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## O&M First!

## Actions You Can Take Now to Save Water and Reduce Costs

Water costs can be a significant cost at federal sites, especially with rising rates across the country. As reported in the *Raftelis Water and Wastewater Survey (2004)*, water rates have risen about 9 percent in a short two years from 2002 to 2004 across the United States. Sewer rates have gone up about 4 percent over this same time period. As water and sewer rates rise, some areas in the United States are also facing water supplies shortages across drought-stricken areas of the country.



On top of these pressures, all federal sites are required to implement water-efficiency measures as mandated through the Executive Order 12123. EO 13123 states that all federal sites must develop a water management plan that includes appropriate operations and maintenance practices, as well as implement cost effective water-efficiency retrofits as described through the FEMP Water Efficiency Best Management Practices (BMP). For a full description of these goals and BMPs, go to: [http://www.eere.energy.gov/femp/technologies/water\\_fedrequire.cfm](http://www.eere.energy.gov/femp/technologies/water_fedrequire.cfm)

Balancing all of these issues—rising water and sewer costs, possible water shortages, and required water conservation—managing your water resources proactively should be a high priority at your facility. Starting now to manage your water effectively will help minimize the impact of rising costs, potential drought, help to meet the EO goals, and save you water and money. There are a multitude of simple low- and no-cost operations and maintenance (O&M) opportunities that can save

significant amounts of water. This fact sheet covers O&M savings opportunities for common water-using equipment at federal sites, including plumbing fixtures, irrigation, cooling towers, and single-pass cooling equipment. Also vital to good management of water is the ability to detect leaks, so general information on leak detection is discussed.

### Opportunity 1: Operate plumbing fixtures under optimal conditions

If asked, most people would probably name showers, toilets, sinks, and urinals as major water-using appliances. If pressed, people may even recall that there are low-flow versions of these appliances that will save water. However, most people would probably not realize how important operation and maintenance of existing water appliances can be. What sort of operation is there? You turn it on, you turn it off. You flush, you walk away. Maintenance? Doesn't the janitor clean it daily? Isn't that enough? Well, no, it's not.



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## Test your pressure

It is important to remember that these fixtures are merely one visible manifestation of the water supply system and that operation of that system and the associated appliances is all inter-related. From an O&M standpoint, one of the most significant parameters of the water supply system is water pressure. Excessive water pressure in the system leads directly to more water use in buildings and also to more maintenance problems. Doubling the water pressure in a fixed-diameter pipe increases the flow by about 40 percent, amplifying the effect of any sort of leak. Water pressure over 80 pounds per square inch (psi) is actually a violation of the plumbing code and will typically void fixture manufacturer's warranties.

## Ensure proper flow

For water-using fixtures like showers, toilets, sinks, and urinals, the basic purpose is to provide water only when it is requested. From an O&M perspective, this means that attention should be paid to those components that control the flow of water and to making sure that the appliances are really "off."

For sinks, the aerator usually determines the flow rate. In a shower, the flow rate is usually controlled by the showerhead. For both aerators and showerheads, make sure they are routinely cleaned to maintain design performance. The other flow control component of sinks and showers is the valve mechanism. Make sure you have a

designated person to perform periodic inspection and repair of these valves. It is also important to have an easy way of reporting leaks. Post the name and phone number of the person responsible for fixing any problems in the plumbing equipment, so that staff members can easily report leaks or other concerns.

In the standard tank and bowl toilet (see picture on following page), the main flow control consists of the flapper, trip lever, and fill valve. Care should be taken that the proper flapper is installed, and that the flapper and flush valve seat remain clean and undamaged. Harsh toilet cleaning chemicals dispensed through the toilet tank can damage the flapper and should be avoided. In the common flush valve toilet, make sure the water pressure to the toilet is appropriate and the valve is properly adjusted.

Leaks in tank toilets come in two types—those you can see and hear and those you can't. Fixing both types of leaks relies on cleaning and/or replacement of the flapper or flush valve. Toilets should be tested periodically for "unseen" or "unheard" leaks that can waste surprising amounts of water. The test in question is commonly referred to as a dye test, with colored dye being placed in the tank and looked for in the bowl after a suitable period of time. If dye shows up in the bowl, you have a hidden leak and the flapper or valve mechanism should be replaced (see Text Box 1).

