California Energy Commission

DRAFT STAFF REPORT

STAFF ANALYSIS OF TOILETS, URINALS, AND FAUCETS

California Energy Commission

2014 Appliance Efficiency Pre-Rulemaking

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PREFACE

On March 14, 2012, the California Energy Commission issued an Order Instituting Rulemaking (OIR) to begin considering standards, test procedures, labeling requirements, and other efficiency measures to amend the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 through Section 1608). In this OIR, the Energy Commission identified a variety of appliances with the potential to save energy and/or water. The goal of this prerulemaking is to develop the proposed appliance efficiency standards and measures to realize these energy savings opportunities.

On March 25, 2013, the Energy Commission released an "Invitation to Participate" to provide interested parties with the opportunity to inform the Energy Commission about the product, market, and industry characteristics of the appliances identified in the OIR. The Energy Commission reviewed the information and data received in the docket and hosted staff workshops on May 28 through 31, 2013, to vet this information publicly.

On June 13, 2013, the Energy Commission released an "Invitation to Submit Proposals" to seek proposals for standards, test procedures, labeling requirements, and other measures to improve the efficiency and reduce the energy or water consumption of the appliances identified in the OIR.

The Energy Commission reviewed all information received to determine which appliances were strong candidates for the development of efficiency standards and measures. Based on its assessment, the Energy Commission will proceed with appliances in phases for the remainder of the rulemaking. The first phase of rulemaking commences with the development of staff reports and proposed regulations for faucets, toilets, urinals, fluorescent dimming ballasts, air filters, and heat-pump water chillers.

ABSTRACT

This staff report discusses proposed updates to the toilet, urinal, and faucet standards in the *Appliance Efficiency Regulations* (California Code of Regulations, Title 20, Sections 1601 to 1608). These proposed updates are part of the 2012 Appliance Efficiency Rulemaking, Phase I (Docket # 12-AAER-2C).

This report presents the California Energy Commission staff's analysis of the cost-effectiveness and technical feasibility of proposed standards for toilets, urinals, and faucets. The statewide water and energy (electricity and natural gas) use and savings, and other related environmental impacts and benefits, are also included in this analysis.

Through the enactment of Assembly Bill 715 (Laird, Chapter 499, Statutes of 2007), California has already adopted water efficiency standards for toilets and urinals that exceed the federal efficiency requirements. However, these statutory standards have not been incorporated into Title 20, which dictates the allowable water consumption values for products for sale or offered for sale in California and provides a means for enforcement of those standards. The proposed updates to Title 20 would set the efficiency level for toilets at 1.28 gallons per flush (gpf) and 0.5 gpf for urinals. In addition to modifying the maximum flush volumes, the proposed standard would establish minimum performance standards (waste extraction standards) for toilets and would establish new water conservation standards for replacement valves for plumbing fixtures that were designed for fixtures in buildings built in or before 1994.

California has also adopted water efficiency standards for the installation of interior faucets through Senate Bill 407 (Padilla, Chapter 587, Statutes of 2009). The proposed updates to Title 20 would go beyond SB 407 to set maximum water consumption levels of 1.5 gallons per minute (gpm) for lavatory faucets, 1.8 gpm for kitchen faucets, and 0.5 gpm for public lavatory faucets.

The proposed update to the standards for toilets, urinals, and faucets would save about **8.2** billion gallons of water, **24.6** million therms (Mtherm) of natural gas, and **169** gigawatt hours (GWh) per year the first year the standard is in effect.

By the year that the toilet stock turns over (2039), the proposed standards would have a combined annual savings of about **86.6** billion gallons of water, **223** Mtherm of natural gas, and **1,660** GWh. This equates to roughly **$1.12** billion in savings to California businesses and individuals.

In addition, the proposed standards would reduce greenhouse gas emissions by **1.9 million** tons of carbon dioxide equivalents (CO_2e) annually.

The Energy Commission staff analyzed available market data and concluded that the updates to standards for toilets, urinals, and faucets would significantly reduce energy and water consumption and are technically feasible and cost-effective.

Keywords: Appliance Efficiency Regulations, appliance regulations, water efficiency, energy efficiency, toilets, water closets, urinals, faucets

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Legislative Criteria

Section 25402 (c)(1), of the Public Resources Code[1] mandates the California Energy Commission to reduce the inefficient consumption of energy and water by prescribing efficiency standards and other cost-effective measures for appliances whose use requires a significant amount of energy and water on a statewide basis. Such standards must be technically feasible and attainable and must not result in any added total cost to the consumer over the designed life of the appliance.

In determining cost-effectiveness, the Energy Commission considers the value of the water or energy saved, the affect on product efficacy for the consumer, and the life-cycle cost or benefit to the consumer for complying with the standard. The Energy Commission also considers other relevant factors, including, but not limited to, the effect on housing costs, the total statewide costs and benefits of the standard over the product's lifetime, the economic impact on California businesses, and alternative approaches and their associated costs.

Background

Water – A Scarce Resource

Water is a scarce resource, which is often taken for granted. California relies on rainfall and the annual snowpack, which accounts for about a third of the state's water supply. Rainfall has been lower than normal in 2012, and 2013 was the driest year in recorded history for many areas in California. The snow survey taken on February 27, 2014, showed that the snowpack's water content is about 25 percent of average.[2] This has raised serious concerns over the state's water supply, and on January 17, 2014, Governor Brown proclaimed a State of Emergency and directed officials to take all necessary measures to prepare for drought conditions.[3]

In 2012, the Commission identified in its Order Instituting Rulemaking that toilets, urinals, and faucets contribute to significant water and energy consumption in California homes.[4] The

1 Warren-Alquist State Energy Resources Conservation and Development Act, Division 15 of the Public Resources Code, § 25000 et seq. Retrieved from http://www.energy.ca.gov/2014publications/CEC-140-2014-001/CEC-140-2014-001.pdf

2 California Natural Resources Agency Weekly Drought Update March 24, 2014. Retrieved from http://ca.gov/drought/Weekly-Drought-Update.pdf

3 Office of Governor Edmund G. Brown Jr., Governor Brown Declares Drought State of Emergency. Retrieved from http://gov.ca.gov/news.php?id=18379.

4 California Energy Commission, Order Instituting Rulemaking Proceeding, Order No. 12-0314-16 (Mar. 14, 2012). Retrieved from

California investor-owned utilities (IOUs) subsequently submitted information through their Codes and Standards Enhancement (CASE) initiative in coordination with the Natural Resources Defense Council (NRDC) indicated that California consumes about 2.9 trillion gallons of water per year for residential indoor, outdoor, commercial, and industrial uses.[5] About 12 percent of this water is used for flushing toilets and urinals, and faucets.[6] Water usage for these three sources is the largest use of urban indoor water use. Thus, reducing the water consumption by establishing minimum efficiency standards for them is a key component of California's overall water and embedded energy use strategy.

Product Description

Toilets

Toilets (also known as water closets) and urinals are sanitation fixtures used to dispose of human waste. In urban areas, toilets and urinals discharge to sewage lines, which carry waste from the toilet to a wastewater treatment facility. In rural areas that do not have sewage collection systems and centralized wastewater treatment facilities, toilets and urinals discharge to a septic system[7].

There are two types of toilets: siphoning and blowout. As the name implies, a *siphoning toilet* uses a siphon action to remove the waste, and a blowout toilet uses high-pressure, high-volume

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http://www.energy.ca.gov/appliances/2012rulemaking/notices/prerulemaking/2012-03-14_Appliance_Efficiency_OIR.pdf.

5 CASE Report, *Toilets & Urinals Water Efficiency* (July 29, 2013), at p. 1 (citing Christian-Smith, Juliet; Heberger, Matthew; and Luch Allen. *Urban Water Demand in California to 2100: Incorporating Climate Change*. 2012. Pacific Institute. http://www.pacinst.org/reports/urban_water_demand_2100/full_report.pdf). Retrieved from: http://energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/California_IOUs__and__Natural_Resources_defense_Councils_Responses_to_the_Invitation_for_Standards_Proposals_for_Toilets__and__Urinals_2013-07-29_TN-71765.pdf.

6 Use information was based on a series of surveys conducted by Aquacraft, Inc. Water Engineering and Management. Residential End Uses of Water Study. 1999. Prepared for the American Water Works Association. These surveys included *Seattle Home Water Conservation Study: the Impacts of High Efficiency Plumbing Fixture Retrofits in Single-family Homes*. 2000. Prepared for Seattle Public Utilities and the United States Environmental Protection Agency.
Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-family Homes in the East Bay Municipal Utility District Service Area. 2003. Prepared for East Bay Municipal Utility District and the United States Environmental Protection Agency.
California Single Family Water Use Efficiency Study. 2011.Prepared by DeOreo, W., Mayer, P., Martien, L., Hayden, M., Funk, A., Kramer-Duffield, M. & R. Davis. http://www.aquacraft.com/node/63. Boulder, Colo.: Aquacraft, Inc. Water Engineering and Management.

7 CASE Report, *Toilets & Urinals Water Efficiency* (July 29, 2013), at p.6 to 10.

water to flush the waste out of the bowl. Siphoning toilets are most common in homes, offices, and commercial facilities, while blowout toilets are used primarily in locations subject to high abuse, such as airports, stadiums, and prisons, due to their durability. With the exception of blowout type, toilets are further classified as tank-type (gravity-flush, pressure-assisted, or vacuum-assisted) or valve-type, according to the method used to deliver water to the bowl. Blowout toilets commonly use a flushing valve to deliver water for flushing instead of a water tank.[8]

Gravity-Flush Tank-Type

Gravity-flush tank-type toilets account for the majority of residential, as well as small percentage of commercial toilets. When toilets are flushed, a portion of the water flows to the toilet bowl rim to rinse the sides of the bowl, and a portion flows into a siphon hole to initiate the siphon. This siphon action pulls and pushes water and waste out of the toilet bowl to the sewer line. In the meantime, as the water in the tank empties, a flapper valve at the bottom of the tank falls back onto the drain tube, which stops the water to the toilet bowl. The water tank refills through a ballcock or fill valve, which closes when the water reaches the proper level, as controlled by a float ball. As the tank refills, a portion of the refill water is diverted through a tube to refill the toilet bowl.

Vacuum-Assisted or Pressure-Assisted Tank-Type

To improve waste removal in toilets that consume less water, manufacturers have employed pressure-assisted systems and vacuum-assisted systems. In a pressure-assisted system, an airtight enclosure is inserted into the tank. Water fills from the bottom of the enclosure and pressurizes the air space above, providing additional pressure to the flushing water for proper flushing. Vacuum-assisted systems use specialized double-S trap toilet bowls connected to a built-in sealed chamber by a vacuum tube. When the toilet is flushed, the draining water seals the air vent in the trapway. At the same time, water draining from the vacuum-sealed chamber creates a vacuum that is transmitted to the airspace in the trapway. This modest vacuum force combines with the inherent siphonic action of the toilet bowl to enhance the "pull" on the toilet bowl contents for an effective boost in the flush.

