Resource Manual for Building WaterSense® Labeled New Homes

Version 1.1

August 30, 2012

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Residential water use accounts for more than half of publicly supplied water in the United States. In the average American home, 70 percent of total household water consumption is from indoor plumbing use and 30 percent from outdoor use. During summer months in arid climates, however, these percentages can easily be reversed. To address the growing nationwide concern about water shortages and our country's ever-increasing thirst for water, the U.S. Environmental Protection Agency (EPA) established WaterSense to protect the future of the nation's water supply and to promote water-efficient products and services with a simple, easy-to-identify label.

The WaterSense label is a symbol to consumers that a product uses less water and performs as well as or better than standard models. Before a product can earn the WaterSense label, it must be independently certified to meet EPA's criteria for efficiency and performance. The label can be found on a variety of products that typically use at least 20 percent less water than the standard, and more products are being considered for the label every year.

I. A Brief Overview of WaterSense Labeled New Homes

The WaterSense new homes program is designed 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 *Version 1.1. WaterSense New Home 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. WaterSense is a market transformation program designed to shift the market in incremental steps. Builders and other users can go beyond the criteria in the specification, which identifies the minimum requirements for a water-efficient new home.

How WaterSense Labeled Homes Save Water

WaterSense labeled new homes combine WaterSense labeled products with other water-efficient fixtures, systems, and practices to reduce the amount of water used by approximately 20 percent compared to typical new homes. In addition to WaterSense labeled toilets, faucets, and showerheads, these new homes include dishwashers and clothes washers with the ENERGY STAR® label, if those appliances are installed when the home is built. WaterSense labeled new homes incorporate a hot water delivery system that decreases the amount of time it takes for hot water to reach the faucet or shower, since waiting for hot water can waste consumers thousands of gallons of water each year. A maximum water service pressure in the house is set to reduce the maximum water flow from fixtures and the likelihood of leaking pipes and hoses.

Outside the home, builders are required to meet minimum landscaping requirements. Although irrigation systems are not required, WaterSense has developed efficiency criteria for installed irrigation systems including the use of WaterSense labeled weather-based irrigation controllers if such a controller is used after this criterion goes into effect (June 1, 2013).

While the amount of savings that can be realized by living in a WaterSense labeled new home is dependent upon the number of people living in the home and their water use habits, a WaterSense labeled new home is designed and built to be about 20 percent more efficient than

similar new homes being built today. At this level of efficiency, a family of four could save 50,000 gallons of water per year compared to a traditional home. WaterSense labeled new homes will also realize significant energy savings, due to the reduced amount of hot water used.

Overview of the Specification

For new homes to receive the label, they must be built by a WaterSense builder partner and be newly constructed:

- Single-family homes or townhomes
- Residential units in a multi-family building, three stories or less in size
- Residential units in multi-family buildings, including mixed-use buildings, that have independent heating, cooling, and hot water systems separate from other units

Units in buildings that utilize central hot water systems powered by alternative energies, such as solar or geothermal, for domestic hot water are allowed if the alternative energy source provides at least 50 percent of the hot water needs for the residential units.

In addition, the home must meet all applicable criteria in the specification and be certified by a WaterSense licensed certification provider for new homes. The home must meet EPA's criteria for indoor water efficiency, outdoor water efficiency, and homeowner and building management education to qualify for the WaterSense label. This is a pass/fail program where all criteria must be met for the home to pass inspection.

The *Version 1.1 WaterSense New Home Specification* uses a combination of prescriptive and performance-based approaches and requires the use of fixtures that meet specific water use and performance criteria. For some fixtures, this means using WaterSense labeled products (i.e., toilets, bathroom sink faucets, showerheads, flushing urinals). Where performance-based standards are specified, the builder may use any appropriate design or product that meets applicable codes and standards in order to meet EPA's criteria.

Local Rules, Ordinances, and Permits

The WaterSense specification is not intended to replace or contravene state or local codes and requirements. All homes, landscapes, and irrigation systems are required to meet all applicable national, state, and local building codes and regulations. In addition, all plumbing and irrigation system installers shall meet all applicable state and local licensing requirements.

Inspection and Certification Process

In order to earn the WaterSense label, new homes must be built by a WaterSense builder partner, meet all of the applicable criteria in EPA's specification, and be certified by a licensed certification provider. Builders work with the following organizations during the certification process:

- EPA Licensed Certification Provider: An organization that commits to hire or contract with inspectors, train inspectors, oversee new home inspections, and issue certification documentation for inspected homes. A listing of licensed certification providers for the

WaterSense new homes program can be found on the WaterSense website at www.epa.gov/watersense/meet_our_partners.html.

- Water-Efficiency Home Inspector (Inspector): An individual who provides inspection services for new homes in accordance with the *Version 1.1 WaterSense New Home Specification.* The inspector must be trained by a licensed certification provider in accordance with training materials prepared by WaterSense. In addition, the inspector must work with a licensed certification provider (either as a direct employee, a contract employee, or some other business relationship).

The third-party certification of WaterSense labeled new homes is intended to verify that the builder has met the criteria of EPA's specification. The inspector will complete the following:

- Check for leaks
- Verify service water pressure
- Test the performance of the hot water delivery system
- Verify WaterSense labeled fixtures
- Test flow rate of faucets and showerheads
- Verify optional appliances and equipment
- Verify landscape design and mulch criteria
- Verify water feature requirements
- Verify design or installation and audit of the irrigation system
- Verify homeowner and building management education criteria

If a home includes a landscape irrigation system, a professional certified by a WaterSense labeled program must design or install the system *and* audit the system to make sure it meets the criteria outlined in the specification.[1] The inspector will verify that the builder had a WaterSense irrigation partner complete the system audit. The irrigation auditor will complete the following:

- Check water distribution uniformity ratio (minimum 65 percent)
- Verify the irrigation system causes no runoff or overspray
- Identify appropriate system elements
- Ensure proper use of sprinkler and microirrigation systems (i.e., no sprinklers on slopes or strips)
- Verify controller features
- Check for schedules posted at controller
- Verify that schematics and information are provided for homeowners or building management

Builders should be sure that all of the applicable WaterSense criteria are met before the inspection. Some of the criteria—including the hot water delivery system and the irrigation systems—are complex, built-in systems. If they aren't installed properly and don't meet the

[1] Waivers from these requirements are available if there are an insufficient number of available WaterSense irrigation partners that provide services to the area where the house is being constructed.

criteria, they will be difficult and potentially expensive to fix in order to meet the criteria. Builders should use qualified and experienced professionals to design and install the hot water delivery system, design a water-efficient landscape, and, if applicable, design and install an efficient irrigation system. The licensed certification provider will not be able to issue the WaterSense label until all appropriate criteria are met.

Purpose of This Manual

This resource manual is designed to help builders better understand the WaterSense requirements for labeled homes and assist them in meeting the criteria so they can receive the label for their new home construction.

The organization of the document follows the layout of the *Version 1.1 WaterSense New Home Specification*. Each criterion is identified, the specification language is provided, the intent of the criteria is described, information for understanding and implementing the criteria is provided, and, when appropriate, information for identifying and finding the required fixtures, appliances, or equipment is also provided. Additional resources on appropriate topics are provided at the end of the manual.

II. WaterSense Indoor Water-Efficiency Criteria

All homebuilders wishing to earn the WaterSense label for a new home must meet the criteria for leaks, service pressure, hot water delivery systems, toilets, flushing urinals, faucets, and showerheads described in this section. If the homebuilder finances, installs, or sells as upgrades dishwashers, clothes washers, evaporative cooling systems, water softeners, and/or drinking water treatment systems, then the criteria described below for these components must also be met.

Water conservation has become increasingly important in some parts of the country, and some local jurisdictions might require indoor water conservation measures be met for new home construction. These measures, if applicable, should be considered in addition to the WaterSense criteria. Furthermore, some state agencies and local water utilities may provide tax incentives or rebates for high-efficiency fixtures and fittings that will help offset costs.

II.A Leaks (3.1)

Intent
Properly installed water-using fixtures, equipment, and appliances should not leak.

WaterSense Criteria

There shall be no detected leaks from any water-using fixtures, appliances, or equipment. Compliance shall be verified through pressure-loss testing and visual inspection.

Background

An American home can waste, on average, more than 10,000 gallons of water every year due to running toilets, dripping faucets, and other household leaks.

Likely sources of leaks include:

- Pipes and fittings running between the utility's water main and the foundation of the home.
- All connection points in the hot water delivery system.
- Toilet angle valves and connections.
- Toilet flapper valves.
- Hot/cold water connection hoses and valves at kitchen and bathroom faucets.
- Shower arm and showerhead threaded connections.
- Shower diverter in bath/shower combinations.
- Connections and valves to dishwashers, clothes washers, refrigerator ice machines, evaporative air conditioners, water softeners, and drinking water treatment systems, if installed.

Although not required as part of a WaterSense labeled new home, many devices and systems exist to detect leaks in residential plumbing systems at predetermined locations (e.g., clothes washers, dishwashers, toilets, water heaters, sinks, and pipes that may freeze). Some devices automatically shut off the water supply to the house or to the specific appliance to reduce water

loss through leaks or ruptures. Other devices may sound a loud alarm for early water leak detection. Most of these devices have components that are battery operated and, therefore, require homeowner maintenance to ensure performance. If operating correctly, devices that automatically shut off the water may significantly reduce the amount of water loss through leaks and ruptures. They may also serve as a selling feature of the house due to their potential to reduce or prevent property damage caused by flooding. Installing water meters at each single-family home, if not provided by the municipality, is another way for homeowners to check for leaks. Water meters can indicate that a leak exists if flow is detected when all water fixtures are turned off. Residents could also benefit from the installation of a water meter by obtaining a more accurate account of water use for utility billing purposes.

Inspection

To determine if there are any leaks in the home, inspectors will conduct a pressure-loss test. For single-family homes with only one water supply to the home, the inspector will attach a pressure gauge to an outside faucet, take a reading, and then shut off the municipal water supply to the house. After several minutes, the inspector will determine if the pressure has dropped. A loss of pressure indicates an unseen leak. For homes with more than one water supply or without an outdoor faucet, inspectors will attach a pressure gauge to the cold water faucet for the washing machine hookup or other cold water faucet and take the pressure reading. For homes with a separate water supply for irrigation (e.g., reclaimed water), the inspector will check both the outdoor and indoor water supplies for leaks using the approach described above. All leaks must be fixed before a home can be certified and receive the WaterSense label certificate.

Conducting a pressure-loss test on homes in multi-family buildings will vary based on the plumbing system design. Homes that are supplied through a single line with a shutoff can be tested at any point of use within the home. If the home is supplied by multiple supply lines, the inspector will need to coordinate with the builder to ensure that all individual supply systems are tested.

During the inspection, the inspector will check for leaks at all visible water supply connections and valves for water-using fixtures, appliances, and equipment. To check for toilet leaks from the flapper valve, the inspector will remove the tank lid and add some food coloring or a dye tablet to the tank. After about 5 minutes, if the water in the toilet bowl is colored, the flapper valve is leaking. Flush immediately upon completing the experiment and check to make sure the tank and bowl are both clear of the coloring to avoid any staining.

If possible, the builder can fix any identified leaks while the inspector is still at the home, and those areas can be immediately reinspected. Some leaks, such as those from irrigation systems, may be more difficult to immediately fix and may require reinspection at a later date.

II.B Service Pressure (3.2)

WaterSense Criteria

The static service pressure shall be a maximum of 60 pounds per square inch (psi) (414 kilopascal [kPa]). Compliance for homes supplied by groundwater wells shall be achieved by use of a pressure tank. Compliance for single-family homes with publicly supplied water may be achieved by one of the following methods:

Intent
Reduced water pressure saves water, conserves energy, and helps ensure proper operation of fixtures and appliances.

- *Use of a pressure-regulating valve (PRV) downstream of the point of connection. All fixture connections shall be downstream of the PRV.*
- *Determination that the service pressure at the home is 60 psi or less at the time of inspection and documentation from the public water supplier that service pressure is unlikely to regularly exceed 60 psi at the home on a daily or seasonal basis.*

For units in multi-family buildings, the service pressure within each unit shall be at a maximum of 60 psi.

Piping for home fire sprinkler systems is excluded from this requirement and should comply with state and local codes and regulations.

Background

Municipalities and private water supply companies use pumps and pumping stations to boost water supply pressures in supply mains. In some cases, the pressure can exceed 200 psi. Most plumbing codes require PRVs on domestic systems where the pressure of the supplied water exceeds 80 psi, as higher pressures can rupture pipes and damage fixtures.

Ensuring that the pressure entering a WaterSense labeled new home does not exceed 60 psi can result in significant water savings by reducing the amount of water coming out of the fixture and reducing the likelihood of leaking water pipes, leaking water heaters, dripping faucets, and catastrophic events if pipes, hoses, or component parts in a water-using product burst. Keeping the pressure at 60 psi can also help in maintaining the performance of water fixtures, reduce dishwasher and washing machine noise, and reduce breakdowns in a plumbing system.

Reducing the amount of hot water consumed will also reduce the amount of energy required to heat the water, resulting in energy savings.

Implementation

The most common type of water pressure-reducing valve is a direct-acting valve. Direct-acting valves consist of globe-type bodies with a spring-loaded, heat-resistant diaphragm connected to the outlet of the valve that acts upon a spring. Water entering the valve is constricted within the

valve body and directed through the inner chamber, which is controlled by an adjustable spring-loaded diaphragm and disc. Even if the water pressure fluctuates, the PRV ensures a constant flow of water at a functional pressure. In general, the minimum flow through a PRV should be between 10 and 15 percent of the maximum desired flow rate. Select a regulator for which operating pressures fall within the middle of its rated range, not based on the size of the pipe to which it will be attached.[2]

Source: www.ci.austin.tx.us/watercon/prvfaq.htm

It is important to note that use of a PRV creates a closed system and that thermal expansion can lead to increased pressure in some cases. Local plumbing codes should provide guidance on controlling this issue.

Builders should also note that piping for home fire sprinkler systems is not included in this specification. These systems should be installed and maintained in accordance with state and local codes and regulations.

Inspection

The inspector will determine if the home receives publicly supplied water or receives water from a groundwater well. If the home's water is supplied by a groundwater well, the inspector will verify that a pressure tank is installed and that the pressure is set to 60 psi or less. If the home's water is publicly supplied, the inspector will either verify that a PRV is installed downstream of the point of connection or verify that the water pressure to the home or unit in a multi-family building is 60 psi or less. If a PRV is not installed, the inspector will also verify that there is written documentation from the water supplier that pressure is not expected to exceed 60 psi.

II.C Hot Water Delivery Systems (3.3)

WaterSense Criteria

Intent
Efficiently designed hot water delivery systems reduce the amount of time it takes hot water to reach a fixture, saving both water and energy.

To minimize water loss from delivering hot water, the hot water delivery system shall store no more than 0.5 gallons (1.9 liters) of water in any piping/manifold between the hot water source and any hot water fixture. To account for the additional water that must be removed from the system before hot water can be delivered, no more than 0.6 gallons (2.3 liters) of water shall be collected from the hot water fixture before hot water is delivered. Recirculation systems must be demand-initiated. Systems that are activated based solely on a time and/or temperature sensor do not meet this requirement.

[2] Water Safety & Flow Control: Water Pressure Reducing Valves. Accessed on August 25, 2009. www.watts.com/pro/division/watersafety_flowcontro/learnabout/learnabout_wprv.asp

Background[3]

One of the primary factors affecting homeowner satisfaction is the relative comfort associated with the hot water delivery system. The distance from the water heater has a great impact on the temperature of the water that arrives at a fixture and how long it takes for the hot water to be delivered.[4]

Heating water is typically the second largest use of energy in a home (after space heating and cooling).[5] Despite its resource intensity, the hot water delivery system is seldom an area of significant focus when constructing a home. As a result, many homes today are built with poor performing, inefficient hot water delivery systems that take minutes to deliver hot water to the point of use and waste large amounts of energy in the process. Approximately 10 to 15 percent of the energy use associated with the hot water delivery system is wasted in distribution losses, and studies have shown that the average home wastes more than 3,650 gallons of water per year waiting for hot water to arrive at the point of use.[6] Researchers have found that water and energy 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.

Both the generation and use of hot water can be reduced through simple product solutions. Specifying WaterSense labeled products adds to both the energy and water efficiency of the system by requiring less hot water at the point of use. Specifying water heaters with higher energy factors reduces the energy needed to serve a home's hot water needs.

Unlike generation and use, effective and efficient distribution of hot water requires a whole system approach and can be challenging to many builders. However, considering the hot water delivery system early in the design phase and carefully following a plumbing design can deliver superior homes and reduced installation costs.

The length of piping between the water heater and each fixture, the pipe diameter and material from which the pipe is made can have the greatest impact on hot water delivery system efficiency, because these factors determine the volume of water stored within the delivery system. The volume of stored water affects how long it takes for hot water to reach each fixture and the temperature retention of the water as it is delivered. Systems with the least stored volume waste the least amount of water and energy.

Insulation of hot water pipes can improve the efficiency of a hot water distribution system. Insulation of hot water pipes reduces the rate of heat loss and can deliver water that is 2º F to 4º F hotter than uninsulated pipes can. Pipe sleeves made with polyethylene or neoprene foam with thicknesses of either ½ or ¾ inch are the most commonly used insulation. The pipe sleeve

[3] EPA has prepared a separate *Guide for Efficient Hot Water Delivery Systems* with additional detailed information on selecting and implementing hot water delivery systems.
[4] U.S. Green Building Council. 2008. LEED for Homes Reference Guide.
[5] Energy Information Administration, Office of Energy Consumption and Efficiency Statistics, 2009 Residential Energy Consumption Survey.
[6] Klein, Gary. "Hot-Water Distribution Systems Part 1." *Plumbing Systems & Design.* Mar/Apr 2004.

inside diameter should match the diameter of the pipe for a close fit. Securing insulation every one or two feet using tape, wire, or cable tie will also help to fit insulation close to the pipe. Insulation should be used along the entire length of hot water pipes, including elbows and joints, but should be kept 6 inches away from the flue of gas water heaters. Insulation performs better with an R-value of R-3.0 or greater.[7]

Implementation

Trunk and branch plumbing is characterized by one long, large diameter main line (i.e., the "trunk") that runs from the water heater to the farthest fixture in the house. As illustrated in Figure 1, along the way, "branches" from the main trunk supply hot water to various areas of the home, and smaller "twigs" branch off to supply hot water to individual fixtures. Typically the main trunk uses larger diameter piping to ensure adequate flow, with smaller diameter piping branching off to individual fixtures.

Trunk and branch systems are the most common type of hot water delivery system. They can be utilized in both single- and multi-family homes. In terms of maximizing hot water delivery system efficiency, they are most suitable for smaller homes, homes with relatively few fixtures, or in multi-family housing if installed individually in each unit. It may be difficult to design an efficient trunk and branch system in larger homes with spacious layouts and a large number of fixtures.

