2009 WaterSense® Single-Family New Home Specification Supporting Statement

I. Introduction

The WaterSense® Program has developed criteria for water-efficient new homes. The intent of the *WaterSense Single-Family New Home Specification* (Specification) is to reduce indoor and outdoor water usage in new homes and encourage community infrastructure savings. The Specification is applicable to newly constructed single-family homes and townhomes, three stories or less in size.

II. Current Status of Water Use in Residential New Homes

The environmental impact of the residential sector is significant. There are 80.4 million single-family detached homes in the United States. There were 5.07 million new construction single-family homes built from 2003 through 2006, averaging 1.27 million new homes built per year.[1] Typically, for all homes, 70 percent of household water is used indoors and 30 percent is used outdoors; however, these percentages can easily flip during summer months in arid climates. Outdoor water use, especially for irrigation, can strongly affect a municipality's peak water use, upon which the sizing of water supply facilities is based. Table 1 presents the average indoor water consumption data for an existing American home.[2]

Table 1. Typical Indoor Household Water Use

Type of Use	Daily Use (gallons/person)	Approximate % of Total Indoor Use
Toilets	18.5	26.7
Clothes Washers	15.0	21.7
Showers	11.6	16.8
Faucets	10.9	15.7
Leaks	9.5	13.7
Other	1.6	2.2
Baths	1.2	1.7
Dishwashers	1.0	1.4
Total	**69.3**	**100.0**

Water use inside the home has been addressed nationally through two mechanisms. The Energy Policy Act of 1992 (EPAct) established the maximum flush volume of toilets typically installed in residential settings at 1.6 gallons per flush (gpf), and the maximum flow rate for bathroom sink faucets, kitchen faucets, and showerheads at 2.5 gallons per minute (gpm) at 80 pounds per square inch (psi) static pressure. In 1998, the U.S. Department of Energy adopted a maximum flow rate standard of 2.2 gpm at 60 psi for all faucets.[3]

1 U.S. Census. 2007 American Housing Survey, Table 1A-1. www.census.gov/prod/2008pubs/h150-07.pdf
2 AWWA Research Foundation, 1998. Residential End Uses of Water.
3 63 *Federal Register* 13307; March 18, 1998.

The water consumption of appliances found in homes is not currently specified in national standards, but Congress approved future water use standards for dishwashers and clothes washers in the Energy Independence and Security Act of 2007 that would take effect in 2010 for dishwashers and 2011 for clothes washers. The water use of clothes washers is also addressed in the ENERGY STAR® program.

Due in part to their environmental impact, many of today's homebuilders are building more efficient homes under voluntary local, regional, and national green building programs. In fact, green building has increased its market share despite the down market economy. By 2013, the residential green building market is expected to be 12 to 20 percent of new, single-family housing. Approximately 36 percent of builders were expected to be heavily involved in green building by 2009, with 21 percent of those builders committing to building 90 percent of their projects green. Forty percent of builders indicated that green homes are easier to market in a down economy. Research indicates that quality is the top driver behind green home building, indicating that many green home buyers are buying a green home for investment and performance reasons. [4]

Every year, builders are adopting more green principles in their construction of new homes. As this trend continues and green homes become more mainstream, the way we define a green home will also evolve. Although there is much debate within the industry as to what constitutes a green home, the industry has begun to agree that green homes contain a number of common elements such as energy efficiency, improved indoor air quality, water conservation, resource efficiency, and high-performance construction processes.[5] Reports indicate that energy efficiency is the top practice in green home building.[6] The use of water-efficient products and practices, however, is often overlooked in the construction of green homes and is not considered a priority in many of the existing green building programs being used today.

Recent studies indicate that it is feasible to build a home that uses 20 percent less water than other new homes. Specifically, Environments for Living's summary report "Water Efficiency and Performance in Diamond Class Test Homes" [7] states that "the technologies and equipment to achieve overall water savings between 20 and 30 percent and maintain or improve overall performance in new homes are readily available."

WaterSense is working to actively promote the transformation of the mainstream home building industry towards increased water efficiency. While there are already a number of green home building programs, the Specification provides national consistency in defining the features of a water-efficient new home and enables builders anywhere in the country to obtain a WaterSense label on their homes. The *WaterSense Single-Family New Home Specification* can be integrated into existing green home building programs to reach a large number of homebuilders and facilitate its adoption as a national specification. To maximize water efficiency, WaterSense has set both indoor and outdoor water use criteria and requires homeowner education to help improve water-efficient behaviors.

[4] McGraw-Hill Construction. 2008. *The Green Home Builder Navigating for Success in a Down Economy SmartMarket Report*.
[5] McGraw-Hill Construction. 2006. *Residential Green Building SmartMarket Report*.
[6] Ibid.
[7] Released in September 2005

III. 2009 WaterSense Single-Family New Home Specification

Scope
The WaterSense Program developed this specification to address criteria for improvement and recognition of water-efficient new homes. The Specification focuses specifically on new homes to address water efficiency during the planning and design stages of home construction, where significant impacts can be achieved using readily available technologies. Due to differences in the design and construction of multi-dwelling units, this specification focuses on single-family detached homes and town homes, three stories or less above grade.