Another common type of toilet is the flush valve (often called flushometer) toilet. The flush valve flushes high

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## Pressure Testing and Pressure Reduction

Testing the pressure at the building level is most easily accomplished by looking at a water pressure gauge in your building's system. If you don't have a gauge already, you can hook a simple pressure gauge (available at most hardware stores) up to your building's water system. These gauges are typically threaded for standard hose fittings, so an outdoor hose faucet close to the water supply inlet for the building is one way to measure the supply pressure. The pressure gauge can also be used on interior faucets or piping as long as appropriate connections between the gauge and desired measuring location are available (see picture). If the pressure in the building is too high, you should talk to your water supplier about reducing the pressure. A Reduced Pressure (RP) device can be installed close to the water meter to create a closed, lower pressure system for the building. However, the RP device itself can be a source of water waste if it leaks.



Photo courtesy of Lonnie Burke, Resource Wise

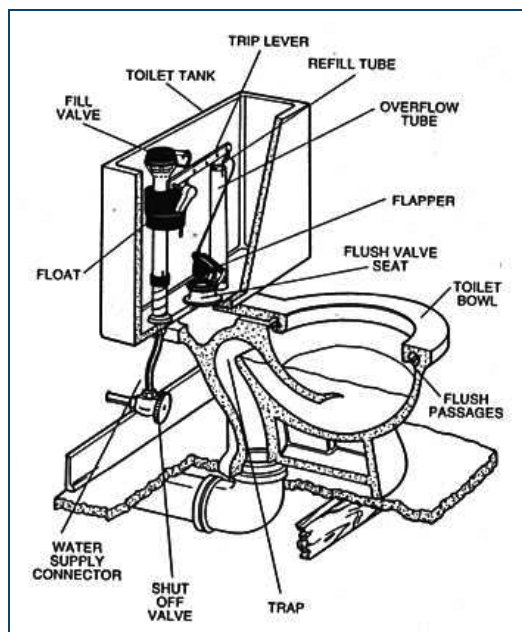


Image courtesy of Lonnie Burke, Resource Wise

**Diagram of standard tank and bowl toilet**

velocity water through the toilet, which is made possible by the line pressure (a minimum line pressure of around 30 psi is required). This is the same basic mechanism for flush valve urinals. Both flush valve toilets and urinals need routine valve repair and replacement, which is typically about every 2 to 3 years, depending on fixture usage. Valves have a tendency to get jammed or “stuck,” typically caused by rough treatment such as kicking or hitting the valves. Posting signs that request careful treatment of the flush valves may help avoid problems. When repairing or replacing a valve, be sure that the proper valve is installed (see Text Box 2).

## Text Box 1: The Dye Test

- *Remove the toilet tank cover.*
- *Remove any in-tank bowl cleaners that color the water and begin with clear water in both tank and bowl.*
- *Add some colored material to the tank. Food coloring, instant coffee, and powdered fruit drinks work as well as the dye capsules you may be able to get from your water supplier. Make sure the water in the tank is deeply colored.*
- *Wait 30 minutes without letting anyone use the toilet.*
- *If you see colored water in your bowl, your toilet is leaking.*

Adopted from <http://www.toiletology.com/leaking.shtml>

## Text Box 2: Flush and Urinal Valve Replacement

*If you currently have low flush toilets and urinals installed at your facility, be sure to have a supply of new 1.6-gallon-per-flush (gpf) valves for toilets and 1.0-gpf valves for urinals in stock for maintenance. It is easy to mistakenly replace a 1.6-gpf valve with a 3.5-gpf valve, allowing the toilet to use 3.5 gallons per flush. The same is true for flapper valves in tank toilets. A low-flush tank toilet can be retrofitted with an old flapper and use much more water than intended. A study by the Metropolitan Water District of Southern California (available at [http://www.cuwcc.org/products\\_tech.lasso](http://www.cuwcc.org/products_tech.lasso)) found that low-flush toilets were unlikely to maintain their performance if incorrect replacement flappers were used. If plumbing service is contracted out, make sure the contractor uses only the correct valves and flappers. Don't “flush” away your water savings!*

## For more information go to:

Toiletology—basics on operations and maintenance of toilets: [www.toiletology.com](http://www.toiletology.com)

California Urban Water Conservation Council Technical Information—studies and reports on toilet performance and other related issues: [www.cuwcc.org/products\\_tech.lasso](http://www.cuwcc.org/products_tech.lasso)

H2O House Water Saver—residential water conservation information: [www.h2ouse.org/](http://www.h2ouse.org/)