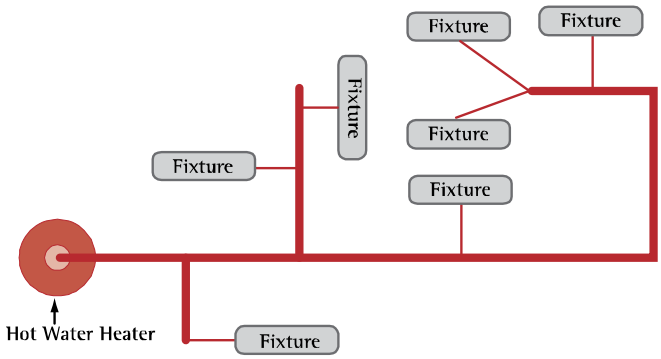


Figure 1. Trunk and Branch Plumbing System

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. The length and the internal diameter of the pipe(s) determine the volume of water contained within the distribution system. Systems with the least internal volume waste the least amount of energy and water. They also typically provide hot water to the plumbing fixture with the shortest waiting period.[8] The table below identifies the volume of water in common piping materials.

[7] Home Builders Association of Metro Denver. 2007. Guide to the 2007 Built Green Checklist.
[8] Klein G., Wendt R., 2007 Residential Hot Water Distribution System Research Suggests Important Code Changes. January/February 2007.

Determining Volume of Piping Systems
Internal Volume of Various Water Distribution Tubing

Ounces of Water Per Foot Length of Hot Water Tubing							
Nominal Size (Inch)	Copper M	Copper L	Copper K	CPVC CTS SDR 11	CPVC SCH 40	PEX-Al-PEX PE-AL-PE ASTM F 1281	PEX CTS SDR 9
⅜	1.06	0.97	0.84	N/A	1.17	0.63	0.64
½	1.69	1.55	1.45	1.25	1.89	1.31	1.18
¾	3.43	3.22	2.90	2.67	3.38	3.39	2.35
1	5.81	5.49	5.17	4.43	5.53	5.56	3.91
1¼	8.70	8.36	8.09	6.61	9.66	8.49	5.81
1½	12.18	11.83	11.45	9.22	13.20	13.88	8.09
2	21.08	20.58	20.04	15.79	21.88	21.48	13.86

Source: Modified from *2009 International Plumbing Code Table E202.1.* International Code Council.
Conversions: 1 gallon = 128 ounces
1 ounce = 0.00781 gallons
0.5 gallons = 64 ounces
0.6 gallons = 76.8 ounces

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. Each of these system types is described below.

Core plumbing systems

Core systems are a particular type of trunk and branch system that utilize a central plumbing core, where plumbing areas (i.e., kitchens, bathrooms, laundry rooms) are placed in close proximity to the water heater. Hot water is piped directly to each fixture or group of fixtures using smaller diameter piping when appropriate and as direct a path as possible. Figure 2 illustrates the main design principles of this configuration. As the figure shows, the relative proximity of the fixtures and direct horizontal runs minimize the length of piping and the amount of time required for hot water to reach each fixture.

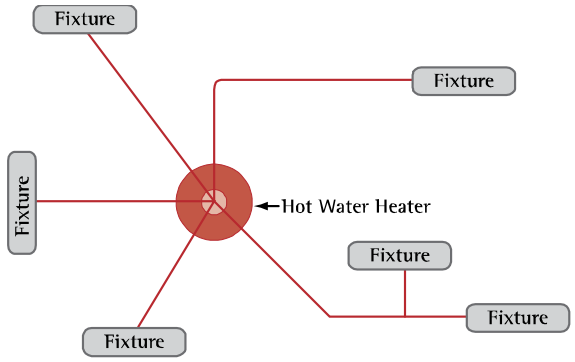


Figure 2. Core Plumbing System

Because core systems use less and smaller diameter piping, they can significantly reduce conductive heat loss and the amount of water that users waste waiting for hot water to arrive at the fixtures. They can also be made with any type of piping (or multiple types if necessary); copper, CPVC, or cross-lined polyethylene (PEX) are the most commonly used types. As a result, core systems provide greater flexibility and can be less expensive and quicker to install relative to other system types.

Core systems can be utilized in both single- and multi-family homes. They are similar to trunk and branch systems in that they are most suitable for smaller homes or homes with relatively few fixtures. They may not be suitable for multi-family buildings if used as a building-wide hot water delivery system. It is also important to note that since core systems supply each fixture or point of use with their own line, they can be difficult to retrofit later.

Demand-initiated hot water recirculation systems

Recirculation systems consist of one continuous hot water supply loop that recirculates water throughout the home. As shown in Figure 3, a circulating pump draws hot water through the recirculation loop and returns to the water heater any ambient-temperature water residing within the loop. Alternately, the pump can return this water to the cold water line while simultaneously drawing hot water from the water heater. Utilizing the cold water line as the return is often a convenient solutions for inefficient distribution systems that are being retrofitted. Recirculation systems save water both because they can reduce the wait time for hot water to nearly nothing (thus eliminating the loss of water down the drain) and by returning ambient-temperature water stored in the piping is back to the heater. This decreases the work that a water heater must do to reach an acceptable temperature. In addition, the recirculation loop is typically located where it can be kept as short as possible and within 10 feet of every fixture.[9]

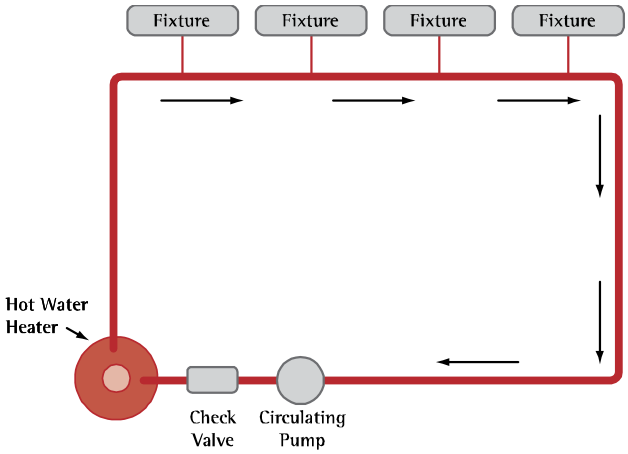


Figure 3. Demand-Initiated Hot Water Recirculating System

Demand-initiated recirculation systems have been found to be more energy-efficient than other timer- or temperature-based recirculation systems, because hot water is only drawn into the recirculation loop when hot water is needed. Demand-initiated systems use sensor electronics installed at the fixtures to automatically adjust standing ambient temperatures in the hot water recirculation loop. When the user activates the pump by pushing a button, or via a motion sensor located near the hot-water fixture, the sensor measures temperature changes in the recirculation loop and activates the circulating pump until the water in the loop reaches a specified temperature, at which time the water is delivered to the fixture.

It is important to note that timer- and temperature-based recirculation systems may not be used to meet WaterSense new home specification criteria. Research indicates that these systems can use a large amount of energy to maintain the water temperature in the recirculation loop and are considered to be energy-inefficient.

Demand-initiated recirculation systems can offer builders more flexibility than the other types of systems, because they can allow for longer pipe runs and less centralized fixture placement.

[9] Acker, L., G. Klein. 2006. "Benefits of Demand-Controlled Pumping." *Home Energy*.

Although demand-initiated recirculation systems use energy in their operation, they can save energy in three ways:

- The water in the recirculation loop that is returned to the water heater is generally warmer than water coming into the house; therefore, the water heater requires less energy to keep the water heated.
- Since hot water is distributed at a high flow rate to fixtures, significantly less heat is lost during distribution.
- The high distribution flow rate allows hot water to reach the fixtures faster and, therefore, less hot water is needed to prime the recirculation loop.[10]

While the cost of the pump and wiring of the required sensors represents incremental costs, recirculation systems can be quicker to install and utilize less pipe than traditional distribution systems, which in turn can reduce installation costs.

Due to the energy required to recirculate the ambient-temperature water stored in the system, demand-initiated recirculation systems may not be suitable for larger homes, where large loops are necessary or where it is not practical to locate fixtures within 10 feet of the loop. So while builders should weigh the water-efficiency benefits against the potential energy-related drawbacks associated with the use of this type of system in large homes, the energy saved by reducing the amount of water that is heated and then run down the drain typically far outweighs the energy use of the system.

Whole house manifold systems

Whole-house manifold systems, also called parallel pipe or home run systems, use small diameter, flexible piping (such as PEX) that run directly to each individual fixture from a central manifold. As shown in Figure 4, the central manifold is typically kept in close proximity to the water heater. The manifold may be constructed of either plastic or metal.

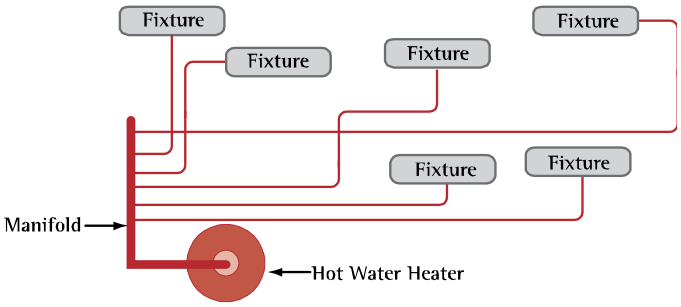


Figure 4. Whole House Manifold System

The use of flexible piping allows these systems to be installed more quickly than rigid, non-flexible plumbing systems, because fewer fittings are necessary during installation. Because the flexible piping is supplied as spools of continuous piping, plumbers can lay out relatively long piping runs without needing to install coupling fittings at regular intervals. Furthermore, by virtue of the piping's flexibility, it can be redirected as needed using continuous sweeping turns, eliminating the need for elbow fittings, which are time-consuming to install and contribute to the loss of pressure and heat as water moves through the system.

[10] Acker, L., G. Klein. 2006. "Benefits of Demand-Controlled Pumping." *Home Energy*.

Whole-house manifold systems also equalize pressure, and therefore, several fixtures can be used simultaneously without dramatic changes in pressure or temperature. As noted above, the elimination of inline fittings also reduces pressure losses, allowing for the use of smaller 3/8 inch diameter piping. Reduced pipe diameters in turn delivers hot water to fixtures faster and with less water and energy waste than conventional piping systems.

Whole-house manifold systems can be utilized in either single- or multi-family homes. This system type is an ideal option for larger homes with more spacious layouts and multiple fixtures in which longer piping runs may be necessary. Like core systems, whole-house manifold systems supply each fixture with an independent line and can be difficult to retrofit.

Inspection

As stated above, two types of recirculating plumbing systems, timer- and temperature-based, may not be used to meet the criteria. The inspector will verify that neither system was installed.

The inspector will test all hot water delivery systems installed in the home at the fixture that is located the farthest distance from the hot water source(s). To pass inspection, the water's ending temperature must have increased by 10º F from the starting temperature before 0.6 gallons are collected from the fixture.

Systems that do not pass the initial performance test can be retested after the system completely cools down, which can take several hours and might require that the inspector come back another day. Homes that do not pass after a second test could require difficult and expensive fixes to comply with the criteria. Additional water heaters could be required to address the farthest fixtures, and/or plumbing might need to be rerouted to reduce overall pipe length. Therefore, it is important to use experienced and trained professionals to design an efficient system that works with the floor plan and to install the system according to the plan. Builders should check that the plumbing systems were installed according to the design plans and that they meet the inspection criteria before it becomes too difficult to modify the system.

II.D Toilets and Flushing Urinals (3.4)

WaterSense Criteria

All toilets shall be WaterSense labeled tank-type toilets. All flushing urinals, if installed, shall be WaterSense labeled flushing urinals.

Intent
WaterSense labeled toilets and flushing urinals are independently tested and certified to meet EPA's water efficiency and performance criteria.

Background

Toilet flushing accounts for nearly 30 percent of residential indoor water consumption. Recent improvements and advancements in toilet design and performance have allowed toilets to use 20 percent less water than the current federal standard, while still providing equal or superior performance. WaterSense labeled toilets have been independently certified to meet rigorous criteria for both efficiency and performance.

The WaterSense specification covers both single-flush and dual-flush tank-type toilets. All tank-type toilets store water in the toilet tank and include the standard gravity type (found in most homes), pressure-assisted, and electrohydraulic-assisted toilets. Dual-flush toilets are similar to single-flush toilets, but have two flush volumes—a full flush for solids and a reduced flush for liquids only. Tankless valve-type or flushometer valve toilets—toilets that rely on water pressure controlled by flushing valves to remove waste rather than gravity—are not covered by this specification, because of their differing design, patterns of use, and performance expectations.

The primary water efficiency and performance criteria of the WaterSense tank-type toilet specification are:

- The toilet's maximum average flush volume must be no more than 1.28 gallons per flush (gpf) (4.8 liters per flush [lpf]. The average maximum flush volume for dual-flush toilets is determined by averaging the volumes of one full flush and two reduced flushes.

- The toilet must be able to completely remove 350 grams of solid waste test media in four out of five test attempts.

For flushing urinals, the WaterSense specification covers: flushing urinal fixtures that receive liquid waste and use water to convey the waste through a trap seal into a gravity drainage system; pressurized flushing devices that deliver water to urinal fixtures; and flush tank (gravity type) devices that deliver water to urinal fixtures.

The WaterSense flushing urinal specification requires that the average maximum water consumption must not exceed 0.5 gpf (1.9 lpf) when tested in accordance with national performance standards (i.e., ASME A112.19.2/CSA B45.1 [ceramic urinals], ASME A112.19.3/CSA B45.4 [stainless steel urinals], IAPMO Z124.9 [plastic urinals], ASSE #1037 [pressurized flushing devices]). The specification also includes three requirements to ensure the long-term performance and water savings of these high-efficiency devices:

- The primary actuator must be a non-hold-open design to limit the amount of water released per flush, regardless of how long the actuator is held open.

- The device's flush volume can be adjustable, but only to within ± 0.1 gpf of its rated flush volume. This will allow for field adjustments that may be necessary depending on building water pressure or other onsite conditions.

- The device should be designed to prohibit the interchangeability of replaceable or maintainable parts with parts that would cause it to exceed its rated flush volume.

WaterSense has not developed any criteria for bidets. Bidets may be installed at the builders' discretion and will not be evaluated as part of the WaterSense inspection.

Implementation

The WaterSense website provides a complete listing of WaterSense labeled tank-type high-efficiency toilets and flushing urinals at www.epa.gov/watersense/product_search.html.

All toilets are required by the ASME/CSA performance standards to be marked with their water consumption. Product packaging and documentation will likely bear the WaterSense label. Both the product and product packaging for WaterSense labeled flushing urinals must be marked with the rated flush volume in gpf and lpf and will likely bear the WaterSense label.

Inspection

Inspectors will obtain the make and model name and number of all toilets and flushing urinals installed in the house and verify that they are on EPA's list of WaterSense labeled tank-type toilets and flushing urinals.

II.E Bathroom and Kitchen Faucets (3.5)

WaterSense Criteria

All bathroom sink faucets shall be WaterSense labeled bathroom sink faucets or faucet accessories (e.g., aerators). All kitchen sink faucets shall comply with federal standards for maximum flow rate of 2.2 gallons per minute (gpm) (8.3 lpm).

Intent
WaterSense labeled bathroom sink faucets and accessories can reduce a sink's water use by 30 percent without sacrificing performance.

Background

Bathroom sink and kitchen sink faucets account for approximately 15.7 percent of indoor residential water use in the United States, or about 1.1 trillion gallons of water used each year across the country. The Energy Policy Act of 1992 originally set the maximum flow rate for both lavatory and kitchen faucets at 2.5 gpm at 80 psi static pressure. In 1994, ASME A112.18.1M-1994–Plumbing Supply Fittings set the maximum flow rate for lavatory faucets at 2.2 gpm at 60 psi. In response to industry requests for conformity with a single standard, in 1998, the U.S. Energy Department adopted the 2.2 gpm at 60 psi maximum flow rate standard for all faucets. Other than this maximum flow rate standard, there currently are no universally accepted performance tests or specifications (i.e., rinsing or wetting performance standards) for faucets.

In order for a new home to earn the WaterSense label, all bathroom sink faucets or faucet accessories must be WaterSense labeled. A lavatory faucet accessory is a device that can be added to or removed from a bathroom sink faucet (typically, it screws onto the tip of the faucet spout). Faucet accessories frequently serve as the flow control mechanism that determines if a

faucet meets the minimum and maximum flow rate requirements of the WaterSense specification. Faucet accessories control flow rate either through flow restriction (narrowing the opening through which the water is discharged from the faucet) or flow regulation (adapting the width of the opening through which the water is discharged from the faucet based upon fluctuations in water pressure to maintain a constant flow rate). Faucet accessories include:

- *Aerators:* Add air into the water stream to increase the sensation of flow (this is the most common type of faucet accessory).
- *Laminar flow devices:* Force the water through small openings to produce dozens of parallel water streams, creating a more uniform flow and potentially reducing splash.
- *Other types of flow restrictors:* Control flow through means other than aerating the water stream or creating laminar flow.
- *Other types of flow regulators:* Control flow through means other than aerating the water stream or creating laminar flow, but also compensate for changes in water pressure.

To earn the WaterSense label, a bathroom sink faucet or faucet accessory must have a maximum flow rate of 1.5 gpm (5.7 lpm) when tested at 60 psi and a minimum flow rate of 0.8 gpm (3.0 lpm) when tested at 20 psi. WaterSense included the minimum flow rate requirement to ensure a high level of performance in locations with very low water pressure.

Since there is not a WaterSense label available for kitchen sink faucets, this specification relies on the current national standard for kitchen sink faucets—a maximum flow rate of 2.2 gpm (8.3 lpm) when tested at 60 psi (414 kPa). There are many kitchen sink faucets available with maximum flow rates significantly less than 2.2 gpm (8.3 lpm). When installing these lower flow models, contractors must be mindful of the difference in use and user expectations between bathroom sink and kitchen faucets. The major drawback of reduced maximum flow rates for all faucets is increased wait times for hot water and the filling of pots or containers. Kitchen sinks are more commonly used for filling containers, and increased wait times might not be tolerated in the kitchen.

Implementation

All faucets and attachable accessories are required by the ASME/CSA performance standard to be marked with their maximum flow rate. Checking the faucet marking will indicate if a bathroom sink faucet meets the WaterSense maximum flow rate, but not the minimum flow rate. To determine if the product meets all aspects of the WaterSense specification, look for the WaterSense label on the product packaging and documentation (the specification requires these materials to bear the WaterSense label). The WaterSense website also provides a listing of labeled faucets and accessories at www.epa.gov/watersense/product_search.html.

As with bathroom sink faucets, kitchen faucet manufacturers are required by law to mark their products with the maximum flow rate. Any faucet or faucet accessory marked as a 2.2 gpm fixture meets the requirements of this specification.

