Study and 1999 Residential End Use Study most household water leaks can be attributed to toilets. It is assumed toilet leaks account for 80% of the median leakage rate, or 6.64 gpd.
- It is assumed replacing flapper or fill valves will eliminate toilet-related leakage.
- It is assumed half of distributed flappers and fill valves are installed.

Given these assumptions, water savings are 3.32 gpd, or 1212 gpy.

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 5 years

Peak Period Savings Percent:

Unit Sewer Savings: Same as water savings

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 3

Non Residential Measures

ID	Name	Class	Category
N1	WaterWise Evaluations for Commercial Buildings	Non Residential	Audits & Reports

Water Savings: Assumes basic analyst or staff evaluations identify an average of 20% potential water savings per site, per CUWCC (2005). For calculating water savings, we assume 50% of potential savings are realized. Average realized water savings is therefore 10% of site use, which matches the assumption used by the SFPUC Retail Demand Model. Average water use per site (circa 2014) is 2,154 gpd, per SFPUC Retail Demand Model.

Water savings = 0.2 x 0.5 x 2,154 gpd = 215 gpd (78,475 gpy)

(NOTE: A higher estimate is warranted if SFPUC targets sites with higher than average use.)

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA. No savings persistence data reported in CUWCC (2005).

Useful Life: No savings persistence data reported in CUWCC (2005). We assume same average life as S1 – 5 years.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year, 80% of outdoor savings occur in peak period. Peak period runs from May 1 to Sep 30, representing 42% of days. Assumes 18% of savings are irrigation-related, per CUWCC (2005).

Peak % = (0.42 x 0.82 x 215 gpd + 0.8 x 0.18 x 215 gpd)/215 gpd = 49%

Unit Sewer Savings: Sewer savings = 0.82 x 215 gpd = 176 gpd (64,240 gpy)
Wastewater to water savings ratio = 0.820

Unit Electricity Savings: NA. No data on electricity savings

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006), that hot water comprises 67% of shower/faucet flow - per DOE (2006) – that one-quarter of indoor water savings involve reductions in shower/faucet flow, and that indoor savings comprise 82% of total survey savings. Gas savings = 0.0072 therms/gal x 0.67 x 0.25 x 0.82 = 0.001 therms/gal

Confidence Score: 3

ID	Name	Class	Category
N2	Commercial Direct Install Audits	Non Residential	Audits & Reports

All assumptions same as N1.

ID	Name	Class	Category
N3a,N3b,N3c	Surveys – Hospitals, Hotels, Schools	Non Residential	Audits & Reports

Water Savings: Number of sites and average daily use per site (circa 2013) shown in table are taken from the SFPUC Retail Demand Model.

Category	Number of Sites	Average Daily Use (gpd)
Hospitals	28	46,429
Hotels	421	9,929
Schools	297	2,559
Wtd Avg		8,365

Assumes basic analyst or staff evaluations identify an average of 20% potential water savings per site, per CUWCC (2005). For calculating water savings, we assume 50% of potential savings are realized. Average realized water savings is therefore 10% of site use, which matches the assumption used by the SFPUC Retail Demand Model. Average water use per site is 8,365 gpd, per above table.

Water savings wtd average = 0.2 x 0.5 x 8,365 gpd = 837 gpd (305,505 gpy)
Hospitals = 0.2 x 0.5 x 46,429 gpd = 4643 gpd (1,694,695 gpy)
Hotels = 0.2 x 0.5 x 9,929 gpd = 993 gpd (362,445 gpy)
Schools = 0.2 x 0.5 x 2,559 gpd = 256 gpd (93,440 gpy)

(NOTE: A higher estimate is warranted if SFPUC targets sites with higher than average use.)

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA. No savings persistence data reported in CUWCC (2005).

Useful Life: No savings persistence data reported in CUWCC (2005). We assume same average life as S1 – 5 years.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year, 80% of outdoor savings occur in peak period. Peak period runs from May 1 to Sep 30, representing 42% of days. Assumes 18% of savings are irrigation-related, per CUWCC (2005).