How Stuff Works—information on the inner workings of toilets: [home.howstuffworks.com/toilet4.htm](http://home.howstuffworks.com/toilet4.htm)

## Opportunity 2: Optimize irrigation equipment, scheduling and plant health

Sound O&M practices in managing landscape irrigation and maintaining healthy turf can have a large impact on water use. Many typical landscape irrigation practices can be very wasteful and use more water than the turf actually needs or can consume. Misplaced or broken irrigation system parts, poorly scheduled irrigation, and high water demand plants can result in thousands of gallons of water wasted each year. You may ask yourself—is my installation a good candidate for saving water and money by optimizing my irrigation system? The answer is probably yes. But the installations that most likely stand to save the most are those that have a significant area that

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requires irrigation (athletic field, family housing with irrigated yards, irrigated landscaping around most buildings, among others). This especially applies to those sites that are in an arid climate like most of the western United States or have high water rates.

### Give them what they need

The first step in optimizing your irrigation is to understand the actual amount of water that is required by the existing landscape in its respective climate. Different types of plants require varying amounts of water and it is best to provide your landscape with the actual water needs. This term is known as the evapotranspiration (ET) rate (see Text Box 3). The ET rate should be compared to your area's current rainfall and soil type to help determine how much irrigation is needed (see Text Box 4). Knowing the soil type is important because it determines how much moisture can be held at the plants' root base (sandy soil will retain much less water than clay soils) and what types of nutrients might be deficient. Soil samples can be sent to the local county extension office to get information on how much organic matter should be added and what nutrients may be deficient for your plants' needs.

### Text Box 3: Evapotranspiration

*Evapotranspiration, the loss of water by evaporation and transpiration, indicates how much water is needed by the plant for the current conditions. The ET rate constantly changes, based on weather conditions including sun, wind, humidity, and temperature. Standard rates based on plant type, soil type, and season can be found using equations (e.g., Penman-Monteith equation, explained at the following website: <http://www.fao.org/docrep/X0490E/x0490e06.htm>) or from charts provided by a local organization, like local universities, or the California Irrigation Management Information System, for instance. Contact your local county extension office or local university's agricultural department to get information on how to estimate ET rates for your landscape.*

### Text Box 4: How to find your monthly rainfall

*How can you get information on typical rainfall in your area so you can compare it to how much water your landscape needs? The National Oceanic and Atmosphere Administration (NOAA) website lists normal precipitation for areas across the country. Go to: <http://www.noaa.gov/climate.html> and click on "Climate Data" then click on "Normal Precipitation, Inches," which provides monthly rainfall in inches for locations across the United States listed by state.*

### Appropriate scheduling goes a long way

After understanding how much water your landscape needs, you can set your irrigation schedule to apply the right amount of water. To do this you need to know the irrigation system's precipitation rate, or PR. Precipitation rate is the rate at which sprinklers apply water, typically provided in inches per hour by the manufacturer. (PR may also be provided in gallons per minute.) Knowing the precipitation rate allows you to calculate the watering time by multiplying the PR by the number amount of water needed (or ET rate). See Text Box 5 for an example.

### Text Box 5: Example for estimating your watering time

*In southern U.S. climates, common turf-grasses (bluegrass and fescue) need about 1 inch of water per week during the summer season to stay green [Landry 2000]. So, during dry periods, the irrigation schedule can be fine tuned to apply approximately 1 inch per week by multiplying the precipitation rate by amount of water needed. If the PR is 1 inch per hour, then the irrigation system should be scheduled for approximately 1 hour over the week if there has been no rainfall.*

There are other important scheduling-related practices that will help run your system more efficiently. Water early in the morning to reduce evaporation and minimize fungus growth. This time period is typically less windy as well, which will avoid overspray and increased evaporation. Steep grades are hard to water efficiently and can be a major cause of water run-off and erosion. Short water time increments can help reduce runoff—try four to five intervals at 5 minute each with a 20-minute break between intervals to give the water a chance to absorb into the root base of the plant, or consider replacing turf on steep grades with other types of landscape.

## Routine maintenance is a must

The entire irrigation system should be checked for broken heads at the beginning and end of each watering season, at the very least. Routine spot checks of the irrigation system are important especially if you water early in the morning. Broken heads and leaks can go unnoticed. Institute a leak detection and repair program that assigns a responsible person/party for keeping the system running efficiently. Check for proper operation and placement of sprinkler heads, ensuring that sidewalks and pavement are not being watered but instead provide an even distribution across the landscape. If your landscape maintenance is not done in-house, make sure that the contractor's agreement states specifically that water efficiency is a high priority. Consider including a performance standard in your contract that sets limits for water use by establishing a realistic water budget that specifies how much water should be used.