Inspection

The inspector will obtain a list of the make and model numbers for all bathroom sink faucets and faucet accessories installed in the home and verify that they have earned the WaterSense label. The inspector will also check the maximum flow rate from all bathroom sink faucets and kitchen sink faucets to ensure that the aerators have not been tampered with or removed. To conduct the test, the inspector will use a small bucket under or attach a flow-measuring bag to the faucet spout, turn on the water completely while starting a stopwatch and, after 10 seconds, turn off the water and check the volume of water collected. The volume of water should be 0.25 gallons or less for bathroom sinks and 0.4 gallons or less for kitchen sink faucets.

These criteria apply to all kitchen sink faucets including bar sinks. These criteria do not apply to pot-filling faucets, utility sink faucets, and laundry sinks.

II.F Showerheads (3.6)

WaterSense Criteria

All showerheads shall be WaterSense labeled showerheads. This includes fixed showerheads that direct water onto a user (excluding body sprays) for bathing purposes and hand-held showers. In cases where more than one showerhead or hand-held shower is provided in combination with others in a single device intended to be connected to a single shower outlet, the entire device must meet the maximum flow requirement in all possible operating modes.

Intent
WaterSense labeled showerheads can reduce water use in the shower by 20 percent. Each shower compartment should contain only one showerhead, or not exceed the 2.0 gpm maximum flow rate for the entire compartment.

The total allowable flow rate of water from all showerheads flowing at any given time, including rain systems, waterfalls, body sprays, and jets, shall be limited to 2.0 gpm per shower compartment, where the floor area of the shower compartment is less than 2,160 square inches (in^2) (1.4 meters^2 [m^2]). For each increment of 2,160 in^2 (1.4 m^2) of floor area thereafter or part thereof, additional showerheads are allowed, provided the total flow rate of water from all flowing devices is equal to or less than the 2.0 gpm per shower compartment and the additional showerheads are operated by controls that are separate from the other showerheads in the compartment.

Background

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.[11],[12] The WaterSense program released its final specification for showerheads on March 4, 2010, to further improve the nation's water and energy efficiency by raising consumer awareness and promoting the use of more efficient showerheads.

WaterSense collaborated with the American Society of Mechanical Engineers/Canadian Standards Association 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. With the showerhead 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.

Implementation

Manufacturers are required by law to mark showerheads with the maximum flow rate. Checking the showerhead marking will indicate if a showerhead meets the WaterSense maximum flow rate. To determine if the product meets all aspects of the WaterSense specification, look for the WaterSense label on the product packaging and documentation (the specification requires these materials to bear the WaterSense label). The WaterSense website also provides a listing of labeled showerheads at www.epa.gov/watersense/product_search.html.

The specification sets the maximum acceptable flow rate per shower compartment at 2.0 gpm of water and the shower compartment size at 2,160 in^2. WaterSense has determined that 2,160 in^2 (36 inches x 60 inches) represents a reasonable maximum size for a single-person shower compartment, including roll-in showers that are large enough for a person in a wheelchair to remain in the chair to shower.

[11] 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.
[12] According to the U.S. Census Bureau, there are 300 million persons in the United States.

Inspection

The inspector will obtain a list of the make and model numbers for all showerheads installed in the home and verify that they have earned the WaterSense label. The inspector will also check the maximum flow rate from the showerheads, similar to the test performed on kitchen sink and bathroom sink faucets. For showers with one showerhead in a single shower compartment, no more than 0.35 gallons of water should be collected by inspector during the 10 second test. For multiple showerheads in a single compartment equal to or less than 2,160 in^2, no more than 0.35 gallons of water should be collected from all showerheads during the flow test. This ensures that together the multiple showerheads do not exceed the maximum flow of 2.0 gpm. For each additional 2,160 in^2 area (or part thereof), an additional 0.35 gallons of water is allowed during the flow test. For example, if the shower compartment is between 2,161 in^2 and 4,320 $in,^2$ then the total allowable volume of water collected from all showerheads during the flow test should be no more than 0.7 gallons.

The inspector will also verify that appropriate flows are obtained in cases where more than one showerhead or hand-held shower is provided in combination with others in a single device intended to be connected to a single shower outlet. If more than one showerhead is installed in a shower compartment larger than 2,161 in^2, the inspector will verify that the showerhead serving the additional area is operated by separate controls.

WaterSense has not established criteria for bathtubs, indoor hot tubs, and indoor pools. These features can be installed at the builders' discretion and will not be evaluated as part of the WaterSense inspection.

II.G Appliances and Other Equipment (3.7, 3.8)

WaterSense Criteria

If dishwashers, clothes washers, individual evaporative cooling systems, water softeners, and/or drinking water treatment systems are financed, installed, or sold as upgrades to the homeowner, they must meet the criteria in Sections 3.7 and 3.8 of the new home specification.

II.G.1 Dishwashers (3.7.1)

Intent
ENERGY STAR qualified dishwashers are also water-efficient.

WaterSense Criteria

Dishwashers, if installed in the new home, shall be ENERGY STAR qualified.

Background

Dishwashers are one of the major water-using appliances in a typical home. ENERGY STAR qualified models use 31 percent less energy and 33 percent less water than conventional machines. ENERGY STAR qualified models include several innovations that reduce energy and water consumption and improve performance, including soil sensors to test how dirty dishes are

throughout the wash, and adjust the cycle to achieve optimum cleaning with minimum water and energy use.[13]

The ENERGY STAR criteria are based on specific energy consumption and water consumption levels. The maximum energy consumption is measured in kilowatt hours per year (kWh/year) and the maximum water consumption is measured in gallons per cycle. The table below identifies the current ENERGY STAR dishwasher criteria.

Category	Capacity	ENERGY STAR Criteria (energy and water consumption)
Standard Sized Models	At least eight place settings plus six serving pieces	</= 307 kWh/year </= 5.0 gal/cycle
Compact Sized Models	Less than eight place settings plus six serving pieces	</= 222 kWh/year </= 3.5 gal/cycle

Implementation

To identify ENERGY STAR qualified dishwashers, look for the ENERGY STAR label on products and product packaging. A listing of qualified ENERGY STAR dishwashers can also be found at www.energystar.gov/index.cfm?fuseaction=dishwash.search_dishwashers.

Inspection

The inspector will verify that the installed dishwasher has an ENERGY STAR label. If no label is present, the inspector will check the brand and model number against ENERGY STAR's list of qualified dishwashers.

II.G.2 Clothes Washers (3.7.2)

WaterSense Criteria

Clothes washers, including those in common-use laundry rooms of multi-family buildings, shall be ENERGY STAR qualified with a water factor of less than or equal to 6.0 gallons of water per cycle per cubic foot capacity.

Intent
ENERGY STAR qualified clothes washers with a water factor of 6.0 or less will help the new home save water and energy.

Information

Clothes washers are one of the major water-using components in the typical home. The average American family washes nearly 400 loads of laundry each year. Using ENERGY STAR qualified clothes washers, homeowners can cut their related water costs and usage by more than half and save enough money in operating costs to pay for the matching dryer.[14] ENERGY

[13] ENERGY STAR website www.energystar.gov/index.cfm?c=dishwash.pr_dishwashers
[14] ENERGY STAR website www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers

STAR qualified clothes washers come in either front-load or advanced top-load designs. Both configurations include technical innovations that help save substantial amounts of energy and water. Front-loaders tumble clothes through a small amount of water instead of rubbing clothes against an agitator in a full tub. Advanced top-loaders use sophisticated wash systems to flip or spin clothes through a reduced stream of water. Both designs dramatically reduce the amount of hot water used in the wash cycle and the energy needed to heat that water. Efficient motors also spin clothes two to three times faster during the spin cycle to extract more water. Less moisture in the clothes means less time and energy in the dryer.[15]

To qualify for the ENERGY STAR label, a clothes washer, both top and front loading, must have a capacity of greater than 1.6 ft^3 and have a minimum modified energy factor (MEF) of 2.0 and a maximum water factor of 6.0. MEF is an equation that takes into account the amount of dryer energy used to remove the remaining moisture content in washed items. The water factor is a water performance metric that allows the comparison of clothes washer water consumption independent of clothes washer capacity.

Implementation

To identify ENERGY STAR qualified clothes washers with a water factor of 6.0 or less, look for the ENERGY STAR label on products and product packaging. A listing of qualified residential clothes washers and their water factors can be found at www.energystar.gov/index.cfm?fuseaction=clotheswash.search_clotheswashers. A listing of qualified commercial clothes washers can be found at www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CCW

Inspection

The inspector will verify that the installed clothes washer has an ENERGY STAR label and water factor equal to or less than 6.0. If no label is present, the inspector will check the brand and model number against ENERGY STAR's list of qualified dishwashers.

II.G.3 Evaporative Cooling Systems (3.8.1)

WaterSense Criteria

Intent
Reducing the amount of blowdown/bleedoff in evaporative cooling systems will reduce water use.

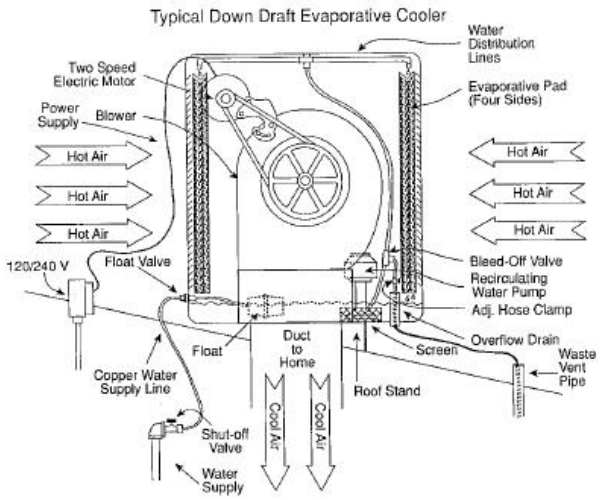
Individual evaporative cooling systems shall use a maximum of 3.5 gallons (13.3 liters) of water per ton-hour of cooling when adjusted to maximum water use. Blowdown shall be based on time of operation, not to exceed three times in a 24-hour period of operating (every eight hours). Blowdown shall be mediated by conductivity or basin water temperature-based controllers. Once-through or single-pass cooling systems, systems with continuous blowdown/bleedoff, and systems with timer-only mediated blowdown management shall not be used to meet these criteria.

[15] ENERGY STAR website www.energystar.gov/index.cfm?c=clotheswash.clothes_washers_advanced_technology

Background

The typical individual evaporative cooler consists of eight major parts: housing (metal or fiberglass), a fan, recirculating water pump, water reservoir, float valve, pads, water distribution lines, and electric motor. Evaporative cooling systems work on the principle of evaporation of moisture. The fan of the cooler draws outside air through pads soaked with water.[16] The pads can be made of wood shavings such as wood from aspen trees or other materials that absorb and hold moisture while resisting mildew. Water soaks the pads and trickles through them to collect in a reservoir at the bottom of the cooler. A small recirculating water pump sends the collected water back to the top of the pads. Since water is continually lost through evaporation, a float valve, much like the one that controls the water in a toilet tank, adds water to the sump when the level gets low. Drawing outside air over the water soaked pads can drop the temperature approximately 20 degrees. This cooled air is blown into the house by a fan.[17]

There are two types of evaporative cooling systems: direct and indirect (also called two-stage). In a direct evaporative cooling system, a blower forces air through a permeable, water-soaked pad. As the air passes through the pad, it is filtered, cooled, and humidified. An indirect evaporative cooling system has a secondary heat exchanger that prevents humidity from being added to the airstream that enters the home. Cooling systems are defined by the temperatures they can hold either in the space and/or the process or equipment, and the amount of heat they can remove at full capacity. This heat removal is normally expressed in tons of cooling (or refrigeration) capacity. One ton of cooling equals precisely 12,000 British thermal units of heat removal per hour (Btu/h).



Source: Karpiscak, M. Marion, M. Arizona Cooperative Extension. Evaporative Cooler Water Use. 1994.

The use of water by coolers is generally dependent on their size, air movement, and relative humidity of the air. All things being equal, a 4,500 cubic foot per minute (cfm) cooler will use less water than a 6,000 cfm cooler. The amount of cooling generated by an evaporative cooler is a function of the amount of evaporation that occurs in the unit. Increased dry air movement over the wet cooler pads will increase the amount of evaporation and produce more cool air. At the same time, decreased air movement will decrease the amount of water used for cooling, while the bleed-off rate will remain the same. The most important difference in water usage rates for evaporative coolers is the use of bleed water. Thermostats and timers can be utilized

[16] Karpiscak, M., Marion, M. Arizona Cooperative Extension. 1994. Evaporative Cooler Water Use.
[17] California Energy Commission. 2006. Consumer Energy Center. Evaporative Cooling: How an Evaporative Cooler Works. www.consumerenergycenter.org/home/heating_cooling/evaporative.html

to decrease the amount of water (and energy) used by evaporative coolers. A thermostat can be set to a certain temperature so that the evaporative cooler is only used when necessary. In addition, timers can be used so that the evaporative cooler can turn on just before residents return home.[18]

Bleed-off valves are typically installed in the recirculating water line and connected to a drain line. Blowdown or bleedoff of water using the bleedoff valves is done to reduce buildup of hard water minerals in the system. While these systems are extremely energy-efficient in hot, dry climates, they can use between 100 to 400 gallons of water per day. Bleedoff is responsible for a large percentage of the water usage.

Implementation

These criteria are not applicable to cooling towers used in multi-family buildings. Builders will need to carefully look at product packaging and documentation to determine if an evaporative cooling system meets all of the requirements of this specification. Talk to distributors or suppliers to help identify and select the allowable systems.

Source: www.oldhouseweb.com

Inspection

The inspector will verify that the individual evaporative cooling system meets the maximum of 3.5 gallons of water per ton-hour and that the blowdown does not exceed three times in a 24-hour period by reviewing the manufacturer's product literature or visiting the manufacturer's website. The inspector will also verify that the evaporative cooling system controls blowdown through conductivity or a basin temperature-based controller by reviewing the manufacturer's product literature or visiting the manufacturer's website.

II.G.4 Water Softeners (3.8.2)

WaterSense Criteria

If installed in the new home, self-regenerating water softeners shall be certified to meet 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:

Intent
If a water softener is installed, it should be a demand-initiated regeneration system that is water- and salt-efficient.

[18] H2ouse.org. Evaporative Cooler Water Use. www.h2ouse.org/action/details/action_element_contents.cfm?actionID=11252FC5-E889-45A5-A088549C8CF50361&elementID=C762FE8A-38B4-4541-907E5203F113D180

- *Be a demand-initiated regeneration system (i.e., it must use a flow meter or water hardness sensor to initiate regeneration; devices that use time clock-initiated regeneration [fixed time schedule] do not qualify for the efficiency rating).*

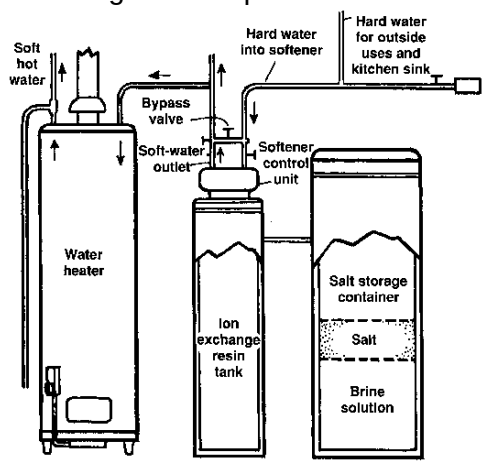
- *Have a rated salt efficiency of not less than 3,350 grains of total hardness exchange per pound of salt, based on sodium chloride (NaCl) equivalency (477 grams of total hardness exchange per kilogram of salt).*

- *Not generate more than 5.0 gallons of water per 1,000 grains of hardness removed during the service cycle (18.9 liters per 64.8 grams of total hardness removed).*

Background

Water softeners are common household appliances found in regions of the country where hard water (or water that contains a lot of dissolved calcium or magnesium) is prevalent. Hard water can cause scales to form on the inside of pipes, water heaters, and other appliances and equipment. Scales do not conduct heat well and can reduce the flow of water through pipes. Hard water also reacts with soap to form a sticky coating on skin and reduce soap's ability to lather, which can make a bath or shower less productive.

Hard water can be managed by softening or filtering the water. Water softeners are often used due to the high costs associated with filtration. The calcium and magnesium ions in the water are replaced with univalent hydrogen, sodium, or potassium ions (i.e., cation exchange). To achieve the ion replacement, the water in the house runs through a bed of small plastic beads or through a chemical matrix called zeolite. The zeolite are covered with hydrogen, sodium, or potassium ions. As the water flows past the hydrogen, sodium, or potassium ions, they swap places with the calcium and magnesium ions. Eventually, the zeolite contain nothing but calcium and magnesium, and at this point they stop softening the water. It is then time to regenerate the zeolite. Regeneration involves soaking the zeolite in a stream of concentrated brine, usually of sodium chloride or potassium chloride, or acid solution. The strong brine displaces all of the calcium and magnesium that has built up in the zeolite and replaces it with hydrogen, sodium, or potassium. The remaining brine plus all of the calcium and magnesium are flushed out through a drain pipe.[19]



Source: www.ag.ndsu.edu/pubs/h2oaqual/watsys/ae1031-2.gif

While the volume of water consumed by these fixtures during the regeneration phase has decreased significantly in recent years, water softeners still generate and discharge a significant volume of wastewater. To minimize the water consumption of these fixtures and reduce the amount of salt discharged into septic and sewer systems, the *NSF/ANSI 44–Residential Water Softener Testing Standard* and the Water Quality Association's *WQA S-100 Residential Water Softener Testing Standard* includ

[19] How Stuff Works website. http://home.howstuffworks.com/question99.htm

efficiency-rated (ER) residential cation exchange water softeners. (These two standards are essentially identical. Therefore, a residential cation exchange water softener can be certified to either standard.)

All residential cation exchange water softeners sold in the United States must be certified to the general requirements of *NSF/ANSI 44* (or *WQA S-100*). The voluntary efficiency requirements found in Section 7 of NSF/ANSI 44 are for manufacturers looking to differentiate and market their products as water- and sodium-efficient. Under Section 7, an ER system must meet the following criteria:

- Be a demand-initiated regeneration (DIR) system. In other words, it must use a flow meter or water hardness sensor to initiate regeneration. Devices that use time clock-initiated regeneration (fixed time schedule) do not qualify for the efficiency rating. Softeners that use time clock-initiated regeneration automatically regenerate on a fixed time schedule set by the user (typically every four days to weekly). This can result in unnecessary regeneration during times of reduced use and waste large volumes of water.

- Have a rated salt efficiency of not less than 3,350 grains of total hardness exchange per pound of salt, based on NaCl equivalency (477 grams of total hardness exchange per kilogram of salt).

- Not generate more than 5.0 gallons of water per 1,000 grains of hardness removed during the service cycle (18.9 liters per 64.8 grams of total hardness removed).