Dual-Flush

An increasing number of toilets are becoming available that provide dual-flush capability in a pressure-assisted design, using different flush volumes to flush solid or liquid waste. Some dual-flush toilets have two different buttons, while others have a single lever that the user can push up or down to deliver different amounts of water for flushing solid or liquid waste. Dual-

8 Water Closet Types. Retrieved from http://www.ehow.com/facts_5836318_water-closet-types.html

flush toilets sold in North America deliver up to 1.6 gallons with the high-volume flush, which is used for solid wastes and between 0.8 to 1.1 gallons with the low-volume flush. Thus, on the average of two small flushes and one large flush, the effective flush volume is about 1.28 gpf.[9]

Valve-Type (Flushometer)

Valve-type toilets, also known as *flushometer valve toilets*, are common in medium- to high-usage commercial and industrial buildings. The actual flush of a valve-type toilet is similar to a tank-type, except that the flushometer valve delivers the water and necessary flushing force using pipe pressure. Fairly high water pressure is required for this type of toilet, and it usually has to be supplied by a 1" plumbing line. It provides a quick flush and rapid recovery, but it is also quite noisy.

Blowout Toilets

A *blowout toilet* is a special type of toilet that uses a flushometer valve instead of a tank for flushing. Blowout toilets have two different characteristics than the more commonly seen residential toilet. It is typically made out of stainless steel and is connected to the sewer system by bracketing it through the wall to a sewer connection (usually located about 10 to 12 inches above the floor) instead of through the floor. Blowout toilets rely exclusively on pipe pressure to deliver the necessary water volume to flush the waste.

There is a special type of blowout toilet that is designed for use in prisons or mental health facilities. These toilets are designed to withstand between 2,000 and 5,000 pounds of force and are typically bracketed to the wall to prevent vandalism or suicide. They also feature components with round edges and that cannot be removed from the primary device through normal means. These toilets have a large trapway diameter so that large pieces of debris can easily pass into the sewer to prevent intentional blockage. They are noisy, but more sanitary, due to their near-instant flush capability that leaves little, if any, residue behind.[10] Because these types of toilets are used with special safety intention, staff recommends that they be exempt from the proposed standards.

Urinals

Urinals are fixtures designed for male users to dispose of liquid waste and are mostly found at commercial buildings. Urinals can be for single or multiple users (e.g., trough-type urinals) and

9 Plumbing Manufacturers International, PMI Issues - CEC Docket No. 12-AAER-2C, February 13, 2014.
10 XPB Lockers. Retrieved from http://www.xpblocker.com/industriallavatoriesandsinks-t-24_72.html.

commonly use a valve-type flushing system, which uses pipe water pressure to flush[11]. Flushing of urinals can be manual or automatic, although trough-type urinal models employ constant drips.[12] Urinals do not employ siphoning action and generally maintain enough water in the trapway to prevent odor escape.

Similar to blowout toilets, the blowout urinals use pipe pressure to flush. They have a hole on the inlet of the trapway that flushes the entire amount of liquid in the urinal. However, the water jet action is utilized at a higher velocity and creates a better and more certain evacuation of all liquid and debris in the urinal. Blowout urinals are particularly well-suited for high-usage commercial applications in stadiums and/or prisons.[13] AB 715 has exempted these units from high-efficiency requirements.

Also similar to blowout toilets, blowout urinals that are installed at prisons or mental health facilities are specially designed with safety in mind; therefore, staff recommends that they be exempted from proposed standard.

Urinals that use less than 0.5 gpf have been in the market for more than 20 years[14], and manufacturers have several models certified by the EPA WaterSense[15]. Some other urinal models employ very little water to flush (0.125 gpf), and some do not use water at all. Blowout urinals use high-pressure water to flush and, like the blowout toilets, are installed at locations that are subject to high abuse, such as airports or stadiums.

Replacement Valves (Flushometer)

As mentioned earlier, water delivered to a toilet bowl or urinal can be from a tank or a valve, or flushometer valve. These valves use building water pressure to flush and can be manually operated (by pushing a lever) or automatically activated by using an electronic sensor. The amount of water delivered by the valve is mostly factory preset; therefore, if toilet or urinal water consumption is reduced, the valve must also be replaced.

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11 CASE Report, *Toilets & Urinals Water Efficiency* (July 29, 2013), at p.10 to 12.

12 Plumbing Manufacturers International, PMI Issues - CEC Docket No. 12-AAER-2C, February 13, 2014.

13 XPB Lockers. Retrieved from http://www.xpblocker.com/industriallavatoriesandsinks-t-24_72.html

14 Koeller, Hohn, P.E. "High-efficiency toilets answer questions,", *Contractor*. September 1, 2006. Retrieved from http://contractormag.com/bathkitchen/cm_newsarticle_987

15 WaterSense, WaterSense Specification for Flushing Urinals. Retrieved from http://www.epa.gov/watersense/partners/urinals_final.html

Faucets

Faucets and accessories are devices that deliver a controlled amount of water at a desired pressure to users. Faucets direct the flow of water, and their accessories regulate the water pressure and flow rate[16].

Faucets are generally designed for a particular application, such as a lavatory or kitchen. Both types of faucet are designed to deliver a mix of hot and cold water to the user, but the water volume flow rate of a kitchen faucet is higher to ensure quick washing of vegetables or quick filling of pots and pans.

There are four categories of faucet accessories: a restrictor to regulate the water flow rate, a pressure compensator to maintain the constant flow of water, an aerator to allow mixing of air to the flowing water to produce softer and adequate volume sensation, and a sprayer to produce several directional water streams to cover the full washing area. Some newer faucets employ dual-flow capability, which delivers a lower flow volume in normal mode and a higher volume through a built-in switch, to allow quick filling of pots and pans in response to customers' desires.

Efficiency Policy

As California's primary energy policy and planning agency, the Energy Commission has long been mandated to reduce the wasteful, inefficient consumption of energy and water in the state by prescribing standards for minimum levels of operating efficiency for appliances that consume a significant amount of energy or water statewide. Standards eliminate the least efficient products and practices from the marketplace, reaping large benefits for California's consumers.

Since 1975, California's building and appliance energy efficiency standards have saved consumers an estimated $75 billion in reduced electricity bills. The state's appliance efficiency regulations saved an estimated 22,923 gigawatt hours (GWh) of electricity and 1,626 million therms of natural gas in 2012 alone, [17] resulting in about $5.24 billion in savings to California consumers in 2012 from these regulations.[18] In 2009, the Energy Commission adopted standards

16 CASE Report, Faucets,(July 29, 2013), at p.6 to 7.

17 California Energy Commission, *California Energy Demand 2014-2024 Revised Forecast*, September 2013. Retrieved from http://www.energy.ca.gov/2013publications/CEC-200-2013-004/CEC_200-2013-004-SD-V1-REV.pdf

18 Using current average electric power and natural gas rates of: residential electric rate of $0.164 per kilowatt-hour, commercial electric rate of $0.147 per kilowatt-hour, residential gas rate of $0.98 per therm and commercial gas rate of $0.75 per therm.

for televisions that will save 6,515 GWh a year. This is enough energy to power 864,000 single-family homes for an entire year, equivalent to powering the cities of Anaheim, Burbank, Glendale, and Palo Alto combined. The recently adopted appliance standards for battery chargers are expected to save 2,200 GWh annually, which is enough energy to power 350,000 California households each year.[19] Still, there remains huge potential for additional savings by increasing the energy efficiency and optimizing the use of appliances.

Reducing Electrical Energy Consumption to Combat Climate Change

The Energy Commission's *Appliance Efficiency Standards* are further driven by several state policies and goals. Appliance energy efficiency is identified as a key component to achieving the greenhouse gas (GHG) emission reduction goals of Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006)[20] (AB 32), as well as the recommendations contained in the California Air Resources Board's *Climate Change Scoping Plan*.[21] Energy efficiency regulations are also identified as key components in reducing electrical energy consumption in the Energy Commission's *2013 Integrated Energy Policy Report (IEPR)*[22] and the California Public Utilities Commission's (CPUC) 2011 update to its *Energy Efficiency Strategic Plan.*[23]

Loading Order for Meeting the State's Energy Needs

California's loading order places energy efficiency as the top priority for meeting the state's energy needs. Energy efficiency standards overcome well-understood barriers in markets for appliances and buildings. When a consumer has limited knowledge of, or influence on, the energy performance characteristics of a product, the marketplace tends not to prioritize efficiency, even if it is simple and inexpensive to do so. Appliance standards benefit consumers by ensuring that cost-effective efficiency improvements are incorporated into consumer purchases.

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19 California Energy Commission, Energy Efficiency Standards for Battery Charger Systems Frequently Asked Questions, January 2012. Retrieved from http://www.energy.ca.gov/appliances/battery_chargers/documents/Chargers_FAQ.pdf

20 Assembly Bill 32, California Global Warming Solutions Act of 2006. Retrieved from http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.html

21 California Air Resources Board, *Climate Change Scoping Plan*, December 2008. Retrieved from http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.

22 California Energy Commission, *2013 Integrated Energy Policy Report*, January 2014. Retrieved from http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf.

23 California Public Utilities Commission, *Energy Efficiency Strategic Plan*, updated January 2011. Retrieved from http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf.

Zero-Net-Energy Goals

The *California Long-Term Energy Efficiency Strategic Plan*,[24] adopted in 2008 by the CPUC and developed with the Energy Commission, the California Air Resource Board, the state's utilities, local government, and other key stakeholders, is California's roadmap to achieving maximum energy savings in the state between 2009 and 2020, and beyond. It includes four "Big Bold strategies" as cornerstones for significant energy savings with widespread benefit for all Californians:

- All new residential construction in California will be zero net energy by 2020.
- All new commercial construction in California will be zero net energy by 2030.
- Heating, ventilation and air conditioning (HVAC) will be transformed to ensure that the energy performance is optimal for California's climate.
- All eligible low-income customers will be given the opportunity to participate in the low-income energy efficiency program by 2020.

These strategies were selected based on the ability to achieve significant energy efficiency savings, and bring energy-efficient technologies and products into the market.

On April 25, 2012, Governor Edmund G. Brown Jr. further targeted zero-net-energy consumption for state-owned buildings. Executive Order B-18-12[25] requires zero-net-energy consumption for 50 percent of the square footage of existing state-owned buildings by 2025 and zero net energy consumption for all new or renovated state buildings beginning design after 2025.

To achieve these zero-net-energy goals, the Energy Commission has committed to adopting and implementing building and appliance regulations that reduce the wasteful power and water consumption. The *Long-Term Energy Efficiency Strategic Plan* calls on the Energy Commission to develop a phased and accelerated "top-down" approach to more stringent codes and

24 California Energy Commission and California Public Utilities Commission, *Long-Term Energy Efficiency Strategic Plan*, updated January 2011. Retrieved from http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf.
25 Office of Edmund G. Brown Jr., Executive Order B-18-12, April 25, 2012. Retrieved from http://gov.ca.gov/news.php?id=17506.

standards.[26] It also calls for an expansion of the scope of appliance standards to Energy consumption and water use. The Energy Commission adopted its detailed plan for fulfilling these zero-net-energy objectives in its *2013 IEPR*.[27]

Governor's Clean Energy Jobs Plan

On June 15, 2010, as a part of his election campaign, Governor Brown proposed a *Clean Energy Jobs Plan*,[28] which called on the Energy Commission to strengthen appliance efficiency standards for lighting, consumer electronics and other products. Governor Brown noted that energy efficiency is the cheapest, fastest, and most reliable way to create jobs, save consumers money, and cut pollution from the power sector. He stated that California's efficiency standards and programs have triggered innovation and creativity in the market — today's appliances are not only more efficient, but they are cheaper and more versatile than ever.

