WaterSense® Specification for Showerheads
Supporting Statement

I. Introduction

Showering is one of the leading uses of water inside the home, representing approximately 17 percent of annual residential indoor water use in the United States. This translates into more than 1.2 trillion gallons of water consumed each year[1],[2]. The WaterSense program released its final specification for showerheads on March 4, 2010, to capitalize on this opportunity to further improve the nation's water and energy efficiency by raising consumer awareness and promoting the use of more efficient showerheads. The intent of this specification is to help consumers identify those products that have met EPA's criteria for water efficiency and performance.

WaterSense collaborated with the American Society of Mechanical Engineers (ASME)/Canadian Standards Association (CSA) Joint Harmonization Task Force to develop the specification criteria for high-efficiency showerheads. This task force is open to the public and comprises a wide variety of stakeholders, including showerhead manufacturers, water and energy utilities, testing laboratories, consultants, and other water-efficiency and conservation specialists. Their participation, resources, and expertise enabled WaterSense to evaluate showerhead efficiency and performance and develop meaningful testing protocols that can effectively differentiate showerhead performance.

Prior to the task force's work there were no universally accepted criteria for measuring showerhead performance. Federal water-efficiency legislation and national performance standards only establish product flow rates that dictate water consumption—they do not address what makes a satisfactory, or unsatisfactory, shower. Now, with this specification, WaterSense and the task force have bridged this consumer information gap by incorporating performance requirements for products seeking to earn the WaterSense label. The requirements address flow rates across a range of pressures, spray force, and spray coverage, three key attributes of showerhead performance, according to consumer testing. These new requirements are designed to ensure a high level of performance and user satisfaction with high-efficiency showerheads.

II. Current Status of Showerheads

With nearly 110 million occupied housing units in the United States[3] and an average of two showerheads per household[4], WaterSense estimates that there are 220 million showerheads

[1] Assumes a per capita shower use of 11.6 gallons. See Mayer, Peter W. and William B. DeOreo. *Residential End Uses of Water.* Aquacraft, Inc. Water Engineering and Management. American Water Works Association. 1998. Page 102.
[2] According to the U.S. Census Bureau, there are 300 million persons in the United States.
[3] See U.S. Census Bureau and the U.S. Department of Housing and Urban Development's *American Housing Survey for the United States*. 2007.
[4] Mayer and DeOreo, op. cit., 99.

currently installed in homes across the United States. WaterSense also estimates that approximately 10 percent of the existing 220 million showerheads are replaced each year due to wear, remodeling, or other reasons. This means that the vast majority of these existing showerheads have flow rates equal to or less than the federal standard of 2.5 gallons per minute (gpm), which was mandated by the Energy Policy Act (EPAct) of 1992. With normal replacements and units sold for new construction, WaterSense estimates that approximately 25.6 million[5] new showerheads are sold each year. Since Congress enacted the federal requirements in the early 1990s, manufacturers have gone on to develop showerheads that use significantly less water than the flow rates set in EPAct 1992. These high-efficiency showerheads can save at least 20 percent compared to standard fixtures, resulting in a potential savings of more than 1,200 gallons per showerhead per year.

III. WaterSense Specification for Showerheads

Scope

This specification applies to showerheads and hand-held showers. Showerheads are fixed devices for directing water onto a user for bathing purposes. Hand-held showers, a subset of showerheads, are moveable devices for directing water onto a user. Hand-held showers can be installed on a support to function as a showerhead.

Multiple showerheads are eligible to receive the WaterSense label provided the showerheads are sold in combination in a single device intended to be connected to a single shower outlet. Further, each showerhead must meet all of the requirements of the specification and the entire multiple-head system must meet the maximum flow rate requirement of the specification in all possible operating modes.

Body sprays are excluded from this specification because their function and design are wholly different than that of a showerhead or hand-held shower. Retrofit devices, including aftermarket flow control devices, are also excluded because the intent of the specification is to recognize and label complete, fully functioning fixtures or fittings, and not individual components.

General Requirements

Many showerheads are sold with multiple modes to provide the user with options for different spray types (e.g., misting, massaging, or pause). WaterSense wants to maintain manufacturing flexibility and consumer choice for multiple mode showerheads, thus the specification addresses these types of showerheads by requiring all modes to meet the maximum flow rate requirement (i.e., no mode can exceed 2.0 gallons per minute [gpm]) and at least one of the modes, as specified by the manufacturer, must meet all of the requirements contained in the specification, including the maximum and minimum flow rates, spray force, and spray coverage requirements.

