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WATER INFRASTRUCTURE

Water-Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows

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Contents

Abbreviations

EPA	Environmental Protection Agency
GAO	General Accounting Office

GAO Accountability * Integrity * Reliability

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Resources, Community, and
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The Honorable Michael Bilirakis
Chairman, Subcommittee on Health and Environment
Committee on Commerce
House of Representatives

The Honorable Sherwood L. Boehlert
Chairman, Subcommittee on Water Resources
and Environment
Committee on Transportation
and Infrastructure
House of Representatives

Water-efficient plumbing fixtures, such as low-flow toilets and showerheads, first became generally available to American consumers in the late 1980s. Subsequently, under the Energy Policy Act of 1992, the Congress established uniform national standards for the manufacture of these fixtures to promote conservation by residential and commercial water users. The act also preempted state and local authorities from setting different standards. Proposed legislation filed in 1999 would have repealed the national standards and eliminated the act's preemptive language.

Concerned about the potential implications of the proposed legislation, you asked us to examine the impact of the national water efficiency standards. Specifically, you asked us to provide information on (1) the estimated impact of the national water efficiency standards on water consumption levels and wastewater flows and (2) how repealing the national standards might affect projected investments in drinking water and wastewater treatment infrastructure, state and local governments' ability to finance their infrastructure needs, and the likelihood of moratoria on new residential and commercial construction if the demand for water is unabated.

Results in Brief

No studies estimating the impact of the national water efficiency standards on water consumption or wastewater flows nationwide have been completed so far. However, studies designed to measure the impacts of using water-efficient plumbing fixtures in specific locations have shown that, compared with their less efficient counterparts, low-flow fixtures conserve water, particularly in the case of toilets. The best example is a comprehensive study of water use in nearly 1,200 homes at 12 study sites that determined, among other things, that homes with low-flow toilets used about 40 percent less water for flushing than other homes in the study.[1] Estimating the impact of the national standards is difficult because some use of low-flow fixtures would likely occur for other reasons—that is, even in the absence of the standards. These reasons include (1) state and local laws that preceded the national standards and (2) incentives, such as rebate programs sponsored by local governments, that encourage the replacement of less efficient fixtures. Nevertheless, major studies initiated by the American Water Works Association and the Environmental Protection Agency (EPA) are developing long-term projections of the nationwide impact of the water efficiency standards, using precise measurements of the water savings per fixture as a starting point and taking into consideration expected population growth, the average replacement rate for plumbing fixtures, and other data. Preliminary results indicate that by 2020, water consumption could be reduced by about 3 to 9 percent, depending on the location, and wastewater flows to publicly owned treatment works could be reduced by an estimated 13 percent nationwide by 2016.

Although their precise impact is uncertain, repealing the national standards could affect the extent to which reductions in water consumption and wastewater flows are achieved and, thus, limit the extent to which local communities' investments in drinking water or wastewater infrastructure can be deferred or avoided. For example, an ongoing study estimates that for the 16 localities analyzed to date, the standards will cause water consumption to be reduced enough to save local water utilities from $165.7 million to $231.2 million by 2020 because planned investments to expand drinking water treatment or storage capacity can be deferred or avoided.[2]

[1]See *Residential End Uses of Water*, American Water Works Association Research Foundation (1999).

[2]The dollar amounts presented here represent the present value of the net savings discounted at 7 and 3 percent, respectively.

Location-specific estimates for wastewater treatment facilities indicate that reductions in wastewater flows can also lead to significant savings. For example, one regional authority estimates savings of $12 million to $14 million for each million-gallons-per-day reduction in wastewater flows. However, the estimates for both drinking water and wastewater infrastructure are only as accurate as the predictions that individual utilities are able to make about future investment decisions and, for the most part, do not account for the fact that some use of water-efficient fixtures would continue in the absence of the national standards. Repealing the national water efficiency standards could exacerbate the financial pressures facing local communities by forcing them to build or expand treatment and storage facilities sooner than planned. However, even if the standards were repealed, state and local officials told us that imposing moratoria on new residential or commercial construction would be considered only as a last resort.

Background

The Energy Policy Act of 1992 established water conservation standards for the manufacture of four types of plumbing fixtures: toilets, kitchen and lavatory faucets, showerheads, and urinals. With limited exceptions, the standards apply to all models of the fixtures manufactured after January 1, 1994.[3] (See table 1.)

[3]For example, the maximum allowable water use for certain gravity tank-type toilets labeled as “Commercial Use Only” manufactured after January 1, 1994, and before January 1, 1997, is 3.5 gallons per flush. Similarly, flushometer valve toilets were not required to meet the 1.6-gallons-per-flush standard until January 1, 1997. In the case of “blowout toilets,” which use pressurized jets of water to flush the bowl’s contents, the maximum allowable water use is 3.5 gallons per flush.

Table 1: National Water Efficiency Standards

Fixture type	Maximum allowable water use
Toilets, including gravity tank-type toilets,[a] flushometer tank toilets,[b] and electromechanical hydraulic toilets[c]	1.6 gallons per flush
Kitchen and lavatory faucets (or replacement aerators[d])	2.5 gallons per minute, when measured at a flowing water pressure of 80 pounds per square inch
Showerheads	2.5 gallons per minute, when measured at a flowing water pressure of 80 pounds per square inch
Urinals	1.0 gallon per flush

[a]A gravity tank-type toilet is designed to flush by gravity only with water supplied to the bowl.

[b]A flushometer tank toilet is designed to flush using a flushometer valve, which is attached to a pressurized water supply pipe and, when actuated, opens the line for direct water flow into the bowl at a rate and predetermined quantity needed to properly operate the toilet.

[c]An electromechanical hydraulic toilet is designed to flush using electronically controlled devices, such as air compressors, pumps, motors, or macerators in place of or as an aid to gravity in flushing the toilet bowl.

[d]An aerator is an apparatus for controlling water flow (e.g., from faucets).

Under the Department of Energy's regulations, water-efficient plumbing fixtures must meet the standards for maximum water consumption. For each model of a regulated plumbing fixture, manufacturers and private labelers must submit a compliance statement to the Department to certify that the model complies with the applicable water conservation standard and that all required testing has been conducted according to the test requirements prescribed in the regulations. In addition, the Department's regulations prohibit manufacturers and private labelers from distributing in commerce any fixture that does not meet the water conservation standard prescribed under the Energy Policy Act of 1992, and provide for the assessment of a civil penalty of not more than $110 per violation.

The plumbing industry has also established certain performance or efficiency standards for water-efficient plumbing fixtures. For example, manufacturers must demonstrate that low-flow toilets consume no more than 1.6 gallons per flush and can pass a series of tests directed at the effectiveness of the toilet's flushing performance and other factors, and each new toilet model must be tested for compliance by an approved laboratory before it reaches the marketplace. Testing protocols for demonstrating compliance with these standards are developed by the American Society of Mechanical Engineers and approved by the American National Standards Institute.

Most of the water consumed for domestic and commercial purposes is supplied by public drinking water systems, which account for about 12 percent of the total fresh water use in the United States, according to a recent report by the U.S. Geological Survey.[4] Water used for agricultural purposes, including water for irrigation and livestock, accounts for about 41 percent of total fresh water use, and the water used by thermoelectric power plants is about 39 percent of the total. Growing concerns about the adequacy of public water supplies to meet increased demands led a number of states and localities to impose their own requirements for water-efficient plumbing fixtures before the national standards took effect.

Water-Efficient Plumbing Fixtures Are Reducing Water Consumption Levels and Wastewater Flows

Substantial evidence shows that the use of water-efficient plumbing fixtures conserves water. A number of localized studies have measured the impact of installing water-efficient plumbing fixtures through sophisticated sensors, before-and-after comparisons of water bills, or other means. Although the results varied, the studies generally concluded that low-flow fixtures are effective in saving water. Determining the extent to which the use of low-flow fixtures is attributable to the national standards is problematic because some use of low-flow fixtures would likely occur for other reasons. Two major studies now under way are attempting to estimate the standards' impact on water consumption and wastewater flows over the long term.