Peak % = (0.42 x 0.82 x 837 gpd + 0.8 x 0.18 x 837 gpd)/837 gpd = 49%

Unit Sewer Savings: Sewer savings = 0.82 x 837 gpd = 686 gpd (250,390 gpy)
Hospitals = 3,807 gpd (1,389,555 gpy)
Hotels = 814 gpd (297,110 gpy)
Schools = 210 gpd (76,650 gpy)
Wastewater to water savings ratio = 0.820

Unit Electricity Savings: NA. No data on electricity savings

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006), that hot water comprises 67% of shower/faucet flow - per DOE (2006) – that 50% of indoor water savings involve reductions in shower/faucet flow, and that indoor savings comprise 82% of total survey savings. Gas savings = 0.0072 therms/gal x 0.67 x 0.5 x 0.82 = 0.002 therms/gal

Confidence Score: 3

ID	Name	Class	Category
N4	Surveys – Large Landscape by Contractors	Non Residential	Audits & Reports

Water Savings: Per SFPUC Retail Demand Model, average use per site is 1.8 af/acre. Average water savings is 10%, also per SFPUC Retail Demand Model.

Water savings per acre = 0.1 x 1.8 x 325,851/365 = 161 gpd (58,765 gpy)

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA. No savings persistence data reported in CUWCC (2005).

Useful Life: No savings persistence data reported in CUWCC (2005). We assume same average life as S1 – 5 years. Same assumption used in SFPUC Retail Demand Model.

Peak Period Savings Percent: Assumes 80% of outdoor savings occur in peak period. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 80%

Unit Sewer Savings: NA

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 3

ID	Name	Class	Category
N5	Surveys – CII Facilities by Contractors	Non Residential	Audits & Reports

Water Savings: SFPUC estimates consultant audits save from 2,450 to 7,790 gpd. Model assumes midpoint of range – 5,120 gpd.

Water savings = 0.5 x (2,450 gpd + 7,790 gpd) = 5,120 gpd (1,868,800 gpy)

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA. No savings persistence data reported in CUWCC (2005).

Useful Life: No savings persistence data reported in CUWCC (2005). We assume same average life as S1 – 5 years. Same assumption used in SFPUC Retail Demand Model.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year, 80% of outdoor savings occur in peak period. Peak period runs from May 1 to Sep 30, representing 42% of days. Assumes 23% of savings are irrigation-related, per CUWCC (2005).

Peak % = (0.42 x 0.77 x 5120 gpd + 0.8 x 0.23 x 5120 gpd)/5120 gpd = 51%

Unit Sewer Savings: Sewer savings = 0.77 x 5120 gpd = 3,942 gpd (1,438,830 gpy)

Unit Electricity Savings: NA. No data on electricity savings

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006), that hot water comprises 67% of shower/faucet flow - per DOE (2006) – that one-quarter of indoor water savings involve reductions in shower/faucet flow, and that indoor savings comprise 82% of total survey savings. Gas savings = 0.0072 therms/gal x 0.67 x 0.25 x 0.77 = 0.0009 therms/gal

Confidence Score: 2

ID	Name	Class	Category
N7	1.5 GPM Showerhead Giveaway	Non Residential	HESH

Water Savings: Water savings estimate assumes program targets lodging establishments where shower water use comprises a significant proportion of total facility water use. Hotel shower water use from data logging done for the 2000 AWWARF CII End Uses of Water Study are summarized in the following table.

Shower Water Use Estimates from AWWARF CII End Uses of Water Study, 2000

Hotel Location	Water Use gpy/showerhead	Implied Utilization Rate minutes/day	Retrofit Water Use gpy/showerhead	Savings gpy/showerhead	% Hot
Irvine	10,203	13	6,957	3,246	71%
Phoenix	13,724	17	9,357	4,367	28%
San Diego	12,446	15	8,486	3,960	
Santa Monica	11,182	14	7,624	3,558	
Average	11,889	15	8,106	3,783	50%

Mean flow rate (gpm)	2.2
Retrofit flow rate (gpm)	1.5

We assume installed showerheads will have a mean savings rate of 3,800 gpy. Field studies of retrofit kit giveaway programs in Irvine (A&N Technical Services 1992d) and Los Angeles (A&N Technical Services 1991) found initial installation probabilities that ranged from 49% to 59%. We assume a 54% installation probability.

Giveaway showerhead savings = 3,800 gpy/showerhead x 0.54 = 2,052 gpy/showerhead

Plumbing Code Savings: Zero. SB 407 mandates showerheads have a maximum capacity of 2.5 gpm. It is assumed the flow rating of replaced showerheads will be 2.5 gpm or less

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 8 yrs, per Alliance for Water Efficiency (2014).