Water-Efficiency Criteria

[5] Units sold for replacement is based upon a 10 percent natural replacement rate. Units sold for new construction is based on 1,797,000 new housing starts per year based on the average number of new housing starts from 2003–2007.from U.S. Census. 2007 American Housing Survey, Table 1A-1. www.census.gov/prod/2008pubs/h150-07.pdf.

The water-efficiency component of this specification establishes a maximum flow rate of 2.0 gpm (7.6 liter per minute [L/min]). WaterSense settled on this flow rate after examining the range of products currently available on the market. This maximum flow rate represents a 20 percent reduction from the current federally allowable maximum flow rate of 2.5 gpm established by EPAct 1992, which is consistent with WaterSense's stated water-efficiency goal.

The specification also includes minimum flow rate requirements at 80, 45, and 20 pounds per square inch (psi) of pressure (the upper, mid, and lower range of potential household pressures) to ensure performance and user satisfaction under a variety of household conditions. Specifically, at 45 and 80 psi the tested flow rate cannot be less than 75 percent of the showerhead's maximum "rated"[6] flow rate value. This minimum requirement is specified at both 45 and 80 psi because some showerheads that are designed to compensate and adjust for changes in water pressure will actually produce maximum flow at 45 psi and not at 80 psi. As a result, WaterSense wants to ensure that this minimum flow rate requirement is met at both pressures. Likewise, at 20 psi the tested flow rate cannot be less than 60 percent of the showerhead's maximum rated flow rate value. Table 1 below provides some examples of the allowable minimum flow rates for showerheads with various rated flow rates. Defining minimum flow rate requirements in this manner ensures that the showerhead is designed to provide consistent flow across a range of pressures.

Table 1. Example Minimum Flow Rates

Showerhead Rated Flow Rate	Minimum Allowable Flow Rate		
	80 psi	45 psi	20 psi
2.0 gpm	1.5 gpm	1.5 gpm	1.2 gpm
1.75 gpm	1.3 gpm	1.3 gpm	1.1 gpm
1.5 gpm	1.1 gpm	1.1 gpm	0.9 gpm
1.0 gpm	0.8 gpm	0.8 gpm	0.6 gpm

WaterSense is requiring both the maximum and minimum flow rates of the showerhead to meet the testing and verification protocols for sampling outlined in the *Code of Federal Regulations* (see 10 CFR 430 Subpart F, Appendix B, Steps 6[b] and 6[a], respectively). The U.S. Department of Energy currently uses the sampling plan outlined in the CFR for assessing compliance of showerhead flow rates with EPAct 1992 requirements, and thus referencing it in this specification provides specific and familiar guidance to third-party certifying bodies for determining whether a showerhead meets the flow rate requirements established by WaterSense.

Performance Criteria

Establishing performance-based criteria for WaterSense labeled showerheads is critical to ensuring user satisfaction and maintaining the integrity of the WaterSense label. Prior to this specification, however, there were no universally agreed-upon testing protocols for showerhead performance or measures that adequately defined user satisfaction. WaterSense worked with

[6] The "rated" flow rate is the showerhead's maximum flow rate, as specified by the manufacturer, verified through testing, and in compliance with this specification.

the task force to determine, through its expertise and supported by consumer testing, the key performance attributes of showerheads.

To measure those attributes in a laboratory setting, the task force undertook an intensive effort to develop test protocols. The spray force and spray coverage requirements contained in the specification are a result of these efforts. Both test protocols subsequently underwent several iterations of round robin testing in various laboratories by multiple manufacturers and independent third-party certifiers in order to ensure that the procedures are repeatable and the results reproducible. Laboratory test data were then compared back to the consumer test data for a variety of showerheads to determine the specific performance levels that are included in the specification. These performance levels define the boundaries for user satisfaction for both spray force and spray coverage.

The spray force component of the specification requires a showerhead's spray force to be at least 2.0 ounces (0.56 newtons [N]) at an inlet pressure of 20 psi when the water is flowing. The testing procedure, described in Appendix A of the specification, is a pass/fail test that assesses the relative force of the shower spray through the use of a force balance fixture. The force balance fixture is equipped with a force target on one side that receives the shower spray and counterbalancing weights on the other side, set to the specified force (i.e., 2.0 ounces). As the shower spray hits the force target, the force balance fixture measures the rotation angle of the balance at the pivot point of the two sides (the spray and counterbalancing weights).