Check your system's pressure to make sure it meets the range of pressures specified in the manufacturer's specifications for each sprinkler head or emitter. If the pressure is too high, a pressure-reducing valve might be needed. These should be checked periodically, as well, because they can also be sources of leaks.

## Healthy plants need less water

Frequent, shallow watering can result in compacted soil, shallow root system, and increased disease incidence; landscape should be watered deeply occasionally instead of lightly every day. Use mulching mowers and alternate blade settings (turf height should be a minimum of 3 inches during the hot part of the summer)—this actually shades the root system, encourages a deeper root system, and cuts down on evaporation. Another



Deep roots in aerated soil



Shallow roots in compacted soil

important aspect to healthy roots is aeration. Aeration (see Text Box 6) is a method that loosens compacted soil allowing more air and water to reach the roots where they are needed, which helps create a deeper and healthier root system. Turf areas should be aerated at least twice a growing season.

### Text Box 6: Aeration

*The most common type of aeration is core aeration, which pulls plugs of earth out evenly over the turf. Another technique of aeration involves injecting vibrating spikes into the turf (see photo) that loosens the soil beneath the sod, but does not leave plugs on the surface. Some aeration tools exist that simply poke holes in the ground without vibrating the earth to loosen it; this method is ineffective as it can risk compacting the soil further. Typically, aeration services are contracted out. Make sure that you understand what type of aeration system is used before entering into an agreement to ensure it meets your needs and expectations.*



Aeration equipment

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## Controllers will help you manage better

Irrigation controllers apply the right amount of water when it is needed. Use controllers that have multiple stations and flexibility with watering schedules to allow for steep grades and areas with different irrigation needs. Automatic timers are helpful for watering during inconvenient times of day, and for preventing over-watering due to negligence of sprinkler shutoff. A manual override option is important for unexpected rain storms or other factors that may render irrigation unnecessary.

Other technologies exist that can assist in adjusting irrigation according to the weather, landscape topography, and plant water requirements. Rain, wind, freeze, and humidity sensors all respond well to weather conditions, can be connected to the existing control system, and are relatively inexpensive (typically under \$500). For example, soil moisture monitors provide feedback of soil conditions and suspend irrigation through existing controllers if the soil has sufficient moisture. These sensors, while effective, may need periodic maintenance or replacement over time. *[Photos courtesy of Brent Mecham, Northern Colorado Water Conservancy District]*



**Irrigation Controller**

A more robust option is a weather-based system, or an ET controller, which can be programmed to match the plant's exact water needs with the precipitation rate of the irrigation system. Often these weather-based controllers are connected to a local weather station, where local conditions are monitored so that the irrigation will respond to environmental changes. It can also be programmed to work with watering restrictions so that plants can be irrigated below the actual ET rate—termed as “deficit watering.” These weather-based systems are expensive, normally priced over \$2,000.

To assist in good operation and maintenance of an irrigation system, the system should be metered so that consumption can be tracked and monitored to ensure the irrigation needs are what were expected. If they differ, investigate the reason and make appropriate changes.

Overall, efficient operations and maintenance of irrigation systems and landscape relies on ensuring that your plants are healthy, irrigation is scheduled appropriately, and controllers are used to run your system at peak efficiency.

## For more information on efficient irrigation practices, go to:

Irrigation Association: [www.irrigation.org](http://www.irrigation.org)

GreenCo: [www.greenco.org](http://www.greenco.org)

Irrigation Technology Center: [irrigation.tamu.edu/](http://irrigation.tamu.edu/)

Source Book for Efficient Irrigation: [www.greenbuilder.com/sourcebook/XeriscapeGuideline5.html](http://www.greenbuilder.com/sourcebook/XeriscapeGuideline5.html)

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## Case Study:

At the Pacific Northwest National Laboratory, the Grounds Management Program has used many of the techniques described in this O&M Fact Sheet and achieved phenomenal results in reducing water use on the grounds at the lab. The award-winning program has saved nearly 220 million gallons of irrigation water annually, a 35 percent reduction, with an approximate savings of \$70,000 annually. This was accomplished mainly by low- and no-cost operation and maintenance improvements such as retrofitting the current irrigation system with automatic controls to help optimize the watering schedule, and regularly aerating the turf. This has created a healthy, drought-resistant landscape that now requires significantly less water. For more information on this program, please go to: <http://www.pnl.gov/conserv-energy/grounds/index.stm>