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 2,052 gpy
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006) and that hot water comprises 50% of shower flow per above table. Gas savings = 0.0072 therms/gal x 0.5 = 0.0036therms/gal

Confidence Score: 3

ID	Name	Class	Category
N8	1.5 GPM Showerhead Direct Install	Non Residential	HESH

Water Savings: Water savings estimate assumes program targets lodging establishments where shower water use comprises a significant proportion of total facility water use. Hotel shower water use from data logging done for the 2000 AWWARF CII End Uses of Water Study are summarized in the following table.

Shower Water Use Estimates from AWWARF CII End Uses of Water Study, 2000

Hotel Location	Water Use gpy/showerhead	Implied Utilization Rate minutes/day	Retrofit Water Use gpy/showerhead	Savings gpy/showerhead	% Hot
Irvine	10,203	13	6,957	3,246	71%
Phoenix	13,724	17	9,357	4,367	28%
San Diego	12,446	15	8,486	3,960	
Santa Monica	11,182	14	7,624	3,558	
Average	11,889	15	8,106	3,783	50%

Assumed Mean flow rate (gpm)	2.2
Retrofit flow rate (gpm)	1.5

We assume installed showerheads will have a mean savings rate of 3,800 gpy/showerhead installed.

Plumbing Code Savings: Zero. SB 407 mandates showerheads have a maximum capacity of 2.5 gpm. It is assumed the flow rating of replaced showerheads will be 2.5 gpm or less

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 8 yrs, per Alliance for Water Efficiency (2014).

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 3,800 gpy
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: Assumes energy requirement of 0.0072 therms/gal for hot water heating, per DOE (2006) and that hot water comprises 50% of shower flow per above table. Gas savings = 0.0072 therms/gal x 0.5 = 0.0036therms/gal

Confidence Score: 3

ID	Name	Class	Category
N9	Device Distribution	Non Residential	Grants

Water Savings: Water savings are a quantity-weighted average of devices distributed by SFPUC. The devices, quantity weights, and annual savings are shown in the following table.

Devices	Annual Quantity	Savings (GPY)	
1.5 gpm bathroom aerator	8229	210	
1.0 gpm bathroom aerator	0	361	
0.5 gpm bathroom aerator	1537	511	
1.5 gpm kitchen laminar	0	210	
1.5 gpm bathroom laminar	0	210	
2.2 gpm kitchen aerator	265	0	
1.5 gpm kitchen aerator	4641	210	
1.5 utility aerator	54	210	
2.0 utility aerator	54	60	
2.2 utility aerator	16	0	
Garden spray hose nozzle	295	0	No reliable estimates
Toilet flapper	3603	1212	
Toilet fill valves	1819	1212	Assumed to be same as flapper savings
Soil moisture meter	7	0	No reliable estimates
Total	20520		
Weighted Avg Savings		491	

Annual savings for aerators are based on the following data and assumptions:

- Median SFR faucet use is 29 gpd (source: Aquacraft SFPUC End Use Study).
- An average of 4 faucets per household is assumed.
- Average use per faucet is 7.25 gpd. The calculation assumes uniform faucet usage, which while unlikely to be true is necessary given lack of data on faucet use.
- Aerators reduce free flowing faucet water consumption. It is assumed half of faucet use is for free flowing uses (e.g. brushing teeth or washing vegetables) and half is for fixed volume uses (e.g. filling pots or getting a drink of water). Free flowing faucet use is therefore 3.63 gpd.
- Average faucet flow is assumed to be 2.2 gpm. Therefore, faucets average 1.6 minutes of free flowing use per day.
- It is assumed half of distributed faucets are installed.

Given these assumptions, savings by aerator flow rate are:

Aerator flow rate (gpm)	Avg Use GPD	Potential Savings (GPD)	Install %	Actual Savings (GPD)	Actual Savings (GPY)
2.2	3.63	0.00	50%	0.00	0
2.0	3.30	0.33	50%	0.16	60
1.5	2.47	1.15	50%	0.58	210
1.0	1.65	1.98	50%	0.99	361

0.5	0.82	2.80	50%	1.40	511

Annual savings for flappers and fill valves are based on the following data and assumptions:

- Median SFR leakage rate is 8.3 gpd, per Aquacraft SFPUC End Use Study.
- According to 2004 CUWCC Toilet Flapper Study and 1999 Residential End Use Study most household water leaks can be attributed to toilets. It is assumed toilet leaks account for 80% of the median leakage rate, or 6.64 gpd.
- It is assumed replacing flapper or fill valves will eliminate toilet-related leakage.
- It is assumed half of distributed flappers and fill valves are installed.