The Specification addresses both indoor and outdoor water use, because water savings achieved through indoor improvements can easily be negated through inefficient outdoor water use. With respect to indoor water use, the Specification addresses leaks, plumbing fixtures, hot water distribution systems, water-using appliances, and other water-using equipment. The Specification addresses the static service pressure in the home to minimize unintentional water waste occurring from high water pressure within the home. Water-efficiency criteria are not set for kitchen and utility faucets, since the different uses (e.g., pot filling) and user expectations (e.g., fill the pot quickly) may not be adequately addressed with low-flow faucets. Water-efficiency criteria are set for shower compartments and will be included for showerheads once WaterSense finalizes its specification for showerheads in 2010. Outdoor water use is addressed through landscape and irrigation system design criteria. The Specification also addresses homeowner education to inform the homeowner of the water-efficient components of the home and yard, as well as to encourage water-efficient behaviors.

The Specification provides the minimum water-efficiency criteria necessary to be considered a WaterSense labeled home. Homes must meet all of the criteria to be considered for the WaterSense label. Additional water conservation measures (e.g., rainwater harvesting, gray water recycling) can be included in the home, provided they do not adversely impact the criteria included in the Specification. The Specification is not intended to contravene local codes and ordinances.

WaterSense requires third-party certification of homes for which builders are seeking to earn the WaterSense label. EPA has developed a new home certification system that requires homes to be inspected by trained inspectors and certified by EPA licensed certification providers. When installed, irrigation systems must be audited by a WaterSense irrigation partner.

EPA will review this specification every three years and revise it as new products such as showerheads and smart irrigation technologies are labeled under the WaterSense program. Revisions may also occur when additional water-efficient building practices become available and cost-effective to homebuilders. Revisions to this specification will not be retroactive and would be made following discussions with builder partners and other interested stakeholders. EPA will provide adequate lead time for builders to implement any changes to the Specification.

Water-Efficiency Criteria
There are three major types of water-efficiency criteria included in this specification: indoor, outdoor, and homeowner education. Each of these is described in detail below.

Indoor Water-Efficiency Criteria

- *Leaks* – The Specification requires that there be no leaks from any water-using fixtures, appliances or equipment. Compliance with this measure shall be verified through pressure-loss testing and visual inspection. Properly installed and maintained water-using fixtures, equipment, and appliances should not leak. American homes can waste 11,000 gallons of water a year due to running toilets, dripping faucets, and other household leaks.

- *Service Pressure* – The Specification establishes a maximum static service pressure of 60 pounds per square inch (psi). Compliance with this measure shall be achieved for homes with publicly supplied water by use of a pressure-regulating valve downstream of the point of connection or documentation from the public water supplier that service pressure will not regularly exceed 60 psi. Compliance for homes supplied by groundwater wells shall be achieved by use of a pressure tank. Piping for home fire sprinkler systems is excluded from this requirement.

  Because flow rate is related to pressure, the maximum water flow from a fixture operating on a fixed setting can be reduced if the water pressure is reduced. For example, a reduction in pressure from 100 psi to 50 psi at an outlet can result in water flow reduction of about one third. Water pressure reductions can also save water by reducing the likelihood of leaking water pipes, leaking water heaters, dripping faucets, and catastrophic events when pipes, hoses, or component parts in a water-using product burst. A study in Denver, Colorado, demonstrated an annual water savings of about 6 percent for homes that received water service at lower pressures when compared to homes that received water services at higher pressures. [8]

- *Hot Water Delivery Systems* – The Specification requires that the hot water distribution system store no more than 0.5 gallons of water in any piping/manifold between the hot water source and the hot water fixture. To account for the additional water that must be removed from the system before hot water can be delivered, this specification requires that no more than 0.6 gallons of water be collected from the hot water fixture before hot water is delivered. Due to their high energy consumption, timer- and temperature-based recirculating systems may not be used to meet the criteria.

  The intent of requiring water-efficient hot water delivery systems is to reduce water waste by using technologies that provide hot water at the tap with a minimal wait time. An average American household wastes more than 3,650 gallons of water each year while waiting for hot water to get to the fixture.[9] Furthermore, approximately 10 to 15 percent of energy use in hot water systems is wasted in distribution losses. Researchers have found that water waste can be reduced by 90 percent in new homes that are constructed with water-efficient hot water systems addressing plumbing design, pipe insulation, demand recirculation, and drain heat recovery.[10]

  Efficient hot water distribution systems are designed and built to have the smallest volume of water between the plumbing fixture and the source of hot water. They also

[8] U.S. EPA. *How to Conserve Water and Use it Effectively* available at www.epa.gov/nps/chap3.html.
[9] Klein, Gary. 2004. Plumbing Systems & Design. *Hot-Water Distribution Systems Part 1*. Mar/Apr.
[10] Private communication with Larry Acker (Metlund Systems) and Gary Klein (California Energy Commission).

typically provide hot water to the plumbing fixture with the shortest waiting period. There are three main types of hot water delivery systems that can be designed and installed to efficiently deliver hot water to fixtures–core systems, demand-initiated hot water recirculating systems, and whole house manifold systems.

