Table of Contents

Outdoor Water Use

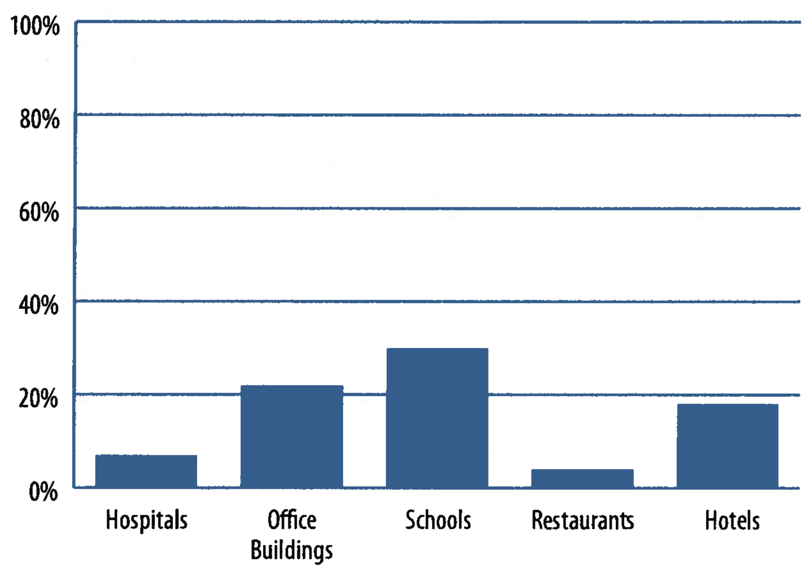
EPA WaterSense

5.1 Introduction to Outdoor Water Use

EPA WaterSense

Outdoor water use can account for between 5 and 30 percent of a facility's total water use, as shown in Figure 5-1.[1] Water is used outdoors for a variety of purposes, including landscape irrigation, swimming pools, and vehicle washing. Improved landscaping and pool maintenance practices and more efficient irrigation equipment can provide opportunities for significant water savings.

Figure 5-1. Water Use Attributed to Outdoor Purposes



Most commercial and institutional facilities that own or maintain surrounding landscape will have some outdoor water use associated with irrigation or landscape maintenance. The amount of outdoor water use is dictated by the size and design of the landscape and the need for supplemental irrigation. Not surprisingly, larger complexes with larger areas of maintained landscape, such as offices, schools, and hotels, can use as much as 30 percent of their water to maintain the health and quality of the landscape. The amount of water used outdoors may also vary due to local climate and facility type. For example, a 2003 study in California estimated that 72 percent of water use in K-12 schools was used outdoors, compared to the 35 percent average from the eight sectors studied.[2] Several sectors, including schools and hotels, also consume a measurable amount of water for the operation and maintenance of pools. Finally, some commercial buildings also use a significant amount of water to clean their fleet of vehicles with a washing station on site.

In many instances, outdoor water use can be controlled and minimized with proper landscape design. Regionally appropriate plant choices, healthy soils with

[1] Created from analyzing data in: Schultz Communications. July 1999. *A Water Conservation Guide for Commercial, Institutional and Industrial Water Users*. Prepared for the New Mexico Office of the State Engineer. www.ose.state.nm.us/wucp_ici.html; Dziegielewski, Benedykt, et al. American Water Works Association (AWWA) and AWWA Research Foundation. 2000. *Commercial and Institutional End Uses of Water*; East Bay Municipal Utility District. 2008. *WaterSmart Guidebook: A Water-Use Efficiency Plan Review Guide for New Businesses*. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook; AWWA. *Helping Businesses Manage Water Use—A Guide for Water Utilities*.

[2] Gleick, Peter H., et al. Pacific Institute. 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. Page 83 and Appendix E.

appropriate grading, the use of mulches, and limiting the use of high water-using plants such as turfgrass can significantly reduce the need for supplemental irrigation. In addition, proper design, installation, and maintenance of irrigation equipment can have a dramatic impact on outdoor water use. For example, using drip irrigation on plant beds instead of traditional sprinklers can reduce irrigation water use by 20 to 50 percent.[3] More efficient sprinkler heads can reduce irrigation water use by 30 percent compared to traditional sprinkler heads.[4] Smart irrigation controllers that schedule irrigation based on weather data or onsite conditions can reduce irrigation water use by 15 percent compared to manual or clock timer irrigation systems.[5]

For schools or hotels with pools, proper pool operation and maintenance can reduce water loss associated with evaporation, filter cleaning, mineral buildup control, leaks, and splashing. For example, pool covers have been shown to reduce evaporation losses by 30 to 50 percent.[6] More efficient filters can reduce water use associated with filter cleaning by 68 to 98 percent.[7]

Vehicle wash facilities are another specialty sector with significant outdoor water use. As much as 95 percent of the water use associated with vehicle wash systems can be attributed to the washing processes and equipment.[8] Reclaiming and reusing vehicle wash water has been shown to save at least 50 percent of the water used in the vehicle-washing process.[9]

Section 5.0: Outdoor Water Use of *WaterSense at Work* provides an overview of and guidance for effectively reducing the water use associated with:

- Landscaping
- Irrigation
- Commercial pool and spa equipment
- Vehicle washing

Outdoor Water Use Case Study

To learn how the Granite Park office complex in Plano, Texas, saved nearly 12.5 million gallons of water by increasing the efficiency of the irrigation system, read the case study in Appendix A.

[3] *Ibid.* Page 8.
[4] Solomon, K.H., et al. 2007. *Performance and Water Conservation Potential of Multi-Stream, Multi-Trajectory Rotating Sprinklers for Landscape Irrigation.* Applied Engineering in Agriculture. 23(2):153-163.
[5] U.S. Environmental Protection Agency's (EPA's) WaterSense program. November 3, 2011. *WaterSense Specification for Weather-Based Irrigation Controllers Supporting Statement.* Page 8. www.epa.gov/watersense/partners/controller_final.html.
[6] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC. September 2010. *Evaluation of Potential Best Management Practices—Pools, Spas, and Fountains.* Prepared for The California Urban Water Conservation Council. Page 34. www.cuwcc.org/products/pbmp-reports.aspx.
[7] *Ibid.* Page 35.
[8] Created from analyzing data in: Schultz Communications, *op. cit.*
[9] Brown, Chris. 2000. *Water Conservation in the Professional Car Wash Industry.* Prepared for the International Carwash Association. www.carwash.org/operatorinformation/research/Pages/EnvironmentalReports.aspx.

5.2 Landscaping

Overview

Water applied to a landscape can account for a significant portion of a commercial or institutional property's overall water use. Studies show that average landscape water use in the commercial and institutional sector can range from 7 percent of total water use for hospitals, 22 percent for office buildings, and up to 30 percent for schools.[10] Typically, a landscape is watered to supplement natural precipitation based on a plant's water needs. In some areas of the country, such as the arid Southwest, this gap in water needs and precipitation can be significant. Landscape design, soil conditions, plant choice, and maintenance all affect the amount of water a landscape needs. *Section 5.2: Landscaping* outlines best management practices that can guide a facility in making more water-efficient landscaping choices.

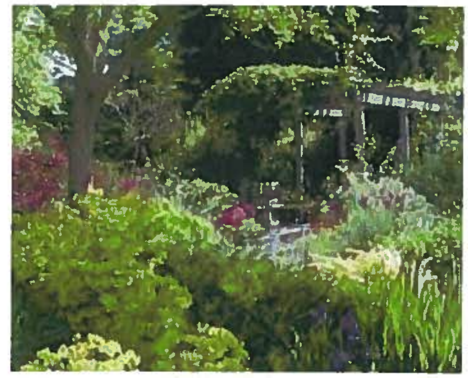
Reduction of turf area with plantings

A well-designed landscape should be supported by healthy soils with appropriate grading, mulches, regionally appropriate plant choices, appropriately sized turf areas, and hydrozones. The following information should also be considered for a well-designed landscape:

- Healthy soils allow water to properly infiltrate and help healthy plant root systems to develop. Soil health can be maintained with a combination of aeration and applying compost or mulch to help the soil retain its nutrients while supporting plant growth.
- Appropriately graded sites with gentle slopes allow water to stay where it is applied and get delivered to the root zone of the plants, instead of leading to stormwater runoff.
- Mulches on landscaped beds can help keep soils cool and minimize evaporation. If organic mulches, such as wood chips or shredded leaves, are used, they can add nutrients to the soil as they decompose.
- An appropriate plant palette consisting of drought-tolerant, native, or regionally appropriate species lays a solid foundation for a water-efficient landscape, reducing water requirements, as well as the time and cost associated with maintaining the landscape.[11]
- A smaller turf area can reduce resources and costs associated with watering, mowing, fertilizing, and removing debris.

[10] U.S. Environmental Protection Agency (EPA's) WaterSense program. August 20, 2009. *Water Efficiency in the Commercial and Institutional Sector: Considerations for a WaterSense Program*. Pages 7-10. www.epa.gov/watersense/docs/ci_whitepaper.pdf.
[11] EPA's WaterSense program. December 2009. *Research Report on Turfgrass Allowance*. Page 6. www.epa.gov/WaterSense/docs/home_turfgrass-report508.pdf.

- Hydrozoning, or grouping plants according to their water needs, will promote efficient irrigation in those zones that require supplemental water.



Non-turf landscape

It is possible in many parts of the country to design a landscape that does not require any supplemental irrigation. If irrigation is used, the irrigation system efficiency is another important factor that affects landscape water use. For information on the efficient use of landscape irrigation systems, refer to *Section 5.3: Irrigation*.

If a water feature (e.g., pond or ornamental pool) is included in a landscape, it should provide a beneficial use, such as a wildlife habitat or stormwater management. In addition, the feature should recirculate water instead of serving as a single-pass device, which can waste significant amounts of water.