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## Opportunity 3: Maintain proper water quality in your cooling tower

Cooling towers are an important part of building cooling equipment, providing heat rejection through evaporation of water in moving air. Typical federal applications of cooling towers are found in air-conditioning systems in commercial and industrial-type facilities. Cooling towers can also provide heat rejection for industrial processes and electric generation. When we look at the various end-uses of water in buildings, cooling towers can be a big water user. But, because their job is to provide cooling by evaporating water, do they represent an opportunity for water savings? One of the FEMP Best Management Practices for water is devoted to cooling tower water use,<sup>1</sup> and we shall see that there is some potential for water savings in cooling towers. A photo of a cooling tower is provided below.

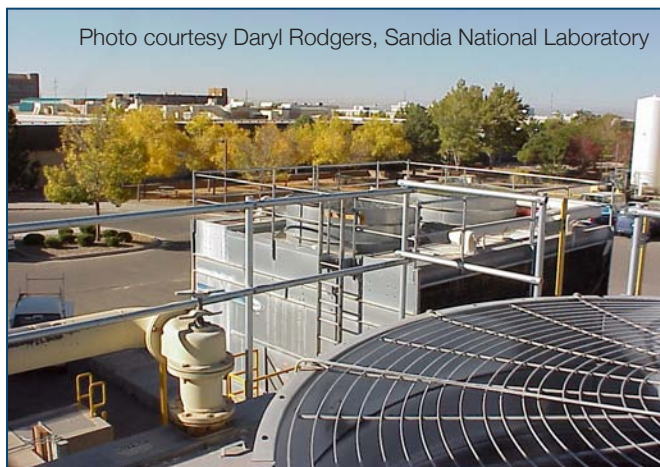


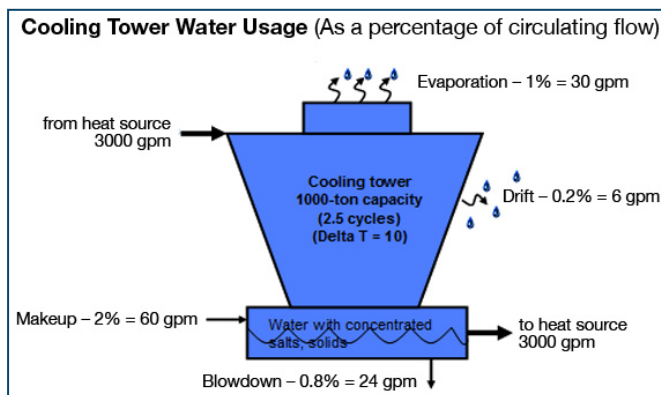
Photo courtesy Daryl Rodgers, Sandia National Laboratory

Typical cooling tower

### How does a cooling tower work?

Cooling towers work by evaporating water—about 3 gallons per minute for every 100 tons of cooling (may vary by climate). A simplified schematic of a cooling tower is provided in the figure. Water is consumed in a cooling

tower in 3 ways: *evaporation* provides the cooling and is the largest user; *drift* is when water drops are blown out of the tower by wind or fan air movement; and *blow-down* (sometimes called *bleed-off*), where water is removed from the cooling tower to control concentrated solids and other pollutants.



$$\text{Water Use} = \text{evaporation} + \text{drift} + \text{blow down}$$

Water savings cannot come from the evaporation component—that is fixed and based on cooling load. Drift, while controllable (and undesirable), is a much smaller piece. Reducing the blow-down is the main way water can be saved in cooling towers.

Active cooling tower management is focused on reducing water lost to blow-down while still maintaining healthy water quality and not impacting the cooling function of the system. One measure used is called the cycles of concentration, or concentration ratio, which is an indication of how many times water circulates in a cooling tower before being discharged. More precisely, the concentration ratio is the relationship between the concentration of dissolved solids in the bleed-off water over the concentration of solids in the make-up water (see related text box). Advice on how to adjust your concentration ratio is given on the following page.