If the shower spray force is greater than the specified minimum, it will overcome, or move, the counterbalancing weights to or beyond the point of balance, achieved when the angle rotates within 0.1^{o} of zero or past it. Under this scenario the showerhead would pass the force requirements. If the showerhead's force is less than the specified minimum, it will not overcome the counterbalancing weights and the angle of balance will not rotate within 0.1^{o} of zero or past it. Under this scenario, the showerhead would fail the force requirements. The target force of 2.0 ounces specified in the specification represents the lower bounds of user satisfaction based on results from consumer tests using a variety of showerheads.

The spray coverage component of the specification, as described in Appendix B of the specification, requires the use of an annular ring gauge consisting of a series of concentric rings, starting with a 2-inch diameter center ring and each successive ring increasing in diameter by 2 inches out to 20 inches. The showerhead is positioned and turned on directly above the surface of the annular ring gauge. The relative amount of water captured in each set of concentric rings provides a representation of the distribution of the spray pattern and can be used to evaluate the showerhead's spray coverage.

Simultaneous to the development of the test apparatus, WaterSense gathered consumer test data to determine user preferences with respect to spray coverage. Data showed general dissatisfaction with showerheads that spray with a hollow spot in the center or that have too much water flowing in the center to form a very narrow beam. Thus the criteria contained in the specification were crafted to capture and disqualify showerheads with these types of coverage characteristics. Specifically, to meet the spray coverage requirement, the total volume of water collected in the two center rings (out to 4 inches) cannot exceed 75 percent of the total collected water volume (i.e., the showerhead cannot deliver all its water through a narrow beam in the center). In addition, the total combined volume of water collected in the three center rings (out to

6 inches) must be at least 25 percent of the total collected water volume (i.e., the showerhead cannot have a hollow spot in the center).

Marking

With this specification, WaterSense has adopted a new approach to product and package flow rate marking. The requirements are designed to clarify and clearly indicate which maximum flow rate value the manufacturer is to use. At the outset of certification, the manufacturer specifies a maximum flow rate value ("rated" flow rate), not to exceed 2.0 gpm, which is subsequently verified through testing. WaterSense requires the manufacturer to mark the product and product packaging with this rated flow rate value, so that the information provided to the consumer is both informative and accurate.

In addition to marking the product and packaging with the maximum rated flow rate, the product packaging (but not the product itself) must also be marked with the showerhead's minimum flow rate at 45 psi. This minimum flow rate is calculated as 75 percent of the manufacturer's specified maximum flow rate value and is subsequently verified through testing. The purpose of this marking requirement is to assist installers in properly matching showerheads and automatic-compensating mixing valves for installation in order to provide protection against thermal shock and scalding events (see Section V below for more information).

Potential Water and Energy Savings

Note: Refer to Appendix A for the assumptions and calculations used to derive these estimates.

Showerheads with a flow rate of 2.0 gpm or less have the potential to save significant amounts of water both individually and at the national level. Replacing standard showerheads with WaterSense labeled showerheads could save more than 1,200 gallons per showerhead or 2,300 gallons of water per household per year. Based upon the amount of water saved, the average household could save 300 kilowatt hours (kWh) of electricity or 1,500 cubic feet of natural gas that would otherwise be required to heat the water.

Nationwide, if WaterSense labeled showerheads were purchased for all normal showerhead replacements and installed in all new construction, WaterSense estimates that water savings could reach 30.3 billion gallons per year. National energy savings could exceed 1.6 billion kWh of electricity and 10.9 million cubic feet (Mcf) of natural gas each year.

Cost-Effectiveness

Note: Refer to Appendix A for the assumptions and calculations used to derive these estimates.

The average homeowner retrofitting his or her showerheads with WaterSense labeled showerheads will realize an accompanying $14 savings on water and wastewater costs annually due to lower water consumption. Factoring in the accompanying energy savings, the average household with electric water heating may save an additional $36, for a combined annual savings of $50. The average household with natural gas water heating may save an additional $18 for a combined annual savings of $32.

If the average showerhead costs $30 retail, the average payback period for the replacement of two standard showerheads per household with WaterSense labeled models would be approximately 14 months for those with electric water heating and about two years for those heating with natural gas.