Many of the actions that can be taken to improve a landscape's water efficiency can have the co-benefit of reducing stormwater runoff. The U.S. Environmental Protection Agency's (EPA's) Green Infrastructure program focuses on solutions to reduce runoff, such as rain gardens and permeable pavements.[12] Local water utilities or municipal governments[13] may also have green infrastructure practices to share or incentives to help improve landscapes to reduce stormwater runoff.

Operation, Maintenance, and User Education

To optimize a landscape's water efficiency, hire a landscape professional with a demonstrated knowledge of water-efficient landscape design, maintain the soil quality and existing plants, and minimize water used for other purposes with respect to the overall landscape design.

Hiring a Landscape Professional

When selecting or employing a landscape professional, consider the following attributes and management strategies:

- Consider selecting landscape professionals trained and certified in water-efficient or climate-appropriate landscaping. Existing professionals can attend courses or seminars to learn water-efficient techniques.
- Periodically review all landscape service and maintenance agreements to incorporate water-, chemical-, and energy-efficiency requirements or performance standards.
- Encourage landscape professionals to report and/or fix irrigation system problems. Many landscape professionals not only install and maintain plants in your landscape, but also install and maintain the irrigation system. These professionals can identify and report leaks or other inefficiencies over time.

[12] EPA. Green Infrastructure. water.epa.gov/infrastructure/greeninfrastructure/index.cfm.
[13] Portland Bureau of Environmental Services. Stormwater Solutions. www.portlandonline.com/bes/index.cfm?c=31870; Philadelphia Water Department. Businesses. www.phillywatersheds.org/whats_in_it_for_you/businesses.

5.2 Landscaping

Maintaining Soil Quality

Consider the following maintenance tactics to ensure a healthy soil quality:

- Add mulch to plant beds to cover bare soil. Re-mulch areas annually to maintain soil coverage and prevent erosion.
- Maintain a sufficient quantity of good topsoil—four to six inches deep—to capture precipitation as it falls and release water back to plants over time, reducing irrigation requirements.
- Consider incorporating soil amendments into water-logged or fast-draining soils to attain proper soil water holding capacity. For soils with poor drainage (i.e., clay soils) or soils that drain too quickly (i.e., sandy soils), consider incorporating topsoil or compost to balance soil composition and restore nutrients.
- For areas that undergo regular foot or vehicular traffic, aerate the soil annually to alleviate compaction and improve water infiltration rates.

Maintaining Existing Plants

When maintaining your landscape's existing plant life, consider the following water-efficient tips:

- Keep the irrigated landscape free of weeds so that water is available for the decorative landscaping. Pull weeds manually instead of using herbicides, which can contaminate local water sources.
- Raise the blade on mowers to allow grass to grow longer. Longer grass promotes deeper root growth and more drought-resistant turf. Some species of turfgrass go dormant during dry periods. Consider letting the grass turn brown during these times. It will recover when rainfall returns.
- Encourage the inclusion of shaded areas in the overall landscape design, which decreases the water needs of surrounding plants. Consider planting additional trees and shrubbery to increase the amount of shaded area in the future.

Minimizing Water Used for Other Purposes

To minimize the amount of water used for other outdoor-related purposes, consider the following:

- Recirculate water in decorative fountains, ponds, and waterfalls. Shut off these features when possible to reduce evaporation losses. Check water recirculation systems annually for leaks and other damage. Consider using non-potable water in these systems (refer to *Section 8: Onsite Alternative Water Sources* for additional information).
- Do not use water to clean sidewalks, driveways, parking lots, tennis courts, pool decks, or other hardscapes. Sweep these areas instead.

Retrofit and Replacement Options

Many of the actions that might be undertaken to retrofit or replace a landscape are similar. The goal for either retrofitting or replacing landscaping should be to optimize water use and hold water in the soil rather than allowing it to run off site. Differences in practices and options are primarily those of scale. Because the replacement of a commercial or institutional landscape could carry a considerable cost, it is important to ensure that the landscape is properly designed from the start. Consider hiring a licensed landscape architect or a qualified site planner/designer to assist. Local botanical gardens may also have information on how to develop a landscape that is beautiful, functional, and water-efficient. For example, the Conservation Garden Park developed by the Jordan Valley Water Conservancy District in West Jordan, Utah,[14] has a wealth of information and virtual tours demonstrating water-smart landscaping that can even be beneficial to people outside of the area.

Site Preparation

How the site is prepared has a significant impact on the ability for the landscape to retain moisture and limit the need for supplemental irrigation. Before retrofitting, replacing, or installing a new landscape, consider the following site preparation tips:

- To the extent feasible, limit the removal of native vegetation and soils.
- Minimize soil compaction in the construction phase by limiting areas for use of heavy equipment.
- Install temporary protective fencing around trees to protect their root zones.
- Reduce runoff from steep slopes in the landscape by either grading appropriately or terracing. If slopes cannot be avoided in landscape design, install plants with deeper root zones to provide stabilization and prevent erosion.
- Before the landscape is installed, ensure that the soil is properly amended, tilled, and contoured to hold water. Where turfgrass is used, the area should include at least six inches of well-amended soil capable of easily absorbing and holding water in the root zone.

Plant Selection

Plant selection can make all the difference in a water-efficient landscape. Consider the following when redesigning a landscape:

- Evaluate site conditions and plant appropriately. Areas of the same site may vary significantly in soil type or exposure to sun and wind, as well as evaporation rates and moisture levels. Be mindful of a site's exposure to the elements and choose plants that will thrive in the site's conditions.

[14] Jordan Valley Conservation Gardens Foundation. Visit the Conservation Garden Park. conservationgardenpark.org/visit/.

5.2 Landscaping

Climate-appropriate plants

- Select drought-tolerant or climate-appropriate turfgrass, trees, shrubs, and ground cover when replanting landscaped areas. Information about climate-appropriate plants may be available through your local extension office[15] or on EPA's WaterSense® program website.[16]
- Incorporate shade trees into your landscape or plant near large shade trees. Shaded areas typically require less supplemental water than areas exposed to direct sun. Additionally, shade trees and other vegetation placed strategically to shade the south-facing wall of a building can eventually help to reduce energy costs.[17]
- Consider reducing the area of turfgrass in the landscape, as most turf generally requires more water than planted beds, especially if the plants are climate-appropriate and their surrounding soil is covered with mulch.[18]
- Avoid installing "strip grass," such as small strips of grass between the sidewalk and street, because these areas are hard to maintain and difficult to water efficiently.
- Consider installing rain gardens throughout the landscape. These excavated, shallow depressions should include native plantings designed to capture rainwater runoff from roofs, driveways, and sidewalks. These gardens can keep water on the property and absorb up to 40 percent more runoff than typical lawns.[19]

Avoided strip grass

Irrigation

Although it is possible in many parts of the country to design a landscape that can live on rainfall alone, some irrigation may be needed to ensure landscape health. There are many factors that should be taken into account to ensure that an irrigation system is well designed, operated, and maintained. More detailed information about irrigation systems is available in *Section 5.3: Irrigation*, but following are a few tips:

- Use the technique of hydrozoning to group plants with similar irrigation needs together.
- Consider how the interplay between the types of plants and irrigation components can affect the volume of water needed to sustain the landscape. EPA's WaterSense Water Budget Tool,[20] developed to address residential landscapes in WaterSense labeled new homes, can be used as a guide to see how plant types

[15] U.S. Department of Agriculture. Cooperative Extension System Offices. www.csrees.usda.gov/Extension/.
[16] EPA's WaterSense program. What to Plant. www.epa.gov/WaterSense/outdoor/what_to_plant.html.
[17] Sailor, David J. and Dietsch, Nikolaas. October 3, 2005. *The Urban Heat Island Mitigation Impact Screening Tool (MIST)*. Page 2.
[18] EPA's WaterSense program. December 2009, *op. cit.*
[19] EPA's WaterSense program. *Resource Manual for Building WaterSense Labeled New Homes.* www.epa.gov/watersense/docs/newhome_builder_resource_manual508.pdf.
[20] EPA's WaterSense program. The WaterSense Water Budget Tool. www.epa.gov/WaterSense/water_budget/.

and irrigation methods affect the ability of a landscape to meet a water budget based on the local climate. The Water Budget Tool is not intended to estimate actual savings, but it is a tool to help evaluate the relative water savings that can be achieved with different plant palette and technology choices.

- Consider installing a separate meter to measure the volume of water applied to the landscape. Separately metering irrigation systems can reduce wastewater costs in some jurisdictions and can help to identify leaks more quickly.
- Consider where alternative water sources can be used as a substitute for potable water sources for irrigation. Information about rainwater harvesting and reuse can be found on the WaterSense website[21] or see *Section 8: Onsite Alternative Water Sources* for more information.

Other Features

When planning hardscape retrofits, consider the following to enhance outdoor water efficiency:

- If replacing sidewalks or parking lot pavement, consider installing permeable surfaces (e.g., permeable pavement) rather than impermeable hardscape.
- Use bushes, mulch, rain gardens, permeable hardscape, or curb cuts in parking lot islands or in the areas between sidewalks and the roadway. These should be at a lower elevation than surrounding hardscape so that runoff flows into them.

Rain garden

- While water features are common in many landscapes, consider the annual water use of the specific feature before installing one. Ideally, these features should provide a beneficial use, such as a wildlife habitat, stormwater management, and/or noise reduction. Because water from these features is often lost to evaporation, use alternative water sources or look for a feature that recirculates water in order to reduce the amount of potable water used. Smaller pumps, lower pumping rates, and/or pressure-reducing valves can help reduce water flow.[22]

Savings Potential

Landscape water use is largely dependent upon climate, plant type, and an irrigation system's efficiency. Soil health, grade, and maintenance also play a role. In order to evaluate landscape improvements and their associated savings, one must first know how much water is being applied to the landscape. Dedicated irrigation meters can be used to track irrigation water use and document savings from various measures.