- *Toilets* – The Specification requires that all toilets installed in the home be WaterSense labeled toilets. These toilets have a maximum effective flush volume of 1.28 gallons per flush (gpf) and must effectively clear 350 grams of waste. Information on these toilets is available at www.epa.gov/watersense/products.

- *Urinals* – The Specification requires that all urinals, if installed, be WaterSense labeled flushing urinals. These urinals have a maximum flush volume of 0.5 gpf. Information on these urinals is available at www.epa.gov/watersense/products.

- *Bathroom Faucets* – The Specification requires that all bathroom faucets installed in the home be WaterSense labeled bathroom faucets or faucet accessories (e.g., aerators). The WaterSense specification sets the maximum flow rate of faucets and aerators at 1.5 gallons per minute (gpm) tested at a flowing pressure of 60 psi. The Specification also includes a minimum flow rate of 0.8 gpm tested at a flowing pressure of 20 psi to ensure performance across a variety of different household conditions. Information on these faucets is available at www.epa.gov/watersense/products.

- *Showerheads* – The Specification does not establish a new maximum flow rate for individual showerheads; however, it does establish a total allowable flow rate from all showerheads flowing at any given time at 2.5 gpm per shower compartment. This requirement also applies to rain systems, waterfalls, bodysprays, and jets. The Specification defines a shower compartment as an area no larger than 2,160 square inches, which should be large enough to accommodate individuals in wheelchairs.

  Market research suggests that up to four percent of new homes are being constructed with multiple showerheads per shower compartment, due in part to the ease of installation of these shower systems and consumer demand for upgraded showers that allow for luxury shower experiences. These systems can use as much as 10 gpm of water.[11] Limiting showers designed for single individuals to one showerhead minimizes the amount of water used per shower.

- *Dishwashers* – The Specification requires that dishwashers offered, financed, installed, or sold as upgrades through the homebuilder shall be ENERGY STAR® qualified. ENERGY STAR qualified dishwashers use at least 41 percent less energy than the federal minimum standard for energy consumption and much less water than conventional models.

- *Clothes Washers* – The Specification requires that clothes washers offered, financed, installed, or sold as upgrades through the homebuilder shall be ENERGY STAR qualified and have a water factor (WF) of less than or equal to 6.0 gallons per cycle per cubic foot capacity. WF is the number of gallons used per cycle per cubic foot of clothes

[11] Biermayer, Peter. 2006. Potential Water and Energy Savings from Showerheads. Ernest Orlando, Lawrence Berkley National Laboratory. LBNL-58601-Revised.

washer capacity. The lower the WF, the more water-efficient the clothes washer. Most ENERGY STAR qualified clothes washers use 35 to 50 percent less water and 50 percent less energy per load.

- *Evaporative Cooling Systems* – The Specification requires that evaporative cooling systems installed by the homebuilder shall use 3.5 gallons (or less) of water per ton-hour of cooling when adjusted to maximum water use. Blow-down shall be based on time of operation, not to exceed 3 times in one 24-hour operating period.

  Although evaporative cooling systems use about one-fourth the electricity of a conventional air conditioner, they add about 19,000 gallons, on average, to a homeowner's annual water consumption.[12] Research indicates that some units appear to more efficiently evaporate water, thus producing more cooling per unit of water used.[13]

- *Water Softeners* – The Specification establishes that water softeners installed by the homebuilder shall be certified to meet the NSF/ANSI 44 Residential Cation Exchange Water Softeners, including the voluntary efficiency rating standards in Section 7 – *Mandatory testing for elective claims* for efficiency rated systems, which states that water softeners shall be demand-initiated regeneration systems, have a specified salt efficiency, and not generate more than 5 gallons of water per 1,000 grains of hardness removed.

  Demand-initiated systems measure water usage with a water meter and regenerate only when the meter counts down to zero. These systems use less water than auto-initiated systems because they regenerate more closely to the time they need to and do not waste water during unnecessary regenerations. NSF, the Water Quality Association (WQA) and Underwriters Laboratories, Inc., test and certify to the NSF/ANSI standards for water softeners. NSF and WQA maintain lists of the products they have tested and certified on their Web sites.

- *Drinking Water Treatment Systems* – The Specification establishes that drinking water treatment systems installed by the homebuilder shall be certified to meet applicable NSF/ANSI standards and yield at least 85 gallons of treated water for each 100 gallons of water processed. Systems using carbon filters can meet these criteria.