[4]See *Estimated Use of Water in the United States in 1995*, U.S. Geological Survey Circular 1200 (1998).

Studies Using Precise Measurements Show That Water-Efficient Plumbing Fixtures Conserve Water

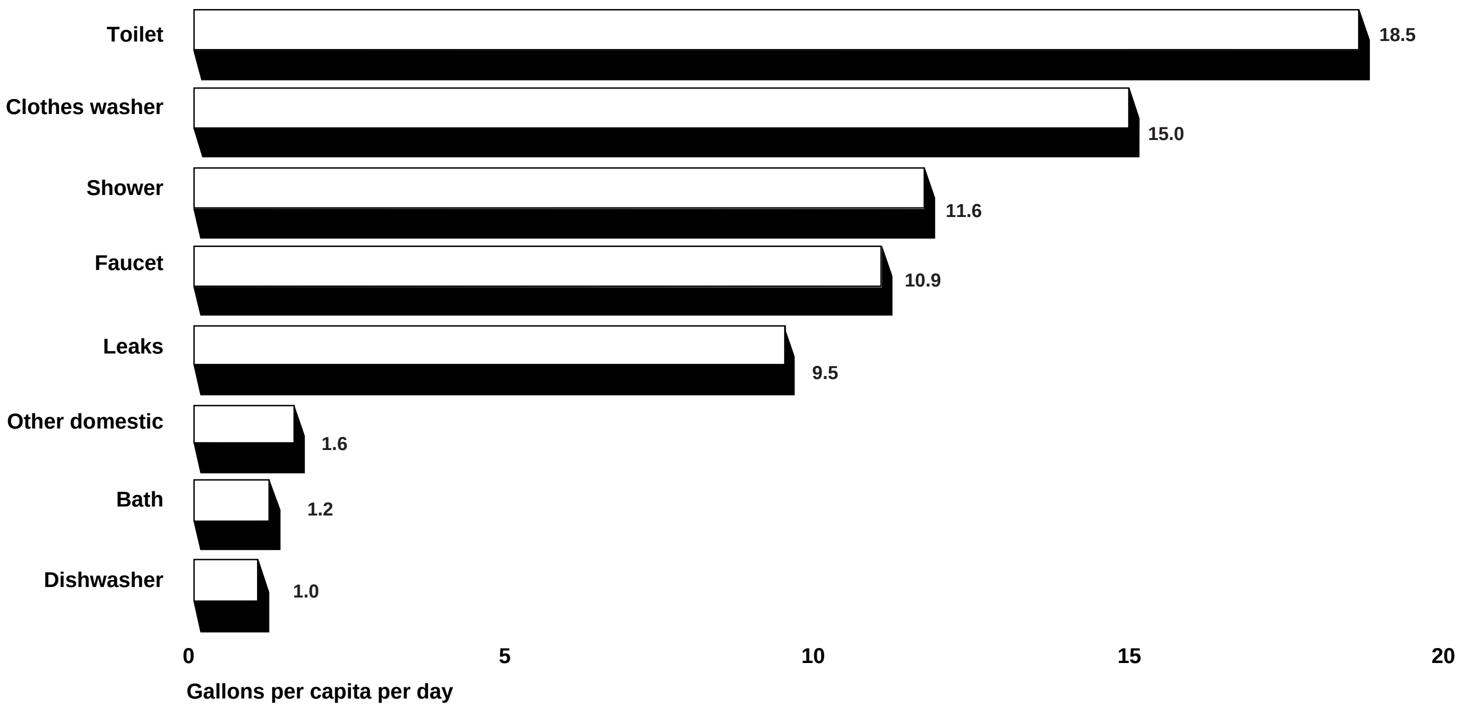
Although no major studies estimating the nationwide impact of the national water efficiency standards have been completed so far, a number of studies have been conducted to measure the extent to which water-efficient plumbing fixtures conserve water. The most comprehensive study we found was funded by the American Water Works Association's Research Foundation, in conjunction with 22 municipalities and water organizations.[5] The purpose of the study was to gather empirical evidence on variations in water use for plumbing fixtures and other water-using appliances within single-family homes.[6] Sophisticated sensors were placed on residential water meters at about 100 households in each of the 12 participating study sites to obtain detailed information on actual water use.[7] Figure 1 shows, for the 12 study sites, the distribution of indoor water use by type of fixture. According to the study, total mean indoor per-capita water use was 69.3 gallons per day, of which, toilets accounted for about 18.5 gallons per capita per day, or about 27 percent of the total.

[5]See *Residential End Uses of Water*, American Water Works Association Research Foundation (1999). The American Water Works Association is a professional organization representing individuals from the water supply industry and the drinking water community at large.

[6]The study involved 12,000 randomly selected customer accounts, or about 1,000 in each of 12 study sites, and included households with low-flow fixtures, those with less efficient fixtures, and those with a mix of low-flow and higher-volume fixtures. Sensors were used to record detailed water use data at about 10 percent of the households.

[7]The 12 study sites were Boulder, Colorado; Cambridge and Waterloo, Ontario, Canada; Denver, Colorado; Eugene, Oregon; Las Virgenes, California; Lompoc, California; Phoenix, Arizona; San Diego, California; Scottsdale and Tempe, Arizona; Seattle, Washington; Tampa, Florida; and Walnut Valley, California.

Figure 1: Mean Daily Residential Water Use at 12 Study Sites



Source: *Residential End Uses of Water*, American Water Works Association Research Foundation (1999), p. xxv.

Among other things, the detailed water flow data captured by the sensors allowed researchers to compare water consumption in homes equipped with low-flow toilets with those using higher-volume models. Significantly, the study found that the average number of flushes per day in households with low-flow toilets was 5.04—only slightly higher than the average of 4.92 flushes per day in households with higher-volume toilets.[8] Table 2 summarizes the results of the analysis.

[8]See *Residential End Uses of Water*, American Water Works Association Research Foundation (1999), p. xviii.

Table 2: Water Use by Type of Toilet

			Average water use	
Household toilet types	**Average gallons per flush**	**Number of households**	**Gallons per toilet per day**	**Gallons per capita per day**
Low-flow only	< 2.0	101	24.2	9.6
Mix of low-flow and higher-volume	2.0 – 3.5	311	45.4	17.6
Higher-volume only	> 4.0	776	47.9	20.1
All households		1,188	45.2	18.5

Legend

< means less than

> means greater than

Source: *Residential End Uses of Water*, American Water Works Association Research Foundation, pp. 131-132.

In addition to the comprehensive study by the American Water Works Association's Research Foundation, a number of studies have used similarly sophisticated equipment to measure water flow to individual appliances at a small number of households. The purpose of these studies was to estimate whether water-efficient fixtures reduce water consumption in residences and if so, by how much. Toilets consume the most water in residences, and, as such, they have been the focus of the greatest attention, but showerheads, faucets, and clothes washers have also been considered in these studies, although the latter will not be subject to national standards until 2004.[9] The studies all agree that compared with older toilets, ultra-low-flow toilets save significant amounts of water, easily overwhelming any changes in user practices (such as the frequency of flushing). Table 3 summarizes the results of the studies we examined.

[9]On May 23, 2000, the Department of Energy reached an agreement with appliance manufacturers and environmental and energy conservation organizations to phase in water and energy efficiency standards for clothes washers beginning in 2004.

Table 3: Reported Savings Attributable to Low-Flow Toilets in Studies Using Precise Measurements

			Water use in toilets (gal. per capita per day)			
Location	Date published	Number of households	Before retrofit	After retrofit	Amount saved	Percentage saved
Boulder, Colo.[a]	May 1996	14	15.9	7.6	8.3	52
East Bay Municipal Utility District, Calif.	Oct. 1991	25	12.8[c]	6.7[c]	5.3[c]	41[c]
Seattle, Wash.[b]	July 2000 (draft)	37	18.8	8.1	10.6	57
Tampa, Fla.	Feb. 1993	25	13.3	7.2	6.1	46

[a]In this study, half of the toilets were replaced with low-flow toilets and half were not; the reported savings were obtained by averaging the results for all toilets—higher-volume and low-flow. For the purpose of this table, we computed the water use and the amount of savings on the basis of the results for the replaced toilets.