Savings for converting high water-using landscapes to low water-using landscapes vary by plant type and climate. Keep in mind that calculations are property-specific. In general, various studies have reported savings ranging from 18 to 50 percent from

[21] EPA's WaterSense program. Rainwater & Reuse. www.epa.gov/WaterSense/outdoor/rainwater_reuse.html.
[22] EPA's WaterSense program, *op. cit.*, Page 41.

converting landscape plants with high water requirements to those with lower water requirements.[23] A more water-efficient landscape can also provide ancillary benefits by reducing the need for maintenance, fertilizer application, and fuel use.[24]

Additional Resources

American Society of Landscape Architects. www.asla.org.

Denver Water. Xeriscape Plans. www.denverwater.org/Conservation/Xeriscape/XeriscapePlans/.

EPA. Green Infrastructure. water.epa.gov/infrastructure/greeninfrastructure/index.cfm.

EPA. GreenScapes Program. www.epa.gov/epawaste/conserve/rrr/greenscapes/index.htm.

EPA's WaterSense program. *Resource Manual for Building WaterSense Labeled New Homes*. www.epa.gov/WaterSense/docs/newhome_builder_resource_manual508.pdf.

EPA's WaterSense program. The WaterSense Water Budget Tool. www.epa.gov/WaterSense/water_budget/.

EPA's WaterSense program. Water-Efficient Landscape Design. www.epa.gov/watersense/outdoor/landscaping.html.

Rosenberg, David E., et al. June 2011. *Value Landscape Engineering: Identifying Costs, Water Use, Labor, and Impacts to Support Landscape Choice. Journal of the American Water Resources Association* (JAWRA) 47(3):635-649.

Rushton, Betty, Ph.D. Southwest Florida Water Management District. May 2002. *Infiltration Opportunities in Parking Lot Designs Reduce Runoff and Pollution.* www.p2pays.org/ref/41/40363.pdf.

Sailor, David J. and Dietsch, Nikolaas. October 3, 2005. *The Urban Heat Island Mitigation Impact Screening Tool (MIST).* www.heatislandmitigationtool.com/Introduction.aspx.

[23] EPA's WaterSense program. December 2009, *op. cit.*

[24] Rosenberg, David E., et al. June 2011. *Value Landscape Engineering: Identifying Costs, Water Use, Labor, and Impacts to Support Landscape Choice. Journal of the American Water Resources Association* (JAWRA). 47(3):635-649.

5.3 Irrigation

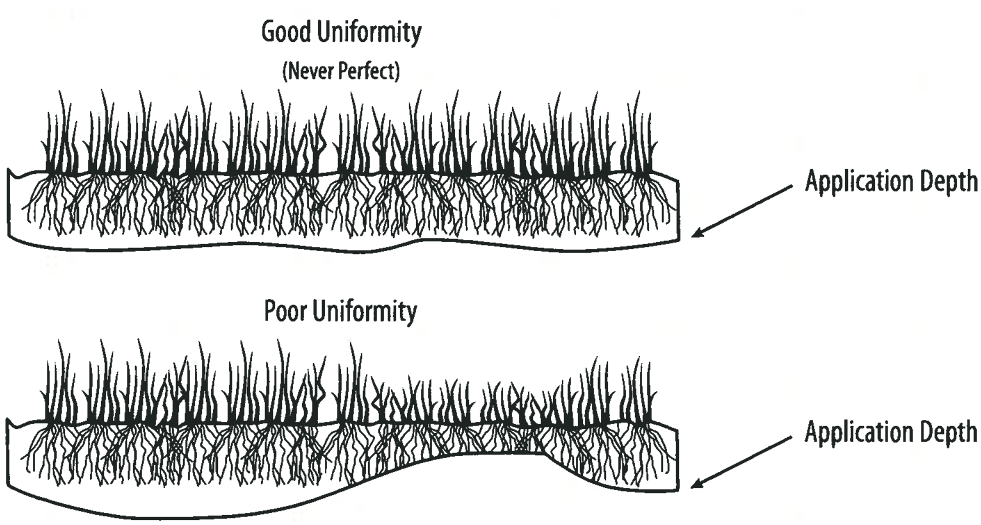
EPA WaterSense

Overview

The efficiency of an irrigation system is dictated by many factors, including human, mechanical, and environmental components. Implementing mechanisms and practices that increase an irrigation system's efficiency could save a property more than half of its outdoor water use. In landscapes around the country, a significant amount of water is lost from evaporation, wind, or runoff due to improper irrigation system design, installation, and maintenance. Eliminating this waste requires trained professionals, appropriate irrigation schedules, and efficient technologies. Additionally, the landscape itself (e.g., plant palette, soil type, etc.) plays a role in irrigation water use and provides the potential for additional water savings. See *Section 5.2: Landscaping* for more details.

One of the most important concepts associated with irrigation system efficiency is distribution uniformity, or how evenly water is applied over the landscape. This concept is illustrated in Figure 5-2.[25] Extra water is often applied if the system is not distributing water in a uniform manner. Without proper distribution, the landscape is watered to keep the driest spot green, over-irrigating other areas. Figure 5-3 provides an illustration of head-to-head coverage, which is a practice to increase distribution uniformity. Using this practice, each sprinkler head (depicted with numbers 1 through 4 in Figure 5-3) is positioned so that its spray arch just touches the head of each surrounding sprinkler. This ensures that there is sufficient overlap and no areas are without coverage.

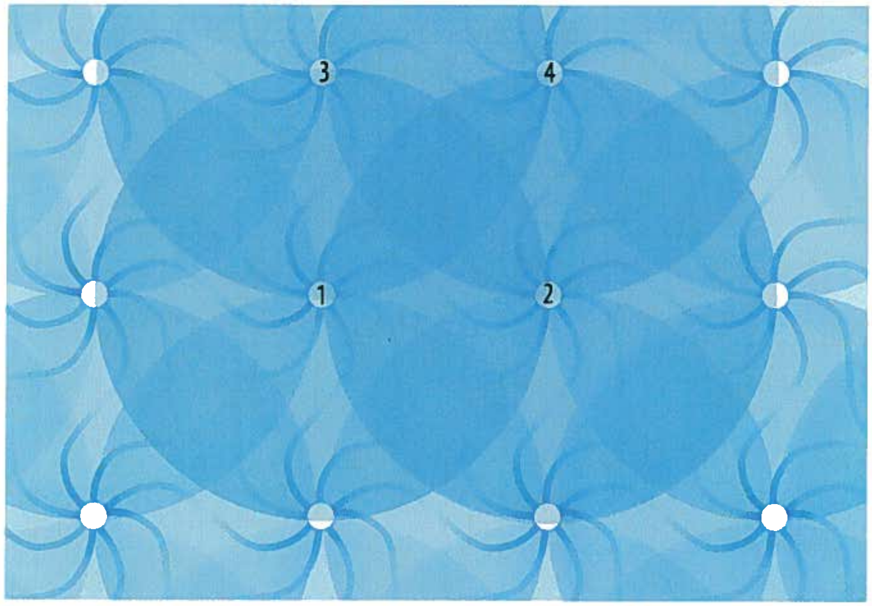
Figure 5-2. Good and Poor Distribution Uniformity



[25] Irrigation Association (IA). Falls Church, Virginia.

5.3 Irrigation

Figure 5-3. Example of Head-to-Head Coverage Spray Pattern



In addition to considering how evenly water is applied, it is equally important to consider the irrigation schedule, which dictates the amount and timing of the water applied. Landscape water needs change with the seasons, and so should the irrigation schedule. Many landscapes are watered at the same level all year, which is unnecessary. Over-watering can damage plants more than under-watering and can also damage streets, curbs, other paving, and building foundations.

Not only do proper design, installation, and maintenance of an irrigation system play a significant role in landscape water efficiency, but there are also a variety of irrigation technologies that can help reduce water use. For example, drip irrigation is a highly efficient method of application because it directs water to plant roots at a low flow rate, avoiding water lost to wind or runoff. This technology uses between 20 to 50 percent less water than conventional in-ground sprinkler systems.[26] There are also efficient types of sprinkler heads that distribute water in larger droplets, avoiding wind drift and increasing distribution uniformity. The Southern Nevada Water Authority (SNWA) estimates water-efficient sprinkler technologies can reduce water use by as much as 30 percent when compared to standard pop-up sprinklers.[27] Additionally, scheduling technologies relying on weather data, soil moisture, or other onsite conditions apply water only when needed.

To capitalize on the water savings potential from these scheduling technologies, the U.S. Environmental Protection Agency's (EPA's) WaterSense® program published a specification to label weather-based irrigation controllers. WaterSense labeled weather-based irrigation controllers (WBICs)[28] are independently certified to meet plants' watering needs without over-watering.

[26] Gleick, Peter H., et al. Pacific Institute. 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. Page 8.
[27] Solomon, K.H., et al. 2007. *Performance and Water Conservation Potential of Multi-Stream, Multi-Trajectory Rotating Sprinklers for Landscape Irrigation*. Applied Engineering in Agriculture. 23(2):153-163.
[28] U.S. Environmental Protection Agency's (EPA's) WaterSense program. WaterSense Labeled Irrigation Controllers. www.epa.gov/WaterSense/products/controltech.html.

WaterSense has evaluated a number of studies conducted by a variety of organizations that cover numerous WBIC brands. Results from these studies indicate a range of overall savings from 6 to 30 percent. Individual site savings can vary beyond these overall numbers, depending upon the watering habits prior to installing the WBIC. In some cases, site water use can increase if the facility was practicing deficit irrigation before installing a WBIC. In a 2009 comprehensive study, first-year savings were shown to be approximately 6 percent.[29] For a limited subset of controllers in this study that were tracked for three years, overall savings were shown to be 16 percent in the third year after installation. In full consideration of the findings of these numerous studies, WaterSense anticipates seeing overall water savings of approximately 15 percent after proper installation of WBICs, when compared to systems that use a clock timer with manual programming.[30]

The key to saving irrigation water is to combine efficient irrigation practices with efficient technologies. Additional details on many of these principles, practices, and technologies can be found in the Irrigation Association's (IA's) Landscape Irrigation Scheduling and Water Management and Turf and Landscape Best Management Practices[31] documents.