  Applicable NSF/ANSI standards are:
  - NSF/ANSI 42 Drinking Water Treatment Units – Aesthetic Effects
  - NSF/ANSI 53 Drinking Water Treatment Units – Health Effects
  - NSF/ANSI 55 Ultraviolet Microbiological Water Treatment Systems
  - NSF/ANSI 58 Reverse Osmosis Drinking Water Treatment Systems
  - NSF/ANSI 62 Drinking Water Distillation Systems

Outdoor Water-Efficiency Criteria

[12] National Association of Home Builders Research Center. Toolbase Services. Evaporative Coolers Whole-house Cooling in Arid Regions at a Low First Cost. http://www.toolbase.org/Technology-Inventory/HVAC/evaporative-coolers.
[13] Karpiscak, M., Mario, M. 1994. Arizona Cooperative Extension. *Evaporative Cooler Water Use*. May.

- *Landscape Designs* – The Specification establishes that homebuilders shall landscape the front yard and other areas improved upon by the builder so that either (1) the landscape design is developed using the water budget tool, or (2) the turfgrass allotment shall not exceed 40 percent of the landscaped area. Temporary landscapes (e.g., straw over bare soil) may be installed if permanent landscapes cannot be installed due to climate conditions. Homes with temporary landscapes can be inspected for compliance with indoor criteria and may be sold before a permanent landscape is installed. However, the WaterSense label certificate will not be issued until the permanent landscape is installed, inspected, and certified to comply with the outdoor criteria. Lots with total landscapable areas equal to or less than 1,000 square feet are exempt from this landscape design criterion.

  How and where turfgrass is placed in the landscape can significantly reduce the amount of irrigation water needed to support the landscape. Homeowners tend to water lawns more than other vegetation. Limiting turfgrass to areas where it aesthetically highlights the house or where it has a practical function, such as in play areas, and grouping turfgrass areas together can increase watering efficiency and significantly reduce evaporative and runoff losses.

  The landscape water budget tool establishes the maximum amount of water the landscape can be designed to use, based on climate, landscape size, irrigation efficiency, and plant needs.

- *Slopes* – The Specification requires that slopes in excess of 4 feet of horizontal run per 1 foot vertical rise (4:1) shall be vegetated. Installing plantings such as groundcover on steep slopes provides stabilization to prevent erosion and increases filtration as water passes down the slope.

- *Mulching* – The Specification requires that all exposed soil shall include a 2- to 3-inch layer of mulching material. Mulches aid in greater retention of water by minimizing evaporation, reducing weed growth, moderating soil temperatures, and preventing erosion. Organic mulches also improve the condition of soil as they decompose. Mulches are typically composed of wood bark chips, wood grindings, pine straw, nut shells, small gravel, or shredded landscape clippings.

- *Pools/Spas* – The Specification requires that pools and spas financed, installed, or sold as upgrades by the homebuilder shall have an appropriate cover. In addition, the water surface area of pools and/or spas shall be considered in the landscape design as turfgrass. Pools and spas are treated as turfgrass to account for their annual evaporation rates and water use requirements.

- *Ornamental Water Features* – The Specification requires that ornamental water features financed, installed, or sold as upgrades by the homebuilder must recirculate water and serve a beneficial use. In addition, the water surface area of the ornamental water features shall be considered as turfgrass. Water features are treated as turfgrass to account for their annual evaporation rates and water use requirements. This requirement helps differentiate closed system water features that contain and recirculate water from those features that are less efficient.

- *Irrigation System Designs* – The Specification requires that irrigation systems, if installed, shall, at a minimum, (1) be designed or installed and audited by a WaterSense irrigation partner; (2) have no detected leaks during the operation of the system; (3) be designed and installed to sustain the landscape without creating flow or spray that leaves the property; (4) achieve a lower quarter distribution uniformity of 65 percent or greater; (5) be equipped with technology that inhibits or interrupts operation of the system during periods of rainfall or sufficient moisture. Irrigation systems are not required to be designed or installed by WaterSense irrigation partners if an insufficient number of partners with appropriate certifications provide services to the new home site.

  Good irrigation design and scheduling provide one of the greatest opportunities for water efficiency in the landscape. Irrigation design consists of the layout of the sprinkler system, equipment selection and sizing, filtration, pressure control, hydraulics, and layout. The goal of a good design and layout is to provide an irrigation system with high overall distribution uniformity to maintain plant health while conserving water resources. Lower uniformity results in over-application of water to parts of the landscape in order to apply enough water to those areas that are under-irrigated. Efficient systems should have no overspray across or onto a street, driveway, or any other non-vegetated area that does not require irrigation.

  WaterSense irrigation partners have a demonstrated level of experience and have passed a comprehensive exam covering general irrigation subjects as well as specialty areas, including water efficiency.

- *Irrigation Controllers* – The Specification requires that irrigation systems, if installed, be equipped with irrigation controllers that have multiple programming capabilities, multiple start times, variable run times, variable scheduling, a percent adjust (water budget) feature, the capability to accept external soil moisture and/or rain sensors, non-volatile memory or self-charging battery circuit, and complete shut-off capability for the total cessation of outdoor irrigation. The irrigation controller, considered to be the brain of the system, turns the valves on and off. The more programming flexibility the controller has, the more efficiently water can be applied to the landscape. These irrigation controller criteria will be revised after the release of the final *WaterSense Weather-Based Irrigation Controllers Specification*.