Implementation

Most manufacturers indicate on the product packaging and literature that their product meets the NSF/ANSI 44 Residential Cation Exchange Water Softeners Efficiency Rating. In addition, the following organizations that independently certify water softeners to the NSF/ANSI standards maintain a listing of products that meet the voluntary efficiency rating:

- Water Quality Association (WQA) Gold Seal Certification Listings at www.wqa.org/sitelogic.cfm.
- NSF International (NSF) Product and Service Listings at www.nsf.org/Certified/DWTU
- Underwriters Laboratories, Inc. (UL) Online Certification Directory at database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html

Inspection

The inspector will verify through the manufacturer's product specification sheet or product manual that the softener has been certified to meet NSF/ANSI 44 Residential Cation Exchange Water Softeners, including the voluntary efficiency rating standards in Section 7.

II.G.5 Drinking Water Treatment Systems (3.8.3)

WaterSense Criteria

Intent
Water-efficient drinking water treatment systems should waste no more than 15 gallons of water for every 100 gallons of water processed.

Drinking water systems, if installed, shall be certified to meet applicable NSF/ANSI standards, which 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*

Such systems shall yield at least 85 gallons of treated water for each 100 gallons of water processed.

Background

Public water suppliers must meet federal and state safe drinking water criteria to ensure water is safe to drink without additional treatment. Public water suppliers must notify consumers if a contaminant affecting health is found to exceed the standard. In some cases, the supplier may be required to provide an alternate water supply. Private water supplies, on the other hand, are not regulated or tested. Individuals with private wells are responsible for protecting the water supply from contamination, testing the water quality, and selecting treatment if needed.

To select an appropriate treatment system, a builder should know which contaminants or water properties the treatment system will address. There is no single device or method that removes all contaminants or solves every water problem, and no single test to determine if water requires treatment. Though most water treatment dealers can provide free in-home or laboratory tests, the tests normally are for nuisance contaminants such as hardness, pH, iron, manganese, sulfur, and total dissolved solids. Occasionally, a dealer may test for nitrate. Seldom does any test include all the contaminants covered by the Safe Drinking Water Act (SDWA).

Most nuisance problems such as iron, manganese, hardness, pH, and odor require treatment at the point of entry of the water in the house. Some contaminants that affect health such as nitrate and lead are a concern only for water used for drinking or cooking, so point-of-use equipment at a separate tap that treats water only where it will be used for that purpose may be adequate. Bacteria and some organic contaminants will require point-of-entry equipment to prevent exposure during bathing or other water uses.

Most residential drinking water treatment systems, with the exception of most reverse osmosis treatment systems, meet the 85 percent efficiency rating. In fact, most non-reverse osmosis systems are 100 percent efficient, as all of the water that flows into the filtration system is treated for use.

NSF International has developed the following standards that apply to drinking water treatment systems:

- 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

Products that have been tested or evaluated by NSF to meet the minimum requirements are entitled to display the NSF listing mark on the products or in advertising literature for products. Models that meet the applicable standard are included in a listing published twice annually.

Implementation

To determine if a drinking water treatment system meets the applicable NSF/ANSI standard and has an 85 percent minimum rating, check the manufacturer's product literature. Suppliers should also be able identify systems that meet this specification.

Nearly all water treatment devices require some maintenance, monitoring, and/or testing to evaluate and ensure proper operation. Builders should ensure that the appropriate information is obtained from the manufacturer and provided to the homeowner.

Inspection

The inspector will verify through manufacturer product literature that the installed drinking water treatment system meets the applicable NSF/ANSI standard and yields at least 85 gallons of treated water for each 100 gallons of water processed.

II.H Metering (3.9)

WaterSense Criteria

In multi-family buildings, each unit must be individually metered, submetered, or equipped with an alternate technology capable of tracking water use and making the information available to the residents of the individual unit.

Intent
Individual metering or submetering of each unit allows residents to understand and better manage their water use.

Background

An important rule in water management is that you can't manage what you don't measure. In many traditional multi-family buildings, an entire building might be metered, but residential units might not be individually metered or individually monitored. As a result, the persons directly responsible for the water use are not informed of their impact and often have no motivation to

manage their consumption. Metering individual units provides awareness of and promotes and empowers individual residents to proactively manage their water use. One national study on submetering of multi-family buildings showed that residents in submetered units used approximately 15 percent less water than residents in unmetered units.[20] Monitoring individual units also enables property managers to more easily identify and manage potential issues such as leaks that might be occurring within a specific unit. Better managed water use will result in lower water and wastewater utility bills, an attractive offering to potential residents.

Several options exist to meet the WaterSense criteria for monitoring water use on a per unit basis. Meters are typically owned by the water purveyor and represent separate accounts. In order to be separately metered, each unit must typically represent a wholly separate plumbing system attached to the main line. Submetering typically involves using smaller meters to monitor the different uses of water under a single account. Several technologies are also emerging that give property managers the ability to track water use on a per unit basis without installing physical meters or submeters for each unit. These technologies can be used to meet the WaterSense criteria and often carry the added benefit of having high level user interfaces that allow residents to view their water use in an up-to-date and easy-to-understand display. It is important to make sure that, regardless of which option is chosen, the building continues to meet all applicable building codes and meets the manufacturer specifications for optimal operation.

Due to the cost associated with separately metering each unit, submetering is often the most feasible option for many buildings. Planning for submetering of individual units must occur during the early stages of the plumbing system design. Accurate submetering of individual units requires each unit be supplied with a single pipe source for water, or alternatively, each source of water entering the unit must be separately metered. This is in contrast to conventional design where multi-family buildings are plumbed by sector, rather than by unit, to minimize the piping and installation costs.[21] Because submetering generally requires water to be supplied to each unit through a single pipe source, as an added benefit water can be shut off to individual units without interrupting water service to other units.

In addition to plumbing design, installing the right type of equipment and ensuring it functions properly is critical for accurate water use measurement. There are many types and sizes of meters intended for different uses, so it is important to choose the correct one. For example, an undersized water meter can cause excessive pressure loss, reduced flow, and noise. Oversized meters are not economical and do not accurately measure minimal flow rates.[22]

Implementation

As a first step, when designing the plumbing system for a multi-family building, consider supplying each unit with a single pipe source for the water to facilitate individual unit

[20] Mayer, P. et al. 2004. "National Multiple Family Submetering and Allocation Billing Program Study." <http://www.allianceforwaterefficiency.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=704>.
[21] Alliance for Water Efficiency. 2010. "Submetering Introduction." http://www.allianceforwaterefficiency.org/submetering.aspx.
[22] Smith, Timothy A. April 22, 2008. "Water-Meter Selection and Sizing." http://www.park-usa.com/skins/park/standard.aspx?elid=71&arl=108.

submetering. This will reduce costs associated with having to install multiple meters for several points of use attached to a single riser pipe.

Second, choose equipment that is best suited for accurately measuring water use in each unit. Because water use within individual units will fluctuate between low and peak flows, depending on the unit's occupancy and the time of day, positive displacement meters are often the best option. Also, work with the meter manufacturer to select an appropriately sized submeter. It is critical to understand both the building's and individual units' size, function, fixture types, usage occupancy, and peak population in order to select an appropriately sized meter. These statistics determine the minimum and maximum flow rates and will assist in the selection of a properly sized water meter for each unit.[23]

Follow manufacturers' instructions closely so that proper installation can occur. Improper installation can lead to metering inaccuracies. In general, meters (including submeters for individual units) should be installed in an accessible location to allow for reading and repair. In addition, the meter location should be protected from potential damage. To ensure uniform flow entering and exiting the meter, the meter should be located where there is sufficient length of straight pipe above and below the meter. Also, install a strainer to prevent debris and sediment from entering the meter and causing reading inaccuracies.[24]

To further facilitate water use tracking, consider integrating individual unit submeters into a centralized building management system, making it easy for the property manager to track usage on a unit-level basis. Centralized building management systems are capable of electronically storing data, reporting hourly, daily, monthly, and annual water use. They can also trigger alerts when leaks or other operational anomalies are detected.

Include information on and a map indicating the location of all water supply meters and individual unit submeters in the Building Operating Manual. Also, consider including information on individual unit submeters in the Occupant Operating Manual.

Individual unit submetering does add construction costs; however, some local water utilities offer technical assistance and cost-sharing for individual metering of multi-family buildings. Contact the local utility to inquire about such programs.

As noted above, when submetering of an individual unit is not possible, there are alternatives available for estimating the system's water use. Flow sensors or end-use meters can be attached to major water-using appliances, such as water heaters, showers, toilets, faucets, dishwashers, and washing machines. End-use data can be collected at a central location and be used to estimate each unit's water use by adjusting it proportionally to the master meter consumption records.[25]

[23] Smith, *op. cit.*
[24] Smith, *op. cit.*
[25] Alliance for Water Efficiency. o*p. cit.*

Inspection

The inspector will verify that a submeter or an alternative for tracking water use is installed for each unit within the multi-family building. The inspector will also ensure that information from the submeter is readily available to the unit's occupants.

II.I Additional Measures for Indoor Water Efficiency

There are many additional water- and/or energy-saving measures that can be implemented to go above and beyond the scope of this specification. Although none of the following items in this section is addressed by the WaterSense specification, builders should consider the following information when constructing a high-performing, water-efficient home. Certain fixtures may not be applicable in all homes, and specific home characteristics should be considered when choosing any of the following measures or products.

II.I.1 Water Heaters

Water heaters use a variety of methods to heat water from the cold water inlet; the five main types of water heaters are conventional storage, demand (also known as tankless), heat pump, solar, and tankless coil. ENERGY STAR labels five types of water heaters: gas condensing, heat pump, high-efficiency gas storage, solar, and whole-house gas tankless.[26] Each of the five main types of water heaters is discussed below.

Conventional Storage

Conventional storage water heaters are found in most homes and use a storage tank ranging anywhere from 20 to 100 gallons in size to store water once it is heated. Hot water exits the top of the tank when a hot water tap is turned on and is replaced with cold water, ensuring that the tank is always full. Water is heated using gas, propane, oil, or electricity, but gas and electric conventional storage water heaters are most common. Gas and propane tanks operate by using a gas burner to heat the tank from underneath. A thermostat regulates the temperature and opens the gas valve when the water temperature falls. Oil-fired water heaters operate under the same mechanism, except that power burners that mix oil and air are ignited by an electric spark. Electric water heaters have one, sometimes two, electric elements that each have their own thermostat. In a two-element system, elements are located at the top and bottom of the tank, with the bottom element maintaining a minimum temperature, and the top element providing hot water recovery with increased demand. Because conventional storage water heaters constantly heat water in the tank, energy can be lost due to standby heat

[26] ENERGY STAR Web Site. www.energystar.gov/index.cfm?c=products.pr_find_es_products

loss when hot water taps are not running. Well-insulated storage tanks help to reduce the effect of standby heat loss.[27]

Demand
Demand, or tankless, water heaters heat water only as it is needed and do not require a storage tank. Demand water heaters are connected to a cold water pipe and begin to receive water flow once a hot water tap is turned on. Gas or electricity can only be used in this type of system. With a gas system, a gas burner heats the water as it passes through. An electrical system, on the other hand, uses electric elements to heat the water. Demand water heaters do not experience standby heat loss, since they only heat water as it is needed.[28]

Heat Pump
Heat pump water heaters can work as stand-alone units or be used in a combination water heating and space conditioning system. Heat pump water heaters act as refrigerators in reverse by drawing heat from the surrounding air and using it to heat water contained in a tank. In this system, a low-pressure liquid refrigerant is vaporized in the heat pump's vaporizer and passes through to the compressor, its temperature increasing as its pressure increases. The heated refrigerant then flows through a condenser coil in the storage tank and heats the water that is stored there. Heat pumps use electricity and cannot be gas-fueled. Because heat pumps do not produce heat directly, they operate more effectively in locations with excess heat, e.g., a furnace room, that remain in the range of 40° F to 90°F year-round.[29]

Homes with a geothermal heat pump already installed can use a desuperheater heat pump to heat water. Desuperheaters are auxiliary heat exchangers that use superheated gases from the geothermal heat pump's compressor to heat water. There are also tankless desuperheater models, which take excess heat during the warmer months that is normally dispelled to the ground and use it to heat water. Desuperheaters that operate in this fashion need a backup source of hot water (either conventional storage or tankless) to provide hot water during colder months.

Solar
There are several different types of water heaters that use solar energy to heat water. Solar water heaters differ based on how the solar energy is collected. Solar energy is collected in residential applications using either flat-plate collectors, integral collector-storage systems, or evacuated-solar tube collectors. Flat-plate collectors collect solar energy using a dark absorber plate that can be either glazed or unglazed. Integral collector-storage systems preheat cold water as it passes through a system of black tanks or tubes and deliver hot water to the backup water heater (usual a conventional storage tank). Evacuated-solar tube collectors use "fins" attached to tubes to collect solar energy. A vacuum created between the tubes eliminates conductive and convective heat loss.

[27] Energy Savers website. Water Heating. www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12760
[28] Home Builders Association of Metro Denver. 2007. Guide to the 2007 Built Green Checklist.
[29] Energy Savers website. Water Heating. www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12760

Solar water heaters can operate as either active or passive systems. Active systems use an electric pump to circulate water or other heat-transfer fluids through the collectors, while passive systems rely on thermo-siphoning to circulate water. Solar water heaters operate most effectively in climates with frequent direct sun exposure.

Tankless Coil

Tankless coil water heaters use a home's space heating system to heat water. A tankless coil water heater uses a heating coil or heat exchanger installed in a main furnace or boiler. Whenever a hot water faucet is turned on, the water flows through the heat exchanger. These water heaters provide hot water on demand without a tank, like a demand water heater, but because they rely on the furnace or boiler to heat the water directly, tankless coil water heaters work most efficiently during cold months when the heating system is used regularly. They may be an inefficient choice for many homes, especially for those in warmer climates.[30]

Choosing a Water Heater

Several factors should be considered when selecting a water heater, including the location of the water heater relative to hot water fixtures and the characteristics of the hot water distribution system. In a typical new construction home, demand water heaters can be used in all climates, are relatively affordable, and may contribute to a water-efficient hot water distribution system. A single, gas-fired demand water heater can typically provide hot water for a 2.5 bath home. Multiple demand water heaters installed at hot water fixture locations can ensure the largest amount of water savings by reducing the distance—and therefore time—hot water must travel. If multiple demand water heaters are used in a home, installing them in parallel can increase their effectiveness. Demand water heaters cost between $200 and $1,000, based on size and hot water production rate. Prices increase with higher flow rates. Conventional storage water heaters cost less at $300 to $400 but have a shorter expected life of 10 to 15 years, versus 20 years for tankless models.[31] Heat pump, tankless coil, and solar water heaters can also offer advantages where those technologies are applicable.

Once a water heater type is chosen, the next step is to choose a fuel source. Water heaters can be heated using gas, electricity, fuel oil, propane, or solar energy, but are most commonly heated using either gas or electricity. Gas can be used in conventional storage, demand, and tankless coil systems. Electricity can be used in conventional storage, demand, and tankless coil systems and are the only option for heat pump water heaters. Gas-fueled water heaters can heat water faster than other fuel methods and, therefore, can reduce water wasted while waiting for hot water and save energy by heating less water.[32]

[30] U.S. Department of Energy, Energy Efficiency and Renewable Energy: Energy Savers. Tankless Coil and Indirect Water Heaters
www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13020
[31] Consumer Energy Center website. Water Heaters.
www.consumerenergycenter.org/home/appliances/waterheaters.html
[32] California Energy Commission. 2009. Consumer Energy Center. Water Heaters.
www.consumerenergycenter.org/home/appliances/waterheaters.html

II.I.2 Sump Pumps

Sump pumps are used in the basements of homes that are prone to flooding or built in areas with high water tables. Sump pump systems use a nearby sump pit to monitor water levels and remove water from the basement to prevent flooding when needed. There are two types of sump pumps: pedestal or submersible. The motor in a pedestal sump pump is mounted above the sump pit and is connected to a float ball, used to monitor the water level. Alternatively, the motor of a submersible pump is mounted inside the sump pit along with the float ball. Both types of sump pumps use an impeller, which turns on inside the pump once high water levels are detected. The centrifugal force from the impeller creates a low-pressure void, drawing in water, which is then pushed by the impeller into outflow pipes. The outflow pipes distribute the water away from the home's foundation.

Sump pumps are most commonly connected to the home's electrical system. However, there are some models currently on the market that use water pressure to power the sump pump. Water powered pumps work by pushing water through a Venturi nozzle at a high speed, causing water pressure to drop. The low water pressure creates a suction, much like an impeller does in electric-powered models, that draws in water. Water-powered sump pump systems require a fresh water flow and may use a significant amount of water, which might not be a strong selling feature of a water-efficient home.

II.I.3 Whole-House Humidifiers

Dry environments with low humidity may require the use of a whole-house humidifier. Whole-house humidifiers, which are connected to a home's heating and cooling ducts, are generally divided into two types: evaporative and vaporizer. Evaporative humidifiers provide moisture passively using either a drum or flow-through system. Drum systems use belts that rotate through a reservoir of water, allowing air to absorb the moisture as it blows over the belt. Flow-through humidifiers use a similar method, but instead use a wet screen or mesh over which air flows. Vaporizer humidifiers inject moisture directly into the air in the form of mist. There are also several other, less commonly used humidifier technologies, including impeller and ultrasonic models, which use a spinning disc and a vibrating diaphragm, respectively, to distribute moisture into the air.

The water efficiency of whole-house humidifiers varies by technology. Efficient whole-house humidifiers use all or most of the water they receive to produce humidity, which can range from two to seven gallons per day. Less efficient units can use upwards of 50 gallons per day. Efficient units reuse excess water, while inefficient units allow excess water to bleed into the sewer drain. Evaporative humidifiers, like evaporative cooling systems, may also use continuous bleed or periodic blowdown methods to remove mineral buildup on evaporation pads. Flow-through models tend to be more inefficient than other models because they use blowdown. If a whole-house humidifier is to be installed, builders should look for humidifiers that reuse water and do not use blowdown to remove mineral buildup.[33]

[33] Alliance for Water Efficiency Resource Library.
www.allianceforwaterefficiency.org/Humidifier_intro.aspx?terms=whole+house+humidifiers

III. WaterSense Outdoor Water-Efficiency Criteria

On average, single-family homes in the United States use 30 percent of their water outdoors; however, in some drier areas of the country, that number is as high as 70 percent. Experts estimate that up to half of the water applied to a landscape is wasted by evaporation, wind, or runoff due to improper irrigation system design, installation, and maintenance.

A home with a water-efficient landscape can provide all the benefits of a conventional landscape with less water and less maintenance, while maintaining an attractive and healthy outdoor space. Additional information about water-efficient landscapes can be found on the WaterSense website at http://www.epa.gov/watersense/outdoor/landscaping.html.