Operation, Maintenance, and User Education

There are several best practices a facility can consider to optimize an irrigation system's efficiency, such as ensuring irrigation professionals are properly educated on water-efficient practices and that existing irrigation systems are properly operated and maintained.

Irrigation Professional Education

Consider the following to ensure irrigation professionals have a strong understanding of the principles of water-efficient irrigation:

- Ensure existing professionals or staff managing the irrigation system become familiar with water-efficient irrigation practices through partnerships, classes, seminars, and/or published guidance documents. Encourage professionals or staff managing the system to:
    - Become certified through a WaterSense labeled irrigation certification program with an emphasis on water efficiency.[32]
    - Consult the local water utility, community colleges, or agricultural services for courses or seminars on water-efficient irrigation practices.
    - Review technical guidance documents provided by local cooperative extension services and irrigation trade associations.

[29] Mayer, Peter, et al. The Metropolitan Water District of Southern California and the East Bay Municipal Utility District. July 1, 2009. *Evaluation of California Weather-Based "Smart" Irrigation Controller Programs.* www.aquacraft.com/node/32.
[30] EPA's WaterSense program. November 3, 2011. *WaterSense Specification for Weather-Based Irrigation Controllers Supporting Statement.* Page 12. www.epa.gov/watersense/partners/controller_final.html.
[31] IA. Best Practices & Standards: Turf & Landscape Irrigation Best Management Practices. www.irrigation.org/Resources/Turf___Landscape_BMPs.aspx.
[32] EPA's WaterSense program. Professional Certification Program. www.epa.gov/WaterSense/outdoor/cert_programs.html.

65 percent is equal to a rating of "very good" for fixed spray heads, according to IA.[37] To help ensure consistent uniformity, require that replacement equipment is compatible with existing equipment and made by the same manufacturer.

- In addition to a full audit every few years, the system should be periodically monitored for effectiveness throughout the year. Ask the irrigation professional or staff managing the system to ensure certain sprinkler components are placed and adjusted so that they water the cultivated plants and not the pavement or other hardscape. Verify that irrigation system pressure is within manufacturer specifications.
- Request that irrigation professionals or staff managing the system include immediate reporting and repair of problems in maintenance programs, and require regular maintenance routines as part of the overall irrigation maintenance program.
- Install a dedicated water meter for the irrigation system to measure the amount of water applied to the landscape. Some water utilities offer an interruptible rate for the service or will not apply sewer charges to water used for irrigation. The irrigation professional or staff managing the system should keep a record of trends in irrigation water use as part of the maintenance program.

Retrofit Options

If retrofitting an irrigation system, consider the following options to decrease landscape water use.


Weather-based irrigation controller

Irrigation System Controllers and Sensors

An existing irrigation system can be optimized by the following retrofits to the controls or components:

- Consider replacing existing irrigation system controllers with a more advanced control system that waters plants only when needed. There are many available technologies using weather or soil moisture information to schedule irrigation according to plant needs. The following are a few options to discuss with the service provider, auditor, or consultant/designer:
  - WaterSense labeled WBICs[38] can be added to an existing system. These products are independently certified to minimize irrigation excess and maximize irrigation adequacy, while also providing other performance and user features. In order to work effectively, these WBICs must be installed and programmed properly, taking into account facility-specific landscape conditions and the irrigation system installed.

[37] IA. March 2005. *Landscape Irrigation Scheduling and Water Management.* Pages 1-22. www.asla.org/uploadedFiles/PPN/Water%20Conservation/Documents/LISWM%20Draft.pdf.

[38] EPA's WaterSense program. WaterSense Labeled Irrigation Controllers, *op. cit.*

- When hiring new irrigation professionals to work with the system, inquire about their water-efficiency certification or specific training that promotes efficient irrigation. For example, professionals certified by WaterSense labeled irrigation certification programs[33] have demonstrated knowledge in water-efficient irrigation.

Irrigation System Operation

In addition to periodically reviewing all irrigation service agreements to emphasize the operation of a water-efficient system, verify that the irrigation schedule is appropriate for climate, soil conditions, plant materials, grading, and season as follows:

- Irrigation schedules should be updated based on changing weather conditions and as part of regular maintenance. Require the irrigation professional and/or auditor to deliver options for automating schedule changes based on changing weather conditions. Installing and properly programming WaterSense labeled WBICs[34] or soil moisture sensors can provide this capability.
- Certain soil types or steep slopes could increase the chance of surface runoff. Irrigation events may need to be separated into multiple applications depending upon landscape conditions. This is commonly known as a "cycle and soak" methodology. If currently installed irrigation controller(s) are not capable of such programming, consider using more current technology.
- Generally, it is better to apply water in larger amounts, but less frequently, resulting in deep watering. A less frequent but more intense schedule encourages the growth of deep roots, resulting in healthy plants. Note that soil type plays a role in creating this type of schedule and should be taken into consideration.
- Incorporate a water budget, which can be used as a performance standard for water use. A budget provides a specified amount of water that should be applied to the landscape and can be used as a comparison to the property's actual water use.

Irrigation System Maintenance

Irrigation systems require regular maintenance to ensure optimal performance. Consider the following key system maintenance tips:

- Require a full audit of the irrigation system every three years by a qualified irrigation auditor, such as a professional certified by a WaterSense labeled program.[35] IA provides audit guidelines.[36] A full audit should include an in-depth assessment of the irrigation system, its performance, and schedule. In addition, the audit should expose deficiencies that have occurred from either system changes and/or landscape changes. The audit is an opportunity to identify appropriate, new technologies as well. An audit should analyze the distribution uniformity of the system to ensure it is at least 65 percent. A distribution uniformity of

[33] *Ibid.*
[34] EPA's WaterSense program. WaterSense Labeled Irrigation Controllers, *op. cit.*
[35] EPA's WaterSense program. Professional Certification Program, *op. cit.*
[36] IA. Technical Resources: Irrigation Audit Guidelines. www.irrigation.org/Resources/Audit_Guidelines.aspx.

- Soil moisture sensors can be inserted into the soil to measure moisture. They can be connected to an existing system, enabling irrigation as needed by plants.

- Consider installing rain-sensing technology to prevent irrigation from taking place during periods of sufficient moisture. Many cities and some states require rain-sensing technology by law. Check with the state or city on relevant mandates.

- Consider installing other sensors to cut down on wasted water. For example, wind-sensing technology interrupts irrigation cycles in the presence of significant wind. Freeze-sensing technology prevents irrigation during freeze conditions. Flow rate-monitoring equipment can interrupt irrigation if excess flow is detected (i.e., caused by broken pipes, fittings, emitters, sprinklers, etc.).

- If managing a large property, consider installing complete central control systems that use demand-based controls to enable a water manager to centrally operate and manage multiple irrigation systems at multiple locations with various means of communication.

Irrigation System Hardware

In addition to retrofitting the control system to decrease water use, a facility can consider retrofitting irrigation system hardware as follows:

- Consider retrofitting a portion of the spray heads that water trees, shrubs, or plant beds with low-flow, low-volume irrigation, also called micro-irrigation or drip irrigation. Many plant beds do not require the spray heads traditionally used to water turf areas.

- Consider exchanging existing sprinkler heads with more efficient heads designed to minimize water lost to wind and distribute water in a more uniform manner. Sprinklers with a fine mist are susceptible to water waste from wind drift. Also, some sprinklers do not apply water evenly over the landscape. Consider pressure-regulating heads with matched precipitation and/or multi-trajectory rotating spray heads as water-efficient sprinkler head options.

- Pay attention to sprinkler head spacing during replacement to ensure the heads have matched trajectories and offer head-to-head coverage.

- Retrofit other water-using devices on the property to use water more efficiently. For example, attach shut-off nozzles to handheld hoses to make sure water is going directly to the plants rather than dripping on the ground.

Replacement Options

If replacing an irrigation system, there are as many opportunities to increase its efficiency during the phases of system design and installation as there are during system operation and maintenance. Hiring qualified irrigation professionals and ensuring a well-designed system are key to ensuring water savings from an irrigation system replacement.

Qualified Irrigation Professionals

Select an irrigation installation and maintenance professional that has been certified by a WaterSense labeled program[39] or otherwise has experience in water efficiency. In addition, consider the following:

- If using onsite staff, encourage them to become certified through a WaterSense labeled certification program that focuses on water efficiency.
- Upon completion of new irrigation systems, use a qualified irrigation auditor, such as one certified by a WaterSense labeled program,[40] to audit the system and ensure the installed system's performance meets the design intent. The auditor can then make minor adjustment recommendations as needed.

System Design Considerations

When replacing an irrigation system, recommend that the system be designed, installed, and maintained according to technical guidance published by local co-operative extensions or IA. Following industry best practices helps the irrigation professional address water-efficient techniques from design through installation and proper maintenance. Visit IA's website for further technical guidance and information related to the most widely known irrigation best practices.[41] In addition, consider the following:

- Design the system for maximum water application uniformity (i.e., distribution uniformity). As noted above, aim for a distribution uniformity of at least 65 percent. Request the following of the designer:
  - Ensure no direct distribution of water over impermeable surfaces or non-target areas.
  - Maximize sprinkler distribution uniformity by following manufacturer recommendations for head spacing and design the system with head-to-head coverage.
- Create irrigation hydrozones by placing plants with similar water needs together. Also consider varying soil conditions, sun/shade/wind exposure, slope, and other site specifics that could impact watering needs.
- Consider installing the following components for optimal water efficiency:
  - Drip/micro-irrigation for all areas suitable for such technology.
  - High-efficiency sprinkler heads for turf and other areas that require spray irrigation.
  - Check valves in all sprinklers to retain water in lateral pipes between cycles.
  - Demand-based irrigation controls (i.e., weather- or sensor-based controls).