- *Sprinkler Irrigation* – The Specification requires that sprinkler irrigation, other than as a component of a microirrigation system, shall not be used to water plantings other than maintained turfgrass. Sprinkler heads shall have a 4-inch or greater pop-up height and matched precipitation nozzles. In addition, sprinkler irrigation shall not be used on areas of turfgrass less than 4 feet wide, nor on slopes greater than 4:1. Long, narrow turf areas are difficult to water efficiently, and sprinkler irrigation can lead to excessive runoff when used on slopes steeper than 4:1.

- *Microirrigation Systems* – The Specification requires that microirrigation systems shall, at a minimum be equipped with pressure regulators, filters, and flush end assemblies. Pressure regulators control the pressure of the water in the system and prevent more water from being applied than necessary. Filters remove sand and larger suspended particles before they enter the distribution network. Flush end assemblies allow the systems to be maintained properly by flushing out particles that accumulate in microirrigation pipelines before they build up to sizes and amounts that can cause the pipes to become clogged.

Microirrigation applies water at a low flow rate and low pressure to the roots of plants by depositing the water either on the soil surface or directly to the root zone. Microirrigation systems lose significantly less water to runoff and evapotranspiration than conventional systems, because the water is applied to the roots and/or soil and soaks directly into the soil. These systems may be appropriate for slopes and narrow strips of turfgrass that require supplemental water.

- *Schedules* – The Specification requires that two watering schedules, developed by the WaterSense irrigation partner as part of the post-installation audit, be posted at the controller. One schedule shall be designed to address the initial grow-in phase of the landscape, and the second schedule shall be designed to address an established landscape. Both schedules shall vary according to the seasons. Regularly changing the irrigation schedule is an important component of a water-efficient landscape. Many homeowners forget to change their irrigation schedules, which results in applying the same amount of water in the summer, when plants water needs are the highest, and in the winter, when plants water needs are often the lowest.

Homeowner Education

This specification establishes that the builder shall develop and provide to the homeowner a written operating and maintenance manual for all water-using equipment or controls installed in the house and yard, including all relevant WaterSense materials on indoor and outdoor water use. If clothes washers or dishwashers are not provided, general information about water-efficient appliances shall also be included. In addition, if an irrigation system is installed, the builder shall provide the homeowner with a record drawing (schematic) of the system, an itemized list of the irrigation components, copies of the irrigation schedules, and information about changing the schedule after establishment. The intent of the manual is to educate homeowners on the efficient use of water and the benefits of doing so, as well as how to operate and maintain their homes to achieve the highest level of performance.

Potential Water and Energy Savings

Water Savings

The average indoor household water usage for homes constructed after 1994 with toilets, faucets, and showerheads that comply with EPAct standards is estimated to be approximately 130 gallons per household per day (see Table 2). Expected water usage for homes constructed to be water-efficient is difficult to estimate as limited data are available. Data from five studies are shown:

- High efficiency homes being offered by Durham Region in Canada, in conjunction with Tribute Communities, Natural Resources Canada, and the Federation of Canadian Municipalities demonstrated a water savings of 22.3 percent during a six month period (October 2006 to March 2007) compared to standard homes constructed at the same time in the same development. The 91 upgraded homes were constructed with ENERGY STAR qualified, water-efficient front-loading clothes washers, ENERGY STAR qualified dishwashers, high-efficiency toilets, and efficient showerheads.[14]

- The Masco Contractor Services Environments for Living® program conducted a detailed study of water efficiency in three new homes from 2004 to 2005. The homes were constructed with low-flow faucets and showerheads, high-performing toilets, ENERGY STAR qualified dishwashers, top-performing clothes washers, electronic-demand hot water distribution systems, weather-based irrigation controllers, and a water-efficient landscape. The study encountered problems getting data after the houses were bought but one of the homes demonstrated an indoor water savings of 34 percent.[15]

- A series of three intervention studies were conducted from 1999 to 2003 to collect data on water-conserving fixtures and appliances. Seattle Public Utilities conducted the first study on 37 single-family homes in 1999 and 2000, East Bay Municipal Utility District in northern California conducted the second study on 33 homes from 2001 to 2003, and Tampa Water in Florida conducted the third study on 26 homes in 2003. All homes included in the studies were retrofitted with high-efficiency clothes washers, showerheads, toilets, and faucets. Water usage data after the retrofits demonstrated a water savings of 37.2 percent in Seattle, 39 percent in northern California, and 49.7 percent in Tampa.[16,17,18]

To estimate the potential indoor water savings of water-efficient single-family new homes, WaterSense developed an expected water use associated with the required features of the home, then compared those usage estimates to typical water usage for those features to derive savings per feature. Savings for all of the features in the new home specification were added to

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[14] Veritec Consulting, Inc. 2007. Region of Durham Efficiency Community, Interim Report. May 4, 2007.