Addressing Drought Conditions

On January 17, 2014, with California facing water shortfalls in the driest year in recorded state history, Governor Brown proclaimed a State of Emergency[29] and directed state officials to take all necessary actions to prepare and respond to drought conditions. The Energy Commission's prioritization of water efficiency measures for faucets, toilets, and urinals implements Governor Brown's call for all Californians to conserve water in every way possible.

Regulatory Approaches

Historical Approach

Before 1970, most toilets consumed 6 gpf or more, and some faucets used as much as 7 gallons per minute (gpm). Effective January 1, 1978, California law required all toilets to consume no more than 3.5 gpf and all faucets to consume no more than 2.75 gpm.[30] In the 1980s and early 1990s, several states, including California, had established water efficiency standards for toilets and urinals. Congress used these state-level standards as the basis for the first federal standards for these appliances, passed in the Energy Policy Act of 1992 (EPAct 1992). These standards took

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26 California Energy Commission and California Public Utilities Commission, *Long-Term Energy Efficiency Strategic Plan*, p. 64.
27 California Energy Commission, *2013 IEPR*, pp. 21-26.
28 Office of Edmund G. Brown Jr., *Clean Energy Jobs Plan*. Retrieved from http://gov.ca.gov/docs/Clean_Energy_Plan.pdf.
29 Office of Edmund G. Brown Jr., "Governor Brown Declares Drought State of Emergency," January 17, 2014. Retrieved from http://gov.ca.gov/news.php?id=18368.
30 California Energy Commission. 1978. Conservation Division Regulations for Appliance Efficiency Standards, (including requirements for Intermittent Ignition Devices). Amended, July 19, 1978.

effect in 1994 and set the maximum flush volumes at 1.6 gpf for toilets, 1.0 gpf for urinals, and maximum allowable flow rate for lavatory and kitchen faucets at 2.2 gpm.[31]

Federal Regulations

The U.S. Department of Energy (DOE) adopted the EPAct 1992 standards into the Code of Federal Regulations in 1998.[32] These standards have remained unchanged since then, and DOE has not indicated any intent to amend these standards.

On December 22, 2010, DOE waived federal preemption for energy conservation standards with respect to any state regulation concerning the water use or water efficiency of faucets, showerheads, toilets, and urinals.[33] This waiver allows states to set their own standards for the relevant plumbing products as long as the state standard is more stringent than the federal standard.

DOE recently updated its test procedures for showerheads, faucets, toilets, urinals, and commercial prerinse spray valves.[34] The final rule incorporates by reference the updated American Society of Mechanical Engineers (ASME) standard A112.18.1–2012 test procedure for faucets and showerheads, and ASME A112.19.2–2008 test procedure for water closets and urinals. The DOE stated that these changes will not affect measured water use of these products. Instead, they will primarily clarify the manner in which to test for compliance with the current water conservation standards.

California Regulations

The current standards in the *Appliance Efficiency Regulations*, adopted August 19, 2003, mirror the federal standards for toilets, faucets, and urinals.[35]

In 2007, the California Legislature enacted Assembly Bill 715 (AB 715), which set a schedule for manufacturers to meet water conservation standards for toilets and urinals sold or installed in the state such that after January 1, 2014, toilets cannot use more than 1.28 gpf and urinals cannot use more than 0.5 gpf.[36] AB 715 required the California Building Standards Commission to incorporate these standards into the California Building Code, which it did in adopting the 2013 California Plumbing Code (§ 401.2).

31 Energy Policy Act of 1992, Pub. L. 102-486, § 123(f)(2) (Oct. 24, 1992).
32 63 Fed. Reg. 13308 (Mar. 18, 1998).
33 75 Fed. Reg. 245, (December 22, 2010).
34 78 Fed. Reg. 62970 (Oct. 23, 2013).
35 Cal. Code Regs., tit. 20, § 1605.1(i).
36 California Assembly Bill 715 (Laird, Chapter 499, Statutes of 2007).

In 2009, the California Legislature enacted Senate Bill 407 (SB 407), which requires that homes and commercial buildings built on or before 1994 be retrofitted with more efficient plumbing fittings and fixtures by 2014 for single-family buildings undergoing a retrofit, by 2017 for all single-family buildings, and by 2019 for multifamily and commercial buildings. [37] Specifically, SB 407 requires that, by the effective date, all noncompliant fixtures be replaced with toilets that use no more than 1.6 gpf, urinals that use no more than 1.0 gpf, and faucets that use no more than 2.2 gpm.

The *2013 California Green Building Code* (*CALGreen 2013)* included mandatory water efficiency standards for toilets, urinals, and faucets in new and renovated buildings.[38] Effective January 1, 2014, *CalGreen 2013* mandates that:

- Toilets have to be 1.28 gpf or less.
- Urinals have to be 0.5 gpf or less.
- Lavatory faucets must have a maximum flow rate of 1.5 gpm at 60 psi and a minimum flow rate of 0.8 gpm at 20 psi.
- Kitchen faucets must have a maximum flow rate of 1.8 gpm measure at 60 psi. They may temporarily increase flow to 2.2 gpm measure at 60 psi but must default back to a maximum flow rate of 1.8 gpm measure at 60 psi.

The *2013 California Plumbing Code* sets the same efficiency standards set by *CalGreen 2013*. In addition, it requires that faucets in common or public use area in homes shall not exceed 0.5 gpm.[39]

As building codes, the *California Plumbing Code* and *CALGreen* establish standards for products installed during new construction or alterations, but they do not regulate products *sold or offered for sale* in California. SB 407 is also enforced only at the point of installation, when a permit is issued, and not at the point of sale. While AB 715 specifies that the standards apply at both sale and installation, it does not specify how to enforce the standards at the point of sale.

Local Regulations

In 2009, the City of Los Angeles passed an ordinance that established water efficiency requirements for newly constructed buildings and renovations of existing buildings. Among other provisions, the code requires all toilets installed in new buildings or during retrofits to

37 California Senate Bill 407 (Padilla, Chapter 587, Statutes of 2009).

38 Cal. Code Regs., tit. 24, pt. 11 (2013).

39 California Code of Regulations (CCR), Title 24, Part 5. December 7, 2013. p.53.

have an effective flush[40] volume of 1.28 gpf or less. The maximum flush volume for urinals installed after October 1, 2010, cannot exceed 0.125 gpf.[41]

Regulations in Other States

In 2010, New York City adopted a municipal code provision to revise the water efficiency standards in the local plumbing code. Local Law 57 sets the maximum flush volumes of 1.28 gpf for toilets and 0.5 gpf for urinals, and 1.5 gpm for faucets.[42]

Two states have enacted statutes regulating the water efficiency of toilets and urinals. In June 2009, Texas enacted standards that would require toilets and urinals sold or offered for sale to achieve 1.28 gpf and 0.5 gpf, respectively.[43] In March 2010, Georgia enacted standards that required toilets and urinals installed in newly constructed buildings to achieve 1.28 gpf and 0.5 gpf, respectively.[44]

Two other states are considering efficiency standards for toilets and urinals. In 2013, Oregon's legislature introduced Senate Bills 692 and 840 that would require toilets and urinals sold in Oregon to achieve 1.28 gpf and 0.125 gpf, respectively.[45] And Washington's legislature is considering House Bill 1017, which would require water consumption of toilets and urinals sold in Washington to be no more than 1.28 gpf and 0.5 gpf, respectively.[46]

WaterSense®

WaterSense, a partnership program by the U.S. Environmental Protection Agency (EPA), collaborates with stakeholders to establish voluntary specifications for high-efficiency water-consuming appliances, such as toilets, urinals, and lavatory faucets. Manufacturers certify and

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40 Effective flush means a water flush volume of a dual flush toilets averaging of two small and a large flush.

41 City of Los Angeles, California. 2009a. Water Efficiency Requirements for New Development and Renovations of Existing Buildings. Ordinance Number 180822.
2009b. "Water Efficiency Requirements for New Development and Renovations of Existing Buildings." Municipal Code § 125 (2009).

42 City of New York, New York. "Local Law No. 54. To amend the administrative code of the city of New York, in relation to enhanced water efficiency standards." 2010.

43 Texas House Bill 2667. House Member Hinojosa. 2009 Regular Legislative Session.

44 Georgia Senate Bill 370. State Senator Ross Tolleson. 2009 – 2010 Regular Session.

45 Oregon Senate Bill 692. Committee on Environment and Natural Resources. 2013. http://gov.oregonlive.com/bill/2013/SB692/.
Oregon Senate Bill 840. Committee on Environment and Natural Resources. 2013.http://gov.oregonlive.com/bill/2013/SB840/.

46 Washington House Bill 1017. 2013.

label their products according to standards developed by EPA-licensed laboratories. A WaterSense label means the products:

- Perform as well or better than their less efficient counterparts.
- Are 20 percent more water-efficient than average products in that category.
- Realize water savings on a national level.
- Provide measurable water savings results.
- Achieve water efficiency through several technology options.

WaterSense labels make it easy for consumers to find and select water-efficient products. WaterSense-labeled toilets and urinals must not exceed 1.28 gpf and 0.5 gpf, respectively. WaterSense-labeled faucets must not exceed 1.5 gpm, and the faucet must be able to deliver a minimum flow rate of 0.8 gpm at 20 pounds per square inch (psi).

The CASE Report

In July 2013, the IOUs and NRDC submitted a CASE report[47] to the Energy Commission in response to the Commission's invitation to submit proposals. The CASE report recommends water efficiency standards of 1.28 gpf for toilets, 0.125 gpf for urinals, a maximum flow rate of 1.0 gpm at 60 pounds per square inch (psi) and a minimum flow rate of 0.5 gpm at 20 psi for home lavatory faucets, and a 1.8 gpm flow rate with optional 2.2 gpm (for filling pots and pans) for residential kitchen faucets. The CASE report estimates that implementing these recommended measures would result in a reduction of about 55.3 billion gallons of water, 790 GWh of electricity, and 149 Mtherms of natural gas each year after full-stock turnover.

In February 2014, the IOUs and NRDC submitted two addenda to their July 2013 CASE report. The first addendum adds information to support a 0.125 gpf standard for urinals.[48] The second

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47 Code and Standard Enhancement (CASE) report. http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/California_IOUs__and__Natural_Resources_defense_Councils_Responses_to_the_Invitation_for_Standards_Proposals_for_Toilets__and__Urinals_2013-07-29_TN-71765.pdf, and http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/California_IOUs_and_Natural_Resources_defense_Councils_Response_to_the_Invitation_for_Standards_Proposals_for_Faucets_-_Updated_2013-08-05_TN-71810.pdf.