Given these assumptions, water savings are 3.32 gpd, or 1212 gpy.

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 5 years

Peak Period Savings Percent:

Unit Sewer Savings: Same as water savings

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 3

ID	Name	Class	Category
N10a	HET Rebates (Tank) - CII	Non Residential	HET

Water Savings: Savings based on CUWCC CII Toilet Savings Study (2001). Assume 10% of rebates replace ULFTs
Water savings = 0.9 x 1.15 x 25 gpd + 0.1 x 25 gpd = 28.4 gpd (10,366 gpy)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent:
Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 42%

Unit Sewer Savings: Sewer savings = same as water savings
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
N10b	HET Rebates (Flushometer) - CII	Non Residential	HET

Water Savings: Savings based on CUWCC CII Toilet Savings Study (2001). Assume 10% of rebates replace ULFTs
Water savings = 0.9 x 1.15 x 25 gpd + 0.1 x 25 gpd = 28.4 gpd (10,366 gpy)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent:
Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 42%

Unit Sewer Savings: Sewer savings = same as water savings
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
N11a,N11b,N11c	HET Rebates Schools, Hotels, Muni (Tank)	Non Residential	HET

Water Savings: Assumes program targets non-ULF toilets. CUWCC (2001) estimated replacing non-ULF toilets with ULF toilets in schools, hotels, and government facilities resulted in average daily savings shown in the table.

Category	Avg Savings Per ULF Toilet (gpd)	Imputed Flushes/Day
Schools	18	8.4
Hotels	16	7.4
Government	25	11.6
Avg Savings	20	9.3

Note: GPD savings from CUWCC (2001). Imputed flushes/day assumes avg of replaced toilet was 3.75 gpf

Assume 10% of rebates replace ULFTs
Schools: [0.1(1.6-1.28)+0.9(3.75-1.28)] x 8.4 = 18.9 gpd (6,914)
Hotels: [0.1(1.6-1.28)+0.9(3.75-1.28)] x 7.4 = 16.7 gpd (6,096)
Gov: [0.1(1.6-1.28)+0.9(3.75-1.28)] x 11.6 = 26.2 gpd (9,563)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent:
Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 42%

Unit Sewer Savings: Sewer savings = same as water savings
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
N11d,N11e,N11f	HET Rebates Schools, Hotels, Muni (Flushometer)	Non Residential	HET

All assumptions same as N11a, N11b, N11c.

ID	Name	Class	Category
N12a	HET Direct Install (Tank) - CII	Non Residential	HET

Water Savings: Assumes program targets non-ULF toilets. CUWCC (2001) estimated replacing non-ULF toilets with ULF toilets resulted in average daily savings of 25 gpd. Assuming non-ULF toilets have an average flush volume of 3.75, the HE toilet would save approximately 15% more than a ULF toilet.

Water savings = 1.15 x 25 gpd = 29 gpd (10,585 gpy)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent:
Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 42%

Unit Sewer Savings: Sewer savings = 29 gpd (10,585 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
N12b	HET Direct Install (Flushometer) - CII	Non Residential	HET

All assumptions same as N12a.

ID	Name	Class	Category
N13	HET Direct Install School/Hotel	Non Residential	HET

Water Savings: Assumes program targets non-ULF toilets. CUWCC (2001) estimated replacing non-ULF toilets with ULF toilets in schools and hotels resulted in average daily savings shown in the table.

Category	Avg Savings Per ULF Toilet (gpd)	Imputed Flushes/Day
Schools	18	8.4
Hotels	16	7.4
Avg Savings	17	7.9

Note: GPD savings from CUWCC (2001). Imputed flushes/day assumes avg of replaced toilet was 3.75 gpf

It is assumed direct install toilets would only replace non-ULF. Assuming non-ULF toilets have an average flush volume of 3.75, the HE toilet would save approximately 15% more than a ULF toilet.