[15] Environments for Living. Summary Report: Water Efficiency and Performance in Diamond Class Test Homes. September 2005.

[16] Mayer, P., DeOreo, W., et al. 2000. *Seattle Home Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes.* Aquacraft, Inc. Water Engineering and Management. December 2000.

[17] Mayer, P., DeOreo, W., et al. 2003. *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*. Aquacraft, Inc. Water Engineering and Management. July 2003.

[18] Mayer, P., DeOreo, W., et al. 2004. *Tampa Water Department Residential Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes*. Aquacraft, Inc. Water Engineering and Management. January 2004.

estimate the total water savings. As shown in Table 2, WaterSense expects a water-efficient home to use approximately 21 percent less water indoors than a standard home.

Assuming that the average indoor household water usage for homes constructed to current plumbing standards is 130 gallons/day (gpd), the water savings from the indoor requirements can result in an annual savings of approximately 10,000 gallons per home (see Calculation 1).

Calculation 1. Average Household Water Savings
128.1 gpd X 20.7% water savings = 26.5 gpd savings X 365 days/year =
= 9,670 gal saved/year/house

Extrapolated to the national level, potential estimated water savings from the indoor components of the home could be as great as 12 billion gallons annually (see Calculation 2). These estimates clearly demonstrate the significant water savings potential of building water-efficient new single-family homes.

Calculation 2. National Water Savings Potential
9,670 gal/year/house X 1,270,000 annual housing starts for single family homes[19] = 12.3 billion gallons water saved

WaterSense also expects significant outdoor water savings for homes installing a water-efficient landscape and irrigation system, if applicable. However, few data exist on the “standard” landscape and “standard” outdoor water usage for single-family homes. Data indicate that the national average for residential irrigation ranges from 25 to 29 gallons per person day.[20]

WaterSense estimates that a reduction of turfgrass from about 80 percent in a typical yard to 40 percent in a water-efficient landscape results in a water savings of approximately 25 percent.[21] In addition, WaterSense estimates that an efficient irrigation system with appropriate scheduling can result in a water savings of 25 percent over non-efficient irrigation systems.[22] WaterSense has not attempted to estimate potential household or national savings associated with the outdoor criteria due to the variability associated with outdoor water usage across the country.

Energy Savings

WaterSense expects water-efficient single-family homes to save approximately 3,300 gallons of hot water per year (see Table 3 and Calculation 3). This expected hot water savings results in 580 kilowatt-hours (kWh) of electricity or 2,880 cubic feet of natural gas savings each year (see Calculations 4 and 5).

In addition to the energy savings from the home itself, WaterSense estimates that an additional 32 kWh of electricity is saved by not supplying and treating the 9,670 gallons of water saved per home (see Calculation 6). National energy savings could exceed 329 million kWh of electricity and 2.0 billion cubic feet (Bcf) of natural gas each year (see Calculations 7 and 8).

[19] U.S. Census. 2007 American Housing Survey, Table 1A-1. www.census.gov/prod/2008pubs/h150-07.pdf

[20] Vickers, A. 2002. Handbook of Water Use and Conservation. Plow Press.

[21] WaterSense analysis based on evaluation of watering requirements of landscapes with 80 percent turf and 20 percent bushes and trees compared to landscapes with 40 percent turf and 60 percent bushes and trees in various locations in the country.

[22] Gleick, P., Haasz, D., et al. 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. p 70. Pacific Institute for Studies in Development, Environment, and Security. November 2008.

These calculations are based upon the following assumptions:

- An estimated 73 percent of faucet water used in a household is hot water, [23] 100 percent of dishwasher water is hot water, and 28 percent of water used for clothes washing is hot water.[24]
- Approximately 40 percent of occupied residences in the United States heat their water using electricity, and 56 percent heat their water using natural gas.[25]
- Approximately 85 percent of households in the United States are connected to a water supply system.[26]
- Total electricity required to supply and dispose of each gallon of water delivered to a house is 0.0033 kWh. Surface water supply requires 0.0015 KWh of electricity per gallon of water delivered (includes pumping raw water, filtration/treatment, and distribution) and wastewater treatment requires 0.0018 KWh of electricity per gallon of water treated (average across various treatment types and plant sizes). [27]
- Water heating consumes 0.2 kWh of electricity per gallon of water heated (see Calculation 9), assuming:
  - Specific heat of water = 1.0 BTU/lb X °F
  - 1 gallon of water = 8.34 lbs
  - 1 kWh = 3,412 BTUs
  - Incoming water temperature is raised from 55°F to 120°F (Δ 65°F)
  - Water heating process uses 90 percent-efficient, electric hot water heater

Calculation 3. Average Household Hot Water Savings
9.0 gpd hot water saved X 365 days/year = 3,285 gal hot water saved/year

Calculation 4. Electricity Savings Per Household From Hot Water Savings
3,285 gal/year X 176.5 kWh of electricity/1,000 gal = 580 kWh of electricity/yr