48 http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/The_California_Statewide_IOU_Codes_and_Standards_Team_Addendum_2_to_the_Toilets_and_Urinals_CASE_Report_2014-02-21_TN-72713.pdf.

addendum recommends a maximum performance (MaP[49]) score for toilets of no fewer than 600 milligram (mg).[50]

Industry Proposals

Plumbing Manufacturers International (PMI), which represents many plumbing-fixture manufacturers, submitted a proposal that identifies water efficiency levels equal to those specified in AB 715 for toilets and urinals. The proposal also identifies water efficiency levels for faucets, proposing a flow-rate restriction of 1.5 gpm for home lavatory faucets, 1.8 gpm with optional 2.2 gpm (for filling pots and pans) for residential kitchen faucets and 0.5 gpm for public lavatory faucets, and 0.2 gallons per cycle for metered public lavatory faucets.[51] These proposed efficiency levels are identical to those set in the *2013 California Plumbing Code* and *CalGreen 2013*, effective January 1, 2014.[52]

Fluidmaster, Kohler, and Moen Incorporated submitted proposals making the same recommendations as PMI.

Alternatives Consideration

Staff has analyzed the proposal in the CASE report to determine whether it meets the legislative criteria for Commission's prescription of appliance efficiency standards. Staff also reviewed and analyzed the federal (including standards suggested by WaterSense), state, and local standards, and stakeholders' proposals, for three alternatives scenarios. Maintaining current Title 20 standards, revising Title 20 to incorporate the CASE report suggestion (most restrictive), or revising Title 20 to incorporate PMI are suggested measures.

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49 *Maximum performance* or *MAP* indicates the toilet ability to flush solid waste. A higher score means the toilet is more effective to remove solid waste with a same volume of water.

50 http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/The_California_Statewide_IOU_Codes_and_Standards_Team_Addendum_to_the_Toilets_and_Urinals_CASE_Report_2014-02-21_TN-72711.pdf.

51 http://energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/PMI_Comments_re_Invitation_to_Submit_Proposals_2012-2013_Appliance_Efficiency_Rulemaking_Water_Appliances_2013-07-26_TN-71717.pdf; http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/PMI_Comments_re_the_CEC_Current_Rulemaking_on_Water_Closets_Urinals_and_Faucets_2013-10-28_TN-72309.pdf.

52 California Code of Regulations (CCR), Title 24, Part 5. December 7, 2013.

Maintaining Current Title 20

Staff does not believe maintaining current Title 20 "as is" viable because the current standards reflect market and feasibility situations adopted in 1993 and are inconsistent with current legislative intent regarding improving water efficiency as expressed in AB 715. Moreover, there are available appliances in the market that perform satisfactorily while saving significant water and energy.

Adopting CASE Report Proposal

The CASE report proposes standards for toilets and urinals that are similar to AB 715 except the CASE report also proposes to restrict water consumption of wall-mounted urinals to no more than 0.125 gpf. Although there are 0.125 gpf urinal models (called ultra-low volume) available in the market, staff has decided not to recommend setting this standard for wall-mounted urinals at this flushing volume because:

- Ultra-low-volume urinals require significantly more maintenance than those with a flush volume of 0.5 gpf to avoid mineral clogging, pipe corrosion, and high odor that results from the lower volume of water used[53].
- There is a lack of support provided from manufacturers for setting standards at 0.125 gpf for urinals.
- There is risk of consumer rejection and backlash for future standards development when technologies improve or infrastructure is replaced.

The CASE report also proposed standards for home lavatory and kitchen faucets. Because the technology used to reduce water flow from these faucets is not different for public lavatory faucets, and because there are well-performing public lavatory faucets available,[54] staff recommends that the staff-proposed standards also apply to public lavatory faucets.

The CASE report proposed to limit home lavatory faucets to 1.0 gpm flow at 60 psi with a minimum flow of 0.5 gpm at 20 psi. At this flow rate, consumers may experience a slower delivery of hot water to the faucet; therefore, if the only purpose of the lavatory faucet were for hand washing, staff would recommend these water flow restrictions in the standard. But because lavatory faucets are also used for other purposes, such as face washing, waiting a long time to get hot water delivered may actually cause water waste that would negate the savings

53 http://energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/TN 72842 03-26-14 T Ngo CEC Consideration of Urinal Flush Levels.pdf; http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C.

54 *Green Building Operation Manual*. p.198. Retrieved from http://www.greenseal.org/Portals/0/Documents/IG/PHA%20Manuals/Chapter10_Green_Building_OM_Manual_PHA.pdf.

from the low-flow faucet. After further consideration, staff recommends not adopting the CASE report's proposed flow restriction for faucets.

Adopting Industry Proposals

PMI, with the support of other manufacturers, submitted a proposal to restrict water consumption of toilets and urinals to the levels specified in AB 715. These levels are 1.28 gpf for toilets and 0.5 gpf for urinals. PMI also suggested restricting flow for home lavatory faucets at 1.5 gpm and 0.8 gpm minimum flow, kitchen faucets at 1.8 gpm with optional temporary flow of 2.2 gpm (for filling pots and pans), public lavatory faucets at 0.5 gpm, and metered public lavatory faucets at 0.2 gallon per cycle (gpc). Overall, the industry proposal contains efficiency levels set by California Plumbing Code.

Staff applied the market data usage assumptions from the CASE report to calculate the cost-effectiveness and the water and energy savings from PMI's proposal, and to evaluate PMI's proposal for technical feasibility. The calculations and assumptions used are provided in **Appendix B**, and the results and discussions are provided in the following sections. Based on the results, staff recommends developing standards as proposed by the plumbing industry.

Proposal for Toilets, Urinals, and Faucets Regulations

Energy Commission staff has analyzed the approaches proposed in the CASE report and by the plumbing industry and evaluated comments from stakeholders, approaches federally and in other states, and the cost-effectiveness and technical feasibility of each approach for California consumers. Staff has determined that the savings resulting from reduced water and energy consumption under the proposed standards are significant while imparting no incremental cost to consumers. In addition, staff has found that the proposed standards are attainable through already available products in the market.

Staff's proposed standards for toilets, urinals, and faucets, which will take effect one year after adoption by the Energy Commission, are the following:

- All toilets, except those designed for prisons or mental health facilities, shall not consume more than 1.28 gpf and shall have a MAP score of no fewer than 350 grams.
- All urinals, except trough-type and those designed for prisons or mental health facilities, shall not consume more than 0.5 gpf.
- All home lavatory faucets shall not exceed 1.5 gpm flow rate with pipe pressure at 60 pounds per square inch (psi) and shall have a minimum flowrate of 0.8 gpm at 20 psi.
- All kitchen faucets shall not exceed 1.8 gpm flowrate and may have capability to increase to 2.2 gpm momentarily for filling pots and pans.
- All public lavatory faucets shall not exceed 0.5 gpm flowrate at 60 psi.

Standards for the following appliances will take effect January 1, 2019.

- All replacement valves for toilets shall not exceed 1.6 gpf.
- All replacement valves for urinals shall not exceed 1.0 gpf.

Based on its independent analysis of the best available data, including those from the CASE report and information provided by plumbing manufacturers, staff concluded that these proposed regulations are both cost-effective and technically feasible. Staff assumptions and calculation methods are provided in **Appendix B** of this report.

Staff-proposed standards would result in significant water and energy savings, and there are many efficient products available in the market. Manufacturers confirm that no technical issues exist with these products or with meeting consumers' needs with these products.

Staff did not propose more stringent standards because they may not be cost-effective and may cause adverse effects on the existing infrastructure. In contrast, the proposed standards for toilets and urinals restrict just the right amount of water flow necessary to carry waste to the main sewage drainage system without requiring modifications to the existing drainage system. As for faucets, the proposed standards would maintain the right flow of water to ensure that there is no impact on health, safety, or sanitation, and to be accepted by users. More stringent standards may save more energy or water, but with too great an impact on consumer acceptance and existing plumbing and sewer infrastructure.

Savings and Cost Analysis

The proposed updated standards for toilets, urinals, and faucets would significantly reduce water and energy consumption. In **Table 1**, staff provides the potential water and energy savings of the proposed standards. Water and energy savings are further separated into first-year savings and stock savings. First-year savings mean the annual reduction of water and energy associated with annual sales one year after the standards take effect. Annual existing and incremental stock savings means the annual water and energy reductions achieved after all existing stock in use comply with the proposed standards.

Table 1: Statewide Annual Energy Savings

	First Year Savings				Annual Existing and Incremental Stock Savings			
	Water (Mgal)	Nat.Gas (Mthm)	Energy[b] (GWh)	Savings (M$)	Water (Mgal)	Nat.Gas (Mthm)	Energy[b] (GWh)	Savings (M$)
Residential toilets	808	N/A	8.11	7.35	15,880	N/A	160	145
Commercial toilets	96.6	N/A	0.97	0.86	1,110	N/A	11.2	9.73
Urinals	134	N/A	1.35	1.20	1,550	N/A	15.5	13.7
Residential lavatory faucets	2,450	8.04	61.8	36.20	22,070	72.4	557	326
Kitchen faucets	3,290	10.78	82.9	48.56	29,700	97.4	749	439
Public lavatory faucets	1,420	5.81	14.2	16.95	16,280	53.4	164	184
Total	**8,200**	**24.6**	**169**	**111**	**86,590**	**223**	**1,660**	**1,120**

Source: CASE reports, as modified by staff (see Appendix B for assumptions)

a. The first year and stock savings are totals of product categories in Appendix A.
b. Energy savings include embedded energy (energy used to supply the water) and heating energy (electric-heated water).

Staff's calculations and assumptions used to estimate first year savings and stock change savings are provided in **Appendix B**. As provided in **Table 1**, staff estimated that if all toilets, urinals, and faucets complied with the proposed standards (annual existing and incremental stock savings), California would save 86.6 billion gallons of water, 223 million therms of natural gas, and 1,660 GWh of energy per year. Out of these numbers, about 19 billion gallons of water and 190 GWh of embedded energy savings are the direct result of standards set forth in AB 715. Using a residential rate of $0.16 per KWh electric and $0.99 per therm of natural gas, and a commercial rate of $0.14 per KWh electric and $0.75 per therm of natural gas, staff estimated that implementation of the proposed standards for toilets, urinals, and faucets would achieve roughly $1,120 million a year in reduced utility costs.

Staff also calculated the peak power reduction to be 1,660 GWh/8,760 hours, which equals to about 190 MW. This calculation is based on the simplified assumption that the load profile for toilets, urinals, and faucets is completely flat and energy would be evenly generated over the entire year to provide electricity for transporting and treating of water used by toilets, urinals, and faucets.

The CASE report for toilets, urinals, and faucets shows that the proposed standards are cost-effective as the cost per unit of compliant appliances is the same as the cost per unit of noncompliant appliances, indicating that there is no incremental cost to improve the efficiency of the appliance. **Table 2** summarizes the unit cost-effectiveness of the proposed standards based upon an aggregated version of **Appendix B**.