[39] EPA's WaterSense program. Professional Certification Program, *op. cit.*
[40] *Ibid.*
[41] IA. Technical Resources. www.irrigation.org/Resources/Technical_Resources.aspx.

- Rain, freeze, and wind sensors to interrupt irrigation during unfavorable weather conditions.
- Flow rate-monitoring equipment that can interrupt irrigation if excess flow is detected.

- Use alternative sources of water (see *Section 8: Onsite Alternative Water Sources*) where environmentally appropriate and local regulations allow. Keep in mind that while alternative sources are an additional way to save water in a landscape, efficiency should come first. Apply all the principles above to build the optimal, efficient system, and then consider using alternative sources.

Savings Potential

Irrigation water savings can be achieved through proper design, installation, and maintenance, combined with efficient technologies. In addition, the landscape itself (e.g., plant palette, soil type, etc.) plays a role in irrigation water use and provides potential for additional water savings (see *Section 5.2: Landscaping* for more details).

In order to consider irrigation system improvements and their associated savings, it is important to first understand how much water is being applied to the landscape. Dedicated irrigation meters track irrigation water use and allow facilities to document actual savings.

The WaterSense Water Budget Tool,[42] developed by EPA to support residential landscapes associated with WaterSense labeled new homes, can be used to see how relative water needs adjust by changing the plant palette and associated irrigation type. For example, replacing a large turf area irrigated by spray heads with plant beds irrigated by drip irrigation could significantly reduce water use. The Water Budget Tool allows a landscape professional to alter the irrigation type in a virtual setting, analyzing the relative water savings associated with each design change. The tool, however, is not intended to estimate actual savings; it is meant to evaluate the relative water savings achieved with different palette and technology choices.

Savings from implementing any of these technologies are dependent upon the system as a whole, including the landscape and climate, and, therefore, are landscape-specific. Following are a few examples of savings realized from implementing water-efficient technologies in the landscape:

- Installing drip irrigation uses 50 percent less water than conventional in-ground sprinkler systems.[43]
- Water-efficient sprinkler technologies can reduce water use by as much as 30 percent when compared to standard pop-up sprinklers.[44]

[42] EPA's WaterSense program. The WaterSense Water Budget Tool. www.epa.gov/WaterSense/water_budget/.
[43] Gleick, Peter H., *op. cit.*
[44] Solomon, K.H., et al., *op. cit.*

- Properly installing a WaterSense labeled WBIC may reduce irrigation water use by 15 percent.[45]
- A project in Florida demonstrated a savings of 13,567 gallons every time a rain sensor prevented an irrigation event on half an acre of landscape.[46]

Additional Resources

EPA's WaterSense program. The WaterSense Water Budget Tool. www.epa.gov/WaterSense/water_budget/.

EPA's WaterSense program. *Resource Manual for Building WaterSense Labeled New Homes*. www.epa.gov/WaterSense/docs/newhome_builder_resource_manual508.pdf.

EPA's WaterSense program. Meet Our Partners. www.epa.gov/watersense/meet_our_partners.html.

EPA's WaterSense program. Watering Wisely. www.epa.gov/watersense/outdoor/waterwisely.html.

EPA's WaterSense program. WaterSense Labeled Irrigation Controllers. www.epa.gov/watersense/products/controltech.html.

Irrigation Association. Best Practices & Standards: Turf & Landscape Irrigation Best Management Practices. www.irrigation.org/Resources/Turf___Landscape_BMPs.aspx.

Irrigation Association. March 2005. *Landscape Irrigation Scheduling and Water Management*. www.asla.org/uploadedFiles/PPN/Water%20Conservation/Documents/LISWM%20Draft.pdf.

Irrigation Association. Technical Resources: Irrigation Audit Guidelines. www.irrigation.org/Resources/Audit_Guidelines.aspx.

[45] EPA's WaterSense program. November 3, 2011, *op. cit.*
[46] Dukes, Michael D. and Haman, Dorota Z. University of Florida IFAS Extension. August 2002. *Residential Irrigation System Rainfall Shutoff Device*. edis.ifas.ufl.edu/ae221.

5.4 Commercial Pool and Spa Equipment

EPA WaterSense

Overview

Pools and spas are found in many commercial or institutional settings, including hotels, schools, community centers, hospitals, and apartment complexes. The size and features of these pools vary widely depending on their intended use and setting. Table 5-1, which summarizes typical pool sizes for commercial pools and spas in California,[47] shows that a typical commercial pool can contain between 34,000 and 860,000 gallons of water. Spas are much smaller, containing on average 1,100 gallons. Due to a lack of data, the California Urban Water Conservation Council (CUWCC) document from which this data was taken assumes that the typical pool sizes estimated for California are representative of pool sizes nationally.

Table 5-1. Typical Sizes for Commercial Pools and Spas

Pool Type	Area (square feet)	Depth (feet)	Volume (gallons)
Spa	40	3.0	1,100
Hotel (in-ground)	1,000	4.5	34,000
Public (in-ground)	4,000	5.0	150,000
Olympic (in-ground)	14,000	8.0	860,000

Overall, a large volume of water is used to fill commercial pools or spas. Much of this water is often lost in day-to-day operation due to evaporation, leaking, and splashing. Ongoing pool or spa maintenance also creates significant losses in filter cleaning and mineral buildup control.

Because evaporation, filter cleaning, and mineral buildup control represent the greatest uses of water for commercial pools and spas, they also provide the most significant opportunities to achieve water savings. CUWCC estimates that water evaporation, filter backwashing, and mineral buildup control account for 56, 23, and 21 percent of pool water use, respectively, across all pools installed in California.[48] Water losses from leaks and splashing are not included in this estimate because they are difficult to quantify. Although the estimates used in this section are specific to California, EPA assumes that, with the exception of evaporation (which is dependent upon local climate), they are applicable to and representative of pools and spas nationwide.

Evaporation

Water continually escapes pools and spas due to evaporation from the pool/spa surface. The rate of evaporation will depend upon several factors, including: water temperature, the pool's ambient conditions (e.g., indoor or outdoor), the extent of convection over the pool's open surface, and the surface area of water that comes in

[47] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC. September 2010. *Evaluation of Potential Best Management Practices—Pools, Spas, and Fountains*. Prepared for the California Urban Water Conservation Council. Pages 3-30. www.cuwcc.org/products/pbmp-reports.aspx.
[48] *Ibid*. Page 30.

contact with air. Table 5-2 provides an overview of evaporation losses for various pool sizes, as estimated by CUWCC.[49] These estimates show that water losses from evaporation can be significant. For example, the total volume of water lost annually in spas is several times larger than the volume of the spa itself. For larger pools, this effect is reduced; however, the water loss still can be significant and of the same order of magnitude as the volume of the pool itself.

Table 5-2. Evaporation Water Losses by Pool Type

Pool Type	Pool Volume (gallons)	Water Loss (gallons per year)
Spa	1,100	6,300
Hotel (in-ground)	34,000	40,000
Public (in-ground)	150,000	160,000
Olympic (in-ground)	860,000	570,000

Filter Cleaning

All swimming pools require pool filtration systems in order to keep the water free of particulate matter. These systems include pumps, filters, drains, and skimmers. In terms of water efficiency, the distinguishing factors are the type of filter and the amount of maintenance associated with it. The other components of the filtration system have little impact on water use.

Pool filters are differentiated by the media used to treat pool water. These media primarily include sand, sorptive media (i.e., pre-coat filters), and cartridge filters. While these filter types operate on the same principle of circulating water through filter media to separate suspended particles, their design differences affect how often they need to be cleaned, which in turn affects how much water they use. Each type requires a trade-off between water and material use efficiency.

Pool and spa filters must be cleaned on a regular basis to maintain efficiency. As debris builds up on the filter, water flow becomes restricted and reduces filter efficiency, performance, and sanitation. For this reason, filters must be cleaned regularly. The rule of thumb is that filter cleaning is necessary after the filter pressure has increased by 5.0 to 10.0 pounds per square inch (psi).[50]


Commercial pool

Pool operators must backwash sand and sorptive media filters to clean them. During this process, water is run backwards through the filter to remove the accumulated debris and particulates from the filter media. The filter backwash water is typically drained to sanitary sewer lines.[51]

Sand filters are composed of silica sand, zeolite, or crushed recycled glass, while sorptive media filters have a diatomaceous earth, cellulose, or perlite base. Sand filters can be backwashed several times before the media must be

[49] *Ibid*. Page 10.
[50] *Ibid*. Page 19.
[51] Southern Nevada Water Authority. How to Drain a Pool or Spa. www.snwa.com/land/pools_drain.html.

replaced, but they use the greatest amount of water to flush particulates out of the sand in the backwash process. Sorptive media filters use less water, but must be replenished after every backwash, as the media is purged from the filter grid along with the debris. Replenishment is accomplished by mixing new sorptive media with water and pouring it into the skimmer closest to the pump. The pump then transports the sorptive media to the filter and deposits it onto the filter grid.

Cartridge units eliminate backwashing by using pleated filters made from a paper-type material that can be reused or disposed. Instead of backwashing, disposable cartridge filters are removed, discarded, and replaced with a new filter. Reusable filters are rinsed with a spray hose or soaked in a cleaning solution before being brushed or rinsed. While cartridge filtration is the most water-efficient, it is not usually a viable option for large commercial pools because the cartridge replacement rate quickly becomes cost-prohibitive and labor-intensive.[52]

Large commercial pools sometimes use a fourth filter type, industrial filters, which are a specific type of sorptive media filter. These filters are more efficient than traditional sorptive media filters because they can recycle the sorptive media up to 30 times before it must be discarded and replaced. Unlike traditional sorptive media filters, which pass water straight through the filter during backwashing, industrial filters recycle the water that is used to backwash the filter. As a result, the total volume of water used during backwashing is reduced to only twice the volume of the filter.[53]

The East Bay Municipal Utility District in Oakland, California, recommends using sorptive media for commercial pools and cartridge filters for spas.[54] Table 5-3 provides an overview of the water use associated with each filter type, as estimated by CUWCC.[55] These estimates show that, for smaller pools and spas, cartridge filters use less water than sand, sorptive media, or industrial filters. For larger pools, industrial filters are much more efficient.