[b]We obtained a copy of the draft report on this study. Because the authors are still finalizing the report, we did not have all of the information that would be useful in evaluating the results of this study.

[c]Because the study did not explicitly report the average water use before and after retrofit, we estimated these values by multiplying the average volume per flush by the number of flushes per person. The difference between these values does not equal the amount of savings reported in the study, which was measured separately for each toilet before averaging and, thus, is more accurate.

Sources:

Boulder: *Project Report: Measuring Actual Retrofit Savings and Conservation Effectiveness Using Flow Trace Analysis*. Prepared for: City of Boulder, Colorado, Utilities Division, Office of Water Conservation, by Aquacraft Water Engineering & Management (May 16, 1996).

East Bay: *East Bay Municipal Utility District Water Conservation Study.* Prepared for: East Bay MUD, Oakland, California, A. Aher, et al, Stevens Institute of Technology, Building Technology Laboratory, T. P. Konen, Director, Report No. R 219 (Oct. 1991).

Seattle: Draft report prepared for EPA and Seattle Public Utilities, by P. Mayer and W. DeOreo, Aquacraft, Inc., private communication from P. Mayer (July 2000).

Tampa: *The Impact of Water Conserving Plumbing Fixtures on Residential Water Use Characteristics: A Case Study in Tampa, Florida.* Prepared for: City of Tampa Water Department, Water Conservation Section, by Stevens Institute of Technology and Ayres Associates, T. P. Konen and D. L. Anderson, Principal Investigators (Feb. 1993).

While it is widely believed that the installation of water-efficient showerheads and sink faucets also results in significant savings, the studies we reviewed are not in complete agreement on this point. The East Bay, California, study reported savings of 1.7 gallons per capita per day with low-flow showerheads—about one-third of the savings resulting from toilet replacement. The Tampa, Florida, study reported savings of 3.6 gallons per capita per day—(1) more than half of the savings from toilet replacement and (2) just over one-third of the total water used for showers before the replacement. On the other hand, the study in Boulder, Colorado, which also used the most advanced equipment, found that showerhead replacement had no statistically significant effect on shower water consumption. The authors of this study called for further research, knowing that this result was anomalous compared with other, similar studies.

For clothes washers, the largest user of water in households after toilets, two studies examined the savings associated with using water-efficient appliances: one in Boulder, Colorado, and one in Seattle, Washington. In Boulder, only 4 of the 14 homes involved in the study had water-efficient washers installed for the test period—2 homes used one model of washer, and 2 homes used another model. In the test homes, the study found an average reduction of 61 percent in water use for clothes-washing—from 17.9 to 7.0 gallons per capita per day. One of the models tested reduced water consumption for clothes-washing by 39 percent on average, and the other produced a 76-percent reduction. A variety of clothes washers were tested in the Seattle study, and the results showed a savings of 5.4 gallons per capita per day, or a reduction of about 37 percent from the baseline water use.

Although the studies discussed here all indicate that low-flow toilets and other water-efficient fixtures save significant amounts of water, evidence suggests that the savings could be even greater if performance across all models of the fixtures were more consistent. In the case of toilets,[10] the technology has improved over time, according to water industry representatives, manufacturers, plumbing contractors, and an official with the American Society of Mechanical Engineers. They told us that when the national standards first took effect, existing toilet models were modified so that they used less water, but until the basic design was changed to accommodate the lower water flow, some models did not perform effectively. Today, there is wide agreement that the technology is much better than in the past; however, some of the officials we interviewed, including plumbing contractors and water industry representatives, believe that the performance tests required under the industry standards for low-flow toilets are too easy to pass and, as a result, some poorly performing models still reach the market. (See app. I for additional information on the

[10]For the purpose of this report, we focused on low-flow toilets—the fixtures that (1) have the greatest potential for water savings and (2) have been subject to the most complaints regarding their performance.

required performance tests for low-flow toilets and how the requirements have evolved over time.)

Ongoing National Studies Suggest That National Water Efficiency Standards Will Continue to Reduce Water Consumption and Wastewater Flows in the Long Term

Estimating the impact of the national standards is difficult because some use of low-flow fixtures would likely occur for other reasons—that is, even in the absence of the standards. Nevertheless, major studies initiated by the American Water Works Association and EPA are developing long-term projections of the nationwide impact of the water efficiency standards, using precise measurements of the water savings per fixture as a starting point and taking into consideration expected population growth, the average replacement rate for plumbing fixtures, and other data. Preliminary results indicate that over the long term, reductions in water consumption and wastewater flows could be substantial.

Estimating the National Standards' Impact Is Difficult Because Some Use of Water-Efficient Fixtures Would Likely Occur Even Without the Standards

The studies by both the American Water Works Association and EPA are attempting to quantify the effect of the national water efficiency standards for plumbing fixtures. In both cases, the estimate of future savings depends in part on assumptions about the baseline—that is, the extent to which the use of low-flow fixtures would occur for reasons other than the national standards. We identified the following circumstances in which the use of water-efficient plumbing fixtures had occurred prior to the standards, as well as factors suggesting that their use is likely to continue whether or not the national standards are in effect:

- *State and local standards that preceded the national standards.* Sixteen states and 6 localities had water efficiency standards for at least two of the plumbing fixtures regulated under the Energy Policy Act before the national standards took effect in 1994. As of 1999, about 50 percent of the nation's population resided in these locations. All of the states and localities had standards for low-flow toilets that, with one exception, were consistent with the current national standard. State and local standards for showerheads, faucets, and urinals varied from the national standard more frequently. Officials from all 16 states and 2 of the 6 localities with preexisting standards believe that their standards would automatically revive if the national standards were repealed.[11] (See app. II for detailed information on state and local water efficiency standards.)

[11]As a general principle, state and local regulations or ordinances "revive" (i.e., are automatically reinstated) under these circumstances. However, this principle may be applied differently or not at all, depending on the law of a particular state. State officials in Texas and city officials in Phoenix, Arizona, expressed concern that their state legislatures might resume previous attempts to repeal their state standards if the national standards were no longer in place.

- *Incentives, such as rebates, to encourage the installation of low-flow fixtures.* We identified at least 36 localities in 12 states that have sponsored rebate or free replacement programs, mostly in states and/or localities whose own standards for water-efficient plumbing fixtures preceded the national standards. Under these programs, the community offers some type of financial incentive to encourage people to replace their toilets or other plumbing fixtures with more efficient models sooner than they would have otherwise. We selected six localities—Austin, Texas; Los Angeles, California; New York, New York; Phoenix, Arizona, and Tampa and Hillsborough County, Florida—to collect information about their rebate programs, all of which began before or during 1994.[12] We found that over 2.3 million low-flow toilets have been installed under the six rebate programs, thereby saving more than 100 million gallons of water per day. With the exception of New York City, all of these communities continue to offer rebates, and, according to a city official, New York is considering a second rebate program. (See app. III for a summary of the accelerated toilet replacement programs in the six localities.)

- *Manufacturers' desire for consistency.* According to an official with the Plumbing Manufacturers' Institute and industry representatives, manufacturers would be reluctant to return to making higher-volume plumbing fixtures because of (1) the high cost of retooling and (2) the ease of complying with a single national standard rather than a hodgepodge of requirements across the country.