<sup>1</sup> [http://www.eere.energy.gov/femp/technologies/water\\_bmp8.cfm](http://www.eere.energy.gov/femp/technologies/water_bmp8.cfm)

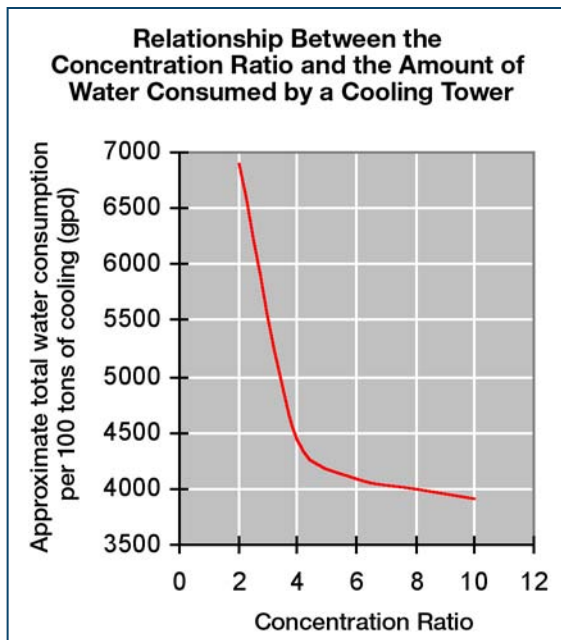
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### Calculating concentration ratios.

$$\text{Concentration Ratio} = \frac{\text{Bleed-Off}_{\text{concentration}}}{\text{Make-Up}_{\text{concentration}}}$$

Although this equation is the ideal computation to estimate the concentration ratio, it can be difficult to know the actual concentration of dissolved solids in the make-up and bleed-off water. As a surrogate to the actual concentrations, the concentration ratio can be calculated by using the volume of the make-up and bleed-off water if metered.



### Get to know your tower

The first thing you should do is understand your system. Consider metering the make-up and blow-down water and calculating the amount of water lost to evaporation. Some water utilities will provide a credit to the sewer charges for evaporative losses. Another way to understand your system better is to measure the conductivity of the cooling tower water with a conductivity sensor. Conductivity actually shows how well electricity is conducted through the water, which is a function of the total ionic dissolved solids in the water. You can find

out if conductivity is actually representative of your controlling parameter—the controlling parameter is the factor you are monitoring to determine when water should be bled-off. Depending on your water supply, the equipment being cooled, and the temperature differential across the tower, your control parameter may very well be hardness, silica, total dissolved solids, algae, or others. Once you determine the relationship between conductivity and your controlling parameter, set your blow-down to keep that parameter constant.

To help you understand this issue better, install conductivity and flow meters on make-up and bleed-off lines. Meters that display total water being used as well as current rate of flow are most useful. Check the ratio of conductivity of make-up water and the bleed-off conductivity. Then check the ratio of bleed-off flow to make-up flow. If both ratios are not about the same, check the tower for leaks or other unauthorized draw-off. Read conductivity and flow meters regularly to quickly identify problems. Keep a log of make-up consumption, bleed-off consumption, dissolved solid concentration, evaporation, cooling load, and concentration ratio.

Sometimes cooling tower maintenance functions are performed by contractors at your site. While out-sourcing can bring in needed expertise, your contractor should have stated goals for water conservation and chemical use in addition to maintaining a healthy cooling tower environment. Similar to landscape contractors whose main goal is to keep the grass green, maintaining good water quality in a cooling tower does not guarantee water savings will follow.

### Concentrate on water quality to save water

In order to increase the concentration ratio and thus save water, you need to focus on maintaining water quality through chemical or other treatment methods. There are several types of treatment options that may be appropriate for your site, including:

- **Shade cooling tower** from sunlight by installing covers to block sunlight penetration. Reducing the amount of sunlight on tower surfaces can significantly reduce biological growth such as algae.



- **Ultraviolet light** is added through an intense UV lighting module that provides disinfection which kills microorganisms in the cooling tower that can build up and lead to fouling or even legionnaire's disease.
- **Sulfuric (or other) acid treatment** controls scale build-up. When added to recirculating water, acid can improve the efficiency of the water by controlling scale buildup created from mineral deposits. Acid treatment lowers the pH of the water, and is effective in converting a portion of the calcium bicarbonate, the primary cause of scale, into the more readily soluble forms. Make sure that workers are fully trained in the proper handling of acids. Also note that acid overdoses can severely damage a cooling system, so use a timer and add acid at points where the flow of water is well mixed and reasonably rapid. Also beware that lowering pH may mean you may have to add a corrosion inhibitor.
- **Sidestream filtration** filters a portion of the flow (much like a swimming pool filter) to remove sediment and other impurities. A sidestream filtration is composed of a rapid sand filter or high-efficiency cartridge filter to cleanse the water. These systems draw water from the sump, filter out sediment and return the filtered water to the tower, enabling the system to operate more efficiently with less water and chemicals. Sidestream filtration is particularly helpful if your system is subject to dusty atmospheric conditions, and can turn a troublesome system into a more trouble-free system.
- **Ozonation** is a powerful oxidizer that controls scale, corrosion, and biological growth, and can produce high cycles of concentration in cooling towers.