Table 2: Unit Water and Energy Savings and Cost-Effectiveness

Individual Appliance Savings								
	Design Life (years)	**Water Savings (gal/yr)**	**Nat. Gas Savings (therms)**	**Heating Energy Savings (kWh/yr)**	**Embedded Energy Savings (kWh/yr)**	**Incremental Cost ($)**	**Average Annual Savings ($)**	**Life Cycle Benefit ($)**
Residential Toilets	25	646	N/A	N/A	6	0	1.82	45.5
Commercial Toilets	12	245	N/A	N/A	2	0	1.82	22.8
Urinals	12	1357	N/A	N/A	14	0	10.07	121
Residential Faucets	10	823	3	12	8	0	7.21	72.1
Kitchen Faucets	10	2154	7	33	22	0	18.28	183
Public Faucets	3	3598	12	No	36	0	40.74	122

Source: CASE reports, as modified by staff (see Appendix B for assumptions)

The values shown in **Table 2** are sales and compliance averages for each type of appliance. The design life, incremental cost, and savings, in 2013 dollars, were incorporated into this table by averaging the annual sales of each product. The incremental cost for each product category is zero because there is no cost premium for a compliant product (meaning that an efficient product and an inefficient product cost the same, all other variables constant). This means that consumers will immediately save money on their utility bill upon installing a compliant product. Thus, the average annual savings are the savings that consumers will get once the product is installed. The life-cycle benefit represents the savings the consumer will get over the life of the appliance and is simply the product of the average annual savings multiplied by the average design life of the unit.

The savings estimates compare the baseline water and energy consumptions for each product with their respective water and energy consumptions under the proposed standards. For statewide estimates, these savings are multiplied by sales for first-year figures and by California annual existing and incremental stock for stock figures. The details of these calculations are available in **Appendix B**.

In conclusion, the proposed standards are clearly cost-effective as a compliant product carries no premium cost. Thus, ratepayers can enjoy immediate water, energy, and monetary savings and continue reaping those savings over the life of the product.

Toilets, Urinals, and Faucets Regulations: Technical Feasibility

Toilets

Manufacturers use a variety of approaches to achieve good performance with 1.28 gallons of water or less. These technologies are described below:

Better Gravity-Flush Tank-Type Toilets

Manufacturers redesigned the toilet bowls and trapways (the S-shaped pipe through which the toilet bowl drains) using advanced computer modeling to achieve better waste removal. They also introduced a better flapper such that in most 1.28 gpf toilets, the flapper closes before the tank is completely drained; thus, only about half of the water in the tank empties during a flush. By only partially emptying the tank, the full vertical static pressure of a larger tank is available for flushing force, resulting in lower water consumption. This also minimizes tank sweating (condensation outside the tank) because entering cold water is mixed with the existing water that remains in the tank.

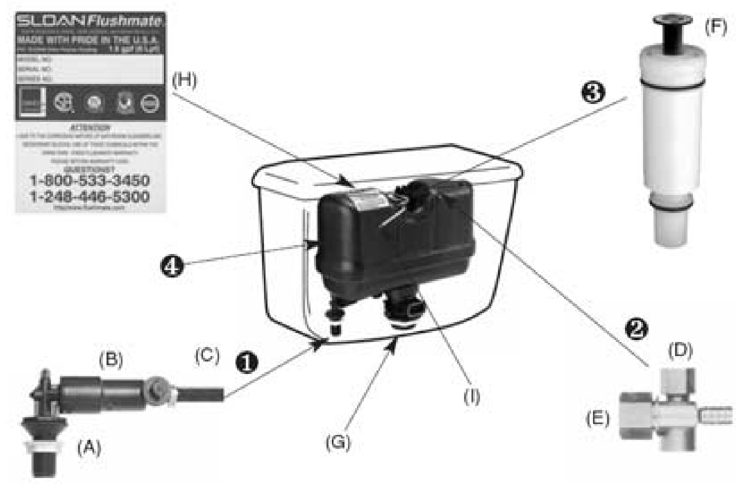
Redesigned Flush Valve

Enlarging the size of the flush valve ensures rapid flow of water to the toilet bowl, which shortens the flush duration while increasing the siphonic action, resulting in an effective flush.

Pressure-Assisted Flushometer Tank

A pressure-assisted toilet uses a separate, airtight flushometer tank inside the conventional tank to provide the pressure necessary to start the siphonic action in the bowl. Compressed air above the water inside the flushometer tank provides the additional pressure . After flushing, the water fills the tank from below, and because the tank is airtight, the incoming water compresses the air inside the tank to aid in flushing.

Figure 1: Pressure Assisted Flush-O-Meter Tank



Source: http://www.flushmaterepairparts.com/troubleshooting

Flapperless Gravity Flush

This type of toilet uses a trough inside the tank to collect water, and the tank itself does not have a flapper. It does not rely on water pressure or static head in the tank to flush; instead, it relies on fast release of a measured load of water to the tank by the water collection trough. Because the tank has no flapper, water is flowing rapidly to the bowl, which initiates an effective flush.

Figure 2: Flapperless Gravity Flush Tank

Source: http://www.niagaraconservation.com/water_conservation/products/toilets/detail?object=8664

Vacuum-Assisted Toilet

Instead of using gravity or pressure to push water through a toilet to induce the flush, a vacuum-assisted toilet uses a vacuum to help pull the waste out of the toilet bowl. Two approaches are typical with vacuum-assisted toilets: the more common self-contained or passive vacuum, and the less common centrally located vacuum.

Self-contained or *passive vacuum-assisted* toilets use the water itself to induce a vacuum in a specially designed and interconnected trapway and water bowl. When flushing is initiated, water flows down to both the toilet bowl (to start siphonic action) and the vacuum trapway. When the vacuum trapway is filled, it starts draining and creates a vacuum, which helps pull the waste from the toilet bowl.

The less common *vacuum-assisted toilets*, designed for airplanes or ships, connect to a centrally located waste collection vacuum tank. When flushing starts, a valve opens, and the waste is pulled from the toilet bowl. This type of system is less common because it is expensive and not suitable for homes or small businesses, although it uses very little water. Toilets on airplanes consume about a cup of water per flush.

Dual-Flush Toilets

An increasing number of toilets rely on two flush volumes, an approach that is very popular in Europe and Australia. Dual-flush toilets sold in the United States typically deliver 1.6 gallons with the high-volume flush for solid wastes, and 0.8 to 1.1 gallons with the low-volume flush for liquid wastes. The average water usage per flush equals about 1.28 gallons. Dual-flush action can be initiated in a conventional gravity feed or a pressure-assisted toilet, where the consumer selects which flush to engage. There is also a dual-flush retrofit device for conventional high-flush toilets.

Early Clogging Issues With Low-Volume Toilets

Although early low-volume flushing toilets performed well in the lab, they clogged up easily and needed to be double-flushed, plunged, or even snaked, upon field installation. This was a major cause of complaints from consumers in the early stage of low-volume flushing toilets. The most significant issue was that none of the early test methods addressed the likelihood of blockages. In response, more than a dozen municipalities and utility companies in Canada and the United States funded an exhaustive investigation to follow up on the National Association of Home Builders Research Center study *Maximum Performance Testing of Popular Toilet Models* (MaP Testing).

Maximum Performance (MaP)[55] testing identifies and ranks how well toilet models remove bulk waste using a realistic test media. A soybean paste having similar physical properties (density, moisture content) to human waste is used in combination with toilet paper as the test media. All toilet samples are adjusted, where possible, to the rated flush volume (typically 1.6 gallons) before testing to ensure a level playing field.

The testing protocol requires the soybean paste to be extruded through a 7/8-inch (22-mm) die and cut into 50-gram (50g) specimens (each specimen about 100 mm or 4 inches in length). Toilet models are subjected to progressively larger loadings (in 50-gram increments) until the unit fails to completely clear the bowl in two of three attempts or to fully restore a minimum 50mm (2-in.) trap seal, essentially a "test to failure."

The U.S. Environmental Protection Agency (EPA) has adopted 350g of uncased MaP media (soy bean paste) as the minimum performance threshold for high-efficiency toilets in its WaterSense program. Many water utilities with toilet replacement rebate and installation programs also apply a MaP of 350g.

Since the use of the MaP test, early problems of frequent clogging are alleviated, and low-volume toilets now receive favorable acceptance from users.

Potential Clogging Issue With Incompatible Toilet Paper Media

Consumers' improper use of an appliance can cause potential clogging of toilets and sewage system[56]. In this case, the fibrous bathroom wipes, because of their high tensile strength, would not break down after being flushed to the sewer system. This can create sewage blockage in the house or main sewage collection system. For this problem, staff suggests that toilet manufacturers voluntarily imprint a label on the product or its installation manual, or to publish consumer education materials in its website to remind consumer not to put anything but urine, feces, and toilet paper into toilets.

Blowout Toilets and Urinals

Reducing water consumption of blowout toilets and urinals is accomplished by better distribution of water flow to the rim and maintaining the necessary pressure to flush. Thus, minimal change to the bowl or urinal is needed. The CASE report and the Energy Commission

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55 Maximum Performance Testing. *Maximum Performance (MaP) Testing Toilet Fixture Performance Testing Protocol: Version 5*. March 2013. http://www.map-testing.com/maximum-performance/background.html.

Appliance Database indicate that there are compliant blowout toilets already in the market[57]. This market availability indicates that qualifying products are technically feasible and readily available in California.

As of July 2013, 292 WaterSense-labeled urinal models, with valves of various flushing systems (including blowout) from 19 brand names, complied with the proposed regulation. The quantity and variety of high-efficiency urinals available for sale are an indication that compliant products are technically feasible and readily available in California.

Urinals

As a urinal is mainly used for disposing of liquid waste, it does not have as many problems with clogging or effective waste removal as toilets; however, manufacturers have made important technology improvements in urinals to achieve better waste removal and lessen evaporation of liquid in the trap.

As of July 2013, there were 256 WaterSense-labeled urinal fixtures, valves, and systems from 19 brand names. Thirty-five percent of all WaterSense-labeled urinal fixtures, valves, and systems consume just 0.125 gpf or less. The quantity and variety of high-efficiency urinals available for sale indicate that compliant products are readily technically feasible and *are readily available in California and throughout the United States.*

Faucets

Controlling flow from faucets still relies on existing technology: restricting the flow area with a gasket and creating a feeling of adequate flow or coverage with an aerator (laminar flow or gentle spray). Because the technology has not changed, reducing the flow rate of kitchen or lavatory faucets is a matter of maintaining sanitation and users' acceptance.

As of July 2013, the Energy Commission Appliance Database listed 3,400 lavatory faucets and accessories and 2,900 kitchen faucets and accessories for sale. The database shows that 41 percent of the lavatory faucets and 22 percent of kitchen faucets would comply with the proposed standard. The quantity and variety of high-efficiency kitchen and lavatory faucets available for sale indicate that qualifying products are technically feasible and readily available in California.

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57 http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/The_California_Statewide_IOU_Codes_and_Standards_Team_Addendum_to_the_Toilets_and_Urinals_CASE_Report_2014-02-21_TN-72711.pdf.

Environmental Impacts and Benefits

Impacts

Toilets, urinals, and faucets are replaced when they are at the end of their useful lives; therefore, replacement of these appliances would present no additional impact to the environment beyond their natural cycle.