- *Local ordinances requiring low-flow fixtures.* For example, we found a few instances of local "retrofit on resale" ordinances in California, two of which were adopted before the national standards took effect.[13] Typically, these ordinances require that for any residential or commercial property offered for sale, the owner must certify that the property has been totally retrofitted with low-flow toilets and other efficient plumbing fixtures. According to an official with the California

[12]The criteria used to select these locations included (1) water efficiency standards that preceded the national standards, (2) the use of rebate and/or retrofit programs to accelerate the installation of low-flow toilets and other water-efficient fixtures, and (3) an assessment of the programs' impact on water consumption.

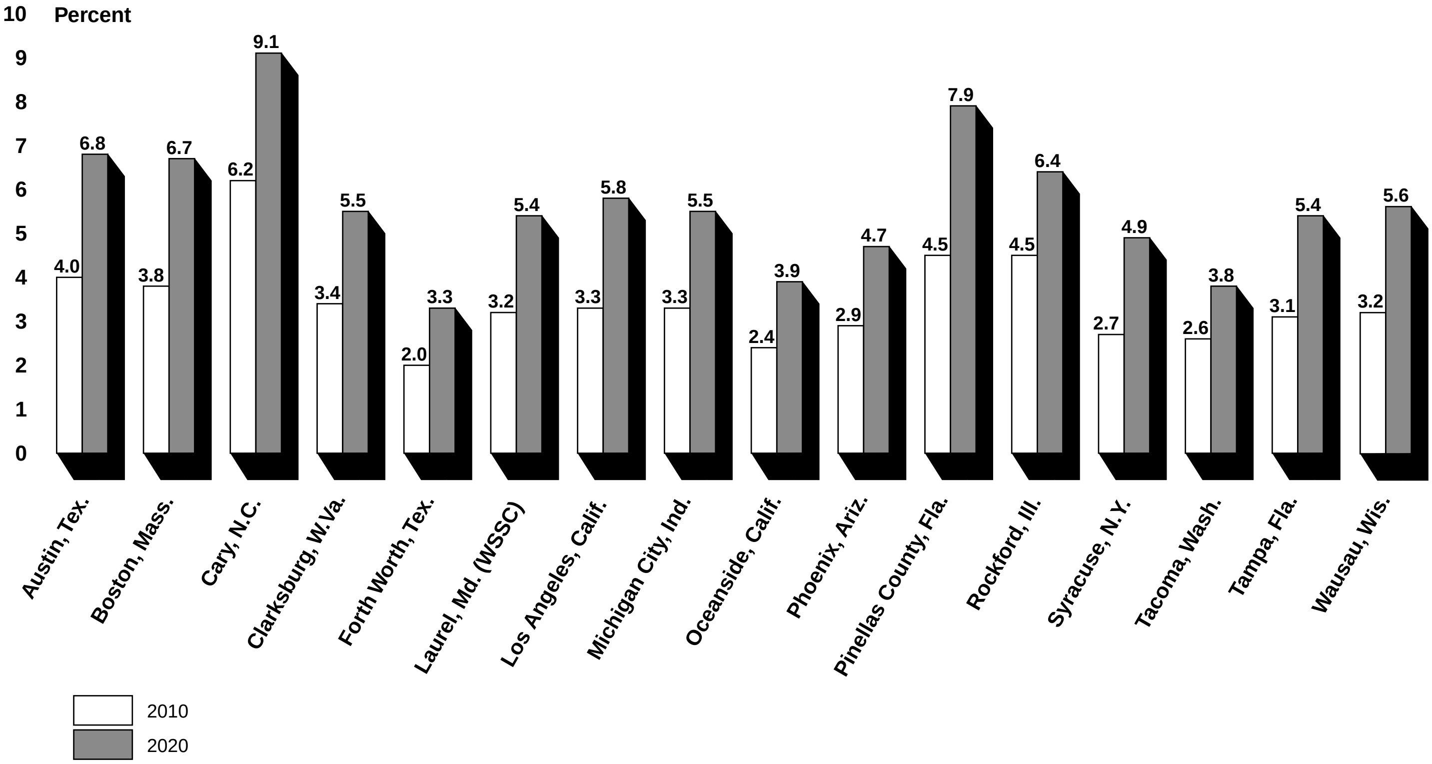
[13]Communities in California currently using "retrofit on resale" programs include the Cambria Community Services District, Los Angeles, the North Marin Water District, San Diego, San Francisco, and Santa Monica.

Urban Water Conservation Council, this requirement is currently being considered for statewide application because of the state's severe water shortage.

American Water Works Association Is Studying Impact on Water Consumption

In January 2000, the American Water Works Association commissioned a study to estimate the long-term impact of the national water efficiency standards on water consumption from public water systems. To obtain a national picture of the standards' impact, surveys were sent to over 3,700 drinking water utilities across the United States; as of June 21, 2000, over 650 utilities had responded. The Association's contractor is analyzing the responses and entering this information into a model developed to estimate future water demand with and without the national standards. The estimated completion date for the study is September 30, 2000. As shown in figure 2, preliminary projections for 16 utilities, which currently serve nearly 11 million people, indicate that given expected population growth, water consumption will be reduced by 3.3 to 9.1 percent by 2020 as a result of the national standards. (See app. IV for a table of the projected water savings by 2010 and 2020, by location.)

Figure 2: Percentage of Water Savings by Location



Legends

WSSC=Washington Suburban Sanitary Commission

Source: Analysis conducted by Maddaus Water Management for the American Water Works Association.

The American Water Works Association's study attempts to estimate the savings associated with water-efficient plumbing fixtures by using location-specific data on projected population growth, projected water demand, and the age of the existing housing stock. With the information on existing housing stock, the study makes assumptions about the percentage of households that already have low-flow fixtures (e.g., homes constructed after January 1, 1994, should be completely fitted with efficient fixtures) and the rate at which older, higher-volume fixtures will be replaced with low-flow models. The accuracy of these assumptions could have a significant effect on the validity of the projected reduction in water consumption. For example, the study uses a relatively conservative assumption regarding the replacement rate for toilets—3 percent per year compared with the plumbing industry's estimates of 4 to 5 percent per year. Using a higher replacement rate would increase the savings attributable to water-efficient fixtures by 2020.

As noted above, one difficulty in estimating the impact of the standards is determining a baseline against which projected water savings are derived, taking into account the savings that might occur without the national standards. In estimating water consumption without the national standards, the model used by the Association's contractor assumes that about 30 percent of the toilets installed in the future would be low-flow models (1.6 gal. per flush) and that the remaining 70 percent would use 4.6 gallons per flush. If the factors noted above resulted in a greater-than-30-percent proportion of low-flow fixtures, even in the absence of the national standards, then the actual savings attributable to the standards would be less than that estimated by the Association.

EPA Is Studying Impact on Wastewater Flows

While the American Water Works Association focused on water consumption from drinking water facilities, EPA is sponsoring a major study to estimate the long-term impact of the national water efficiency standards on the level of wastewater flows into treatment plants. The model used to predict the standards' impact on wastewater flows incorporates information from a variety of sources, including plumbing manufacturers, *U.S. Census Statistical Abstracts*, water utility case studies, *Consumer Reports*, the American Water Works Association Research Foundation, and other sources. Preliminary results from this study indicate that wastewater flows to publicly owned treatment works will be reduced by about 13 percent by 2016.[14]

As in the American Water Works Association study, the reasonableness of key assumptions in EPA's study could have a significant effect on the

[14]In May, we reported that the estimated reduction in wastewater flows by 2020 was about 25 percent, according to the preliminary results of an EPA-sponsored study. (See *Water Infrastructure: Impact of National Water Efficiency Standards*, GAO/RCED-00-161R, May 1, 2000.) At that time, to compute the percent reduction in wastewater flows, we used data on total U.S. flows at publicly owned treatment works from EPA's *1996 Clean Water Needs Survey Report to the Congress,* table C-3, the most recent data available. Since then, EPA has provided a better approximation of future wastewater flows, and the agency's estimate of the projected reduction in wastewater flows has been revised with more conservative assumptions. In addition, the availability of yearly projections of the reductions in wastewater flows from the agency's contractor allowed us to use data for 2016, consistent with the time period for EPA's estimate of wastewater flows to publicly owned treatment works.

validity of results. Most significantly, EPA's study attributes all savings from water-efficient plumbing fixtures to the national standards and does not attempt to estimate the reduction in wastewater flows that would have occurred in the absence of the standards. Consequently, the estimated savings are likely overstated.