Water savings = 1.15 x 17 gpd = 19.6 gpd (7,154 gpy)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent:
Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 42%

Unit Sewer Savings: Sewer savings = same as water savings
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
N14	CII HET Voucher	Non Residential	HET

All assumptions same a N10

ID	Name	Class	Category
N15	HET Voucher School/Hotel	Non Residential	HET

Water Savings: Assumes 90% of vouchers go to non-ULF and 10% go to ULF toilets. CUWCC (2001) estimated replacing non-ULF toilets with ULF toilets in schools and hotels resulted in average daily savings shown in the table.

Category	Avg Savings Per ULF Toilet (gpd)	Imputed Flushes/Day
Schools	18	8.4
Hotels	16	7.4
Avg Savings	17	7.9

Note: GPD savings from CUWCC (2001). Imputed flushes/day assumes avg of replaced toilet was 3.75 gpf

Savings = [0.1 x (1.6 – 1.28) + 0.9 x (3.75 – 1.28)] x 7.9 = 17.8 gpd (6,497 gpy)

Comparison to Retail Demand Model (RDM) Estimate: this measure is not in the RDM.

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent:
Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days.

Peak % = 42%

Unit Sewer Savings: Sewer savings = same as water savings
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
N16	HET/Fixture Install thru On-Bill Financing	Non Residential	HET

All assumptions same as N12a

ID	Name	Class	Category
N17a, N17b	HEU Rebate - CII	Non Residential	HEU

Water Savings: From Koeller & Company (2005). Urinals in CA used an estimated 28,000 AFY in 2005. Average flush rate is 2 times per day per male employee. Total employment in 2005 is 16.8 million, 55% male. Average flush volume = 28000 x 325851/[2 x 16.8 x 10^6 x 0.55 x 365) = 1.35 gpf

25 x 10^6 gal/day / 1.35 gal/flush = 18.5 x 10^6 flushes/day

18.5 x 10^6 flushes/day / 1.4 x 10^6 urinals (circa 2005) = 13.2 flushes/urinal/day

0.5 gpf: (1.35-.5) x 13.2 flush/day = 11.2 gpd (4,088 gpy)
0.25 gpf: (1.35-.25) x 13.2 flush/day = 14.5 gpd (5,293 gpy)
0.125 gpf: (1.35-.125) x 13.2 flush/day = 16.2 gpd (5,913 gpy)

Plumbing Code Savings: Effective Jan 1, 2014, same as water savings

Plumbing Code NRR: 3% per M.Cubed (2014)

Annual Decay Rate: NA. Leakage and double flushing assumed no worse than toilets replaced.

Useful Life: NA. Plumbing code ensures toilet cannot revert to lower efficiency.

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Same as water savings
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 3

ID	Name	Class	Category
N18	HEU Direct Install - CII	Non Residential	HEU

All assumptions same as N17.

ID	Name	Class	Category
N20	Energy Star Washer Rebates (WF 4.5)	Non Residential	HEW

Water Savings: Assumes rebates are for common area laundry rooms, not individual apartments. Without rebate, participant will purchase either top- or front-load washer. Current market share (circa 2012) of top-load washers is 52%, per DOE (2012). Current Energy Star market share (circa 2012) is 50%, per DOE (2012). Maximum allowed WF for Energy Star washer after 2011 is 6. Maximum allowed WF for non-Energy Star washer is 9.5, per National Appliance Standard. (National Appliance Standard changes in 2015 to 4.5 WF for front-load and 8.0 WF for top-load, and again in 2018 to 6.0 WF for top-load). Average WF of new washer is:

Avg WF of New Washer Without Rebate = 0.5 x 6.0 + 0.5 x 9.5 = 7.75 (note this will overstate avg WF after 2015 due to nat'l appl stdrd)

Average loads per day for machines with load capacity under 25 pounds is 3, per Sutter and Pope (2006). Average washer volume is assumed to be 4 cubic feet.

Water savings = (7.75 – 4.5) x 4 x 3 = 39 gpd (14,235 gpy)

Plumbing Code Savings: Effective Jan 1, 2015, appliance standard is 4.5 WF for front-load and 8.0 WF for top-load. Given current front- and top-load market shares and Energy Star market share, average WF under appliance standard in 2015 is:

2015 Avg WF under Nat'l Appl Std = 0.52 x (0.5 x 8.0 + 0.5 x 6.0) + 0.48 x 4.5 = 5.8

Effective Jan 1, 2018, appliance standard is 4.5 WF for front-load and 6.0 for top-load. Average WF under appliance standard in 2018 is:

2018 Avg WF under Nat'l Appl Std = 0.52 x 6.0 + 0.48 x 4.5 = 5.3.

For modeling conservation program benefits, we use the average of these two water factors – 5.6 -- and start the standard in 2015. Plumbing code savings starting in 2015 are:

Plumbing code savings = (7.75 – 5.6) x 4 x 3 = 26 gpd (9,490)

Plumbing Code NRR: 12.2%, average of the turnover rates assumed by AWE (11.1%) and DOE (13.3%) for commercial washers.