IV. Certification and Labeling

WaterSense has established an independent third-party product certification process, described on the WaterSense Web site at www.epa.gov/watersense/partners/certification.html. Under this process, products are certified to conform to applicable WaterSense specifications by accredited third-party licensed certifying bodies. Manufacturers are then authorized to use the WaterSense label in conjunction with certified products.

V. Other Issues

Detailed Drawings for the Force Balance Test Apparatus

As the specification indicates, the spray force performance requirement is measured via a force balance test apparatus. This force balance test apparatus was developed by the task force specifically for the purpose of determining a showerhead's compliance with the specification's force requirements; therefore it is not a readily available or mass-produced piece of testing equipment. In addition, the test apparatus needs to be manufactured with very specific tolerances to ensure the results are repeatable and reproducible in any laboratory setting. WaterSense has made available the specification drawings to facilitate the construction of this test equipment. Detailed drawings for the force balance test apparatus are available on the WaterSense Web site at www.epa.gov/watersense/products/showerheads.html.

Health and Safety

In developing this specification, WaterSense and the task force considered potential negative impacts of reducing the flow rate on consumer satisfaction, including potential health and safety issues once these products are installed in the plumbing system. Of particular concern is the potential for increasing the risk of thermal shock or scalding as shower flow rates are reduced. Thermal shock or scalding can be caused when a hot- or cold-water-using device is activated (e.g., flushing the toilet or running the dishwasher) while the shower is running. Water is diverted away from the shower, causing a pressure drop in either the hot or cold water supply line to the shower. As a consequence, the balance of hot and cold water is shifted either to a hotter or colder temperature mix. This sudden change in temperature can either cause a user to abruptly move away from the shower stream, potentially resulting in an injury or fall, or if the temperature increase is severe enough, scalding can occur.

To mitigate the risks of temperature-related shower injuries, most U.S. plumbing codes require showers to be outfitted with individual automatic-compensating mixing valves that comply with either the American Society of Sanitary Engineers (ASSE) 1016 or ASME A112.18.1/CSA B125.1 standards. An automatic-compensating mixing valve is a device that is installed as part of the shower's flow control that helps to regulate water temperature; it is not part of the showerhead itself. The valve works either through balancing the incoming hot and cold water pressures or through controlling the mixed outlet temperature with a thermostatic element that can maintain water temperature to within +/- 3.6°F.

Despite advances in plumbing codes and mixing valve technology, thermal shock and scalding risks are still present under two scenarios. First, automatic-compensating mixing valves are currently only required to be tested and certified at a flow rate of 2.5 gpm at 45 psi. When these devices are outfitted with a showerhead that has a lower flow rate, there may not be adequate assurance that the valve is sensitive enough to provide the required protection. This is potentially true for all showerheads, as standard showerheads are currently tested and certified at a flow rate of 2.5 gpm at 80 psi. Second, not all homes are equipped with an automatic-compensating mixing valve. The risks are of particular concern for showerhead retrofits in homes built prior to 1987.

As a part of the development of the criteria for showerheads, WaterSense and the task force evaluated the link between flow rate and temperature deviations associated with pressure and temperature changes. The task force gathered and presented data to compare the temperature profiles that result from a drop in hot and cold water pressure for both standard and high-efficiency showerheads under the two risk scenarios: (1) installation with various types of automatic-compensating mixing valves (thermostatic, pressure balancing, or combination) designed for a flow rate of 2.5 gpm at 45 psi and (2) installation without the protection of an automatic-compensating mixing valve. The data showed that the risks are present for showerheads of all flow rates, but that more efficient showerheads are more sensitive to sudden changes in water pressure. As a consequence, a temperature change in water exiting the shower may be amplified when the pressure within the cold water or hot water supply plumbing suddenly changes.

Ultimately, WaterSense and the task force came to the conclusion that the thermal shock and scalding risks cannot be fully addressed through the specification for showerheads. First, there is a clear disconnect between the showerhead and automatic-compensating mixing valve compatibility, as the products are tested at different pressures (80 psi and 45 psi, respectively) and currently automatic-compensating mixing valves are only tested at a flow rate of 2.5 gpm. Second, the potential temperature of the hot water is controlled by the design of the hot water heater and delivery system, which can discharge water well in excess of the code required 140°F due to "layering" and the location of the thermostat at a point that is not necessarily the location of the hottest water. Because of the interrelated nature of these three components in the plumbing system, the control of the risks cannot solely rest on the design of the showerhead. In fact, the showerhead itself has very little, if any, control over the outlet water temperature.