Furthermore, according to the agency's contractor, few historical data are available to validate the model's projections, but the model uses relatively conservative assumptions that are periodically cross-referenced against data from industry and other sources. At the time of our review, the extent of the risk analysis, which is done to determine how sensitive the long-term projections are to plausible variations in the values assigned to key variables, was limited to replacement rates for the plumbing fixtures. For example, the contractor computed a *low estimate* of long-term water savings using a 2-percent replacement rate for residential toilets and a *high estimate* using a 7-percent replacement rate.

Repealing the National Water Efficiency Standards Will Affect the Timing and Cost of Infrastructure Investments

By reducing water consumption and wastewater flows, the use of water-efficient plumbing fixtures may allow local communities to save money by deferring or even avoiding investments in water or wastewater infrastructure. Case studies of specific localities suggest that the nationwide savings in infrastructure investments could potentially be in the billions of dollars. Repealing the national standards could force local communities to expand the capacity of their drinking water or wastewater treatment facilities sooner than they would otherwise, presenting problems for those already hard-pressed to handle the cost of upgrading or replacing existing facilities. Determining the precise impact of repeal is problematic because, as noted above, the installation of water-efficient plumbing fixtures—and the associated water savings—will continue to some extent in the absence of national standards. Although many communities are concerned about the scarcity of water resources, they would probably pursue other alternatives before considering moratoria on new construction, according to the states and localities we contacted.

National Studies Show Potential Savings as a Result of Deferring or Avoiding Some Infrastructure Investments

Preliminary results from the ongoing study sponsored by the American Water Works Association indicate that the ability to avoid or defer planned investments in drinking water infrastructure as a result of reduced water consumption could save local communities millions of dollars. For the 16 utilities included in the study so far, the total savings associated with deferred or avoided infrastructure are estimated to range from $165.7 million to $231.2 million by 2020, depending on whether the projected savings are discounted at 3 or 7 percent, respectively. The projected savings amount to approximately 3.6 percent of the total project costs without the national water efficiency standards in place.[15]

The savings estimated for individual localities vary widely on the basis of their size, the projected water demand, and the timing and cost of planned investments in expanded treatment or storage capacity over the next 20 years. (See app. V for a table that shows projected infrastructure investments with and without the national water efficiency standards and the present value of the estimated savings, by location.)

While the estimated savings associated with a community’s ability to defer or avoid investments appear to be substantial, the American Water Works Association’s contractor acknowledged that the estimates are only as accurate as the predictions that individual utilities are able to make about future investment decisions. He told us that some utilities simply have not prepared detailed demand forecasts or projected their long-term infrastructure needs. He believes that other utilities may have provided information on their total infrastructure needs—including the investments needed to comply with Safe Drinking Water Act requirements or to replace or upgrade existing facilities—and did not isolate the investments related to expanded capacity. In addition, to the extent that the analysis does not account for the fact that some use of water-efficient fixtures would continue in the absence of the national standards, the estimated savings are likely overstated.

As part of its ongoing study of the impact of the national water efficiency standards on wastewater flows, EPA intended to develop a national estimate of how reduced wastewater flows might affect planned investments in wastewater treatment infrastructure, using its database on projected wastewater treatment needs. However, the database does not

[15] Project costs include the cost of capital investments, energy, and treatment chemicals.

adequately distinguish between planned investments in expanded capacity and those for replacing or upgrading existing capacity. In addition, the database does not provide enough detail on the cost of individual treatment processes or the timing of planned infrastructure investments. Finally, the wide variation in the size and configuration of local wastewater treatment facilities makes developing a national estimate problematic.

As an alternative to developing a national estimate, EPA's contractor is using a case study approach and collecting information on the impacts of reduced wastewater flows on planned infrastructure investments in specific localities. Several cases have been developed to date, but it is difficult to isolate the impacts of using water-efficient plumbing fixtures from other conservation measures adopted by the localities, as shown in the following examples:

- The average dry weather flows at New York City's 14 wastewater treatment plants have dropped about 17 percent from fiscal year 1994 to fiscal 1999, and plans to expand the capacity of at least 4 of the plants have been halted. The cost of expanding one plant alone was estimated to be as high as $1.2 billion. However, aggressive conservation efforts—including an accelerated toilet replacement program, leak detection and repair, large-user audits, and other measures—made this and other investments unnecessary.

- After a 1995 study projected that existing wastewater treatment capacity would be exceeded by 2001, a regional wastewater treatment authority in Washington State used several approaches to reduce wastewater flows, including the reduction of infiltration and inflow,[16] rebates for low-flow toilets and clothes washers, toilet leak reduction, public education, and submetering.[17] The authority estimates that it will save about $12 million to $14 million for every 1 million gallons per day of capacity expansion it can avoid.

[16]Infiltration occurs when water gets into the system as a result of groundwater that seeps into damaged sewer lines. Inflow is water that enters the system through stormwater drains.

[17]Submetering is metering for units that are a part of a larger service connection, such as apartments in a multifamily building.

Repealing the National Standards May Increase Financial Burden on Local Communities

According to EPA's infrastructure needs surveys for drinking water and wastewater treatment, local communities are faced with potentially huge investments to expand or upgrade their facilities.[18] In 1997, EPA reported to the Congress that the total projected needs for all categories of activities eligible for funding under the clean water state revolving fund were $139.5 billion over the next 20 years, including $44.0 billion just for secondary and advanced wastewater treatment.[19] Similarly, EPA reported in 1997 that the nation's 55,000 community drinking water systems must invest a minimum of $138.4 billion over the next 20 years to install, upgrade, or replace infrastructure.[20] About $48 billion of the estimated needs is for drinking water treatment and storage facilities.

More recently, the Water Infrastructure Network, an affiliation of various utility, government, and public works associations, sponsored its own study of water and wastewater infrastructure needs.[21] The final report concluded that the total needs—including capital investments, the cost of financing, and annual facility operation and maintenance costs—will approach $2 trillion over the next 20 years. The report also states that in terms of capital investments, the gap between what local communities are currently spending and the amount needed to build, replace, and rehabilitate new and existing water and wastewater systems is an estimated $23 billion per year, of which $11 billion is needed for drinking water systems and $12 billion is needed for wastewater systems.

To the extent that using water-efficient plumbing fixtures allows communities to defer or even avoid investments in drinking water and wastewater treatment infrastructure, repealing the national standards

[18]Officials from EPA's Office of Ground Water and Drinking Water and Office of Wastewater Management told us that with the exception of the needs reported by a few larger utilities, the needs estimates do not factor in the impact of using water-efficient plumbing fixtures on projected capacity needs. The Office of Wastewater Management is revising its reporting instructions for its next needs survey so that the estimates submitted by local wastewater utilities will consider the impact of the standards in the future. Similarly, according to one official, the Office of Ground Water and Drinking Water will consider revising its reporting instructions for future surveys.

[19]See *1996 Clean Water Needs Survey Report to Congress*, U.S. Environmental Protection Agency (1997).

[20]See *Drinking Water Infrastructure Needs Survey: First Report to Congress*, U.S. Environmental Protection Agency (Jan. 1997).

[21]See *Clean & Safe Water for the 21st Century*, Water Infrastructure Network (2000).

could force local communities to make these investments sooner than anticipated. It is difficult to predict the precise impact that such a repeal would have on local communities because some conservation efforts will continue, regardless.