Table 5-3. Filter Cleaning Water Consumption Estimates by Pool and Filter Type

Pool Type	Pool Volume (gallons)	Water Use (gallons per year)			
		Sand	Sorptive Media	Cartridge	Industrial
Spa	1,100	940	470	300	N/A*
Hotel (in-ground)	34,000	30,000	9,400	3,600	5,000
Public (in-ground)	150,000	170,000	42,000	N/A	9,000
Olympic (in-ground)	860,000	960,000	240,000	N/A	17,000

*N/A: not applicable

[52] East Bay Municipal Utility District (EBMUD). 2008. *WaterSmart Guidebook—A Water-Use Efficiency Plan Review Guide for New Businesses*. Page 171. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.
[53] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC, *op. cit.*, Pages 18-19.
[54] EBMUD, *op. cit.*, Page 174.
[55] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC, *op. cit.*, Page 35.

Mineral Buildup Control

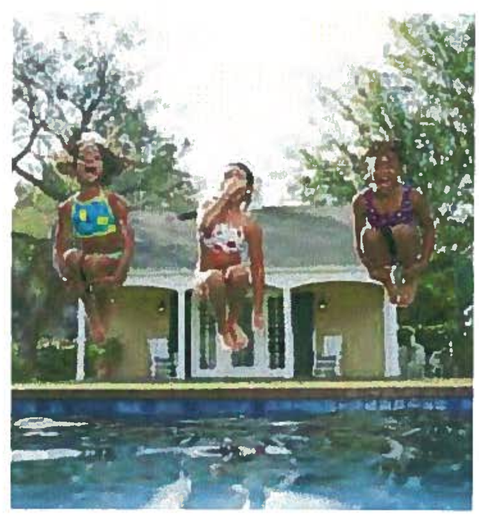
Water in pools and spas experiences a continual buildup of dissolved solids in the form of mineral salts and treatment chemicals. This buildup must be treated or removed to prevent scale buildup or corrosion of pool surfaces and equipment. Proper pool maintenance and water quality control are essential for extending the useful life of the water. Water quality control significantly saves water by reducing the number of times the pool must be completely drained and refilled, the number of filter backwashes needed, and the potential for leaks due to corrosion or other factors.

All pools require water to be exchanged periodically in order to control the buildup of solids and other contaminants. This water exchange can be either partial or full and can be controlled manually or through an automated process. When draining the pool manually, the pool operator will simply pump pool water directly to the drain at some predetermined point in time. The automated approach utilizes conductivity controllers, which drain a portion of the pool water once a predetermined concentration of total dissolved solids is reached. Conductivity controllers save water by limiting exchanges to when they are necessary. The amount of water lost in the exchange process will depend upon pool volume, dissolved solids concentration in the make-up water, type and amount of treatment chemicals added, and the local evaporation rate.[56]

Reverse osmosis systems, which operate independently from pool filters, are also utilized to prolong the useful life of pool water. During reverse osmosis filtration, pool water is passed through a membrane filter, which selectively excludes dissolved minerals and suspended particles from passing through the filter. Water is able to permeate through the barrier and is recovered and returned to the pool. The dissolved minerals and suspended particles that are trapped behind the membrane filter are then discharged to sanitary sewer lines as reject water. Recovering the pool water in this manner eliminates the need to dump and refill the pool. While reverse osmosis systems are effective at filtering minerals, they waste a large amount of water in the treatment process. A large facility should consider the amount of reject water that would be produced if utilizing this equipment.

Leaks and Splashing

Water is lost in pools and spas from leaks and splashing throughout their useful life. Common leak locations include pump seals, pipe joints, piping in filtration system suction or return lines, pool liners, and along pool edges. A leak may be present if a pool is losing more than two inches of water per week. Air bubbles in either the pump strainer basket or water return line can also indicate the presence of a leak.[57] Water is also lost during pool use from splashing and drag-outs as swimmers exit. Water loss from drag-outs can be mitigated by the use of gutter and grate systems installed along the edge of the pool. Although leaks and splashing contribute to water loss, it is difficult to quantify the frequency and extent to which they can occur.



[56] *Ibid*. Page 15.
[57] *Ibid*. Page 12.

Operation, Maintenance, and User Education

Controlling evaporation, splashing, leaks, and mineral buildup and ensuring that filters are cleaned properly are important operation and maintenance measures to ensure commercial pool and spa equipment efficiency.

Evaporation

To control evaporation, consider the following:

- Do not heat pools above 79°F to reduce water evaporation rates.[58]
- Limit the use of sprays, waterfalls, and other features.[59]
- Use pool covers to reduce evaporation rates during periods in which the pool is not in use. Covers also prevent debris from entering the pool, which in turn leads to reduced water usage from filter backwashing.[60]
- As an alternative to pool covers, liquid barriers can be used to control evaporation. These alcohol-based chemicals prevent evaporation by forming a thin film along pool surfaces that acts as a barrier.[61] Liquid evaporation barrier products are available through pool supply vendors.[62]

Splashing

Splashing contributes to water loss. To reduce the amount of water loss from splashing, set the pool water level to several inches below the edge of the pool.[63] In addition, plug the overflow line when the pool is in use or when adding water.[64]

Filter Cleaning

Filter cleaning represents the greatest use of water attributed to pools or spas. Although water use depends upon the type of filter system installed and the extent to which the pool is used, consider the following:

- Clean filter media only as necessary and not on a set schedule (i.e., clean only when the filter is no longer operating effectively). Although there are several methods by which effectiveness is measured, the typical rule of thumb is that filter cleaning is necessary after the filter pressure has increased by 5.0 to 10.0 psi.[65]
- Utilize the sight glass if one is installed to monitor the visual quality of the backwash water running through the filter and determine when backwashing is complete, rather than backwashing for a predetermined set amount of time (e.g.,

[58] Alliance for Water Efficiency (AWE). Swimming Pool and Spa Introduction. www.allianceforwaterefficiency.org/Swimming_Pool_and_Spa_Introduction.aspx.
[59] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC, *op. cit.*, Page 33.
[60] *Ibid.*
[61] *Ibid.* Page 34.
[62] Williams, Kent. Professional Pool Operators of America. November 2002. "Liquid Pool Covers Save Energy." *Pumproom Press.* # 25. www.lincolnaquatics.com/Documents/7536.pdf.
[63] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC, *op. cit.*, Page 13.
[64] AWE, *op. cit.*
[65] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC, *op. cit.*, Page 19.

five minutes). Backwashing is complete once the water that passes through the sight glass is clear and free of particulates.

Mineral Buildup Control

Pools and spas must be drained of some water on a regular basis in order to control the mineral salt concentrations that gradually build up. The frequency of these events can be reduced by prolonging the useful life of the water by considering the following:

- Maintain proper pH, alkalinity, and hardness levels to avoid the need to drain the pool or to avoid using excess make-up water to correct water quality issues.
- When draining the pool, perform a partial drain rather than a full drain. Consider using the drained pool water for irrigation or other purposes. See *Section 8: On-site Alternative Water Sources* for more information.[66]

Leaks

To check your pool for leaks and prevent them for occurring, actively monitor the pool's water levels. If the pool is losing more than two inches of water per week, it could be leaking.[67] In addition, actively monitor for leaks around the pump seals, pipe joints, piping in filtration system suction or return lines, pool liners, and along the pool edges. Repair leaks as soon as they are identified.

Retrofit and Replacement Options

If retrofitting an existing pool or spa, there are a several options to minimize overall water use by addressing evaporation, filter cleaning, mineral buildup control, leaks, and splashing. If designing a new or replacement pool or spa, use the management techniques listed in the previous section and the equipment options below.

Evaporation

To prevent water loss from evaporation, cover the pool when it is not in use. In addition, consider the following to control the evaporation of pool or spa water:

- Reduce wind movement across the water by using fences, walls, non-shedding hedges, or other similar barriers.
- Use a liquid barrier. These alcohol-based chemicals prevent evaporation by forming a thin film along pool surfaces that acts as a barrier.[68] Liquid evaporation barrier products are available through pool supply vendors.[69]

[66] *Ibid.* Page 15.
[67] *Ibid.* Page 12.
[68] *Ibid.* Page 34.
[69] Williams, Kent, *op. cit.*

Filter Cleaning

In addition to the operation and maintenance tips outlined in the previous section, consider the following for optimum filter efficiency:

- Install a pool filter pressure gauge. This will provide a means for determining when filter cleaning is necessary (i.e., after a pressure increase of 5.0 to 10.0 psi).
- Install a pool filter sight glass to provide a visual means for determining when backwashing is complete and minimize the backwashing time.
- If replacing existing filtration systems, consider installing cartridge filters for small pools and spas, sorptive media filters for medium-sized pools, or industrial filters for very large pools.

Mineral Buildup Control

To control mineral buildup, consider the following:

- Install a reverse osmosis system to prolong the useful life of pool water and to reduce the number of times that the pool must be drained in order to control the concentration of dissolved solids.
- Install a conductivity controller system to manage the concentration of dissolved solids in the pool. This system will monitor the buildup of dissolved solids so that at a predetermined level, a portion of the pool water can be drained and replaced, rather than the entire volume. This also offers the added benefit of providing a frequent source of water that can be used for irrigation or other purposes. See *Section 8: Onsite Alternative Water Sources* for more information.[70]

Leaks

To reduce water loss from leaks, install a water meter to the pool's make-up line. This will provide a means for directly monitoring and tracking water use for signs of potential leaks.

Splashing

To reduce water loss from splashing, install pool gutter and grate systems along the pool perimeter to mitigate drag-out losses during pool use.