Annual Decay Rate: NA

Useful Life: 14 years, per DOE (2012)

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 39 gpd (14,235 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: 0.0036 KWh/gal. Based on high efficiency washer electricity savings reported in FEMP (2000).

Unit Gas Savings: 0.0035 therms/gal. Based on high efficiency washer gas savings reported in FEMP (2000).

Confidence Score: 3

ID	Name	Class	Category
N21	Energy Star Washer Rebates (WF 4)	Non Residential	HEW

Water Savings: Assumes rebates are for common area laundry rooms, not individual apartments. Without rebate, participant will purchase either top- or front-load washer. Current market share (circa 2012) of top-load washers is 52%, per DOE (2012). Current Energy Star market share (circa 2012) is 50%, per DOE (2012). Maximum allowed WF for Energy Star washer after 2011 is 6. Maximum allowed WF for non-Energy Star washer is 9.5, per National Appliance Standard. (National Appliance Standard changes in 2015 to 4.5 WF for front-load and 8.0 WF for top-load, and again in 2018 to 6.0 WF for top-load). Average WF of new washer is:

Avg WF of New Washer Without Rebate = 0.5 x 6.0 + 0.5 x 9.5 = 7.75 (note this will overstate avg WF after 2015 due to nat'l appl stdrd)

Average loads per day for machines with load capacity under 25 pounds is 3, per Sutter and Pope (2006). Average washer volume is assumed to be 4 cubic feet.

Water savings = (7.75 – 4.0) x 4 x 3 = 45 gpd (16,425 gpy)

Plumbing Code Savings: Effective Jan 1, 2015, appliance standard is 4.5 WF for front-load and 8.0 WF for top-load. Given current front- and top-load market shares and Energy Star market share, average WF under appliance standard in 2015 is:

2015 Avg WF under Nat'l Appl Std = 0.52 x (0.5 x 8.0 + 0.5 x 6.0) + 0.48 x 4.5 = 5.8

Effective Jan 1, 2018, appliance standard is 4.5 WF for front-load and 6.0 for top-load. Average WF under appliance standard in 2018 is:

2018 Avg WF under Nat'l Appl Std = 0.52 x 6.0 + 0.48 x 4.5 = 5.3.

For modeling conservation program benefits, we use the average of these two water factors – 5.6 -- and start the standard in 2015. Plumbing code savings starting in 2015 are:

Plumbing code savings = (7.75 – 5.6) x 4 x 3 = 26 gpd (9,490)

Plumbing Code NRR: 12.2%, average of the turnover rates assumed by AWE (11.1%) and DOE (13.3%) for commercial washers.

Annual Decay Rate: NA

Useful Life: 14 years, per DOE (2012)

Peak Period Savings Percent: Assumes indoor savings evenly distributed through year. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 42%

Unit Sewer Savings: Sewer savings = 45 gpd (16,425 gpy)
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: 0.0036 KWh/gal. Based on high efficiency washer electricity savings reported in FEMP (2000).

Unit Gas Savings: 0.0035 therms/gal. Based on high efficiency washer gas savings reported in FEMP (2000).

Confidence Score: 3

ID	Name	Class	Category
N22	Landscape Grants	Non Residential	Grants

Water Savings: Average savings for previous grants is shown in the following table. The pre-grant average water use per acre is 1.6 AFY/Acre and the average water savings per acre is 0.5 AFY/Acre (33.5%), or 162,926 gpy (446 gpd).