Calculation 5. Natural Gas Savings Per Household From Hot Water Savings
3,285 gal/year X 0.877 thousand cubic feet (Mcf) of natural gas/1,000 gal = 2.88 Mcf (2,880 cubic feet) of natural gas/year

Calculation 6. Electricity Savings From Not Supplying Saved Water to the Home
9,670 gal/year X 0.0033 kWh of electricity/gal = 32 kWh of electricity/year saved

Calculation 7. National Electricity Savings Potential
(580 kWh/year/home X 0.40 X 1,270,000) + (32 kWh/year/home X 0.85 X 1,270,000 homes) = 329 million kWh of electricity/year

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[23] Mayer, P., DeOreo, W., et al. 2004.
[24] Mayer, P., DeOreo, W., et al. 2000.
[25] U.S. Department of Housing and Urban Development and U.S. Census Bureau. American Housing Survey for the United States 2005. Table 1A-4, page 6.
[26] Hudson, Susan S. et al. *Estimated Use of Water in the United States in 2000*. U.S. Geological Survey Circular 1268. Department of the Interior. Table 5. page 14.
[27] Goldstein, R. & W. Smith. 2002. *Water & Sustainability Volume 4: U.S. Electricity Consumption for Water Treatment & Supply – the Next Half Century*. Electric Power Research Institute, March 2002.

Calculation 8. National Natural Gas Savings Potential

2.88 Mcf/year/home X 1,270,000 homes X 0.56
= 2.0 million Mcf of natural gas/year = 2.0 Bcf of natural gas/yr

Calculation 9.

[(1 gal X 1.0 BTU/lbs X °F) (1 kWh/3,412 BTUs)/(1 gal/8.34 lbs) X 65°F] / 0.90
= 0.1765 kWh/gal

- Water heating consumes 0.8768 Mcf of natural gas per 1,000 gallons of water heated (See Calculations 10 and 11), assuming:
  - Specific heat of water = 1.0 BTU/lb X °F
  - 1 gallon of water = 8.34 lbs
  - 1 Therm = 99,976 BTUs
  - Incoming water temperature is raised from 55°F to 120°F (∆ 65°F)
  - Water heating process uses 60 percent-efficient, natural gas hot water heater

Calculation 10.

[(1 gal X 1.0 BTU/lbs X °F) (1 Therm/99,976 BTUs)/(1 gallon/8.34 lbs) X 65°F] / 0.60
= 0.009037 Therms/gal

Calculation 11.

0.009037 Therms/gal · 1,000 gal · 1 Mcf/10.307 Therms = 0.8768 Mcf/kgal

Table 2. Expected Daily Per Capita Indoor Water Savings from WaterSense Labeled New Homes

Indoor Features	Standard Water Use	Standard Use (gal/day/household)	WaterSense Criteria	Expected Use (gal/day/household)	Expected Water Savings (gal/day/household)
Toilets	1.6 gpf	21.0[28]	1.28 gpf	16.8	4.2 (20%)
Bathroom faucets	2.2 gpm	29.1[29]	1.5 gpm[30]	27.6	1.5 (4.8%)
Showerheads	2.5 gpm	25.4[31]	2.5 gpm	25.4	0 (0%)
Hot water delivery systems	~10 gallons per day per household wasted[32]		Assumes 20% water savings for improved design.[33]	8.0	2.0 (20%)
Dishwashers	8.6 gallons per load[34] (6 gallons per cycle)[35]	2.7	5.8 gallons per load (4 gallons per cycle)[36]	1.8	0.9 (33%)
Clothes washers	39.6 gallons per load[37] (12 gallons per cycle per cubic foot)	39.9	24 gallons per load[38] (6 gallons per cycle per cubic foot)	22.0	17.9 (45%)
Total Indoor		128.1		101.6	26.5 (20.7% savings)

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28 Assumes 5.1 flushes/day/person per Mayer. P, DeOreo, W. et al 2000 and 2003.

29 Assumes flow of 1.2 gpm and average use of 9.34 minutes/person/day per Mayer , P., DeOreo, W. et al 2000 and 2003.

30 Assumes flow of 0.97 gpm and average use of 10.97 minutes/person/day per Mayer , P., DeOreo, W. et al 2000 and 2003.

31 Assumes flow of 2.13 gpm, average use of 8.36 min/shower/person, and 0.58 showers/person/day per Mayer P., DeOreo W. et al 2000 and 2003.

32 Klein, Gary. 2004. Plumbing Systems & Design. *Hot-Water Distribution Systems Part I*. Mar/Apr 2004.

33 Acker, L., Klein, G. *Benefits of Demand-Controlled Pumping*. Home Energy. September/October 2006.

34 Assumes 8.64 gallons/load and 0.12 loads/person per Mayer , P., DeOreo, W. et al 2000, 2003, and 2004.

35 ENERGY STAR Frequently Asked Questions on Dishwashers. <energystar.custhelp.com/cgi-bin/energystar.cfg/php/enduser/std_adp.php?p_faqid=2539&o_created…>accessed 2/15/08.