Efficiency improvement of toilets, urinals, and faucets may cause additional stress to some older sewer collection systems because the reduced volume of water for carrying solid waste through the sewage pipes. However, not all sewage systems are affected by the reduced water flow; only antiquated combined sewer systems[58] may be susceptible to this issue, especially in dry weather. One widely cited example of wastewater collection problems due to low-flow fixtures is from San Francisco.[59] In 2009, the City of San Francisco experienced an odor issue, and a few media articles claimed the odor issue was caused by low-flush toilets. The San Francisco Public Utilities Commission (SFPUC) refuted this claim in a letter submitted to the Energy Commission in June 2013.[60]

Although the Energy Commission staff recognizes that there is some controversy about the cause of sewage clogging, staff believes the solution is not to slow down efforts to achieve water conservation and water efficiency goals. Staff also believes that evaluation of the systematic impacts of water conservation, wastewater collection and treatment systems, and development

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58 A *combined sewer* is a type of sewer system that collects sewage and storm water runoff in a single pipe. The design of this kind of system carries two distinct characters different from a typical sewage collection system. One, it contain weirs to prevent solid waste from entering the the public waterway; two, the pipe diameter is several times larger than a conventional sewage collection system. During the dry period, wastewater trickes inside the pipe, and the flow direction is dictated by the placement of the weirs. During the rainy period, wastewater and storm water are flowing in the big pipe, solid waste will be caught in the weirs to go sewage treatment plant, and the storm water would flow over the weirs to a public waterway. Because of this, combined sewers can cause serious water pollution problems due to combined sewer overflows. This type of sewer design is no longer used in new communities, but many older cities continue to operate combined sewers.

59" Low-flow toilets cause a stink in SF,: *SFGate*. Retrieved from http://www.sfgate.com/bayarea/matier-ross/article/Low-flow-toilets-cause-a-stink-in-SF-2457645.php.

60 San Francisco Public Utilities Commission. "Letter to California Energy Commission Appliance Efficiency Standard Staff Regarding 2013 Appliance Efficiency Rulemaking for Water Appliances." Docket 12-AAER-2C. June 3, 2013.
http://www.energy.ca.gov/appliances/2013rulemaking/documents/responses/Water_Appliances_12-AAER-2C/San_Francisco_Water_Power_Sewers_Comments_2013-06-03_TN-71110.pdf.

of a strategy to achieve water conservation goals without compromising the reliability of wastewater collection and treatment systems should be taken on a statewide basis.

Benefits

Staff estimates that the proposed standards will result in reductions of criteria pollutants[61] and greenhouse gas emissions due to the avoided energy used to heat and transport water to the users. Staff tabulated the criteria pollutant and greenhouse gas emissions reductions in **Table 3**. Staff calculated the greenhouse emission reductions using the estimated avoided energy savings and the Commission's *Energy Aware Planning Guide*-suggested emission factor of 690 lbs CO_2e per MW for electricity and 11.65 pound CO_2e per therm (lb/th) for natural gas.[62]

For criteria air pollutants, staff used the California Air Resources Board suggested emission factors used to estimate cost-effectiveness of emission reductions:[63]:

- Oxides of nitrogen (NO_x) = 0.7 lb per MW,
- Sulfur dioxide (SO_x) = 0.01 lb per MW,
- Carbon monoxide (CO) = 0.1 lb per MW,
- Particulate matters ($PM_{2.5}$) = 0.03 lb per MW.

61 Criteria air pollutants are those for which a state or federal standard has been established. They include nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), ozone (O3) and its precursors, oxides of nitrogen (NOx) and volatile organic compounds (VOC), particulate matter less than 2.5 microns (PM2.5) and less than 10 microns in diameter (PM10), and lead (Pb).

62 Energy Aware Planning Guide Feb 2011. http://www.energy.ca.gov/2009publications/CEC-600-2009-013/CEC-600-2009-013.PDF

63 California Air Resources Board Economic Analysis Assumptions http://www.arb.ca.gov/regact/2010/res2010/res10d.pdf

Table 3: Criteria and Greenhouse Gas Emissions Reductions

Air Contaminants	Annual Reductions (tons)			Total Annual Reductions (tons)
	Toilets	Urinals	Faucets	
Oxides of nitrogen (NO_x)	6.17	0.48	52.57	**59.2**
Sulfur dioxide (SO_x)	0.88	0.07	7.51	**8.46**
Carbon monoxide (CO)	8.81	0.68	75.1	**84.6**
Particulate matter ($PM_{2.5}$)	2.64	0.20	22.53	**25.2**
Greenhouse Gas (eCO_2)	58,880	5,360	1,807,370	**1,871,610**

Source: CASE report

As seen from Table 3, more than 175 tons of criteria air contaminants and close to 600,000 tons of greenhouse gas equivalents are avoided annually due to the savings from the proposed standards in embedded energy and the natural gas and electricity used to heat water. This is almost equal to emissions from a conventional combined cycle, natural gas fueled 500 MW power plant.

The proposed standards will also save significant amounts of water, estimated at 86.6 billion gallons annually after full-stock turnover. The decrease in water consumption will result in increased availability of water to other users, decreased need for diversions, decreasing associated environmental impacts to riparian and wetland habitats from those diversions, and decreased drought impacts on California.

APPENDIX A:
Proposed Changes to Title 20

The following is the staff underline and ~~strike-out~~ proposed changes to specific Sections of Title 20. Underline means newly added text and strikeout means deleted text.

Staff also moves the standard for wash fountain in **Table H-1 Standards for Plumbing Fittings** to **Table G-1 Standards for Plumbing Fixtures** because a wash fountain by itself is a plumbing fitting. This is a general housekeeping move and does not change the effectiveness of the current standards for wash fountains.

Section 1601. Scope.

(h) Plumbing fittings, which are showerheads, lavatory faucets, kitchen faucets, metering faucets, replacement accessories~~aerators, wash fountains,~~ tub spout diverters, and commercial pre-rinse spray valves.

(i) Plumbing fixtures, which are water closets~~, and~~ urinals, wash fountains, and replacement valves for water closets and urinals.

Section 1602. Definitions.

(a) **General.**

"MaP" means maximum flushing performance.

(h) **Plumbing Fittings.**

"Replacement accessory" means a device designed to regulate water flow, including but not limited to pressure compensating device, restricting device, aerator, laminar device, or spray device that is sold separately from the lavatory or kitchen faucet to which it is intended to be attached.

~~"Kitchen replacement aerator" means an aerator sold as a replacement, separate from the kitchen faucet to which it is intended to be attached.~~

~~"Lavatory replacement aerator" means an aerator sold as a replacement, separate from the lavatory faucet to which it is intended to be attached.~~

"Plumbing fitting" means a showerhead, lavatory faucet, kitchen faucet, metering faucet, ~~lavatory~~ replacement accessory~~aerator, kitchen replacement aerator, wash fountain~~, commercial pre-rinse spray valves, or tub spout diverter.

"Public lavatory faucet" means a lavatory faucet that is designed and marketed expressly for use at a restroom available to the public.

(i) **Plumbing Fixtures.**

"Blowout type bowl" means a nonsiphonic type water closet bowl that is designed for a blowout action, and that has an integral flushing rim, a trapway at the rear of the bowl, a visible or concealed jet, a wall outlet, and, if wall mounted, a three-bolt hole configuration.

"Blowout water closet" means a water closet with a blowout type bowl.

"Dual-flush average flush volume" means the average of two small flushes and one large flush of a dual-flush water closet.

"Dual-flush water closet" is a water closet that allows a user to choose between two amounts of water to flush.

"Electromechanical hydraulic water closet" means a water closet that uses electrically operated devices, such as, but not limited to, air compressors, pumps, solenoids, motors, or macerators in place of or to aid gravity in evacuating waste from the toilet bowl.

"Flushometer tank" means a flushometer valve that is integrated within an accumulator vessel affixed and adjacent to a plumbing fixture inlet so as to cause an effective enlargement of the supply line immediately before the fixture.

"Flushometer tank water closet" means a water closet using a flushometer tank.

"Flushometer valve" means a valve that is attached to a pressurized water supply pipe and that is designed so that when actuated it opens the line for direct flow into the fixture at a rate and predetermined quantity to properly operate the fixture, and then gradually closes in order to provide trap reseal in the fixture and to avoid water hammer. The pipe to which the device is connected is, in itself, of sufficient size that when open shall allow the device to deliver water at a sufficient rate of flow for flushing.

"Gallons per flush (gpf)" means gallons per flush as determined using the applicable test method in Section 1604(i).

"Gravity tank-type water closet" means a water closet that includes a storage tank from which water flows into the bowl by gravity.

"Plumbing fixture" means an exchangeable device, which is connected to an existing plumbing system to deliver and drain away water and/or waste. For this section, plumbing fixture includes ~~a~~ water closet, ~~or a~~ urinal, wash fountain, or replacement valve.

"Prison-type urinal" means a urinal designed and marketed expressly for use in prison-type institutions.

"Prison-type water closet" means a water closet designed and marketed expressly for use in prison-type institutions.

"Replacement valve" means a valve that is clearly labeled for use to replace the existing flushing valve of an existing toilet or urinal in buildings built on or before 1994.

"Trough-type urinal" means a urinal designed for simultaneous use by two or more persons.

"Urinal" means a plumbing fixture that receives only liquid body waste and, on demand, conveys the waste through a trap seal into a ~~gravity~~ drainage system.

"Vacuum-type urinal" means a urinal whose bowl is evacuated by the application of a vacuum.

"Vacuum-type water closet" means a water closet whose bowl is evacuated by the application of a vacuum.

"Water closet" means a plumbing fixture having a water-containing receptor that receives liquid and solid body waste through an exposed integral trap into a ~~gravity~~ drainage system.

"Water use" means the quantity of water flowing through a water closet or urinal at point of use, determined in accordance with test procedures under Appendix T of subpart B of 10 C.F.R. part 430.

"Waterless urinal" means a urinal designed to be used without the application of water for flushing.

Section 1604. Test Methods for Specific Appliances.

(h) **Plumbing Fittings.**

(2) The test method for other plumbing fittings is 10 C.F.R. Section 430.23(s) (Appendix S to Subpart B of part 430).

(i) **Plumbing Fixtures.**

The test methods for plumbing fixtures are:

(1) 10 C.F.R. section 430.23(t) (Appendix T to Subpart B of part 430).

(2) MaP Testing Toilet Fixture Performance Testing Protocol Version 5-March 2013.

The following documents are incorporated by reference in Section 1604.

MAXIMUM PERFORMANCE (MaP) TESTING

MaP Testing Toilet Fixture Performance Testing Protocol Version 5 – March 2013

Section 1605.1. Federal and State Standards for Federally Regulated Appliances.

(h) **Plumbing Fittings.**

(1) **Showerheads, Faucets, Aerators, and Wash Fountains.** The flow rate of showerheads, lavatory faucets, kitchen faucets, lavatory replacement aerators, kitchen replacement aerators, wash fountains, and metering faucets shall be not greater than the applicable values shown in Table H-1. Showerheads shall also meet the requirements of ASME/ANSI Standard A112.18.1M-1996, 7.4.4(a).