To the extent possible, WaterSense has addressed this issue in the specification by requiring manufacturers to mark the product packaging with the minimum flow rate at 45 psi as determined by testing at that pressure. This is a vital step toward providing the information necessary to "match" the showerhead with a compatible automatic-compensating mixing valve that is rated to perform at the same flow rate and tested pressure. In addition, industry is currently working to harmonize automatic-compensating mixing valve standards and showerhead standards to address potential incompatibilities of these plumbing system components. This will go a long way toward addressing the risks of thermal shock and scalding associated with the installation of a WaterSense labeled showerhead, indeed with all showerheads, particularly in new construction. WaterSense is also educating consumers and program partners regarding the issue and associated risks so that consumers can continue to make informed purchasing decisions.

Appendix A: Calculations and Key Assumptions

Potential Water Savings Calculations

Assumptions:

- Average actual flow rate for an existing showerhead is 2.22 gpm[7] (the average flow rate is less than the standard rated flow rate of 2.5 gpm most likely because the products are rated at 80 psi, but installed in homes with less pressure)
- Average shower duration is 8.2 minutes[11]
- The average person takes 0.67 showers per day[8]
- A WaterSense labeled showerhead reduces the flow rate by 20 percent
- An estimated 10 percent of existing showerheads are replaced each year due to wear, remodeling, or other reasons
- There are an estimated 1,797,000 new housing starts per year based on the average number of new housing starts from 2003–2007[9]

Equation 1. Annual Water Savings Potential from Replacing a 2.5 gpm Rated Showerhead

(((2.22 gpm – (2.22 gpm x (1-0.2))) x 8.2 minutes/shower x 0.67 showers/person/day x 2.6 people/household x 365 days/year) = 2,300 gal/household/year

(2,300 gal/household/year / 2 showerheads/household) = 1,200 gal/showerhead/year

Equation 2. Annual National Water Savings Potential from Replacing All Existing 2.5 gpm Showerheads

(1,200 gal/showerhead/year x 220 million existing showerheads) = 260 billion gal/year

Equation 3. Annual National Water Savings Potential from Natural Replacement with WaterSense Labeled Showerheads

(1,200 gal/showerhead/year x 220 million showerheads * 0.10) = 26 billion gal/year

Equation 4. Annual National Water Savings Potential from Installation of WaterSense Labeled Showerheads in New Construction

(1,200 gal/showerhead/year x 1,797,000 annual new housing starts x 2 showerheads/household) = 4.3 billion gal/year

Unit Abbreviations:
gal = gallon
gpm = gallons per minute
psi = pressure per square inch

Potential Energy Savings Calculations

[7] Mayer and DeOreo, Op. cit., 102.
[8] Calculated based upon an assumed 17.2 gallons per shower and 11.6 gallons per day for showering. (Ibid.)
[9] U.S. Census. 2007 American Housing Survey, Table 1A-1. www.census.gov/prod/2008pubs/h150-07.pdf.

Assumptions:

- Approximately 73 percent of showerhead water used in a household is hot water[10]
- 42,239,000 (approximately 40 percent) of occupied residences in the United States heat their water using electricity[11]
- 60,998,000 (approximately 56 percent) of occupied residences in the United States heat their water using natural gas[11,12]
- Water heating consumes 0.18 kWh of electricity per gallon of water heated assuming:
  - Specific heat of water = 1.0 Btu/lb x º F
  - 1 gallon of water = 8.34 lbs
  - 1 kWh = 3,412 Btus
  - Incoming water temperature is raised from 55º F to 120º F (Δ 65 º F)
  - Water heating process is 90 percent efficient for electric hot water heaters
- Water heating consumes 0.88 Mcf of natural gas per 1,000 gallons of water heated assuming:
  - Specific heat of water = 1.0 Btu/lb x º F
  - 1 gallon of water = 8.34 lbs
  - 1 Therm = 99,976 Btus
  - Incoming water temperature is raised from 55º F to 120º F (Δ 65 º F)
  - Water heating process is 60 percent efficient for natural gas hot water heaters

Electricity

Equation 5. KWh Required to Raise 1 Gallon of Water 65º F

[(1.0 Btu/lbs x º F) (1kWh/3,412 Btus) / (1 gal/8.34 lbs) x 65º F] / 0.90 = 0.18 kWh/gal