During our interviews with officials from states and localities whose water efficiency standards preceded the national requirements, we asked about their ability to finance the additional infrastructure that might be needed if the national standards were repealed. Several of these officials told us that obtaining the funds to finance the costs for additional drinking water and wastewater treatment infrastructure is difficult, primarily because the burden usually falls on individual consumers. While the states have revolving loan funds for financing drinking water and wastewater treatment infrastructure, this money goes only so far. For example, Massachusetts received about $660 million in loan applications from local communities last year to finance improvements in drinking water facilities, of which, the state was able to fund only $127 million—about 19 percent of the total requested.

If financing is not available from the revolving loan funds or other federal sources,[22] local communities must rely on other methods for funding infrastructure, including issuing bonds and/or increasing taxes. According to several of the officials we interviewed, obtaining approval for these funding methods is difficult because of public resistance to higher fees or taxes.

Without National Standards, Communities Would Consider Other Alternatives Before Imposing Constraints on New Construction

We conducted semistructured interviews with officials from the 16 states and 4 of the 6 localities that had adopted their own water efficiency standards about the likelihood that local communities would impose building moratoria or other constraints on new construction if the national standards were repealed. According to several of the officials we contacted, building moratoria are rarely imposed. Only 7 of the 16 states indicated that moratoria have been used as a result of water shortages, usually by only 1 or 2 communities within the state.

[22]Other sources of federal financial assistance for water and wastewater infrastructure include the U.S. Department of Agriculture's Water and Waste Disposal program and the Department of Housing and Urban Development's Community Development Block Grant program.

Officials from the four localities we contacted indicated that they would be extremely reluctant to impose moratoria on new construction and that such measures would be used only as a last resort. For example, local water officials in Tampa and Hillsborough County, Florida, told us that they have never imposed a moratorium on new construction because doing so would be devastating to the region's economic growth. An official from the Southwest Florida Water Management District, the regulatory agency responsible for managing the water resources in a 16-county area, including Tampa and Hillsborough County, said that constraints on new construction are politically infeasible.

State officials told us that localities are using or considering other methods to deal with current or anticipated water shortages—methods that increase water conservation or develop new sources of supply. Officials from Georgia, Oregon, and Utah said that local communities within their state have modified or would consider modifying their water rates to encourage water conservation. In these instances, instead of offering volume discounts, the local water system changes its rate structure so that the rates increase as water use increases. Officials from Dade and Hillsborough Counties in Florida; Tampa, Florida; and Denver, Colorado, told us that they have adopted this inverted rate structure.

Some localities are taking steps to supplement their water supply. One alternative is the use of "reclaimed water," which is wastewater that is treated and reused as a nonpotable water source. Hillsborough County is already using reclaimed water for lawn watering, and Tampa is planning to implement a reclaimed water project in 2001. Desalination of seawater is another option. Tampa Bay Water, which supplies water to public utilities in Hillsborough County and the city of Tampa as well as other abutting counties, is building a desalination plant, which will provide 25 million gallons of water per day by the end of 2002.

Agency Comments

We provided EPA with a draft of this report for review and comment. Officials within EPA's Office of Water, including the Acting Chief of the Protection Branch from the Office of Ground Water and Drinking Water and the Director of the Office of Wastewater Management, generally agreed with the facts presented in the report. However, the Office of Wastewater Management provided a revised estimate of total wastewater flows to publicly owned treatment plants in 2016 and a new determination of the projected reduction in wastewater flows that would be attributable to the population served by such facilities. We incorporated this change into our report. In addition, EPA officials suggested a number of technical corrections and clarifications, which we incorporated as appropriate.

The scope and methodology we used for our work are discussed in appendix VI. We performed our work from January through August 2000 in accordance with generally accepted government auditing standards.

As arranged with your offices, unless you announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will make copies available to interested congressional committees; the Honorable Carol M. Browner, Administrator, Environmental Protection Agency; and the Honorable Jacob J. Lew, Director, Office of Management and Budget. We will make copies available to others on request.

If you have any questions regarding this report, please contact me at (202) 512-6111. Key contributors to this assignment were Willie Bailey, Charles Bausell, Ellen Crocker, Richard Frankel, Ingrid Jaeger, and Robert Sayers.

Peter F. Guerrero
Director, Environmental
Protection Issue

Evolution of Required Performance Tests for Low-Flow Toilets

Despite technological improvements, performance among low-flow toilets can still vary widely in terms of the amount of water used and flushing capability, according to a number of sources. Some of the officials we interviewed, including plumbing contractors and water industry representatives, believe that the performance tests required under the industry standards for low-flow toilets are too easy to pass and, as a result, some poorly performing models reach the market. One concern about current testing procedures is that they do not include an effective performance test that addresses the extent to which a toilet is subject to clogging—a problem that can contribute to higher-than-expected water use. The customer satisfaction surveys we reviewed also indicated that in key aspects of performance, such as clogging and the need for double flushing, the effectiveness of low-flow toilets can vary significantly, depending on the model.[1] Officials from the Plumbing Manufacturers Institute agree that industry standards are an important factor in ensuring that the performance of low-flow toilets is consistently good across the industry. However, they also point to improper installation as a major reason why low-flow toilets may exceed 1.6 gallons per flush or otherwise perform poorly in the field.

Over the past 10 years, manufacturers have been working to strengthen the testing requirements for low-flow toilets, but industry representatives acknowledge that it has taken a long time to reach agreement on new tests that would address the toilets' flushing capability. When the industry standards for low-flow toilets were updated in 1990, an existing test for clogging was eliminated, according to an official with the American Society of Mechanical Engineers. Although such a test was considered and rejected when the standards were updated in 1995, the standards are currently undergoing another revision, and the Society's project team has reached agreement with manufacturers to add a test for clogging.[2] The proposed revision must be approved by the Society to become an American National Standard; a vote is expected in August 2000. Table 4 shows how the testing requirements have changed over the past 10 years.

[1]We reviewed several surveys of participants in accelerated toilet replacement programs; generally, the participants were asked to rate the performance of their low-flow toilet in specific areas and compare it with the higher-volume toilet it replaced.

[2]Under this test, known as a *mixed media* test, a combination of sponges and paper balls must be discharged from the toilet bowl in a prescribed number of flushes.

Table 4: Evolution of Industry Testing Requirements for Low-Flow Toilets

Test name	Test description	1990 edition	1995 edition	Pending revision, 2000[a]
Water consumption per flush	To determine average water consumption: average consumption shall not exceed 1.6 gallons.	New	Same	Same
Maximum water consumption per flush	To determine maximum water consumption after adjusting trim components for maximum water use: average water consumption shall not exceed 2.4 gallons.	N/A	N/A	New
Ball test	To determine solids removal: 100 polypropylene balls are placed in toilet bowl; 75 must be removed in initial flush.	Same	Same	Deleted; combined with granule test
Granule test	To determine solids removal: 2,500 polyethylene disc-shaped pellets are placed in toilet bowl; not more than 125 may remain after initial flush.	Same	Same	Adds 100 nylon balls; not more than 3 are allowed to remain after initial flush
Ink line test	To determine rim washing: a water soluble ink is marked on a bowl's surface; after initial flush, no line segment can exceed ½ inch, and aggregate of all segments may not exceed 2 inches.	Same	Same	A second line is added 2 inches below rim jets; this line is completely washed away
Dye test	To determine water exchange: a dye is added to bowl; 100 percent dilution must occur after initial flush.	Same	Same	Deleted
Trap seal test	To determine if trap seal works properly: fixture must return to full trap seal after each flush.	Same	Same	Same
Mixed media test	To determine solids removal: 12 sponges and 10 paper balls are used; not more than 4 sponges or balls may remain after initial flush.	N/A	N/A	New
Drain line carry test	To determine length of transport of solid wastes: fixture must carry waste a minimum of 40 feet in the drain line.	New	Same	Same
Overflow test	To determine leakage of gravity tank-type toilets: tank fill valve is opened to maximum flow for 5 minutes; fixture shall not leak.	N/A	N/A	New
Water rise test	To determine wetting of person sitting on seat during flush: a vertically positioned rod is placed 3 inches under the bowl rim; during flush, water should not touch rod.	New	Same	Deleted
Rim top and seat fouling test	To determine soiling of rim top and seat: a plate is placed over toilet bowl; no water shall splash on plate during flushing.	N/A	New	Deleted

Legend

N/A = not applicable

[a]The pending changes to the performance tests for low-flow toilets are being proposed by the American Society of Mechanical Engineers (ASME). The changes will be up for approval as a national standard at the August 2000 meeting of the Society.