The criteria in this specification address landscape water efficiency through a combination of appropriate landscape design and efficient irrigation systems, if a system is installed. Certain landscapes in many regions of the country may not need supplemental water. If an irrigation system is not installed, the home is not required to meet irrigation criteria contained in Section 4.2 of the specification. To earn the WaterSense label, however, the home's outdoor landscaping must meet the criteria in Section 4.1.

III.A Landscape Criteria (4.1)

WaterSense Criteria

Intent
Water-efficient landscape design consists of regionally appropriate plants, efficient design, proper treatment of slopes, mulching, and efficient measures for pools, spas, and other water features, if installed.

All landscape criteria for single-family homes apply to the front yard. In addition, the criteria apply to all areas improved upon by the builder for single-family and multi-family buildings, including common-use areas of multi-family buildings intended or made available for the use of building residents. This includes areas with vegetation beyond temporary stabilization measures, irrigation systems, permeable hardscape or softscape features, pools, spas, and/or water features.

Temporary landscapes (e.g., straw over bare soil) may be installed if permanent landscapes cannot be installed due to climate conditions or because occupancy of units in multi-family buildings occurs before common-area landscapes are installed. Homes or buildings with temporary landscapes can be inspected for compliance with indoor criteria and may be sold before a permanent landscape is installed. The WaterSense label designation (including use of stickers and certificates) may not be issued until the permanent landscape is installed, inspected, and certified to comply with all applicable criteria.

Background

Through this specification, builders are encouraged to select native or climate appropriate plantings. Best practice is to choose plantings that are appropriate for the specific features of the site. Even portions of the same site may vary significantly in soil type, exposure to sun,

wind, and associated evaporation rates and moisture levels. Smart planting takes into consideration both local and microclimate conditions. A microclimate is a small location that has environmental conditions that are not typical everywhere else in the area. For example, a microclimate might exist near a large rock. As the sun heats the rock, the rock will give off heat. Thus the environment around the rock will be warmer than the area 10 feet from the rock. In addition, the shade produced from a tree might also be considered a microclimate. The temperature under the tree is different from the temperature further from the tree.

The use of drought-tolerant plants, particularly in dry regions, can significantly reduce demand for water, chemicals, and maintenance. In some climates, it is possible to eliminate the need for permanent irrigation through the use of drought-tolerant plants and improved landscape design.[34] Drought-tolerant plants vary by region, and builders should consult local extension offices or other resources to determine appropriate local plants. Slow-growing perennials and shrubs are often good candidates.

Drought-tolerant turfgrass can also help to reduce water use. Like drought-tolerant plants, drought-tolerant turfgrasses vary by region. Turfgrasses are differentiated by warm-season or cool-season turfgrasses. Warm-season turfgrass is typically more drought-tolerant and should be used in warm-weather climates. Some cool-season turfgrasses can also be drought-tolerant, such as fine fescues, and are more appropriate in cold-weather climates. [35]

Healthy soils effectively cycle nutrients; minimize runoff and maximize water holding capacity; absorb excess nutrients, sediments, and pollutants; and provide a healthy rooting environment and habitat for plants. Preserving existing topsoil, adding organic material, and minimizing compaction are practices that allow soils to function as a base for large, healthy plants that require fewer pesticides, fertilizers, and supplemental water for plant growth. Healthy soils also maintain a permeable soil structure, which ensures higher water infiltration rates that in turn reduce erosion, runoff, and flooding potential.[36]

Implementation

All criteria in the *Version 1.1 WaterSense New Home Specification* apply to the front yard for single-family homes and all areas improved upon by the builder for single-family and multi-family buildings. To calculate this area, use the landscape design provided by the landscape professional. Exclude the footprint of the home and permanent hardscape areas such as driveways, sidewalks, and patios. Also, exclude septic drainage fields and public rights-of-way. The landscaped area will be used in calculations associated with the landscape design described below.

Working with a landscape professional that has experience in water efficiency will build a strong foundation for meeting the outdoor criteria of the specification. Builders should work with their landscape professionals from site design through installation to ensure all criteria are planned for and implemented appropriately.

[34] U.S. Green Building Council. 2008. LEED for Homes Reference Guide.
[35] Amy Vickers. 2001. Handbook of Water Use and Conservation.
[36] The Sustainable Sites Initiative. 2007. Preliminary Report on Standards & Guidelines. November 2007.

III.A.1 Landscape Design (4.1.1)

WaterSense Criteria

Design of the landscaped area shall be developed using the WaterSense Water Budget Tool. In single-family homes, pools, spas, and other water features shall be treated as turfgrass. Lots with total landscapable areas equal to or less than 1,000 square feet are exempt from Criterion 4.1.1: Landscape design. For multi-family buildings, common-use pools/spas and all areas that are reserved for private use of a particular residence/unit (e.g., areas deeded, identified as limited-use common elements, or otherwise restricted by building management) are excluded from the landscapable area. Additional criteria apply to pools/spas in Criterion 4.1.4: Pools/spas.

Intent
Water-efficient landscapes are designed in a way that will minimize the need for supplemental water.

Background

Turfgrass is frequently over-watered by homeowners who do not understand its water requirements. A water-efficient landscape consists of a variety of medium- or low water-using plants in combination with functional turfgrass areas. Limiting turfgrass to areas where it aesthetically highlights the house or where it has a practical function such as in play areas can increase the water efficiency of the yard while still providing benefits to the homeowner. Some communities have prescriptive requirements that limit the coverage of turfgrass as a means to address their local water supply challenges.

The WaterSense Water Budget Tool provides the landscape designer flexibility, incorporating regional differences and plant water requirements. The intent is to determine a regionally-appropriate amount of water that can be applied to the landscape, then design a landscape that will require no more than this amount.

Implementation

The first step is to calculate the landscaped area as described above. For single-family homes, pools, spas, and other water features must be included in this area and are counted as turfgrass. For multi-family buildings, the landscaped area should not include pools, spas, and water features.

Refer to the WaterSense Water Budget Tool and *WaterSense Water Budget Approach* located at www.epa.gov/watersense/water_budget. The tool assists the builder or landscape professional in calculating the allotted amount of water the landscape can be designed to use. The *Approach* document guides the user through the tool and provides examples of the water budget options in different regions of the country. Homes that are built in areas that have prescriptive landscape requirements must still use the Water Budget Tool to meet the specification; however, it is likely that the prescriptive criteria (which typically limit coverage of turfgrass) will result in a landscape that meets the tool.

The WaterSense Water Budget Tool allows the professional to design a sustainable landscape based on a regionally-appropriate amount of water. A water budget is a site-specific method of calculating an allowable amount of water to be used by the landscape, then designing the landscape to meet this budget. The budget takes into account plant type, plant water needs, irrigation system design, and applied water that the landscape receives either by irrigation or by precipitation. Water budgets must be associated with a specified amount of time, such as a week, month, or year.

The water budget tool guides the user through the water budget calculation in three parts. First, the tool calculates the amount of water a standard landscape would require and the amount of water the designed landscape is allowed in order to be considered water-efficient. Next, the tool calculates how much water the designed landscape requires based on climate, plant type, and irrigation system design. Lastly, it determines whether the designed landscape meets EPA's criteria.

This WaterSense labeled home in the mountain region of the southeast designed a landscape using the EPA Water Budget Tool.

WaterSense chose a well-maintained lawn composed entirely of green turfgrass (i.e. cool season turfgrass using 100 percent of the reference evapotranspiration) as the baseline, or conventional model, and a 30 percent reduction in associated water use as the reduction that would result in water efficiency. This does not mean that WaterSense maintains a lawn should be watered with 70 percent of the water it requires, but that a plant mix should be selected that would use 30 percent less water than a landscape comprised entirely of turfgrass. The data used to calculate water use, discussed below, are modeled across the entire United States by zip code, resulting in site-specific allotments. Therefore, while every yard of a WaterSense labeled home must achieve the same minimum percentage reduction, the actual requirement, in gallons of water, varies greatly based on what is appropriate for each region. Additionally, the data are conservative in nature in order to result in a landscape capable of withstanding the most challenging months of the year.

In addition to the types of vegetation planted and irrigation equipment installed, the tool requires two climate-based inputs: local reference evapotranspiration (ET_o) and rainfall. These inputs are automatically supplied via the online Water Budget Tool and are also available via the Water Budget Data Finder, both of which are available at www.epa.gov/watersense/water_budget, which is searchable by zip code. The Water Budget Data Finder must be used to generate the information for the Water Budget Tool. The tool also requires the use of a landscape coefficient for each category of vegetation planted. WaterSense has assigned relative species factors to each category within the broad plant types—trees, shrubs, groundcover, and turfgrass—for the builder to use.

The WaterSense Water Budget Tool functions well for its intended purpose of promoting a water-efficient landscape design. However, it should not be used to determine irrigation scheduling amounts, nor for estimating potential water use, as it would likely result in the over-application/estimation of water.

The landscape professional should consider the local climate when selecting plants and group plants with similar water needs, a practice known as hydrozoning. For example, drought-tolerant plants such as sages or cacti would not be planted in a bluegrass lawn, but would be separated, since bluegrass has a higher water requirement. Hydrozoning also seeks to take advantage of microclimates. Plants that tolerate more heat and wind might be planted near the street, while more sensitive plants might be planted in shade, under roof overhangs, or in fenced areas. Hydrozoning can also refer to a design practice undertaken to improve irrigation efficiency. The system is designed so that plants with similar watering requirements are watered together and separated from plants with different requirements. For example, one group of plants might need watering for 20 minutes, while another group of plants may need only 10 minutes. Similarly, one group might require year-round watering, while another might require it for only a small portion of the year

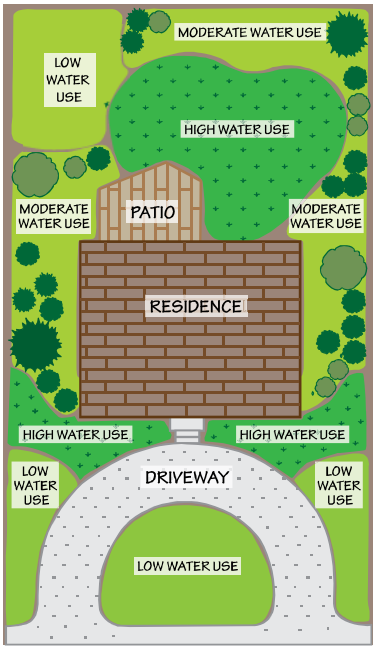


Figure 5. Hydrozoning

Inspection

The inspector will obtain a copy of the completed Water Budget Tool from the builder partner. Using EPA's Water Budget Data Finder, the inspector will type in the home's zip code and verify that the correct peak watering month, ET_o, and rainfall amounts are used in Parts 1 and 2 of the Water Budget Tool. Next, the inspector will verify that the areas (square footage) of each category of vegetation installed are approximately the same as those listed in Part 2 of the Water Budget Tool.

III.A.2 Slopes (4.1.2)

WaterSense Criteria

Slopes in excess of 4 feet of horizontal run per 1 foot vertical rise (4:1) shall be vegetated.

Intent
Installing plantings such as ground covers on steep slopes without sprinkler irrigation provides stabilization to prevent erosion and increase filtration as water passes down the slope.

Background

Steep slopes in landscapes provide a challenge for the landscape design because of their potential for erosion and runoff from stormwater and irrigation water. Erosion can be a serious problem if vegetation is not established. Care should be taken to ensure that appropriate plantings are used and that only irrigation methods suitable

for slopes are applied. South-facing slopes can warm up and dry out quicker than other areas, while north-facing slopes can be cooler than surrounding areas.

Considerations must be given to the plantings installed on slopes, as it may not be safe to operate a lawn mower on slopes greater than 2:1 (2 feet of horizontal run per 1 foot vertical rise). Trees and shrubs create a tight network of roots and stems that not only bind soil particles together, but also act to slow the force of rushing water down the hillside. Turfgrass on steep slopes can help to bind the soil with roots, but might not slow down stormwater runoff. Thus, heavy rains can wash away turf, roots and all. Taller growing grasses, wildflowers, shrubs, and trees do a much better job of slowing stormwater runoff from steep slopes.

Terracing is an alternative approach to planting on slopes. Open terraces can be dug into the slope in the shapes of steps. The existing slope can be cut, and the excavated soil can be used as fill. A low soil berm (ridge) can be formed at the front edge of each step or terrace to slow the flow of water.

Implementation

Builders should work with the landscape professional to either remove or reshape slopes greater than 4 feet of horizontal run per 1 foot vertical rise (4:1, 25 percent or 14 degrees), or ensure those areas are planted. The landscape professional should choose appropriate plant types to hold on to the soil.

Inspection

The inspector will use a laser level, clinometer, or other method to determine if slopes are greater than 25 percent or 14 degrees (i.e., 4:1 slope), then verify that slopes greater than 25 percent have vegetated plantings (e.g., groundcover, shrubs, tall grasses, etc.).

III.A.3 Mulching (4.1.3)

WaterSense Criteria

All exposed soil shall be covered with a 2- to 3-inch layer of mulching material.

Intent
Mulch can provide many benefits to a landscape, including reducing the evaporation of water from the soil.

Background

Mulching has numerous beneficial effects upon the soil and plants, including:

- Preventing loss of water from the soil by evaporation. Moisture moves by capillary action to the surface and evaporates if the soil is not covered by mulch.
- Suppressing weeds when the mulch material itself is weed-free and applied deeply enough to prevent weed germination or to smother existing small weeds.
- Maintaining a more uniform soil temperature. The mulch acts as an insulator that keeps the soil cool under intense sunlight and warm during cold weather.

- Preventing crusting of the soil surface, thus improving absorption and percolation of water into the soil and, at the same time, reducing erosion.
- Improving soil structure by using organic materials as mulch. As mulch decays, the material becomes topsoil. Decaying mulch can also add nutrients to the soil.
- Increasing the beauty of the landscape by providing a cover of uniform color and interesting texture to the surface.

Mulching is an extremely important practice for establishing plantings, as it helps to conserve moisture in the root ball of the new plant until it establishes roots in the adjacent landscape soil. Mulch also helps discourage weeds that can compete with new plantings for water, nutrients, and light. Mulch can be used instead of grass around individual trees and shrubs in a lawn. This greatly reduces the competition for water and nutrients from the turf and increases the growth rate and health of trees and shrubs. In addition to being useful around plants, mulch can be used as a groundcover for walks, trails, driveways, and natural and play areas. It can be used temporarily to cover low-growing tender plants to protect them from frost injury. Mulch also can be composted and used as a soil amendment.[37] For trees, at a minimum, mulch should be applied to the area below the tree's canopy from the tree base to the drip line, or the border of the canopy of the tree, leaving space between the beginning of the mulch layer and the tree trunk to prevent rot.

Too much mulch, however, can create problems. Because mulch helps retain moisture, too much mulch can lead to excess moisture. Especially in trees, this can lead to root rot. Do not pile mulch against the stems of plants or the trunks of trees, as this can cause stress on the plant tissues and lead to pest problems. Too much mulch can also alter the pH of the soil, causing toxicities or deficiencies. Piled mulch provides a home for rodents, which in turn may chew the plant roots and cause tree girdling. Fine mulch can become matted if applied too thick, preventing air and moisture penetration.[38]

Implementation

Mulch entire beds of shrubs, trees, annuals, perennials, and/or ground covers. For the purposes of this specification, mulch is defined as a permeable arrangement of organic and/or inorganic materials that will retain soil moisture, suppress weeds, and allow free movement of oxygen into and out of the soil. For example, organic mulches include wood-based materials such as wood chips or bark, while inorganic mulches include rock-based materials such as pea gravel or lava rock. Artificial turf is considered mulch for the purposes of this specification, provided that it meets the definition.

Make sure mulch is at least 2 inches, but no more than 3 inches deep. When complete, the landscape should not have any areas of exposed soil. Additionally, the landscape professional should take measures to prevent on- and off-site migration of mulching materials to sidewalks, streets, etc.

[37] Alliance for Water Efficiency Resource Library. http://www.allianceforwaterefficiency.org/Mulches_for_the_Landscape.aspx
[38] Proper Mulching. Accessed November 21, 2009. www.onlinetips.org/landscape-mulching.

Inspection

The inspector will verify that all mulched areas are between 2 and 3 inches deep and that there are no areas of exposed soil in the landscaped area.

III.A.4 Pools/Spas (4.1.4)

WaterSense Criteria

Pools and spas financed, installed, or sold as upgrades by the homebuilder in single-family homes shall have an appropriate cover.

Intent
Covers are required to minimize the amount of water lost from pools and spas due to evaporation.

Common-use pools/spas in multi-family buildings must have the following features:

1. *Be independently metered such that water use attributable to the pool and/or spa can be tracked and leaks can be readily identified.*
2. *Be equipped with a gutter or grate system to catch water splashes or drag-outs.*
3. *Be equipped with either sorptive media or cartridge filtration.*

Background

It is difficult to determine how much water an average swimming pool uses. However, by comparing homes with and without swimming pools and correcting for differences in landscape size, it is estimated that single-family homes with a swimming pool use about 58 percent more water outdoors than single-family homes without a swimming pool. This research indicates that the addition of a swimming pool results in a substantial increase in water use.[39]

Covering the pool installed at single-family homes, however, will reduce water loss due to normal evaporation. The cover can also reduce heating bills up to 50 percent by preventing night heat loss and will also save on chemicals. Pool covers come in a wide range of types and costs, and it is important to make sure the cover fits properly.

Swimming pools installed at multi-family buildings primarily lose water by evaporating from the surface, cleaning the pools via backwashing filters, and maintaining overall water quality standards. To mitigate water losses from these sources, WaterSense requires that the pools be independently metered to detect leaks and perform maintenance before significant water loss occurs. WaterSense also requires that pools be designed to reduce water losses from splashing by redirecting or catching the splashes (e.g., overhanging edges, perimeter gutter, and grate systems).

In addition, WaterSense requires that the pools be equipped with water filtration systems using sorptive media or cartridges that use less water during backwashing than other filtration

[39] Alliance for Water Efficiency website. Swimming Pool and Spa Introduction. www.allianceforwaterefficiency.org/Swimming_Pool_and_Spa_Introduction.aspx

systems such as sand. Sorptive media filters include conventional diatomaceous earth (DE) or perlite filters and regenerative filters that reuse the filter media. These filters remove particles down to 5 microns in size, while sand and cartridge filters work in the 10- to 40-micron removal range. Sorptive media filters have hundreds to sometimes more than 1,000 fabric-coated tubes inside a pressure container. The medium (DE or perlite) is made into a slurry and mixed with the water in the filter. The medium is then deposited on the tubes by the water being pumped through the filter. Conventional sorptive media filters must have the DE or perlite replaced after each backwash. With regenerative sorptive media filters, the medium is periodically "bumped" off of the filter tubes by backflow, air agitation, mechanical shaking, or a combination of the three. It is then recoated onto the filter cloth. No water is lost in the recoating process. When the medium is flushed, only a few hundred gallons of water are needed. This makes regenerative sorptive media filters very water-efficient.[40]

Water-efficient cartridge filtration systems use reusable filter cartridges that do not require backwashing to clean the filters. In this type of system, two sets of filters are required and each should last two to five years. When one set is removed for cleaning, the other set is installed in the system. Reusable filter cartridges must be soaked in a cleaning solution, then brushed and rinsed off prior to reuse.[41]

Covering pools during long periods of inactivity, when possible, will also aid in reducing water losses through evaporation.