36 Ibid.

37 Assumes 39.36 gallons/load and 0.39 loads/person per Mayer , P., DeOreo, W. et al 2000, 2003, and 2004.

38 Assumes 24.15 gallons/load and 0.35 loads/person per Mayer , P., DeOreo, W. et al 2000, 2003, and 2004.

Table 3. Expected Hot Water Savings From WaterSense Labeled New Homes

Indoor Feature	Expected Water Savings	Percent Hot Water	Expected Hot Water Savings
Bathroom faucets	1.5 gpd	70	1.1 gpd
Hot water delivery systems	2.0 gpd	100	2.0 gpd
Dishwashers	0.9 gpd	100	0.9 gpd
Clothes washers	17.9 gpd	28	5.0 gpd
Total			9.0 gpd

Cost Effectiveness and Payback Period

WaterSense estimates that the incremental costs associated with the criteria of this specification will range from $700 to $3,000 per home (see Table 4). This analysis is based on the potential incremental costs associated with building a WaterSense labeled new home versus a new home constructed to comply with basic requirements and practices.[39]

Table 4. Estimate of Incremental Costs Associated With the Specification

WaterSense Criteria	Incremental Cost Estimate
Service pressure–pressure regulating valve	$0 to $150[40]
WaterSense labeled HETs	$0 to $100[41]
WaterSense labeled faucets and aerators	$10[42]
Efficient hot water delivery systems	$0 (core plumbing)[43] -$200 (manifold)[44] $2,000 (recirculating system)[45]
ENERGY STAR qualified dishwashers (if installed)	$30[46]
ENERGY STAR qualified clothes washers (if installed)	$270[47]
Turf and mulching	$300[48]
3rd party certification of home	$50 to $400[49]
Total	$700 to $3,000

The homeowner of an average WaterSense labeled new home will realize $58.60 savings on water and wastewater costs annually due to lower indoor water consumption (see Calculation 12).

Calculation 12. Annual Water and Wastewater Cost Savings

9,670 gallons/year X $6.06/1,000 gallons[50] = $58.60/year

39 Assumes home has 2.5 bathrooms, 1 kitchen, 0.36 acre lot (15,682 ft^2); and total landscapable area of 12,280 ft^2 with 6,140 ft^2 in the front yard.

40 Price based on retail list prices of products found on various retailer Web sites. The range assumes some houses are already constructed with the valves in place.

41 Price range based on retail list prices of products found on various retailer Web sites.

42 Assumes the incremental cost is associated with the cost difference between WaterSense labeled aerators at $4/each and standard 2.2 gpm aerators at $1/each.

43 Assumes the incremental cost would be negligible due to reduced piping costs.

44 Assumes a baseline hot water delivery systems is trunk and branch with copper piping with materials and labor $1,100. Assumes manifold system with PEX with materials and labor is $920. Source: NAHB Research Center PATH Field Evaluation. *Evaluation of Residential Water Distribution Piping Installation: Time, Cost, & Performance Comparison PEX & Copper*. September 2006.

45 Assumes increased cost of $1,000 to $2,000 due to increased piping requirements (up to 1/3 more piping required), pump costs, and additional labor for the installation of the additional electrical components. Source: Telephone conversations with the Plumbing Manufacturers Institute.

46 Price based on retail list prices of products found on various retailer Web sites.

47 Price based on retail list prices of products found on various retailer Web sites.

48 Assumes a unit cost of $1.50/ft^2 for a traditional landscape and $1.55/ft^2 for a water-efficient landscape based on limited data on Xeriscape landscaping. These costs may vary greatly across different parts of the country.

49 Telephone conversation with the Residential Energy Services Network (RESNET). Price variation due to reduced fees for existing builder clients.

50 Raftelis Financial Consulting. Water and Wastewater Rate Survey. American Water Works Association. 2006.

Factoring in the accompanying energy savings, the average household with electric water heating may save an additional $67.40 (580 kWh/year X $ 0.1162/kWh[51]), for a combined annual savings of approximately $126. The average household with natural gas water heating will save $39.37 (2.88 Mcf/yr X $13.67/Mcf[52]), for a combined annual savings of approximately $98.

The average payback period for an average WaterSense labeled home would range between 5 and 24 years for those with electric water heating and 7 to 31 years for those heating with natural gas (see Calculations 13 and 14). These payback periods will improve if outdoor water use savings are also realized.

Calculation 13. Average Payback Period (Electric Water Heating)

$700 incremental cost for home/$126 cost savings/year = 5.6 years

$3,000 incremental cost for home/$126 cost savings/year = 23.8 years

Calculation 14. Average Payback Period (Natural Gas Water Heating)

$700 incremental cost for home/$98 cost savings/year = 7.1 years

$3,000 incremental cost for home/$98 cost savings/year = 30.6 years

51 Average Retail Price of Electricity to Ultimate Consumers by End-Use Sector, Energy Information Administration. http://www.eia.doe.gov/electricity/epm/table5_6_a.html.

52 Short-Term Energy Outlook, Energy Information Administration. <www.eia.doe.gov/steo>