Select your chemical treatment vendor with care. Tell vendors that water conservation is a high priority and ask them to estimate the quantities and costs of treatment chemicals, volumes of bleed-off water and the expected concentration ratio. Keep in mind that some vendors may be reluctant to improve water efficiency because it means the facility will purchase fewer chemicals. In some cases, saving on chemicals can outweigh the savings on water costs. Vendors should be selected based on "cost to treat 1000 gallons makeup water" and highest "recommended system water cycle of concentration."

### Other options to try

All large cooling tower systems (over 100 ton) should have an automated chemical feed system installed. The automated feed system should control blowdown/bleed-off by conductivity and then add chemicals based on makeup water flow. These systems minimize water and chemical use while optimizing control against scale, corrosion, and biological growth.

Consider using reclaimed water as make-up water for the cooling tower. "Waste" water from single-pass cooling, reverse osmosis systems, or other plant processes can be used as make-up water in the cooling tower, although diligence in maintaining water quality is extremely important.

### For more information go to:

Federal Technology Alert for more information: [http://www.eere.energy.gov/femp/pdfs/FTA\\_OTCT.pdf](http://www.eere.energy.gov/femp/pdfs/FTA_OTCT.pdf)

Labs for the 21st Century Best Practices for Water [http://www.labs21century.gov/pdf/bp\\_water\\_508.pdf](http://www.labs21century.gov/pdf/bp_water_508.pdf)

## Other Key Opportunities for Saving Water

### Single-Pass Cooling

Many federal facilities have equipment that utilizes single-pass cooling (sometimes called once-through cooling or non-contact cooling). This equipment circulates water only once to remove heat from the equipment, and then dumps this water down the drain. The first step to saving water with single-pass cooling equipment is to identify it. The equipment can often be running 24 hours a day, 7 days a week, wasting thousands of gallons of water unknown to the building manager. Consider a piece of equipment running a cooling load at a mere 2 gallons per minute. This would consume over 20,000 gallons per week alone.

Where should you start? Facilities that often have single-pass cooling equipment are health care facilities, maintenance shops, kitchens, hangers, and labs. Keep your eye out for typical single-pass cooling equipment such as X-rays, CAT scanners, hydraulic equipment, condensers, air compressors, welding machines, ice machines, air conditioners, and degreasers, among others.

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Auditing these systems is important to help understand how much water you are consuming and to learn how cooling can be provided in a manner that saves water. During the audit write down all relevant information: the brand and model number, equipment run-time, the purpose of the equipment, and the flow rate. One method of measuring flow rate is the “bucket and stop watch” method. Measuring the amount of time it takes to fill a precise volume of water (1 gallon, for example), will give you an estimate of the flow rate. Seek to understand the purpose of the equipment by questioning the equipment’s operator to learn how the equipment is run, the operation hours, and if the equipment is shut down during off-hours. Calculate how much water is being consumed by multiplying the operating hours by the flow rate.

Using the nameplate information, track down the manufacturer and get specifications of the equipment, such as allowable flow rates and entering and leaving water temperatures. To maximize water savings, set the flow rate as close to the minimum allowed by the specifications and make sure your entering and leaving temperatures are in the specified range to ensure adequate cooling is taking place.

One of the first improvements you should consider is the possibility of modifying the equipment to operate as a closed-loop system that recirculates the water instead of discharging it. Sometimes this can be a simple retrofit, while other times it may require a major overhaul. Perform an economic analysis based on the current water use uncovered during the auditing process, described above, to see if it is feasible to retrofit your equipment.

If it is not feasible to retrofit your equipment to a closed-loop system, run your equipment at peak efficiency. Make sure to work closely with the operators because they are the vital link to running the equipment efficiently. Require that the operator turns off the equipment and the water supply when it is not in use. Some equipment will run water continuously even when it is turned off. Now you can calculate the new water use by multiplying the new flow rate by the new operating hours to see how much water you will be saving. See Text Box 7 for an example calculation.