Implementation

Builders should work with landscape professionals to ensure the surface area of the pool or spa installed at a single-family home is included in the landscaped area and is treated as turfgrass in the landscape design.

At single-family homes, builders should also ensure that the cover is installed on the pool and/or spa prior to the inspection.

At multi-family homes, builders should ensure that the pool complies with all of the required criteria prior to the inspection.

Inspection

For single-family homes, the inspector will verify that a cover is installed on all pools and spas.

For multi-family homes, the inspector will verify that the pool is independently metered, has a gutter or grate system, and is equipped with either sorptive media or cartridge filtration.

[40] Alliance for Water Efficiency. Watersmart Guide Book: Pools, Spas, and Fountains. http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/non_residential/EBMUD/EBMUD_WaterSmart_Guide_Pools_Spas_Fountains.pdf
[41] Ibid.

III.A.5 Ornamental Water Features (4.1.5)

WaterSense Criteria

Ornamental water features financed, installed, or sold through the homebuilder must recirculate water and serve a beneficial use.

Intent
Recirculation increases the water efficiency of the water feature.

Background

Ornamental water features can be installed as long as they recirculate water and serve a beneficial use such as wildlife habitat, stormwater management, and/or noise reduction. The water consumption of an ornamental water feature can be reduced if smaller pumps, lower pumping rates, and/or pressure-reducing valves are used to reduce water flow. The higher the water flow, the more water wasted due to evaporation.

Recirculating the water reduces the amount of potable water used in an ornamental feature and helps to maintain any plant growths in the feature. Two types of pumps are available for recirculating water—submersible pumps and surface (or line) pumps. Both are normally powered by standard household electrical current. Submersible pumps sit on the bottom of the pool or feature. They may have attachments that power fountain jets or sprays or that supply waterfalls or streams. Surface pumps are concealed near the pool or feature, and water is drawn from the feature and delivered to various outlets through plastic tubing. Surface pumps are not only more expensive than submersibles, but many also require extra plumbing.

Implementation

Ornamental water features should be supplied by recirculating the water from the feature itself.

Inspection

The inspector will verify that the ornamental water feature recirculates water and serves a beneficial use.

III.B Irrigation Systems (4.2)

WaterSense Criteria

Irrigation systems are not required. Irrigation systems that are financed, installed, or sold through the homebuilder must meet the criteria in section 4.2 of the specification.

Intent
Good irrigation design and scheduling provide one of the greatest opportunities for water efficiency in the landscape.

Background

Proper design, installation, and scheduling of irrigation systems provide a holistic approach to landscape irrigation efficiency. This specification addresses water-efficient irrigation by requiring systems to be designed or installed and audited by a WaterSense irrigation partner. During the post-installation audit, the irrigation partner measures efficiency and checks for leaks, runoff, and overspray. The specification also addresses technologies that increase the efficiency of the system, such as microirrigation, rain shutoff devices, and controllers, and requires a seasonally adjusted schedule be provided to the homeowner.

All criteria in Section 4.2 of the specification apply to any installed irrigation system. Not all areas of the country require irrigation, and the installation of a system should be discussed with the landscape professional during the landscape design phase.

III.B.1 Design and Installation (4.2.1)

WaterSense Criteria

All irrigation systems shall be designed or installed by a WaterSense irrigation partner.

Waivers from this requirement may be available if there are an insufficient number of available WaterSense irrigation partners.

Intent
Irrigation systems shall be designed or installed by a WaterSense irrigation partner with the appropriate certification.

Background

Proper design and installation of the landscape irrigation system is essential to meeting the criteria listed under Section 4.2. The specification requires the use of WaterSense irrigation partners because they have a specified level of expertise and have passed a comprehensive exam covering general irrigation subjects, as well as specialty areas including water efficiency. The goal of a good irrigation system design and layout is to develop a system with good overall distribution uniformity to maintain plant health while conserving water resources.

WaterSense has labeled certification programs for irrigation professionals in three categories: designers; installation and maintenance professionals; and auditors. Criteria 4.2.1 and 4.2.2 require the use of an irrigation partner who is:

- A certified designer to design the irrigation system, or a certified installation/maintenance professional to install the irrigation system (4.2.1).
- A certified auditor to audit the irrigation system (4.2.2).

If there are fewer than three available WaterSense irrigation partners who are certified designers *and* fewer than three available irrigation partners who are certified installation/maintenance professionals that provide services to the city, county, or metropolitan area where the home is located, an exemption from criterion 4.2.1 may apply.

If there are no available WaterSense irrigation partners who are certified auditors that provide services to the city, county, or metropolitan area where the home is located, an exemption from criterion 4.2.2 may apply.

Implementation

To determine if there are a sufficient number of WaterSense irrigation partners in the area where the home is being built, conduct the following steps:

1. Go to the WaterSense website at www.epa.gov/watersense/meet_our_partners.html and review the list of irrigation partners by state.

2. If there are three or more irrigation partners who are certified designers, or three or more irrigation partners who are certified installation/maintenance professionals that perform irrigation services in the city, county, or metropolitan area where the home is being built, contact the individuals to determine if they are accepting new residential work. If at least three partners in one of the categories are accepting new residential work, there is no exemption.

3. If there are fewer than three certified designer partners and fewer than three certified installer partners that identified the city, county, or metropolitan area where the home is being built as areas in which they work, but there are additional partners with the appropriate certification indicating they perform work throughout the state, either:
    a. Contact the individual irrigation partners to determine if they perform irrigation services in the city, county, or metropolitan area where the home is being built and are available to take on additional residential work. **OR**
    b. Contact the WaterSense Helpline to ask for assistance in determining if there are three or more available irrigation partners with the appropriate certifications that perform irrigation services in the area where the home is being built.

    If at least three partners in one of the categories are accepting new residential work, there is no exemption.

4. If there are neither three certified designer partners *nor* three certified installer partners that perform residential work in that state, the home is exempt from the requirement(s) to have the irrigation system designed and/or installed by a WaterSense irrigation partner. Contact the WaterSense Helpline to ask for a waiver from the requirement(s).

Builders can contact the WaterSense Helpline via email at watersense@epa.gov or by phone at (866) WTR-SENS (987-7367).

Inspection

The inspector will confirm that the irrigation system was designed or installed by a WaterSense irrigation partner or that the homebuilder obtained a waiver from the requirement.

III.B.2 Post-Installation Audit (4.2.2)

Intent
An audit must be performed to ensure the irrigation system functions properly and meets the specification criteria.

WaterSense Criteria

All irrigation systems shall be audited by a WaterSense irrigation partner. Auditing procedures are described in the Guidelines for Irrigation Audits on WaterSense Labeled New Homes.

Background

An audit of the irrigation system has been shown to be the most effective tool for maximizing water efficiency in irrigated landscapes. WaterSense irrigation partners have demonstrated knowledge of water efficiency in landscape irrigation and have committed to partnering with EPA.

Implementation

The audit shall be conducted according to the *Guidelines for Irrigation Audits on WaterSense Labeled New Homes* at www.epa.gov/watersense/nhspecs/nh_irr_materials.html**Error! Hyperlink reference not valid.**. To ensure that the professional conducting the audit is a WaterSense irrigation partner, check the list on the WaterSense website at www.epa.gov/watersense/meet_our_partners.html. EPA prefers that the auditor be independent of the irrigation system designer and installation professional. If this is not the case, indicate what the irrigation partner's role was during design and installation on the *WaterSense Labeled New Home Irrigation Audit Checklist* at www.epa.gov/watersense/nhspecs/cert_new_homes.html.

To determine if there are a sufficient number of WaterSense irrigation partners in your area to conduct the audit, conduct the following steps:

1. Go to the WaterSense website at www.epa.gov/watersense/meet_our_partners.html and review the list of irrigation partners by state.

2. If there is at least one WaterSense irrigation partner who is a certified auditor that performs irrigation services in the city, county, or metropolitan area where the home is being built, contact the individual to determine if he/she is accepting new residential work. If at least one partner is accepting new work, there is no exemption.

3. If no WaterSense irrigation partners who are certified auditors identified the city, county, or metropolitan area where the home is being built as areas in which they work, but there is at least one partner who is a certified auditor indicating he/she performs work throughout the state, either:
    a. Contact the individual irrigation partner(s) to determine if they perform irrigation services in the city, county, or metropolitan area where the home is being built and are available to take on additional residential work. OR

b. Contact the WaterSense Helpline to ask for assistance in determining if there is an available irrigation partner who is a certified auditor that performs irrigation services in the area where the home is being built.

If at least one partner who is a certified auditor is accepting new residential work, there is no exemption.

4. If there are no WaterSense irrigation partners who are certified auditors that perform residential work in that state, contact the WaterSense Helpline. The WaterSense Helpline will identify a professional who can perform the audit or will grant a waiver from the requirement(s).

Builders can contact the WaterSense Helpline via email at watersense@epa.gov or by phone at (866) WTR-SENS (987-7367).

Inspection

The inspector will confirm that the irrigation system was audited by a WaterSense irrigation partner or that the homebuilder obtained a waiver from the requirement.

III.B.3 Leaks (4.2.3)

WaterSense Criteria

There shall be no detected leaks during the operation of the irrigation system. The system will be checked for leaks during the post-installation audit.

Intent
Significant amounts of water can be saved if leaks in the irrigation system are detected and corrected.

Background

Even before the irrigation system is used, leaks can occur as a result of improper installation, damage from construction equipment, or weather damage (freezing and thawing). In drip systems, leakage problems might be the result of tubing or tape that has been damaged by foot traffic or gnawing and chewing of animals. Indications of leakage from an irrigation system include overgrown or particularly green areas of turf, soggy areas around spray heads and aboveground hoses, jammed spray heads, and torn hoses.

Implementation/Inspection

During the post-installation audit, the WaterSense partner will check the system to ensure there are no leaks.

III.B.4 Runoff/Overspray (4.2.4)

WaterSense Criteria

Irrigation systems shall be designed and installed to sustain the landscape without creating runoff or direct overspray during a minimum operating duration. This will be measured during the post-installation audit, and the WaterSense irrigation partner will determine the minimum operating duration based on landscape conditions and irrigation system design.

Intent
Significant amounts of water loss from runoff or overspray can be avoided if systems are designed, installed, and scheduled properly.

Background

A significant amount of water is wasted due to runoff and overspray from irrigation systems onto non-landscaped areas. Overspray is the situation where irrigation systems apply water to hardscape such as driveways, sidewalks, and streets. Runoff is the situation where the water runs off the landscape and is not available for use by the plants. This is usually a result of poor scheduling or improper design and/or installation.

Implementation

Systems should be designed and installed to avoid the application of water to impermeable and non-vegetated areas. Runoff is common on steep topography, and WaterSense has developed additional criteria for slopes greater than 4:1 (14 degrees). See Section III.B.7 for additional information. During the post-installation audit, the WaterSense irrigation partner will turn on the system for a minimum operating duration and check for overspray and runoff. The minimum operating duration will be determined by the partner based on landscape features such as soil composition.

System components should be selected to avoid runoff. The irrigation designer should select components to keep the sprinkler precipitation rate below the infiltration rate of the soil, and the schedule should use repeat cycles to allow the water to soak into the root zone. In addition, the design should separate zones for sprinklers at the top and bottom of sloped areas, because these areas tend to be the source of runoff.

Inspection

The auditor will run the irrigation system for the appropriate amount of time to ensure that there is no runoff nor overspray occurring.

III.B.5 Distribution Uniformity (4.2.5)

Intent
A distribution uniformity of 65 percent is required to ensure the irrigation system is designed efficiently and installed and operating correctly.

WaterSense Criteria

Irrigation systems shall achieve a lower quarter distribution uniformity (DU_{LQ}) of 65 percent or greater. Distribution uniformity shall be measured on the largest spray-irrigated area during the post-installation audit.

Background

Distribution uniformity is the measure of uniformity of applied irrigation water over an area. DU_{LQ} is the ratio of the average of the lowest 25 percent of measurements to the overall average measurement. A system with a DU_{LQ} of 100 percent would apply water uniformly across the landscape, functioning as a perfectly efficient system. Due to sprinkler head type, spacing, system pressure, and other factors, irrigation systems do not apply water in a perfectly uniform manner. The goal is to have a system that applies water across the landscape as uniformly as possible.

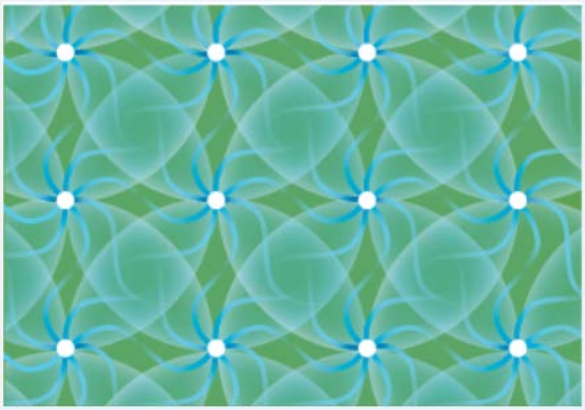


Figure 6: Head-to-Head Coverage

Ensuring a high percentage of distribution uniformity starts with efficient irrigation system design. This includes head-to-head coverage (see Figure 6) and proper sprinkler head spacing and location. To achieve head-to-head coverage, sprinkler heads should be separated by a distance of 50 percent of the spray radius. Because spray uniformity of a single sprinkler decreases further out along the radius of water spray, head-to-head coverage provides a more uniform distribution among the irrigation system as a whole. Sprinkler heads should also be located to avoid overspray onto impermeable surfaces, fences, buildings, and neighboring property.

Specific devices such as pressure-regulated heads or multi-stream, multi-trajectory rotating nozzles will also increase uniformity. Pressure-regulated heads adjust the flowing water pressure to maintain a constant outlet pressure. Most irrigation systems operate better at a water pressure of 30 psi, but some irrigation systems, such as drip irrigation, require lower pressures.[42] Multi-trajectory nozzles can be used in place of standard nozzles and use a number of individual streams of varying trajectories to achieve a more even distribution. Your local utility may offer rebates for high-efficiency nozzles.

[42] Landscape Sprinkler Design Tutorial. Accessed January 5, 2010. www.irrigationtutorials.com/sprinkler12.htm

Implementation

It is essential to work with a qualified irrigation professional such as a WaterSense irrigation partner to design the system in order to meet the DU_{LQ} requirement. If during the audit the system has a DU_{LQ} less than 65 percent, it may be possible to troubleshoot and increase the DU_{LQ} to meet the requirement. But if the system is designed poorly from the beginning, it may be difficult to reach a DU_{LQ} of 65 percent without a major renovation to the system. It is equally important that the irrigation system installer follows the design specifications and the manufacturer's published performance standards.

Inspection

The auditor will determine the DU_{LQ} of the system using the catch-can method. This test shall be conducted according to the Irrigation Association's "Recommended Audit Guidelines" located at http://irrigation.org/certification/pdf/AuditGuidelines_FINAL.pdf. The test shall include areas of turfgrass only and shall be conducted on the largest spray-irrigated area.

III.B.6 Rainfall Shutoff Device (4.2.6)

WaterSense Criteria

Irrigation systems shall be equipped with technology that inhibits or interrupts operation of the irrigation system during periods of rainfall or sufficient soil moisture (e.g., rain sensors, soil moisture sensors).

Intent
Supplemental irrigation is not needed when it is raining.

Background

Irrigation systems are usually set on a timer to start watering regardless of weather conditions, resulting in systems running when it is raining. A rainfall shutoff device interrupts a scheduled irrigation cycle when a certain amount of rainfall has occurred. These devices eliminate unnecessary irrigation, conserving water. Rainfall shutoff devices are relatively low-cost and an essential component of an efficient irrigation system.

Rain sensors are small devices wired to the irrigation system controller and mounted in an open area where they are exposed to rainfall. Rain sensors operate by one of two methods: measuring or weighing collected rainwater using water weight or the electrical conductivity of water, or measuring the proportional expansion of water-sensitive materials such as cork disks.[43]

Soil moisture sensors allow an irrigation event to occur when the sensors determine that sufficient dryness has occurred in the soil. Conversely, the sensors prevent the system from running where there is sufficient moisture in the soil and irrigation is required.

[43] Alliance for Water Efficiency Resource Library. www.allianceforwaterefficiency.org/Rainfall_Shutoff_Devices.aspx

Implementation

These devices are commonly used across the country and are easily attainable by the irrigation professional. Note that some states, such as Florida and New Jersey, require these devices by law. Also, some utilities offer rebates for these products.

Some of the new irrigation controllers have a special connection that allows a rainfall shutoff device to be attached directly to the controller. If such a shut-off device is not available, or the sensor doesn't work with a given controller, the sensor can always be "hard-wired" into the controller. This is done by wiring the rainfall shutoff device in series with the common wire. When a specific amount of rainfall has occurred, the rainfall shutoff device will interrupt the system's common wire, which disables the solenoid valves until the sensor or soil dries.

Builders should work with the irrigation professional to ensure that a rainfall shutoff device is designed and installed in the irrigation system. The device must be wired appropriately and functioning by the time the post-installation audit is conducted.

Inspection

The auditor will verify that a rainfall shut-off device is installed in an open area with access to the weather (i.e., not under an overhand or other protected area).

III.B.7 Irrigation Controllers (4.2.7)

WaterSense Criteria

Intent
Specific capabilities of irrigation controllers can optimize the efficiency of the irrigation system.