Sources: *Hydraulic Performance Requirements for Water Closets and Urinals*, The American Society of Mechanical Engineers, An American National Standard. ASME A112.19.6. (1990, 1995) and *Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals*, The American Society of Mechanical Engineers, ASME A112.19.2 –2000 (May 2000 draft).

Preexisting State and Local Standards for Water-Efficient Plumbing Fixtures and Their Status If National Standards Were Repealed

Sixteen states and 6 localities had water efficiency standards for at least two of the plumbing fixtures regulated under the Energy Policy Act before the national standards took effect in 1994. Table 5 compares the standards adopted by each jurisdiction with the national standards.

Table 5: State and Local Standards for Water-Efficient Plumbing Fixtures

		Water-efficiency standard				
State/locality	Effective date[a]	Ultra-low-flow toilets (gal. per flush)	Low-flow showerhead (gal. per minute)	Kitchen faucets (gal. per min.)	Lavatory faucets (gal. per min.)	Urinals (gal. per flush)
National standard	Jan. 1, 1994	1.6	2.50	2.5	2.5	1.0
States						
Arizona	Jan. 1, 1993	1.6	2.50	2.5	2.0	None
California	Jan. 1, 1992	1.6	2.50	2.5	None	1.0
Connecticut[b]	Jan. 1, 1990	1.6	2.50	2.5	2.5	1.0
Delaware	Apr. 1, 1992	1.6	2.50	2.5	2.0	1.0
Georgia	Apr. 1, 1992	1.6	2.50	2.5	2.0	1.0
Maryland	Apr. 1, 1992	1.6	2.50	2.5	2.0	1.0
Massachusetts	Mar. 2, 1989	1.6	3.00	None	None	1.0
Nevada	Mar. 1, 1993	1.6	2.50	2.5	2.5	1.0
New Jersey[b]	July 1, 1991	1.6	3.00	3.0	3.0	1.5
New York[b]	Jan. 1, 1992	1.6	3.00	None	2.0	1.0
North Carolina[b]	Jan. 1, 1993	1.6	3.00	3.0	3.0	1.5
Oregon	July 1, 1993	1.6	2.50	2.5	2.5	1.0
Rhode Island[b]	Mar. 1, 1991	1.6	2.50	2.0	2.0	1.0
Texas	Jan. 1, 1992	1.6	2.75	2.2	2.2	1.0
Utah	July 1, 1992	1.6	2.50	None	None	None
Washington	July 1, 1993	1.6	2.50	2.5	2.5	1.0
Localities						
Dade County, Fla.	Jan. 1, 1992	1.6	2.50	2.5	2.0	1.0
Denver, Colo.	Mar. 1, 1992	1.6	2.50	2.2	2.2	1.0
District of Columbia	Jan. 1, 1992	1.6	2.50	2.5	2.0	1.0
Hillsborough County, Fla.	Mar. 26, 1992	1.6	2.50	2.2	2.2	1.0
Palm Beach, Fla.[b]	Apr. 1, 1991	1.6	3.00	None	None	1.5
Tampa, Fla.[b]	June 1, 1990	2.0	2.50	2.0	2.0	1.0

[a]The effective date for the national standards applies to all models of the fixtures, with limited exceptions, manufactured after January 1, 1994. For the state and local standards, the effective date applies to the standards for ultra-low-flow toilets. Four states had different effective dates on standards for other plumbing fixtures. For example, Massachusetts' effective date for toilets was March 2, 1989, and August 9, 1996, for showerheads.

[b]After the passage of the Energy Policy Act of 1992, state laws and/or local standards were revised to comply with national standards.

Sources: For each state, data were obtained from telephone interviews of state or local water officials. For all localities except the District of Columbia, data were obtained from local water officials. Data for the District of Columbia were obtained from Ranton, Judith L., *Water Efficient Plumbing Fixture Legislation*, *A Poll of States With Legislation Adopted*, City of Portland, Oreg., Bureau of Water Works (May 1992).

When the Energy Policy Act of 1992 established the national standards, it also preempted state and local authorities from setting differing standards. We conducted semistructured interviews with officials from the 16 states and 4 of the 6 localities with preexisting standards to obtain their views on the likely status of their standards if the national standards were repealed. All of the state officials we contacted believe that their standards would automatically revive. At the local level, officials from two localities told us that their local plumbing codes had been modified to incorporate the national standards. If the national standards were repealed, local officials told us that they would have to take some affirmative action to reinstate water efficiency standards at the local level. The other two localities never amended their local plumbing codes and thus, officials believe that their standards would revive upon repeal of the national standards.

Both state and local officials told us that if the national standards were repealed, enforcement of their standards would become a major problem, particularly for localities. According to several of these officials, although the national standards regulate the manufacture of water-efficient plumbing fixtures and, in effect, make higher-volume products unavailable to consumers, state and local standards typically apply only to the installation of efficient fixtures. Thus, reinstating state and local standards would not affect the manufacture of higher-volume fixtures or prevent the sale of such products in neighboring jurisdictions.

Summary of Accelerated Toilet Replacement Programs in Six Localities

Location	Period covered by program statistics	Number of toilets distributed free or through rebate program	Estimated water savings per toilet (gal. per day)	Total estimated water savings (gal. per day)	Cost of toilet program
Austin, Tex.	1992-Sept. 1999	48,222	29.3	1,400,000	$2.0 million
Los Angeles, Calif.	1990-Feb. 2000	905,923	31.7	28,700,000	107 million[a]
New York, N.Y.	1994-Apr. 1996	1,300,000	53.8[b]	70,000,000	290 million
Phoenix, Ariz.	1994-Mar. 2000	1,226	25.6	78,464	96,000
Tampa, Fla.	1993-Sept. 1999	15,263	29.1	440,400	1.7 million[c]
Hillsborough County, Fla.	1994-Sept. 1999	60,305	23.4	1,400,000	8.8 million
Total		**2,330,939**		**102,018,864**	

[a]Costs include other conservation efforts, such as showerhead and clothes-washer rebates, but the primary costs are for toilets.

[b]A New York City official attributed the higher savings per toilet in that city to the replacement of older, higher-volume toilets (5- to 7-gallons-per-flush toilets installed prior to 1950) in high-density neighborhoods.

[c]In May, we reported that the cost of the Tampa program was $1.2 million dollars. Since then, a program official provided us with revised cost data. (See GAO/RCED-00-161R, May 1, 2000.)