Equation 6. Electricity Saving Potential per Household

(2,300 gal/year x 0.73) x (180 kWh of electricity/1,000 gal) = 300 kWh of electricity per year

Equation 7. National Electricity Savings Potential from Replacing All Existing 2.5 gpm Showerheads

(260 billion gal/year x 0.73 x 0.40) x (180 kWh of electricity/1,000 gal) = 14 billion kWh of electricity nationwide

Equation 8. National Electricity Savings Potential from Natural Replacement with WaterSense Labeled Showerheads

(26 billion gal/year x 0.73 x 0.40) x (180 kWh of electricity/1,000 gal) = 1.4 billion kWh of electricity nationwide

Equation 9. National Electricity Savings Potential from Installation of WaterSense Labeled Showerheads in New Construction

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[10] DeOreo, William B., and Peter W. Mayer. *The End Uses of Hot Water in Single Family Homes From Flow Trace Analysis*. 2000. Aquacraft, Inc.

[11] U.S. Department of Housing and Urban Development and U.S. Census Bureau. *American Housing Survey for the United States: 2007.* 2008. Table 1A-5, page 7.

[12] Ibid.

(4.3 billion gal/year x 0.73 x 0.40) x (180 kWh of electricity/1,000 gal) = 230 million kWh of electricity nationwide

Natural Gas

Equation 9. Therms Required to Raise 1 Gallon of Water 65º F
[(1.0 Btu/lbs x º F) (1 Therm/99,976 Btus) / (1 gal/8.34 lbs) x 65º F] / 0.60 = 0.009 Therms/gal

Equation 10. Converting Therms to Mcf
0.009 Therms/gal x 1,000 gal/kgal x 1 Mcf/10.307 Therms = 0.88 Mcf/kgal

Equation 11. Natural Gas Savings Potential per Household
(2,300 gal/year x 0.73) x (0.88 Mcf of natural gas/1,000 gal) = 1.5 Mcf (1,500 cubic feet) of natural gas per year

Equation 12. National Natural Gas Savings Potential from Replacing All 2.5 gpm Showerheads
(260 billion gal x 0.73 x 0.56) x (0.88 Mcf of natural gas/1,000 gal) = 94 million Mcf of natural gas nationwide

Equation 13. National Natural Gas Savings Potential from Natural Replacement with WaterSense Labeled Showerheads
(26 billion gal x 0.73 x 0.56) x (0.88 Mcf of natural gas/1,000 gal) = 9.4 million Mcf of natural gas nationwide

Equation 14. National Natural Gas Savings Potential from Installation of WaterSense Labeled Showerheads in New Construction
(4.3 billion gal/year x 0.73 x 0.56) x (0.88 Mcf of natural gas/1,000 gal) = 1.5 million Mcf of natural gas nationwide

Unit Abbreviations:
Bcf = billion cubic feet
Btu = British thermal unit
F = Fahrenheit
kgal = kilogallons
kWh = kilowatt hour
lbs = pounds
Mcf = thousand cubic feet

<u>*Cost-Effectiveness Calculations*</u>

Assumptions:
- Price of water and wastewater is $6.06/1000 gallons[13]
- 2009 Price of electricity is $0.12/kWh[14]
- 2009 Price of natural gas is $11.98/Mcf[15]

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[13] Raftelis Financial Consulting. *Water and Wastewater Rate Survey*. American Water Works Association. 2006.
[14] U.S. Department of Energy, www.eia.doe.gov/cneaf/electricity/epm/table5_3.html.

Equation 15. Annual Household Water and Wastewater Cost Savings
2,300 gallons/year x $6.06/1,000 gallons = $14/year

Equation 16. Annual Household Electricity Savings
(300 kWh/household/year * $0.12/kWh) = $36/year

Equation 17. Annual Household Natural Gas Savings
(1.5 Mcf/household/year * $11.98/Mcf) = $18/year

Equation 18. Annual Water, Wastewater, and Electricity Savings
($14/year + $36/year) = $50/year

Equation 19. Annual Water, Wastewater, and Natural Gas Savings
($14/year + $18/year) = $32/year

Equation 11. Average Full Payback Period (Electric Water Heating)
($30/showerhead x 2 showerheads/household) / $50/year = 1.2 years (~14 months)

Equation 12. Average Full Payback Period (Natural Gas Water Heating)
($30/showerhead x 2 showerheads/household) / $32/year = 1.9 years (~ 23 months)

[15] U.S. Department of Energy, www.eia.doe.gov/steo.