As of June 1, 2013, irrigation systems shall be equipped with WaterSense labeled weather-based irrigation controllers or a soil moisture sensor-based irrigation controller that contains the following capabilities in both smart and standard mode:

1. *The controller shall be capable of preserving the contents of the irrigation program settings when the power source is lost without relying on external battery backup.*
2. *The controller shall either be capable of independent, zone-specific programming or storing a minimum of three different programs to allow for separate schedules for zones with different water needs.*
3. *The controller shall be capable of indicating to the user when it is not receiving a signal or local sensor input and is not adjusting irrigation based on current weather or soil moisture conditions.*
4. *The controller shall be capable of interfacing with a rainfall device.*
5. *The controller shall be capable of accommodating watering restrictions as follows:*
    - *Operation on a prescribed day(s)-of-week schedule (e.g., Monday-Wednesday-Friday, Tuesday-Thursday-Saturday; any two days; any single day).*
    - *Either even-day or odd-day scheduling, or any day interval scheduling between two and seven days.*

- *The ability to set irrigation runtimes to avoid watering during a prohibited time of day (e.g., between 9:00 a.m. and 9:00 p.m.).*
- *Complete shutoff (e.g., on/off switch) to accommodate outdoor irrigation prohibition restrictions.*

6. *The controller shall include a percent adjust (water budget) feature. The percent adjust (water budget) feature is defined as having the means to increase or decrease the runtimes or application rates for zones by means of one adjustment without modifying the settings for each individual zone.*
7. *If the primary source of weather or soil moisture information is lost, the controller shall be capable of reverting to either a proxy of historical weather data or a percent adjust (water budget) feature.*
8. *The controller shall be capable of allowing for a manual operation troubleshooting test cycle and shall automatically return to smart mode within some period of time as designated by the manufacturer, even if the switch is still positioned for manual operation.*

Prior to June 1, 2013, irrigation systems must be equipped with a controller (weather-based or using soil moisture sensors) that contains the features listed above.

Background

A controller is an integral part of an irrigation system. It is a tool to apply water in the necessary quantity and at the right time to sustain landscapes and to achieve high levels of efficiency in water, energy, and chemical use. Irrigation controllers have been available for many years in the form of mechanical and electromechanical irrigation timers. These devices have evolved into more sophisticated computer-based systems that allow accurate control of water, energy, and chemicals while responding to environmental changes.[44]

A sensor-based controller uses real-time measurements of one or more local factors including temperature, rainfall, humidity, solar radiation, and soil moisture. A sensor-based system often has historic weather information (i.e., an evapotranspiration [ET] curve) for the site location programmed into memory, then uses the sensor information to modify the expected irrigation requirement for the day.[45]

A signal-based controller receives a regular signal of prevailing weather conditions via radio, telephone, cable, cellular, Web, or pager technology. The signal typically comes from a local weather station (or series of weather stations) and updates the current ET rate to the controller on a regular interval.[46]

Implementation

Builders should work with an irrigation professional to ensure that the irrigation controller contains the features described above. If weather-based irrigation controllers are installed after

[44] Alliance for Water Efficiency Resource Library. www.allianceforwaterefficiency.org/Irrigation_Controller_Introduction.aspx
[45] Alliance for Water Efficiency Resource Library www.allianceforwaterefficiency.org/Smart_Irrigation_Controllers_Introduction.aspx
[46] Ibid.

June 1, 2013, builders should ensure that they are WaterSense labeled weather-based irrigation controllers. Some utilities provide rebates for efficient irrigation control technology.

Inspection

The auditor will verify that a controller is installed and meets the requirements in the specification.

III.B.8 Sprinkler Irrigation (4.2.8)

WaterSense Criteria
Sprinkler irrigation, other than as a component of a microirrigation system, shall not be used to water plantings other than maintained turfgrass. Sprinklerheads shall have a 4-inch or greater pop-up height and matched precipitation nozzles. Sprinkler irrigation shall not be used on strips of turfgrass less than 4 feet wide nor on slopes in excess of 4 feet of horizontal run per 1 foot vertical rise (4:1).

Intent
Homes with irrigation systems can minimize outdoor water use by using the most effective and efficient delivery method depending on the type of landscape.

Background

Different landscape types can be watered most efficiently with different types of irrigation equipment. Sprinkler irrigation is best suited to water maintained turfgrass, as it can be designed to distribute water evenly over uniform turfgrass areas. Shrubs, trees, plant beds, and any other non-turf landscape can be watered most effectively using microirrigation. Microirrigation supplies water directly to plant roots and eliminates overspray and runoff. The varied heights of shrubs, trees, and plant beds can obstruct spray from sprinkler heads.

Sprinkler heads shall have a 4-inch or greater pop-up height, as they need a certain amount of clearance over the turfgrass surface to operate correctly. Over time, as the turfgrass grows, it can build up around sprinkler heads, interfering with the spray pattern. Because taller risers are above the turfgrass, they can distribute water more evenly.

Designing a system with matched precipitation nozzles is an important water-efficiency concept. A sprinkler head's precipitation rate is the speed at which water is applied to a specific area. When an installer designs an irrigation system for a landscape, sprinkler heads are installed to deliver enough water to cover the entire area of the landscape. When all of the sprinkler heads within the zone/system have the same (or very similar) precipitation rates, they are said to have "matched precipitation." Designing a system with matched precipitation rate heads/nozzles can save water by ensuring that all areas of the landscape are watered at the same rate. This is especially important when a landscape has sprinklers with varying coverage (for example, half-arc and quarter-arc sprinklers).

Sprinkler irrigation should not be used on strips less than 4 feet wide, because it is difficult to irrigate narrow strips efficiently without creating overspray. Sprinkler irrigation should not be

installed on slopes in excess of 4 feet of horizontal run per 1 foot vertical rise (4:1), because the flow rates associated with sprinklers are often a source of runoff on steep slopes.

Implementation

An irrigation system installer can match the precipitation rate of the sprinkler heads in the irrigation system by calculating the precipitation rates and manually pairing similar heads in the same zone. The installer can also ensure matched precipitation by installing nozzles throughout the zone from the same family of nozzles produced by the same manufacturer. For matched precipitation, sprinkler head spacing must be consistent, flow rates must be based on coverage, and the pipes need to deliver water at a uniform pressure to each head.

Ensure narrow strips of turfgrass (installed less than 4 feet wide) and steep slopes have microirrigation if they are irrigated.

Inspection

The auditor will verify that sprinkler irrigation systems comply with the criteria in the specification.

In addition, the auditor will verify that the station or zone pressure based upon the emission device or product being used (spray head, rotor head) is within +/- 10 percent of manufacturer-recommended operating pressure. The auditor will test this on a representative zone of the sprinkler irrigation system.

III.B.9 Microirrigation Systems (4.2.9)

WaterSense Criteria

At a minimum, microirrigation systems shall be equipped with pressure regulators, filters, and flush end assemblies.

Intent
Microirrigation is an important feature in a water-efficient landscape but requires additional components to ensure the system operates efficiently.

Background

The term "microirrigation" describes a family of irrigation systems that apply water through small devices and at lower pressure than sprinkler irrigation systems. These devices deliver water onto the soil surface very near the plant or below the soil surface directly into the plant root zone. Compared to sprinkler irrigation systems, the conveyance loss is minimal and evaporation, runoff, and deep percolation are reduced. Because microirrigation operates at a lower pressure, a pressure regulator is required. Filters are required because emission devices are easily clogged by debris. Flush end assemblies flush the laterals after the end of an irrigation cycle.

Implementation

Irrigation professionals should be experienced in the design and installation of microirrigation, as it takes expertise in this area to ensure an efficient system. Microirrigation should be installed on separate zones from the rest of the irrigation system if sprinkler heads are used in other parts of the landscape. Builders should work with an irrigation professional to ensure a pressure regulator, proper filters, and flush end assemblies are installed.

If using drip irrigation, WaterSense recommends using pressure-compensating drip. These products help deliver a constant flow rate over a range of pressures and are intended for landscapes with wide fluctuations in elevation, topography, and pressures.

Inspection

The auditor will verify that any microirrigation systems comply with the criteria in the specification.

In addition, the auditor will verify that the station or zone pressure based upon emission device or product being used (drip emitter, rotor head) is within +/- 10 percent of manufacturer-recommended operating pressure. The auditor will test this on a representative zone of the microirrigation system.

III.B.10 Schedule (4.2.10)

WaterSense Criteria

Two water schedules, developed by the WaterSense irrigation partner as part of the post-installation audit, shall 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.

Intent
Water should only be applied to the landscape when plants need it and in amounts they can use.

Background

One of the single most important aspects of efficient irrigation is proper scheduling of the system. Plant water needs change with plant maturity, seasons, climate, and day-to-day weather. The type of soil also plays a role in the irrigation schedule, due to varying infiltration rates associated with different soils (e.g., silt, sand, clay). Applying too much water in one irrigation cycle will result in runoff or deep percolation. Not applying enough water per cycle will encourage shallow roots. The biggest problems encountered are watering too much and too frequently. Many of the common turfgrass and landscape shrub diseases are made worse by or are the result of watering too frequently. Homeowners often do not change their irrigation system schedules during the year, which can result in significantly overwatering the landscape for large portions of the year.

Implementation

To address these varying water needs, the irrigation professional should create two seasonally-adjusted schedules that take these variables into consideration. The first schedule should apply to the grow-in period, for which the length should be determined by the landscape professional. The second schedule should apply to the mature landscape.

The irrigation professional should identify when the homeowner should switch from the grow-in schedule to the mature landscape schedule. The schedule should also emphasize the dates when the seasonal changes should occur, as many homeowners set their irrigation controller once and do not change it from season to season.

All schedules must comply with any local codes, provisions, or utility service rules designed to prevent water waste.

Inspection

The auditor will verify that two schedules have been created and are posted near the irrigation controller: a schedule for the initial grow-in phase, and a schedule for the established landscape.

III.B.11 Metering (4.2.11)

WaterSense Criteria

If an irrigation system is installed in a multi-family building, the system shall be independently metered, submetered, or equipped with an alternate technology capable of tracking water used for outdoor irrigation.

Intent
Irrigation systems for multi-family buildings can be much larger and more complex than irrigation systems for single-family homes. Independent metering of irrigation systems associated with multi-family buildings can facilitate better management and more efficient irrigation system operation.

Background

A significant amount of water can be wasted from an irrigation system due to leaks, improper scheduling, or overwatering. In some of the larger, more complex irrigation systems that are associated with multi-family buildings, management of an irrigation system is best done when the system's water use is monitored independently.

Installing irrigation meters provides multiple benefits for property managers. First and foremost, it allows the property manager to accurately measure outdoor water use, a key component for assessing and maintaining system efficiency. In addition, in some jurisdictions, wastewater charges may only apply to usage that eventually ends up in the sewer system, therefore, separate outdoor meters can lead to reduced wastewater bills. Irrigation meters can also be a useful drought management tool for both property managers and water utilities because they allow for monitoring and management of peak demands. Finally, separating the irrigation system and meter from the master water main provides a separate shutoff for the irrigation

system. Therefore, if leaks are detected in the irrigation system, water can be shut off to only the irrigation system and not cause outages elsewhere within the multi-family building.[47]

Implementation

To accurately submeter irrigation system use, the irrigation system must be plumbed separately from all other building water uses, preferably with a single-source pipe. The irrigation submeter must be installed on the main water line that supplies the irrigation system so that the entire outdoor water usage can be assessed.

In addition, choose a type of submeter best suited for measuring irrigation system water use. Selection of the water meter should be based on the size of the pipe, the range of flow to be measured, and the head loss due to flow through the meter. This information should be supplied by the meter manufacturer. The flow rate range is one of the most critical elements affecting the accuracy of the meter. The meter should be selected so that the lowest anticipated flow rate will be measured at or near 100 percent accuracy. For example, a positive displacement flow meter may work well for small irrigation systems. Impeller meters may also be considered, although most register total volume of flow only. For more information on irrigation system meter selection and installation, review the University of Florida Institute of Food and Agriculture Science Extension's Selection and Use of Water Meters for Irrigation Water Measurement.[48]

To further facilitate irrigation system water use tracking, consider integrating irrigation submeters into a centralized building management system. The centralized building management systems are capable of electronically storing data, reporting hourly, daily, monthly, and annual water use. They can also trigger alerts when leaks or other operational anomalies are detected.

Finally, include information on and a map indicating the location of all water supply meters and irrigation unit meters in the Building Operating Manual.

Inspection

The inspector will verify that a submeter is installed for the irrigation system and that it is independent of the meters used for the multi-family building or individual units within the building.

III.C Additional Measures for Outdoor Water Efficiency

The above criteria are required to provide a strong foundation for a water-efficient landscape. There are many additional strategies that can be implemented to go above and beyond the

[47] Alliance for Water Efficiency. 2010. "Dedicated Irrigation Meter Introduction." http://www.allianceforwaterefficiency.org/Dedicated_Irrigation_Meter_Introduction.aspx.
[48] Baum, M. M. Dukes, and D. Haman. 2012. Selection and Use of Water Meters for Irrigation Measurement. University of Florida. Institute of Food and Agricultural Sciences (IFAS) Extension. http://edis.ifas.ufl.edu/pdffiles/AE/AE10600.pdf.

scope of this specification. Although none of the following items in this section is required by the WaterSense specification, qualified landscape and irrigation professionals should be considering these strategies as they design the landscape. Certain strategies such as site preparation will require coordination between the builder/developer and landscape professionals. A water-efficient landscape begins in the planning stage with all parties involved. Please consider the following additional strategies to minimize outdoor water use and maximize onsite water retention:

III.C.1 Permeable Surfaces

Install permeable surfaces, rather than impermeable hardscape, where appropriate. Impervious hardscape surfaces such as driveways and sidewalks contribute to stormwater runoff from the site. Stormwater transports pollutants and sediment to nearby water bodies and can lead to erosion downstream. To decrease stormwater runoff, permeable hardscape can be used in place of any impervious hardscape materials or—if unnecessary—removed altogether. This will increase infiltration of water, replenishing aquifers and providing a healthier site for landscape plants.

Where hardscape on the lot is necessary, open pavers or engineered porous materials are a good replacement for impermeable concrete. Permeable pavement options include porous bituminous asphalt, porous concrete, porous paver blocks, and reinforced turf.

When considering permeable pavements, builders should be mindful of site constraints and maintenance requirements. One potential site constraint is a shallow water table. Stormwater is cleaned as it percolates through the soil, but a shallow water table may intercept stormwater from permeable pavements before the water is sufficiently cleaned. Additionally, builders should recognize that like all hardscapes, permeable pavements require maintenance.

III.C.2 Soils

Preserve or restore proper soil structure, chemistry, and depth prior to installing landscape plants. Soil structure, chemistry, and depth are essential to the survival of landscape plants. In many cases, nutrient-rich topsoil is removed from the site, or soil compaction occurs during construction. Healthy soils support thriving plants and biological communities, as well as provide water storage and infiltration, reducing runoff.

The landscape professional should conduct a thorough analysis of both the physical and chemical characteristics of the soil. Based on this analysis, the professional should prepare the soil according to locally accepted best management practices. This may include the addition of top soil, other soil amendments, tillage, or other strategies to create the appropriate planting medium for landscape plants. Soil amendments and tillage improve soil's capacity to support vegetative growth by increasing soil water-retention capacity, improving infiltration, and enhancing soil fertility.

III.C.3 Site Development

Minimize site clearing during the construction phase and ensure appropriate site requirements, such as soil depth and proper grading, prior to landscape installation. Conventional construction practices disturb the site by clearing existing vegetation and moving earth, resulting in bare, compacted soil. Compacted soil makes it difficult for water to pass through the soil and reach the roots of the plants. Construction practices increase erosion, inhabitability of the site for new vegetation, and the likelihood of stormwater runoff. A site that is minimally disturbed is preferable, because it has decreased landscape water use, healthier soils, and decreased erosion and runoff.

Builders should make construction crews aware of site preservation and ensure compliance with all local construction codes related to erosion and stormwater control. Consider grading and topsoil installation where appropriate and repair compacted soils prior to landscape installation by tilling or other suitable means.

III.C.4 Valves

Water flow in irrigation systems is controlled through the use of valves. Valves can be manually or automatically operated and can be used in various irrigation applications to shut off flow completely, reduce flow to a set rate, or regulate water pressure. These functions are accomplished using on/off service valves, control valves, check valves, and pressure-regulating valves. An appropriate valve should be chosen based on the desired valve function. Correct valve sizes should also be chosen to account for pressure loss in the valves. Pressure loss is especially important in automatic valves, which rely on pressure differences to power the system. Builders should refer to manufacturer information on valve models to choose the correct valve.

On/Off Service Valves
Valves used to control water flow by allowing for completely restricted or completely unrestricted flow are known as on/off service valves. On/off service valves are useful in irrigation systems where only certain zones require watering during a scheduled time period. On/off service valves include gate valves, plug valves, and ball valves, which can fully restrict flow, but they cannot achieve a reduced set flow rate or regulate pressure, so should not be used in these applications. On/off service valves can perform well as master valves to control flow to an entire irrigation system. Master valves are recommended for use in emergency situations where water flow to the system needs to be shut off.

Control Valves
Control valves are used to regulate flow to a set rate below the maximum incoming flow rate. In a control valve system, valve motion is driven by an electric or hydraulic-powered actuator. Automatic irrigation systems with a controller typically use electrically powered solenoid valves to control water flow. Globe and angle valves are commonly used in control valve systems, because they are able to regulate flow rate, and both can be securely shut off. Control valves should be used for zone-by-zone control.

Check Valves
Check valves allow flow in only one direction. These valves should be installed to prevent backflow from irrigation water, which can contain toxic chemicals from fertilizers and pesticides, from infiltrating the drinking water supply. Ball, disk lift, piston lift, flapper, foot, and diaphragm valves are all types of check valves.

Pressure-Regulating Valves
Pressure-regulating valves reduce water pressure at the irrigation system inlet to a desired level. A spring is used to throttle water flow in order to maintain a reduced pressure. Irrigation systems tend to perform best at a water pressure of approximately 30 psi. Some irrigation systems, such as drip irrigation, may perform better at lower pressures. Reducing water pressure will in turn reduce the amount of water used.[49]

III.D Additional Measures to Control Stormwater

In addition to the measures mentioned above regarding permeable surfaces and site development, installing rain gardens, green roofs, vegetated swales, rain barrels, or cisterns will further decrease the amount of stormwater leaving the site and filter out pollutants before they enter the municipal system or are discharged to surface water.

A rain garden is an excavated, shallow depression vegetated with native plantings that is designed to capture rainwater from roofs, driveways, and sidewalks. Rain gardens allow stormwater to slowly soak into the ground, capturing contaminants and reducing stormwater flows to the sewer system. Rain gardens can absorb runoff up to 40 percent more efficiently than typical lawns. By using a raingarden to capture rainwater, hold it, and then slowly release it into the soil, the peak runoff from storms can be retained or delayed, allowing rainwater to infiltrate into the ground and be cleaned naturally. Rain gardens are sustainable, cost-effective options for reducing the impact of impervious surfaces on stormwater runoff and can be aesthetically pleasing as well.

Green roofs are vegetated roof covers that include a lightweight, engineered growing media planted with vegetation. They provide stormwater benefits by reducing and delaying stormwater flows from entering the storm sewer system. The number of layers and layer placement of green roofs vary from system to system and green roof type; green roofs should include a single- to multi-ply waterproofing layer, drainage layer, growing media, and plants. Drought-tolerant plants such as *Sedums* are typical green roof plants. Non-drought tolerant plants can also be used on green roofs with deeper substrate layers (> 6-inch depth, which are considered intensive green roofs). However, such plantings would require irrigation and maintenance and are therefore not favorable for water-efficient homes. Under this specification, green roofs would count as landscaped area, and all appropriate criteria would apply.