Table A-1: Standards for Plumbing Fittings

Appliance	*Maximum Flow Rate*
Showerheads	2.5 gpm at 80 psi
Lavatory faucets and replacement accessory	1.5~~2.2~~ gpm at 60 psi [1, 2] and no less than 0.8 gpm at 20 psi
Kitchen faucets and replacement accessory	1.8 gpm with optional temporary flow of 2.2 gpm at 60 psi
~~Replacement aerators~~Public lavatory faucets	0.5~~2.2~~ gpm at 60 psi
~~Wash fountains~~	$\cancel{2.2 \times \frac{\text{rim space (inches)}}{20} \text{ gpm at 60 psi}}$
Metering faucets	0.25 gallons/cycle [3, 4]
Metering faucets for wash fountains	$0.25 \times \frac{\text{rim space (inches)}}{20}$ gpm at 60 psi [3, 4]

[1] **Sprayheads with independently controlled orifices and manual controls.** The maximum flow rate of each orifice that manually turns on or off shall not exceed the maximum flow rate for a lavatory faucet.
[2] **Sprayheads with collectively controlled orifices and manual controls.** The maximum flow rate of a sprayhead that manually turns on or off shall be the product of (a) the maximum flow rate for a lavatory faucet and (b) the number of component lavatories (rim space of the lavatory in inches (millimeters) divided by 20 inches (508 millimeters)).
[3] **Sprayheads with independently controlled orifices and metered controls.** The maximum flow rate of each orifice that delivers a preset volume of water before gradually shutting itself off shall not exceed the maximum flow rate for a metering faucet.
[4] **Sprayheads with collectively controlled orifices and metered controls.** The maximum flow rate of a sprayhead that delivers a preset volume of water before gradually shutting itself off shall be the product of (a) the maximum flow rate for a metering faucet and (b) the number of component lavatories (rim space of the lavatory in inches (millimeters) divided by 20 inches (508 millimeters).

Source: California Energy Commission

(i) **Plumbing Fixtures.**

(1) The water consumption of water closets~~, and~~ urinals, and replacement valves, other than those designed and marketed exclusively for use at prisons or mental care facilities, shall be no greater than the values shown in Table A-2.

Table A-2:
Standards for Plumbing Fixtures

Appliance	*Maximum Gallons per Flush or Average Flush for Dual Flush*
~~Gravity tank-type~~All water closets	1.28~~1.6~~
~~Flushometer tank water closets~~Replacement valve for water closet in building built on or before 1994	1.6
~~Electromechanical hydraulic water closets~~Replacement valve for urinal in building built on or before 1994	1.0~~1.6~~
~~Blowout water closets~~	~~3.5~~
Trough-type urinals	$\frac{\text{trough length (inches)}}{16}$
Other urinals	0.5~~1.0~~
Wash fountains	$2.2 \times \frac{\text{rim space (inches)}}{20}$ gpm at 60 psi

Source: California Energy Commission

(2) Water closets shall achieve a MaP score of no less than 350 grams.

Section 1606. Filing by Manufacturers; Listing of Appliances in Database.

Table A-3”
Data Submittal Requirements

	Appliance	Required Information	Permissible
H	Plumbing Fittings	*Type	Showerhead, lavatory faucet (independent or collective), public lavatory faucet, kitchen faucet, metering faucet (independent or collective), lavatory replacement accessory~~aerator~~, kitchen replacement accessory~~aerator~~, ~~wash fountain,~~ lift-type tub spout diverter, turn-type tub spout diverter, pull-type tub spout diverter, push-type tub spout diverter
		Flow Rate	
		Pulsating (for showerheads only)	Yes, no
		Rim Space (for wash fountains only)	
		Tub Spout Leakage Rate When New	
		Tub Spout Leakage Rate After 15,000 Cycles	
	Commercial Prerinse Spray Valves	Flow Rate (gpm)	
		Cleaning ability test	Pass, fail
I	Plumbing Fixtures	*Type	Blowout water closet, gravity tank type water closet, dual-flush water closet, electromechanical hydraulic water closet, flushometer tank water closet, urinal, prison-type urinal, prison-type water closet, flushometer valve water closet, trough-type urinal, waterless urinal, vacuum type urinal, vacuum type water closet, replacement urinal valve, replacement water closet valve, wash fountain.
		Water Consumption (dual-flush average flush volume for dual-flush water closet)	
		MaP Score (for water closet only)	
		Trough Length (trough-type urinals only)	

APPENDIX B: Staff Assumptions and Calculation Methods

Appendix B discusses the information and calculations used to characterize toilets, urinals, and faucets in California, their current water and energy use, and potential savings. The source of much of the information for these tables is the CASE report. Staff altered some of the figures as appropriate to fit staff's approach to water and energy consumption and savings.

Table B-1 lists estimated annual sales of each appliance, the total stock of appliances for each category, and the appliance lifetimes for the the CASE report. As the CASE report recommended standards for residential lavatory and kitchen faucets, it does not report the annual sale and stock for public places faucets. By extrapolating requirements from the *California Plumbing Codes*, staff assumed that there are an equal number of faucets for each commercial toilet; therefore, the annual sale and stock numbers for public lavatory faucets are essentially the same as for commercial toilets. Staff also assumed that the lifetimes of public lavatory faucets are three years due to their heavy usage by the mass population (because the duty cycle is about three times that of residential lavatory faucets).

Table B-1: Stock, Sales and Design Life

Product	2013 sale	Stock	Lifetime (yrs)
Residential toilets	1,250,866	24,597,887	25
Commercial toilets	393,539	4,525,964	12
Urinals	99,073	1,139,411	12
Residential lavatory faucets	2,976,950	26,815,188	10
Kitchen faucets	1,526,368	13,792,553	10
Public lavatory faucets[a]	393,539	4,525,964	3[b]

Source: CASE reports

Notes: a. Staff assumes a same number of public lavatory faucets as commercial toilets.
b. Staff estimate for lifetime of public places' faucets.

Compliance Rates, Duty Cycle, and Baseline Water Consumption

Table B-2 lists the estimated or reported compliance rates, duty cycle, and the estimated baseline water consumption per use. A compliance rate percentage indicates the ratio of compliant appliances to the total current market or stock. Thus, a compliance rate of 21 percent means that 21 percent of that particular appliance already meets the proposed standard.

Duty cycle of an appliance is an estimate of consumer behavior for that particular appliance. In the context of this report, the duty cycle is the average daily usage of the appliance. For example, a duty cycle of 7.37 for a home toilet means, on the average, each toilet being flushed 7.37 times each day.

Staff calculated the baseline water consumption for each use of each appliance listed in **Table B-2**. The baseline average water consumption represents the water consumption of that appliance reflecting the number of compliant and non-compliant units in the market. For example, a 0.79 value baseline average water consumption for urinal means that each time the urinal is flushed, a market average water consumption of 0.79 gallon is consumed.

Table B-2:
Compliance Rates, Duty Cycle and Baseline Water Consumption

Product	Compliance (%)	Duty Cycle	Baseline Average Water Consumption (gal/use)
Residential toilets	21	7.37	1.53
Commercial toilets	51	5.87	1.44
Urinals	42	18.0	0.79
Residential lavatory faucets	43	13.8	0.78
Kitchen faucets	23	41.6	0.89 + 3gal/day pots and pans filling
Public lavatory faucets	43	24.0	0.60

Source: CASE reports.

Assumptions:

- Census bureau data for California population 37.3 MM persons in 2010. Of these, 13.9 MM are employed. Male and female ratios for employed sector are 0.55 for male and 0.45 for female.
- Survey data from CASE reports show:
  - A typical flushing of one for male and three for female for each working day.
  - Each person flushes about 4.76 times a day using home toilets.
  - Each urinal flushed about 18 times a day.
  - Commercial properties occupied usage duration is 260 days a year.

- Each duration of faucet usage is about 37 seconds.
- Numbers of compliant appliances and total stock.
- A derating factor of 0.67 for all faucets. The derating factor means the correction factor to reflect actual flow of a faucet due to line pressure variation, incomplete opening of faucet's valve, and actual performance of flow restrictor gasket. Thus a faucet rated at 2.2 gpm may actually deliver only 1.5 gpm (2.2gpm x 0.67) on average.

- Compliance rates for home and commercial toilets and urinals are staff estimated based on assumed compliance with AB 715 compliance timeline (see below).
- Embedded energy cited in the CASE reports to be about 10,045 KWh/MM gallon of water delivered to customers.
- Duty cycles for home and commercial toilets are staff estimates based on survey data and census population data. Duty cycles for urinals and all faucets are reported in CASE reports.

Staff Sample Calculations

Compliance Rate

Compliance rate is the percentage of compliant units over the total stock units, or

Compliance rate = (number of compliant units/total stock) x 100

Compliance rate for toilets = annual toilet turnover x number of years since AB715 in effect / total stock, where

annual toilets turnover = stock toilet / lifetime

For example:

Annual toilets turnover = 24,597,887 units / 25 yrs = 1MM units

AB715 in effect since 2010 (5 years), therefore, the compliance rate =

= [(1MM units x 5 yrs) / 24.5MM units] x 100 = 21 percent

Duty Cycle

Residential toilet duty cycle = daily flushes per person x CA population / stock toilets, or

= (4.76 fpd x 37.3 MM person) / 24.1 MM units = 7.37 flushes per toilet per day

Commercial toilet duty cycle = sum of daily flushes for male and female / stock units

= [(0.55 male x 1f) +(0.45female x 3f)] x 13.9 MM = 24.6 MM flushes/day

Thus, daily flushes per commercial toilet is

= 24.6 MM f/d / 4.5 MM toilets = 5.87 flush per toilet per day

Baseline Average Water Consumption

The baseline average water consumption for each use of the appliance is the estimate of water consumed by the market representative ratio of compliant and noncompliant units.

Thus, in the case of a residential toilet, the baseline average water consumption per toilet is

= the sum of (percent complying unit x 1.28 gpf) and (percent of non complying units x 1.6 gpf) / 100

= [(21 x 1.28 gpf) + (79 x 1.6 gpf)] / 100 = 1.53 gpf

And for the case of residential lavatory faucet, the baseline average water consumption per faucet is

= [(43 x 1.5 gpm) + (57 x 2.2 gpm)] x 0.67 x (37sec/use/60sec/min)/ 100 = 0.78 gallon each use

Baseline Water and Energy Use

Table B-3 lists the staff estimated water consumption, embedded electrical energy for transporting and treating of water, electrical energy and natural gas used to heat hot water. Staff calculated the baseline water consumption for each appliance type using the baseline average water consumption and duty cycle listed in **Table B-2**, and the estimated annual sales and stock listed in **Table B-1**. The product of annual sales in 2013 and baseline average water consumption and duty cycle yields the 2013 baseline water consumption for that appliance. Similarly, the product of stock, duty cycle, and baseline average water consumption yields the stock annual water consumption for that appliance.
Staff estimates the embedded energy using CASE reports information on embedded energy and the baseline water consumption. Staff also estimated the electric and natural gas needed to heat water delivered to the faucet using assumptions listed below.