Savings Potential

Significant water savings can be achieved through proper pool and spa operation and maintenance and other water-efficient technologies. Following are a few examples of savings that can be realized from implementing water-efficient practices or technologies in pools or spas:

[70] Koeller, John and H.W. (Bill) Hoffman & Associates, LLC, *op. cit.*, Page 15.

- USA Swimming estimates that using pool covers overnight at heated, commercial indoor swimming pools can save approximately 575,000 gallons of water per year and also provide energy savings.[71]
- CUWCC estimates that evaporation losses can be reduced by 30 to 50 percent by using pool covers and 10 to 30 percent with liquid evaporation barriers.[72] For an Olympic-sized pool, this could save as much as 290,000 gallons per year.
- CUWCC estimates that replacing conventional sand and sorptive media filters with cartridge or industrial filters, where appropriate, can save between 68 and 98 percent of backwash water. For an Olympic-sized pool, replacing sand filters with industrial filters could save as much as 940,000 gallons of water per year.[73]
- CUWCC identified one manufacturer who reported that installing a reverse osmosis system could potentially reduce water consumption by saving 78 percent of the pool water that would otherwise be drained to control mineral buildup. For an Olympic-sized pool, this could save as much as 300,000 gallons of water per year.[74]
- Based on the CUWCC estimates listed above, the combined use of pool covers, cartridge or industrial filters, and reverse osmosis systems could provide a total annual water savings of as much as 1,500,000 gallons for Olympic-sized pools.

Additional Resources

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

East Bay Municipal Utility District. 2008. *WaterSmart Guidebook—A Water-Use Efficiency Plan Review Guide for New Businesses*. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.

Koeller and Company and H.W. (Bill) Hoffman & Associates, LLC. September 2010. *Evaluation of Potential Best Management Practices—Pools, Spas, and Fountains*. Prepared for the California Urban Water Conservation Council. Pages 3-30. www.cuwcc.org/products/pbmp-reports.aspx.

Marin Municipal Water District. Swimming Pool Tips. www.marinwater.org/controller?action=menuclick&id=268.

Poolmanual.com. *Pool Manual*. www.poolmanual.com/poolmanual.aspx.

Southern Nevada Water Authority. How to Drain a Pool or Spa. www.snwa.com/land/pools_drain.html.

State of California Department of Water Resources. 2012. *Commercial, Institutional and Industrial Task Force Best Management Practices Report to the Legislature*.

[71] USA Swimming. A Green Initiative Unique to Natatoriums. www.usaswimming.org/ViewMiscArticle.aspx?TabId=1755&Alias=rainbow&Lang=en&mid=7715&ItemId=3633.
[72] Koeller and Company and H.W. (Bill) Hoffman & Associates, LLC, *op. cit.*, Page 34.
[73] *Ibid.* Page 35.
[74] *Ibid.* Page 30.

USA Swimming. A Green Initiative Unique to Natatoriums.
www.usaswimming.org/ViewMiscArticle.aspx?TabId=1755&Alias=rainbow&Lang=en&mid=7715&ItemId=3633.

Williams, Kent. Professional Pool Operators of America. November 2002. "Liquid Pool Covers Save Energy." *Pumproom Press*. # 25.
www.lincolnaquatics.com/Documents/7536.pdf.

5.5 Vehicle Washing

EPA WaterSense

Overview

Whether at self-service or full-service car washes, or as part of gas stations or vehicle service facilities, there are three types of vehicle-washing technologies: conveyor, in-bay, and self-service. These technologies incorporate some or all of the following steps, as defined by the International Carwash Association:[75]

- Pre-soak: An automated nozzle or handheld spray.
- Wash: A high-pressure spray or brushes with a detergent solution.
- Rocker panel/undercarriage: Brushes or high-pressure sprays on the sides and bottom of the vehicle.
- First rinse: A high-pressure rinse.
- Wax and sealers: An optional surface finish that is sprayed on the vehicle.
- Final rinse: A low-pressure rinse with fresh or membrane-filtered water.
- Air blowers: Air blown over the vehicle to remove water and assist drying.
- Hand drying: Wiping down the vehicle with towels or chamois cloths, which are often laundered in onsite washing machines. See *Section 3.6: Laundry Equipment* for information on using water efficiently in commercial laundry systems.

Many commercial vehicle wash facilities have adopted water reclamation technology, which treats wash and rinse water from previous wash cycles for use during the next vehicle wash in an effort to reduce overall water use. There are several other opportunities for these facilities to minimize water use. In fact, efficient vehicle wash systems can use less water on average per vehicle than washing a car at home.[76]

Conveyor Systems

Conveyor vehicle wash systems use a conveyor belt to pull vehicles through a washing tunnel, which consists of a series of spray arches and/or washing cloths. Vehicle washing can be conducted with the customer inside the vehicle during the wash process, or the customer can wait outside the vehicle as both the interior and exterior are cleaned. In some states, the driver and passengers are required to wait outside the vehicle during washing.

Conveyor facilities employ two different methods of washing: friction or frictionless. During friction washing, the wash equipment (e.g., a cloth curtain) makes contact with the vehicle. Frictionless, or touch-free, washing relies on high-pressure nozzles to clean the vehicle. Conveyors with friction wash cycles use less water per vehicle,

[75] Brown, Chris. 2000. *Water Conservation in the Professional Car Wash Industry*. Prepared for the International Carwash Association.™ Page 10. www.carwash.org/operatorinformation/research/Pages/EnvironmentalReports.aspx.
[76] Alliance for Water Efficiency. Vehicle Wash Introduction. www.allianceforwaterefficiency.org/Vehicle_Wash_Introduction.aspx.

because the cloth brushes or curtains collect water and detergent from previous washes and require less re-wetting.[77]

Conveyor vehicle wash facilities are good candidates for installing reclamation systems because the tunnel length allows for wash wastewater to be easily separated from rinse water of higher quality. Without reclamation, conveyor vehicle washing can use 65.8 gallons per vehicle (gpv) of fresh water during friction washing and 85.3 gpv of fresh water during frictionless washing. A reclamation system can reduce freshwater consumption to as low as 7.8 gpv during friction washing and 16.8 gpv during frictionless washing.[78]

In-Bay Systems

In-bay vehicle washes can be found at many gas stations or similar facilities where vehicle washing is a secondary service option. For in-bay vehicle washing, the vehicle remains stationary while the washing process occurs. Like conveyor vehicle washing, a series of nozzles and/or brushes is used to complete either a friction or frictionless wash process. One set of nozzles is typically used to perform all wash cycles.

In-bay vehicle washing facilities can also benefit from the use of a water reclamation system. However, because there is typically only one wastewater collection pit, an in-bay water reclamation system must be properly designed to separate contaminated water from cleaner water. A water reclamation system can reduce average in-bay water use from 60.0 gpv to as low as 8.0 gpv.[79]

Self-Service Car Washes

Self-service car washes allow customers to wash vehicles themselves, using a hand-held nozzle to perform all washing processes. In some cases, there could be a brush available for the wash cycle. The pricing structure for a self-service car wash is typically set up so that the customer pays for a base amount of time of water use and can make additional payments for each additional time increment.

Of the three types of vehicle washing, self-service vehicle washing tends to use the least amount of water—15.0 gpv, on average.[80] While self-service vehicle washing typically uses the smallest amount of water per vehicle, water reclamation systems are often not feasible for use with a self-service washing facility, because it is difficult to collect and separate the wastewater. Coupled with the fact that water use in these facilities is driven by user behavior, self-service vehicle washing offers the least potential for water savings through retrofit or replacement.

[77] East Bay Municipal Utility District. 2008. *WaterSmart Guidebook—A Water-Use Efficiency Plan Review Guide for New Businesses*. Pages 37-39, WASH1-6. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.
[78] Brown, Chris, *op. cit.*, Page 16.
[79] *Ibid.*
[80] *Ibid.*

Operation, Maintenance, and User Education

For optimal vehicle wash system efficiency, consider the following:

- Conduct routine inspections for leaks and train appropriate custodial and cleaning personnel and users to identify and report leaks.
- Ensure that the main shut-off valve is in proper working order.
- If possible, use a friction washing component in all cycles, especially if water is not reused.
- Sweep all driveways and impervious surfaces instead of washing.
- Minimize pump head pressures based on manufacturer recommendations.

Consider participating in the International Carwash Association™ (ICA) WaterSavers® recognition program, which requires participants to meet certain water usage and quality standards. For more information on the program, refer to the WaterSavers website.[81]

For further vehicle washing efficiency, follow the operating and maintenance tips specific to each type of vehicle wash system described below.

Conveyor Systems

For optimal conveyor system efficiency, consider the following:

- Make sure conveyors are properly calibrated by timing spray nozzles to activate only as the vehicle reaches the spray arch.
- Align spray nozzles properly; they should be oriented parallel to the spray arch.
- If using a water reclamation system, orient blowers so that water is sent back to the water reclamation pit for reuse. Create a dwell time after the final rinse to allow for water to flow back into the reclamation pit.
- Maximize conveyor speed based on manufacturer recommendations.

In-Bay Systems

For optimal in-bay system efficiency, consider the following:

- Align spray nozzles properly; they should be oriented parallel to the spray arch.
- If using sensors that detect when a vehicle is present, make sure they are properly calibrated. Sensors should activate the spray nozzles only as the vehicle reaches the spray arch.

[81] WaterSavers.® washwithwatersavers.com/.

- If using a reclaim system, create a five-second dwell time before the vehicle exits the bay to allow for water runoff to be collected.
- Maximize wash and rinse cycle speeds based on manufacturer recommendations.