A vegetated swale is a broad, shallow channel with a dense stand of vegetation covering the side slopes and bottom. Swales can be natural or manmade, and are designed to channel

[49] Rain Bird website. The Intelligent Use of Water: Water Conservation Tips for Residential and Commercial Landscape Irrigation Professionals. Accessed on January 6, 2010. http://www.rainbird.com/iuow/tips/tips_turf.htm

stormwater while trapping pollutants (total suspended solids, trace metals, and nutrients), promoting infiltration, and reducing the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters, and storm sewer systems. While swales are generally used as a stand-alone stormwater best management practice, they are most effective when used in conjunction with other best management practices, such as wet ponds, infiltration strips, and wetlands.[50]

III.E Alternative Water Sources

To reduce the use of potable water, builders can use alternative sources of water (e.g., non-potable water) where appropriate. Please note that the use of alternative sources is not intended to take the place of water efficiency, but to supplement existing efficiency measures. All local codes and standards should apply.

Non-potable water recommended for residential application can be provided by harvested rainwater using rain barrels or cisterns or obtaining reclaimed water from the municipality. Rainwater and reclaimed water do not meet potable water standards, and therefore have limited use applications. These water sources can supply water for non-spray irrigation and other outdoor water needs during periods of drought but are never suitable for human consumption. Proper signage should be displayed on the structure to caution users that the water source is non-potable.

There is a growing trend of water utilities offering free or price-discounted, pre-fabricated plastic rain barrels to residential customers. These barrels are connected to the downspouts of the home's roof gutters to collect the rain water from the roof. The rain barrels include a tap or spigot at the bottom of the barrel for users to attach garden hoses. The barrels also have an overflow spout and hose to divert excess water away from the home's foundation. Rain barrel systems can be a great way to harvest rainwater to supplement irrigation needs. To properly evaluate their application and benefits, builders should consider the frequency of local rain events that occur during the irrigation season, as well as the need to drain and bypass the rain barrels during seasons of freezing weather.[51]

Cisterns, defined as any tanks used to store water, come in a variety of shapes and sizes. Cisterns are often prefabricated from cement, fiberglass, or plastic and are usually placed underground to hide from view and prevent freezing in colder climates. There are also some above-grade installations made of steel or fiberglass tanks. New designs use corrugated steel bins (originally fabricated for grain storage) with a plastic liner to create a water vessel.[52]

Reclaimed water, sometimes referred to as recycled water, is wastewater (sewage) that has been treated (usually by a municipality) to remove solids and certain impurities. The water is

[50] EPA Office of Water. 1999. Storm Water Technology Fact Sheet: Vegetated Swales. www.epa.gov/owm/mtb/vegswale.pdf.
[51] Alliance for Water Efficiency Resource Library. www.allianceforwaterefficiency.org/Alternative_Water_Sources_Intro.aspx
[52] Ibid.

then allowed to recharge the aquifer rather than being discharged to surface water. Aquifer recharge is often accomplished by using the treated wastewater for irrigation. In most locations, reclaimed water is only intended to be used for non-potable uses, such as irrigation, dust control, and fire suppression. The use of reclaimed water is often restricted, so check with your local utility for more information. Furthermore, reclaimed water and captured stored water could become less available to homeowners if reclaimed water rates rise and/or a lengthy drought minimizes rainfall capture.

IV. Homeowner and Building Management Education Criteria

WaterSense labeled new homes are certified to meet EPA's water-efficiency and performance criteria upon completion of the home and before occupancy. Most new homes are expected to last more than 50 years, during which the occupants will consume energy, water, and other resources and make modifications to the initial design. Some homeowners may know very little about water efficiency, and most will know little about all the water-efficient technologies used in the home. Homeowners should be educated that WaterSense labeled homes need to be operated and maintained properly to keep the designed water efficiency of the home.

IV.A Operating Manual (for single-family homes)(5.1)

WaterSense Criteria

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. This may be a chapter or folder in an existing manual. If clothes washers or dishwashers are not provided, general information about water-efficient appliances shall be included.

Intent
The performance and durability of a WaterSense labeled new home depend on the proper use of its features and the maintenance of its systems throughout their service life.

Background

Homeowners need general information about their water-efficient new home, including its unique features and the proper maintenance of its fixtures, settings, and equipment. WaterSense has developed the *Homeowner Manual Template for WaterSense Labeled Homes* to help builders integrate water-efficiency information into the traditional homeowner's manual that they often provide and that many other green building programs require. This template is included as part of the new homes marketing tools that builders can access when they sign a WaterSense partnership agreement with EPA.

Implementation

The homeowner operating manual should be designed for ease of use. Where possible, include the names of vendors where the homeowner can purchase replacement parts (e.g., flapper valves for toilets) or contractors to service systems. The manual should be designed for long-term use, since it could change hands as homeownership changes. The manual should still be useful many years after the home has been constructed.

EPA includes a checklist in its manual template so that the builder can conduct a walk-through of the home with the buyer, point out the water-efficient features, and explain the proper operation and maintenance procedures for all of the settings and features installed in the home.

IV.A.1 Irrigation System (5.1.1)

WaterSense Criteria

If an irrigation system is installed, the builder shall provide the single-family homeowner with a record drawing (e.g., schematic) of the system, an itemized list of irrigation components, copies of the irrigation schedules, and information about reprogramming the schedule after establishment of the landscape. This information should be included in the operating manual.

Intent
Homeowners must be educated about how to operate their irrigation system efficiently and how to maintain an efficient system.

Background

Providing the single-family homeowner with a schematic of the system is important for conducting system repairs, as well as any future activity that might require excavation. The itemized list will allow homeowners and their irrigation contractors to replace parts as necessary to maintain the performance and efficiency of the system. As mentioned in III.B.9, one of the most important aspects of efficient irrigation is to educate the single-family homeowner on the importance of changing the watering schedule as plants' water needs change.

Implementation

These materials should be obtained from the WaterSense irrigation partner and included in the single-family homeowner's manual.

IV.B Occupant Operating Manual (for homes in a multi-family building)(5.2)

WaterSense Criteria

For multi-family buildings, the builder shall develop and provide to the occupant of each labeled unit a written operating and maintenance manual for all water-using equipment or controls installed in the unit, including all relevant WaterSense materials on indoor and outdoor water use. This may be a chapter or folder in an existing manual. If clothes washers or dishwashers are not provided but hookups are present, general information about water-efficient appliances shall be included. In addition, the manual shall include relevant information on water-saving features of the building outside the unit, including landscape, pools, and laundry facilities.

Intent
The performance and durability of a WaterSense labeled unit in a multi-family building depend on the proper use of its features and the maintenance of its systems throughout their service life.

Background

Occupants of units within a multi-family building need general information about their water-efficient new home, including its unique features and the proper maintenance of its fixtures, settings, and equipment. WaterSense has developed the *Occupant Manual Template for WaterSense Labeled Homes* to help builders integrate water-efficiency information into the traditional multi-family occupant's manual that they often provide and that many other green building programs require. This template is included as part of the new homes marketing tools that builders can access when they sign a WaterSense partnership agreement with EPA.

Implementation

The occupant operating manual should be designed for ease of use. Where possible, include the names of vendors where the occupant can purchase replacement parts (e.g., flapper valves for toilets) or contractors to service systems. The manual should be designed for long-term use, since it could change hands as occupancy changes. The manual should still be useful many years after the unit has been constructed.

EPA includes a checklist in its manual template so that the builder can conduct a walk-through of the unit with the occupant, point out the water-efficient features, and explain the proper operation and maintenance procedures for all of the settings and features installed in the unit.

IV.C Building Operating Manual (5.3)

WaterSense Criteria

For multi-family buildings, the builder shall provide to the building management, an operating and maintenance manual for all water-using equipment or controls outside of individual dwellings or inside of individual dwellings that are maintained by building management.

Intent
The performance and durability of a WaterSense labeled units in a multi-family building depend on the proper use of its features and the maintenance of its systems throughout their service life.

Background

Building maintenance staff need general information about the unique water-using features of the building and information on the proper maintenance of its fixtures, settings, and equipment. WaterSense has developed the *Building Operating Manual Template for WaterSense Labeled Homes* to help builders integrate water-efficiency information into a manual designed for maintenance staff. This template is included as part of the new homes marketing tools that builders can access when they sign a WaterSense partnership agreement with EPA.

Implementation

The building operating manual should be designed for ease of use. Where possible, include the names of vendors where the maintenance staff can purchase replacement parts (e.g., replacement cartridges for pool filtration systems) or contractors to service systems. The

manual should be designed for long-term use, since it may change hands as maintenance staff changes. The manual should still be useful many years after the building has been constructed.

IV.C.1 Irrigation System (5.3.1)

WaterSense Criteria

If an irrigation system is installed, the builder shall provide building maintenance with a record drawing (e.g., schematic) of the system, an itemized list of irrigation components, copies of the irrigation schedules, and information about reprogramming the schedule after establishment of the landscape.

Intent
Building maintenance staff must be educated about how to operate the irrigation system efficiently and how to maintain an efficient system.

Background

Providing the building maintenance staff with a schematic of the system is important for conducting system repairs, as well as any future activity that might require excavation. The itemized list will allow building maintenance staff and their irrigation contractors to replace parts as necessary to maintain the performance and efficiency of the system. As mentioned in III.B.9, one of the most important aspects of efficient irrigation is to educate the maintenance staff on the importance of changing the watering schedule as plants' water needs change.

Implementation

These materials should be obtained from the irrigation partner and included in the Building Operating Manual.

IV.C.2 Pools/Spas (5.3.2)

WaterSense Criteria

If pools and/or spas are present, the builder shall include detailed information regarding filtration equipment and the manufacturer's recommended maintenance schedule, as well as information on monitoring pools/spas for leaks.

Intent
Building maintenance staff must be educated about how to maintain the pool and/or spa to ensure an efficient system.

Background

Providing the building maintenance staff with information on the pool's filtration equipment and the manufacturer's recommended maintenance schedule is important for conducting system repairs and routine maintenance. Providing information on monitoring pool/spas for leaks is also important to ensure the system is working efficiently.

Implementation

These materials should be obtained from the pool/spa contractor and included in the Building Operating Manual.

V. Additional Resources

In addition to these national sources of water-efficiency information, contact your water utility, relevant local agency, or state government about measures and technologies that can be applied to homes in your area to save water indoors and out.

Indoor

Alliance for Water Efficiency Resource Library.
www.allianceforwaterefficiency.org/resource-library/default.aspx

The Alliance for Water Efficiency is a nonprofit organization committed to efficient and sustainable water use. The website has a resource library for all aspects of water efficiency, including a summary of efficient indoor and outdoor water use systems, fixtures, and appliances.

California Urban Water Conservation Council: Residential Hot Water Distribution Information.
www.cuwcc.org/res_hot_water.lasso

The California Urban Water Conservation Council (CUWCC) is a partnership organization focused on conserving California's water resources. CUWCC's Web site links to useful residential hot water system research reports and articles.

NAHB Research Center. Design Guide: Residential PEX Water Supply Plumbing Systems. November 2006.
www.toolbase.org/Design-Construction-Guides/Plumbing/pex-design-guide

The NAHB Research Center created a design guide for PEX water supply systems. The guide covers all aspects of the design process and includes an analysis of energy and water savings.

Toolbase Technology: Hot Water Recirculating Systems
www.toolbase.org/Technology-Inventory/Plumbing/hot-water-recirculation

The Toolbase website provides useful information on hot water recirculating systems, including a summary of the technology and factors to consider before installing.

Toolbase TechSpecs: Home-Run Plumbing Systems
www.toolbase.org/pdf/techinv/homerunplumbingsystems_techspec.pdf

Toolbase TechSpecs provides background information on home-run plumbing systems, useful guidelines for installation, and sample field results.

WaterSense Tank-Type Toilet Specification www.epa.gov/watersense/products

The WaterSense tank-type toilet specification provides criteria tank-type toilets must meet to earn the WaterSense label.

WaterSense Flushing Urinals Specification www.epa.gov/watersense/products

The WaterSense flushing urinals specification provides criteria flushing urinals must meet to earn the WaterSense label.

WaterSense Lavatory Faucet Specification www.epa.gov/watersense/products
The WaterSense lavatory faucet specification provides criteria lavatory faucets must to earn the WaterSense label.

WaterSense specification for showerheads www.epa.gov/watersense/products
The WaterSense showerhead specification provides criteria showerheads must meet to earn the WaterSense label.

Outdoor

Alliance for Water Efficiency Resource Library
www.allianceforwaterefficiency.org/resource-library/default.aspx
The Alliance for Water Efficiency is a nonprofit organization committed to efficient and sustainable water use. The website has a resource library for all aspects of water efficiency, including a summary of efficient indoor and outdoor water use systems, fixtures, and appliances. The resource library also has information on a broad range of landscape and irrigation topics.

American Rainwater Catchment System Association www.arcsa.org
The American Rainwater Catchment System Association is an organization focused on promoting rainwater harvesting systems and provides information on the topic.

American Society for Landscape Architects www.asla.org
The American Society for Landscape Architects (ASLA) is a member of the Sustainable Sites Initiative and offers useful links to landscape planning resources, as well as ASLA guides for various landscaping projects.

Colorado State: Choosing a Soil Amendment www.ext.colostate.edu/pubs/garden/07235.pdf
Colorado State University Extension provides a manual for choosing a soil amendment, including different factors to consider when choosing an appropriate soil amendment.

Cooperative State Research, Education, and Extension Service
www.csrees.usda.gov/Extension/
The Cooperative State Research, Education, and Extension Service offers research-based local information on natural resources, agriculture, and other areas through an educational network. The Extension center provides resources to determine appropriate local landscaping options.

EPA Green Infrastructure: Design and Implementation Resources
http://water.epa.gov/infrastructure/greeninfrastructure/gi_design.cfm
EPA's Green Infrastructure website promotes green infrastructure approaches that deal with stormwater runoff.

EPA GreenScapes Program www.epa.gov/waste/conserve/rrr/greenscapes/index.htm
EPA's GreenScapes Program promotes environmentally conscious landscape planning practices.

EPA GreenScaping Pamphlet
http://epa.gov/oppfead1/Publications/catalog/greenscaping.pdf
EPA's GreenScaping Pamphlet summarizes the landscape planning practices outlined by EPA's GreenScapes Program.

EPA Municipal Handbook
http://water.epa.gov/infrastructure/greeninfrastructure/gi_policy.cfm
EPA provides a handbook that includes a chapter on rainwater harvesting policies to help guide reuse of rainwater.

EPA Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices http://water.epa.gov/polwaste/green/index.cfm
LID strategies and practices are related to protecting and restoring water quality. The report provides information on the cost and benefits of using LID strategies and practices.

Hydrologic and Water Quality Comparison of Four Types of Permeable Pavement and Standard Asphalt in Eastern North Carolina
http://www.bae.ncsu.edu/info/permeable-pavement/
The Biological and Agricultural Engineering Department at North Carolina State University has a research program focused on permeable pavement that released a research report to investigate the hydrologic differences among pavement types, which is useful in choosing an appropriate permeable pavement.

Interlocking Concrete Pavement Institute www.icpi.org
The Interlocking Concrete Pavement Institute is a trade organization that promotes the use of interlocking concrete pavement as a permeable pavement option. The institute's Web site offers information regarding interlocking concrete, including technical publications and other resources to support the use of interlocking concrete pavement.

Irrigation Association. 2009. Recommended Audit Guidelines
www.irrigation.org/certification/pdf/AuditGuidelines_FINAL.pdf
The Irrigation Association is a membership organization for the irrigation industry. The association has created a standard series of guidelines for auditing the performance of landscape irrigation systems.

Irrigation Association. 2005. Landscape Irrigation Scheduling and Water Management.
The Irrigation Association's document "Landscape Irrigation Scheduling and Water Management" is part of a two-document series along with "Turf and Landscape Irrigation Best Management Practices." The scheduling and water management report focuses on achieving efficient and water-conserving landscape irrigation by providing the necessary management methods and evaluation tools.

Irrigation Association. 2005. Turf and Landscape Irrigation Best Management Practices.
"Turf and Landscape Irrigation Best Management Practices" is the second document in the two-document set from the Irrigation Association. The report provides best management practices for achieving efficient water use.

Lady Bird Johnson Wildflower Center www.wildflower.org/plants
Lady Bird Johnson Wildflower Center promotes and educates on the use of native plants and wildflowers. The center is a member of the Sustainable Sites Initiative and has information regarding native plant conservation.

Low Impact Development Urban Design Tools http://lid-stormwater.net/index.html
The Low Impact Development Urban Design Tools is a website intended to be used to benefit watershed managers and includes examples of stormwater management approaches that can be used in residential settings.

NAHB Research Center ToolBase Services
www.toolbase.org/ToolbaseResources/level3.aspx?BucketID=2&CategoryID=17
The NAHB Research Center ToolBase focuses on green building design aspects, which include outdoor practices such as permeable pavement, rainwater harvesting, and xeriscaping.

Smart Water Application Technologies (SWAT) http://www.irrigation.org/SWAT/
SWAT was developed by the Irrigation Association and promotes irrigation system controllers that use weather and/or site data to determine a watering schedule. The website provides a list of tested products, draft protocols, and case studies.

Stormwater Protection Center, Center for Watershed Protection www.stormwatercenter.net
The Stormwater Protection Center was created by the Center for Watershed Production for stormwater management use. The website has a resource library, manuals, and other useful tools for stormwater management.

Sustainable Sites Initiative www.sustainablesites.org
The Sustainable Sites Initiative is a set of voluntary guidelines created by a coalition of organizations for various disciplines. The website offers case studies and information on the voluntary performance benchmarks for sustainable land design, construction and maintenance practices.

U.S. Department of Agriculture Invasive and Noxious Weeds List
http://plants.usda.gov/java/noxiousDriver
The U.S. Department of Agriculture website provides a list of invasive and noxious weeds to avoid when landscape planning.

WaterSense Irrigation Audit Guidelines for WaterSense Labeled New Homes
www.epa.gov/watersense/nhspecs/nh_irr_materials.html
WaterSense provides audit guidelines for the irrigation audit after an irrigation system is installed in a new home. The audit guidelines help to determine whether or not a new home can become WaterSense labeled based on irrigation criteria.

WaterSense Water Budget Tool http://www.epa.gov/watersense/water_budget/

The WaterSense Water Budget Tool is used to determine a water budget for a landscape, given area and evapotranspiration data. The WaterSense Water Budget Approach Document provides an overview of the water budget tool and instructions on how to use it.

U.S. Green Building Council (USGBC) LEED for Homes Reference Guide
www.usgbc.org/DisplayPage.aspx?CMSPageID=147

USGBC is non-profit organization that has created a set of voluntary green building guidelines. The LEED for Homes Reference Guide outlines the criteria to gain LEED certification in residential applications. The criteria cover both outdoor and indoor water and energy use.