Project Name	Project Size (acres)	Pre-Grant Use (mgy)	Projected Savings (mgy)	Projected Savings (%)
Balboa Park Water Conservation Project	17.3	15.4	1.5	10%
Fort Mason Water Conservation Irrigation Upgrades	12.3	25.8	4.6	18%
Sunset Blvd. Landscape Irrigation Retrofit	3.5	16.7	13.8	83%
Jefferson Square Park Water Conservation Project	5.1	6.0	1.7	28%
Alta Plaza Park Water Conservation Project	4.0	9.7	3.8	39%
Laguna Honda Hospital Water Conservation Project	2.5	2.9	0.96	33%
Moscone Recreation Center	6.2	8.8	2.7	30%
Alamo Square Park	9.4	8.8	1.4	16%
Sunol Glen Elementary School	1.7	2.56	1.17	46%
Washington Square Park	1.5	3.0	1.7	60%
Forest Hill Station	0.7	1.13	0.44	39%

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA. No savings persistence data reported in CUWCC (2005).

Useful Life: SFPUC program assumption is 20 years.

Peak Period Savings Percent: Assumes 80% of outdoor savings occur in peak period. Peak period runs from May 1 to Sep 30, representing 42% of days. Peak % = 80%

Unit Sewer Savings: NA

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 2

ID	Name	Class	Category
N24	Equipment Retrofit Rebates	Non Residential	Grants

Water Savings: Water savings are 1 CCF/Yr (748 gpy) per $1 of grant activity

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 10 years

Peak Period Savings Percent: 42%

Unit Sewer Savings: Same as water savings
Wastewater to water savings ratio = 1.000

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 1

ID	Name	Class	Category
N25	Custom Equipment Retrofit Rebates	Non Residential	Grants

All assumptions same as N24

ID	Name	Class	Category
N27	Kitchen Low Flow Spray Valves	Non Residential	Grants

All assumptions taken directly from the SFPUC Retail Demand Model. The SFPUC Retail Demand Model used a daily water savings estimate of 30 gpd (10,950 gpy) and fixture useful life of 10 years. The estimate is based on empirical estimates of daily savings (60 gpd) and a 50% installation and retention rate.

Confidence Score: 1

ID	Name	Class	Category
A3	Irrigation Customer Landscape Budgets	Non Residential	Audits & Reports

Water Savings: Many water suppliers have adopted water budgets for their large landscapes, which provides an effective way for both managing and evaluating large landscape programs. Landscape budgets are a form of customer education/information designed to help customers irrigate landscape efficiently. The effectiveness of this intervention can vary significantly depending on existing water use practices, types of landscapes subject to budgets, types of customers receiving budgets, cost of water, etc. There have been several empirical evaluations of landscape budget performance. Cal WEP provides a good summary of these studies.

The impact of landscape education on compliance with water budgets was evaluated in Orange County, California in a 2004 study. The education component was targeted at landscape contractors and property managers at home-owner associations (HOAs). The results were based on the experience of 47 HOAs that had participated in the program up to that point. The impact evaluation concluded that early participants in the program reduced their water demand by 9%, later participants by 20% (the difference between early and later participants was not explained).

Several studies are available that examine the impact of budget-based rates on large landscape water use. An early study, published in 1997 showed that tiered rates tied to landscape water budgets can reduce irrigation demand by about 20-25%.

Cal WEP compiled data from 12 Bay Area retailers on actual water use versus budget for a sample of large landscapes. On average, actual use exceeded budgeted use by 33%. Cal WEP also compared budget exceedence by type of customer. It found budget exceedence was greatest for HOAs and commercial properties (excluding gold courses) and lowest for parks and schools. The average exceedence for HOAs and commercial was 23% and 34%, respectively; for parks and schools it was 10% and 5%, respectively.

This measure assumes budgets would reduce large landscape water use by 10%, on average. This is at the lower-end of the savings range from empirical studies and significantly less than the average budget exceedence for the sample of 12 Bay Area water agencies. A conservative savings assumption is deemed appropriate because:

- Parks and schools, which tend to have lower budge exceedence, comprise most of the large landscape area in SFPUC's retail service area.
- SFPUC's high retail water rates already discourage wasteful irrigation and landscape water use.
- SFPUC's cool summer climate results in lower irrigation application rates relative to other parts of California with dryer, hotter summer climates.

The average pre-grant irrigation application rate at large landscape sites participating in SFPUC's large landscape grant program is 4 AF/acre (see N22).

Savings = 4 AF/acre x 0.1 = 0.4 AF/acre (130,340 gpy/acre)

Plumbing Code Savings: NA

Plumbing Code NRR: NA

Annual Decay Rate: NA

Useful Life: 1 year

Peak Period Savings Percent: 100%

Unit Sewer Savings: 0

Unit Electricity Savings: NA

Unit Gas Savings: NA

Confidence Score: 3

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