Table B-3:
Baseline Water and Energy Use

Baseline Annual Water, Electricity, and Natural Gas Consumption								
	Water (MM g/yr)		**Embedded Electricity (Gwh/yr)**		**Hot Water Electricity (GWh/yr)**		**Hot Water Natural Gas (MMTherms/yr)**	
	2013	Stock	2013	Stock	2013	Stock	2013	Stock
Residential toilets	5,115	100,577	51.4	1010	N/A	N/A	N/A	N/A
Commercial toilets	869	10,000	8.7	100	N/A	N/A	N/A	N/A
Urinals	366	4,213	3.7	42.3	N/A	N/A	N/A	N/A
Residential lavatory faucets	11,743	105,780	118	1063	178	1606	38.5	347
Kitchen faucets	22,252	201,073	224	2020	338	3052	73.0	660
Public lavatory faucets	1,923	22,118	19.3	222	N/A	N/A	7.9	72.6

Source: CASE reports

Assumptions:

- Embedded energy is 10,045 kWh/MMgal water delivered.
- Water is heated from 60 to 124°F.
- Water heat capacity is 1 BTU/lb-°F.
- Density of water is 8.34 lb/gallon.
- Hot water flowing through faucet is 50 percent of faucet flow rate.
- Combined thermal efficiency to heat water is 60 percent for natural gas and 95 percent for electric.
- About 80 percent of households use natural gas to heat water; the rest used electric.
- Heat content for natural gas is 100,000 BTU/therm.

Staff Sample Calculations

Baseline Water Consumption

Baseline water consumption = baseline average water consumption per unit x duty cycle x annual operating day x number of unit. Thus, for urinals, the baseline water consumption is

= (0.79 gal x 18/day x 260day/yr x 99,073 units) / 1,000,000 = 366 MMgal/yr

And, in the case of residential lavatory faucets

= (0.78 gal x 13.8/day x 365 day/year x 2,976,950 units) / 1,000,000

= 11,740 MMgal/yr

Embedded Energy

Embedded energy = baseline water consumption in MMgal/yr x 10,045 kWh/MMgal. Thus for residential kitchen faucets, the embedded energy is

= 22,252 MMgal/day x 10,045 kWh/MMgal = 223,521,340 kWh or 224 Gwh/yr

Baseline Heating Water Energy Consumption

The baseline energy consumption (to heat water by electricity or natural gas) is calculated from the energy needed to heat a gallon of water from 60 to 124°F multiplied by the baseline water consumption. To do this, staff used a basic heating equation

$Q = m\ Cp\ \Delta T$, where

Q is the heat that needed to heat a gallon of water from 60 to 124°F, in BTU/gal,
m is the weight of a gallon of water or 8.34 lb/gallon
Cp is the water heat capacity, which is 1 BTU/lb-°F,
ΔT is the difference in temperature of the water from 60 to 124 °F.

Using the assumed values listed in **Table B-3**, staff calculated that the heat needed to bring water from 60 to 124°F is 492 BTU/gal.

Using a 60 percent combined efficiency of heating water using natural gas, and 95 percent efficiency for heating water using electric, staff estimates that the heat needed to bring water from 60 to 124°F is

= 492 BTU/gal / (100,000 BTU/therm x 0.6) = 0.0082 therm/gal, or

= 492 BTU/gal / (3,412 BTU/kWh x 0.95) = 0.1518 kWh/gal

The product of the energy (in kWh or BTU for natural gas) and the baseline hot water consumption yields the energy needed (by natural gas or electricity) to heat water that flow through faucets. For example, for residential lavatory faucets, the heating energy needed by using natural gas is

= 0.0082 therm/gal x 11,743 MMgal/yr x 0.5 x 0.8 = 38.5 MMtherm

Compliant Water and Energy Uses

Compliant water and energy uses, tabulated in **Table B-4**, were calculated using annual market sale and stock and their respective water consumption limits, which are:

- 1.28 gpf for toilets,
- 0.5 gpf for urinals,
- 1.5 gpm for residential lavatory faucets,
- 1.8 gpm, with optional 2.2 gpm flow, for kitchen faucets,
- 0.5 gpm for public places faucets.

The product of the above limits water consumption of individual appliance and the respective annual sale and stock yields the annual or stock water consumption. These are listed in the first two columns of **Table B-4**. From the calculated water consumptions, staff calculated the embedded energy, and hot water heating energy using procedures similar to calculating the baseline hot water heating above (explained in **Table B-3**). The results are tabulated in **Table B-4**.

Table B-4:
Compliant Water and Energy Use

Compliant Annual Water, Electricity and Natural Gas Consumption								
	Water (MM g/yr)		**Embedded Electricity (Gwh/yr)**		**Hot Water Electricity (GWh/yr)**		**Hot Water Natural Gas (MMTherms/yr)**	
	2013	Stock	2013	Stock	2013	Stock	2013	Stock
Residential toilets	4,307	84,697	43.3	851	N/A	N/A	N/A	N/A
Commercial toilets	773	8,887	7.8	89.3	N/A	N/A	N/A	N/A
Urinals	232	2,666	2.3	26.7	N/A	N/A	N/A	N/A
Residential lavatory faucets	9,293	83,708	93	841	141	1606	30.5	275
Kitchen faucets	18,965	171,370	190	1721	288	3052	62.2	562
Public lavatory faucets	507	5,834	5.1	58.6	N/A	N/A	2.1	19.1

Source: CASE reports

Costs and Savings

Table B-5 lists the annual water and energy savings for the first year the proposed standards become effective. It also lists the water, energy and monetary savings upon complete stock turnover to products compliant with the proposed standards, that is, 2040 for home toilets, 2026 for commercial toilets and urinals, and 2025 for faucets.

Table B-5:
Statewide Annual Water, Energy, and Monetary Savings

	First Year Savings				Annual Existing and Incremental Stock Savings			
	Water (Mgal)	**Nat.Gas (Mthm)**	**Energy (GWh)**	**Savings (M$)**	**Water (Mgal)**	**Nat.Gas (Mthm)**	**Energy (GWh)**	**Savings (M$)**
Residential toilets	808	N/A	8.11	7.35	15,880	N/A	160	145
Commercial toilets	96.6	N/A	0.97	0.86	1,110	N/A	11.2	9.73
Urinals	134	N/A	1.35	1.20	1,550	N/A	15.5	13.7
Residential lavatory faucets	2,450	8.04	61.8	36.20	22,070	72.4	557	326
Kitchen faucets	3,290	10.78	82.9	48.56	29,700	97.4	749	439
Public lavatory faucets	1,420	5.81	14.2	16.95	16,280	53.4	164	184
Total	**8,200**	**24.6**	**169**	**111**	**86,590**	**223**	**1,660**	**1,120**

Source: CASE reports

Staff estimated and tabulated statewide savings in **Table B-5** using CASE reports information, and results listed in tables B-3 and B-4. Staff assumptions, as well as sample calculations, are provided below.

Assumptions

- CASE reports cost of residential avoided water delivering of $2.82 and treating of $4.66 per 1000 gallons water, and $2.58 and $4.84 per 1000 gal water, respectively, for commercial rate, all in 2013 dollars.
- U.S. Energy Information Administration electricity prices (for 2013) of $0.16/kWh for residential and $0.14/kWh for commercial[64].
- U.S. Energy Information Administration natural gas prices (for 2013) of $0.99/therm for residential and $0.75/therm for commercial[65].

Sample Calculations

First-Year Water and Energy Savings

First-year water and energy savings are the differences between the baseline water and energy consumptions and their respective compliant water and energy consumption. For example, the first-year energy saving for home lavatory faucets is

= (baseline water consumptions for residential lavatory faucets) – (compliant water consumption for residential lavatory faucets)

= 11,743 Mgal/yr – 9,293 Mgal/yr = 2,450 Mgal/yr

Stock Change Water and Energy and Monetary Savings

Similar to first year savings, the stock change water and energy savings are the differences between baseline stock water and energy consumption and compliant stock water and energy consumptions. Staff calculates the stock change monetary savings by multiplying the avoided cost of water delivered, the avoided cost of wastewater treatment, the savings from avoided natural gas and electricity and their respective water and energy savings. The sum of all savings from avoided water and energy is the total monetary savings listed in last column of Table B-5. For example, the stock change monetary saving of public lavatory faucets is

= (stock water savings x ($2.82 + $4.66)/1000gal) + (stock natural gas savings x $0.99/therm) + (stock energy savings x $0.16/kWh)

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64 Energy Information Administration – electricity prices for 2013 through December 2013 http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_b

65 Energy Information Administration – natural gas prices for 2013 through December 2013 http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SCA_m.htm

= (22,070 Mgal x($2.82 + $4.66)/1000) + (72.4 Mth x $0.99/th) + (557 GWh x $0.16/kWh) = $326 Million

Table B-6 lists the annual water and energy savings for each compliant product once the proposed standards become effective. It also lists the design life, annual monetary savings, the incremental cost and the life-cycle benefit of each compliant unit. Because the costs of compliant unit and noncompliant unit are not different, its incremental cost would be zero; therefore, once a compliant unit is installed, cost savings are immediately realized and continue for the lifetime of the appliance.

Table B-6
Annual Water, Energy, and Monetary Savings

	Individual Appliance Savings							
	Design Life (years)	**Water Savings (gal/yr)**	**Nat. Gas Savings (therms)**	**Heating Energy Savings (kWh/yr)**	**Embedded Energy Savings (kWh/yr)**	**Incremental Cost of Improvement ($)**	**Average Annual Savings ($)**	**Life Cycle Benefit ($)**
Residential Toilets	25	646	N/A	N/A	6	0	1.82	45.5
Commercial Toilets	12	245	N/A	N/A	2	0	1.82	22.8
Urinals	12	1357	N/A	N/A	14	0	10.07	121
Residential Faucets	10	823	3	12	8	0	7.21	72.1
Kitchen Faucets	10	2154	7	33	22	0	18.28	183
Public Faucets	3	3598	12	No	36	0	40.74	122

Source: CASE reports

Staff estimated and tabulated annual water, energy, and monetary savings in **Table B-6** using CASE reports information, **Table B-5** assumptions, and the results listed in tables B-3 and B-4. Staff additional assumptions as well as sample calculations are provided below.

Assumptions

- Because most residential Californians paid a monthly fixed rate for sewer services, the savings from avoided water treatment will not immediately benefit residential customers; therefore, the avoided water treatment saving is not factored into staff calculations for annual saving for residential service.
- Similarly, because water delivered to customers typically carries a fixed price, saving resulting from embedded energy is not factored into staff calculations for monetary saving per unit.

Sample Calculation

Water and energy savings per unit, is the difference between the baseline and compliant consumption calculated in previous steps. The average annual savings is calculated using the cost data assumptions listed above in **Table B-5**. The life-cycle benefit is simply the product of each unit's annual savings and its lifetime. For example, the annual savings and life-cycle benefit for public lavatory faucets is following:

Annual savings = (water savings x ($2.58 + $4.84)/1000gal) + (natural gas savings x $0.75/therm) + (energy savings x $0.14/kW)

= 3,598 gal x ($2.58 + $4.84)/1000gal + 12th x $0.75/th + 36 kWh x $0.14/kW

= $ 40.74 per year

Life cycle benefit = $40.74 /yr x 3 yr = $122