Projected Reduction in Water Consumption by 2010 and 2020, by Location

Projected water use and savings in millions of gallons per day

			Average daily water use		Projected daily water savings	
Location	Population	Year	Without water efficiency standards	With water efficiency standards	Amount	Percentage
Austin, Tex., City of Austin Water & Wastewater Utility	650,000	2010	167.5	160.8	6.7	4.0
		2020	230.9	215.2	15.7	6.8
Boston, Mass., Boston Water & Sewer Commission	650,000	2010	84.2	81.0	3.2	3.8
		2020	85.1	79.4	5.7	6.7
Cary N.C., Town of Cary	84,779	2010	16.1	15.1	1.0	6.2
		2020	23.1	21.0	2.1	9.1
Clarksburg, W. Va., Clarksburg Water Board	19,000	2010	2.9	2.8	0.1	3.4
		2020	3.6	3.4	0.2	5.5
Fort Worth, Tex., Fort Worth Water Department	753,116	2010	170.0	166.6	3.4	2.0
		2020	178.8	172.9	5.9	3.3
Laurel, Md., Washington Suburban Sanitary Commission	1,700,000	2010	206.3	199.7	6.6	3.2
		2020	224.1	212.0	12.1	5.4
Los Angeles, Calif., Los Angeles Department of Water & Power	3,800,000	2010	560.6	542.1	18.5	3.3
		2020	560.3	527.8	32.5	5.8
Michigan City, Ind., Michigan City Department of Water	41,000	2010	12.1	11.7	0.4	3.3
		2020	12.7	12.0	0.7	5.5
Oceanside, Calif., City of Oceanside Water	157,869	2010	37.5	36.6	0.9	2.4
		2020	46.2	44.4	1.8	3.9
Phoenix, Ariz., Phoenix Water Services	1,252,425	2010	341.4	331.5	9.9	2.9
		2020	393.6	375.1	18.5	4.7
Pinellas County, Fla., Pinellas County Utilities	643,191	2010	84.4	80.6	3.8	4.5

(Continued From Previous Page)

Projected water use and savings in millions of gallons per day

			Average daily water use		Projected daily water savings	
Location	**Population**	**Year**	**Without water efficiency standards**	**With water efficiency standards**	**Amount**	**Percentage**
		2020	89.9	82.8	7.1	7.9
Rockford, Ill., City of Rockford Water Division	150,000	2010	46.7	44.6	2.1	4.5
		2020	62.5	58.5	4.0	6.4
Syracuse, N.Y., City of Syracuse Department of Water	235,000	2010	40.7	39.6	1.1	2.7
		2020	38.8	36.9	1.9	4.9
Tacoma, Wash., Tacoma Water	306,000	2010	80.8	78.7	2.1	2.6
		2020	92.1	88.6	3.5	3.8
Tampa, Fla., City of Tampa Water Department	450,000	2010	77.4	75.0	2.4	3.1
		2020	81.5	77.1	4.4	5.4
Wausau, Wis., Wausau Water Works	45,000	2010	6.3	6.1	0.2	3.2
		2020	5.4	5.1	0.3	5.6
Total	**10,937,380**	**2010**	**1,934.9**	**1,872.5**	**62.4**	**3.2**
		2020	**2,128.5**	**2,012.1**	**116.4**	**5.5**

Note: Population data are as of 1999.

Source: Analysis conducted by Maddaus Water Management for the American Water Works Association. Using data provided by Maddaus Water Management, we calculated the average daily water use with and without the water efficiency standards.

Projected Investments in Drinking Water Infrastructure by the Year 2020, by Location

Dollars in millions

Location	Investment projected through 2020, discounted at 3 percent: Without water efficiency standards	With water efficiency standards	Amount of savings	Percent savings
Austin, Tex., City of Austin Water & Wastewater Utility	$363.5	$347.8	$15.7	4.3
Boston, Mass., Boston Water & Sewer Commission	820.7	788.6	32.1	3.9
Cary N.C., Town of Cary	108.9	103.0	5.9	5.4
Clarksburg, W. Va., Clarksburg Water Board	8.5	8.3	0.2	2.4
Fort Worth, Tex., Fort Worth Water Department	1,008.7	986.4	22.3	2.2
Laurel, Md; Washington Suburban Sanitary Commission	360.3	339.3	21.0	5.8
Los Angeles, Calif., Los Angeles Department of Water & Power	1,722.8	1,663.6	59.2	3.4
Michigan City, Ind., Michigan City Department of Water	12.7	12.4	0.3	2.4
Oceanside, Calif., City of Oceanside Water	189.3	184.2	5.1	2.7
Phoenix, Ariz., Phoenix Water Services	441.4	428.1	13.3	3.0
Pinellas County, Fla., Pinellas County Utilities	491.1	465.9	25.2	5.1
Rockford, Ill., City of Rockford Water Division	72.0	68.8	3.2	4.4
Syracuse, N.Y., City of Syracuse Department of Water	231.2	224.8	6.4	2.8
Tacoma, Wash., Tacoma Water	302.3	300.3	2.0	0.7
Tampa, Fla., City of Tampa Water Department	209.5	190.8	18.7	8.9
Wausau, Wis., Wausau Water Works	8.1	7.7	0.4	4.9
Total	**$6,351.0**	**$6,120.0**	**$231.0**[a]	**3.6**

[a]Using a 7-percent discount rate, the savings would be $165.7 million.

Source: Analysis conducted by Maddaus Water Management for the American Water Works Association.

Scope and Methodology

In conducting our review, we collected information from a wide variety of sources, including the Environmental Protection Agency's (EPA) Office of Ground Water and Drinking Water and Office of Wastewater Management, the Department of Energy's Office of Energy Efficiency and Renewable Energy, the American Society of Mechanical Engineers, the American National Standards Institute, the American Water Works Association, the Association of Metropolitan Sewerage Agencies, the California Urban Water Conservation Council, plumbing manufacturers and contractors, and selected states and localities. We contacted 16 states and 5 of the 6 localities that adopted standards for water-efficient plumbing fixtures before the national standards took effect,[1] to wit: Arizona; California; Connecticut; Delaware; Georgia; Maryland; Massachusetts; Nevada; New Jersey; New York; North Carolina; Oregon; Rhode Island; Texas; Utah; Washington; Dade County, Florida; Denver, Colorado; Hillsborough County, Florida; Palm Beach, Florida; and Tampa, Florida. In addition, we visited six localities (Austin, Tex.; Los Angeles, Calif.; New York, N.Y.; Phoenix, Ariz.; Tampa, Fla.; and Hillsborough County, Fla.) to collect more detailed information on accelerated toilet replacement programs. The criteria used to select these locations included (1) their use of water efficiency standards, which preceded the national standards; (2) their use of rebate and/or retrofit programs to accelerate the installation of low-flow toilets and other water-efficient fixtures; and (3) an assessment of the programs' impact on water consumption.

We also obtained and analyzed relevant documents and reports, including the applicable regulations; performance standards for low-flow toilets; and a variety of studies on the impact of water-efficient plumbing fixtures. For a complete list of the studies we reviewed, see the Bibliography.

To obtain information on the estimated impact of the national water efficiency standards on water consumption levels and wastewater flows, we reviewed studies that examined the use and impact of water-efficient plumbing fixtures, including (1) studies that made precise measurements of water use in a limited number of households, (2) studies that estimated impacts for an entire locality, and (3) two major studies of the impacts on water consumption and wastewater flows being sponsored by the American Water Works Association and EPA, respectively. To the extent

[1]In one case (Palm Beach, Florida), our contact was limited to verifying local standards for water-efficient plumbing fixtures; we did not conduct a semistructured interview to discuss other issues.

possible, we reviewed the reasonableness of the methodology and assumptions used in the studies. We also collected information on how well the low-flow fixtures work and how they are used in practice by reviewing customer satisfaction surveys administered to participants in accelerated replacement programs and interviewing plumbing manufacturers and contractors and representatives of the American Society of Mechanical Engineers and the American National Standards Institute. To obtain information on the extent to which water-efficient fixtures might be used in the absence of the national standards, we conducted semistructured interviews with and collected documentation from the 16 states and 4 of the 6 localities that adopted their own standards before the national ones took effect. In addition, we collected data on accelerated toilet replacement programs and interviewed plumbing contractors involved in performance-based contracting.

For information on the potential impact of repealing the national standards, we reviewed studies that examined the timing and cost of local infrastructure investments with and without the standards in place. We relied primarily on data and case studies developed for ongoing studies being sponsored by the American Water Works Association and EPA. To the extent feasible, we reviewed the reasonableness of the methodology and assumptions used in the studies we examined. In looking at local communities' ability to finance additional investments in infrastructure, we extracted information from EPA's needs surveys for drinking water and wastewater treatment infrastructure and a more recent needs estimate by the Water Infrastructure Network—a coalition of various utility, government, and public works associations. We also addressed this issue—and the likelihood of constraints on new construction if the national standards were repealed—during our interviews with officials from states and localities with preexisting standards for water-efficient plumbing fixtures.

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