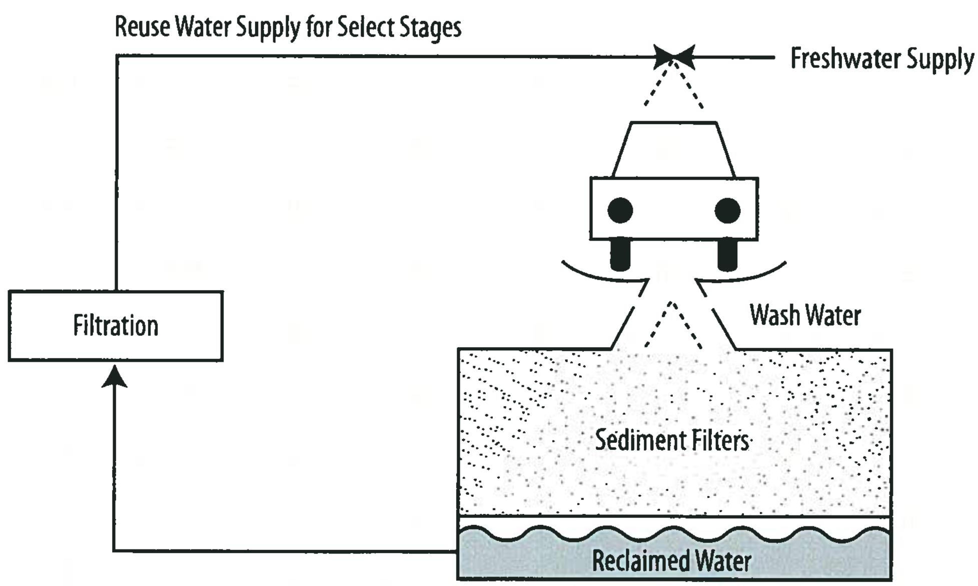
Self-Service Car Washes

For optimal self-service car wash efficiency, educate customers on how to efficiently wash their vehicles using less water.

Retrofit Options

Water reclamation systems that treat wash and rinse water from previous wash cycles for use during the next vehicle wash offer the greatest potential water savings for vehicle wash systems (see Figure 5-4 for an example of a vehicle wash with a water reclamation system). The degree of water treatment needed depends upon which vehicle washing steps use the reclaimed water. At a minimum, water reclaim systems should separate grit, oil, and grease from wash water. This level of water treatment is enough to use reclaimed water during the rocker/undercarriage wash stage. Additional treatment, such as oxidation, filtration, membrane filtration, and deionization, might be necessary for use of reclaimed water during additional vehicle-washing steps. Table 5-4 outlines the recommended level of water treatment for reclaimed water use during each phase.[82]

Figure 5-4. Vehicle Wash Water Reclamation System



[82] Created from analyzing data in: Brown, Chris, *op. cit.*, Page 29.

Table 5-4. Recommended Level of Treatment for Reclaim Systems

Wash Stage	Self-Service	In-Bay	Conveyor	
			Friction	Frictionless
Pre-Soak	N/A*	N/A	Filtration, reverse osmosis or deionization	Reverse osmosis or deionization
Wash	N/A	Filtration	Separation, filtration	N/A
Rocker Panel/ Undercarriage	N/A	Filtration	Separation, filtration	Separation, filtration
First Rinse	N/A	Filtration	Filtration	Filtration
Wax and Sealers	Reverse osmosis	Reverse osmosis	Reverse osmosis or deionization	Reverse osmosis or deionization
Final Rinse	Reverse osmosis	Reverse osmosis	Reverse osmosis or deionization	Reverse osmosis or deionization

*N/A: not applicable

If considering a water reclamation retrofit, be sure to evaluate the feasibility of the installation. The ability to install additional piping and water treatment equipment will determine whether a reclamation system retrofit is appropriate. Industry experts recommend taking the following into account when designing a reclamation system:[83]

- Nature of the contamination to be treated
- Concentration of the contaminants
- Volume of water used per day
- Flow rate per minute of different processes in the professional car wash
- Chemicals and procedures used in the wash or rinse process
- Discharge limits (if applicable)
- Intended use of the reclaimed water and the desired quality for its use

Water reclamation systems require additional maintenance to clean filters and other system components. Cleaning and finish products should be compatible with the system operation.[84]

Water reclamation systems can be retrofitted with existing conveyor or in-bay vehicle washing systems, but they are not recommended for retrofit with self-service vehicle washing.

For additional retrofit options to reduce water use, consider the following retrofit options for each washing type.

[83] *Ibid*. Page 21.
[84] Koeller and Company and Chris Brown Consulting. October 2006. *Evaluation of Potential Best Management Practices—Vehicle Wash Systems*. Prepared for The California Urban Water Conservation Council. Page 23. www.cuwcc.org/products/pbmp-reports.aspx.

5.5 Vehicle Washing

Conveyor Systems

When retrofitting a conveyor system, consider the following:

- Limit freshwater consumption to 40.0 gpv, as recommended by ICA's WaterSavers recognition program.[85]
- For conveyor systems that utilize frictionless washing, consider installing friction washing components to use during the wash cycles.
- If a reverse osmosis treatment system is installed for use with a water reclamation system or to supply spot-free rinse water, capture reject water and reuse during wash cycles.
- Install check valves to prevent backflow wherever possible.

In-Bay Systems

When retrofitting in-bay systems, consider the following:

- Limit freshwater consumption to 40.0 gpv, as recommended by ICA's WaterSavers recognition program.[86]
- For in-bay systems that utilize frictionless washing, consider installing friction washing components to use during the wash cycles.
- If a reverse osmosis treatment system is installed for use with a reclaim system or to supply spot-free rinse water, capture reject water and reuse during wash cycles.
- Install check valves to prevent backflow wherever possible.
- Install laser sensors to evaluate the length of the vehicle being washed and adjust the washing procedure to the specific length of the vehicle.
- Limit water consumption during the rocker panel/undercarriage cycle to 12.0 gallons per cycle.

Self-Service Car Washes

When retrofitting self-service car washes, consider the following:

- Limit nozzle flow rate to 3.0 gallons per minute (gpm), as recommended by ICA's WaterSavers recognition program.[87]
- Install check valves to prevent backflow wherever possible.
- If towel ringers are installed, use a positive shut-off valve.

[85] International Carwash Association (ICA). WaterSavers Criteria. www.carwash.org/industryinformation/watersavers/Pages/default.aspx.
[86] *Ibid.*
[87] *Ibid.*

Replacement Options

Due to the high capital costs involved with replacing a vehicle wash system, first implement all efficient operation and maintenance procedures and perform any retrofits available to optimize the efficiency of the system. Retrofitting an existing vehicle wash system with a water reclamation system can yield the most potential for water and operational cost savings.

Water reclamation systems are appropriate for conveyor and in-bay vehicle washing. When designing a new vehicle washing facility, consider one that incorporates the features described in the earlier "Retrofit Options" section.

Savings Potential

Water savings can be achieved by installing a water reclamation system for conveyor or in-bay vehicle wash facilities. A study by ICA found that facilities using reclamation systems were able to fulfill 51 percent of their water needs, on average, from reclaimed water.[88]

To calculate facility-specific water savings and payback, use the following information.

Current Water Use

To estimate the current water use of an existing vehicle wash system, identify the following information and use Equation 5-1:

- Water use per vehicle. This can be determined based on metered water use. If the facility does not have a meter, ICA found that conveyor and in-bay washes use an average of 75.0 gpv and 55.0 gpv of fresh water, respectively.[89]
- Number of vehicles washed per day.
- Days of facility operation per year.

Equation 5-1. Water Use of Vehicle Wash (gallons per year)

= Water Use per Vehicle x Vehicles Washed x Days of Facility Operation

Where:

- Water Use per Vehicle (gallons per vehicle)
- Vehicles Washed (number of vehicles washed per day)
- Days of Facility Operation (days per year)

[88] Brown, Chris. 2000, *op. cit.*
[89] *Ibid.* Page 16.

Water Savings

According to the ICA's study, vehicle wash facilities can reduce their freshwater use by approximately 50 percent by using a water reclamation system. To calculate water savings that can be achieved from retrofitting an existing vehicle wash system, identify the current water use (as calculated using Equation 5-1) and use Equation 5-2.

Equation 5-2. Water Savings From Vehicle Wash System Retrofit (gallons per year)

= Current Water Use of Vehicle Wash System x Savings (0.5)

Where:

- Current Water Use of Vehicle Wash System (gallons per year)
- Savings (percent)

Payback

To calculate the simple payback from the water savings associated with the vehicle wash system retrofit, consider the equipment and installation cost of the retrofit water reclamation system, the water savings as calculated using Equation 5-2, and the facility-specific cost of water and wastewater. Water reclamation systems might cost $35,000 for equipment and installation.[90]

Additional Resources

Alliance for Water Efficiency. Vehicle Wash Introduction. www.allianceforwaterefficiency.org/Vehicle_Wash_Introduction.aspx.

Brown, Chris. 2000. *Water Conservation in the Professional Car Wash Industry*. Prepared for the International Carwash Association (ICA). www.carwash.org/operatorinformation/research/Pages/EnvironmentalReports.aspx.

Brown, Chris. 2002. *Water Use in the Professional Car Wash Industry*. Prepared for ICA. www.carwash.org/operatorinformation/research/Pages/EnvironmentalReports.aspx.

East Bay Municipal Utility District. 2008. *WaterSmart Guidebook—A Water-Use Efficiency Plan Review Guide for New Businesses*. Pages 37-39, WASH1-6. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.

ICA. WaterSavers Environmental Reports. www.carwash.org/industryinformation/WaterSavers/Pages/WaterSaversEnvironmentalReports.aspx.

Koeller and Company and Chris Brown Consulting. October 2006. *Evaluation of Potential Best Management Practices—Vehicle Wash Systems*. Prepared for the California Urban Water Conservation Council. www.cuwcc.org/products/pbmp-reports.aspx.

[90] Brown, Chris. September 2002. *Water Use in the Professional Car Wash Industry*. Prepared for ICA. Page 43. www.carwash.org/operatorinformation/research/Pages/EnvironmentalReports.aspx.