It is important to routinely clean the coils of the equipment, which will maximize the heat exchange and save energy and water. Consider using the effluent for another use, such as cooling tower or boiler make-up water or landscape irrigation.

### Text Box 7: Example calculation

**Current flow rate = 2 gallons per minute (gpm)**

**Current operating hours = 24 hours per day,  
5 days per week**

**Monthly water use = 2 gpm x 60 min/hr x 24 hr/  
day x 22 days per month = 63,360 gallons**

**New flow rate = 1.5 gpm**

**New operating hours = 12 hours per day,  
5 days per week**

**Monthly water use = 1.5 gpm x 60 min/hr x 12 hr/  
day x 22 days per month = 23,760 gallons**

**Savings = 39,600 gallons per month, 62 per-  
cent reduction**

### Leak Detection

Distribution system leaks can be a large source of water loss, especially in aging infrastructure at many federal installations. If your site was built in the 1950s or before, you are much more likely to be losing a significant amount of water through your distribution system.

What causes leaks in your pipes? Leaks typically occur from loose or corroded areas, improper installation of the piping, settlement, and overloading. Leaks most commonly occur at joints and connections such as meter boxes, hydrants, and valves. Typical leak rates have wide ranges. A large main break can loose water at 1,000 gallons per minute (gpm). A slow service line leak can be as small as 0.5 gpm. These small leaks will most likely grow over time, especially if they are due to corrosion.

Leaks are most commonly found passively by simply noticing wet spots or soil subsidence (where the ground around the leak is sinking into a depression). Ideally, a leak detection and repair program is an active program

with an integral part being a distribution system audit, which goes beyond this fact sheet. (See Text Box 8 for more information.) But if a comprehensive audit is out of the question, the first step is to inspect all vulnerable areas. Inspect and record information on your distribution system valves, meters, and other connections. Make a note of current condition, type, and age of each connection you are inspecting. This will help you learn about your system and note any major problems right away.

### Text Box 8: Distribution System Audit

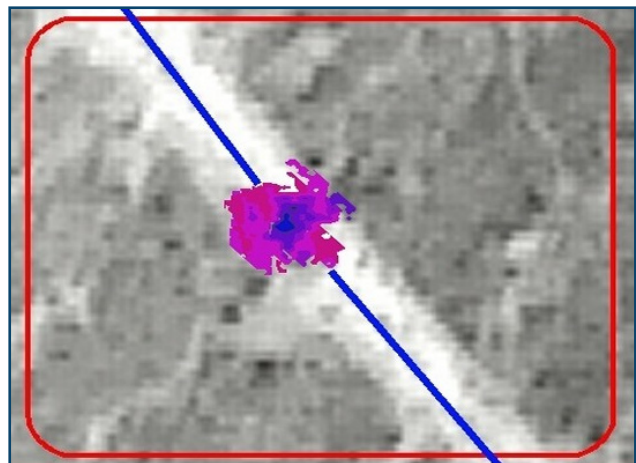
*A distribution system audit is a thorough way to approximate the leaks you may have in your system. A preliminary distribution system audit compares water supply coming into your facility to your known uses of water. First, quantify your water supply either from your utility bills, master meter, or pumping records, for example. If possible, this should show monthly water use over an annual period. Then determine your water uses through sub-metered data or engineering estimates. These are water uses for equipment such as plumbing fixtures, cooling towers, irrigation, and steam systems. For the same time period, sum these “verifiable” uses and compare them to the total water supply coming in. How do they compare? Are your water uses less than 90 percent of your total water supply? If so, then you may have significant leakage or other uses that you are not aware of.*

Another simplified technique for determining if there are leaks in your system is called zone flow measurements, done by examining water use in specific areas or zones of your system. First, isolate a zone from the rest of the distribution system by closing the valves in that area. Then record the flow for about 24 hours if possible. Compare the daytime use to the nighttime use of this zone. If there is significant nighttime use and you are confident that there are no verifiable uses during that time, then most likely there are leaks in this zone. If you have a small

system, this same technique can be done at the master meter for your entire distribution system.

Leaks are most often pinpointed by using electronic listening devices, which detect the sound of the pressurized water being forced through the pipe wall. Typically a trained operator is contracted out to perform leak detection services because it requires specific instrumentation and knowledge of how to determine the sounds and the exact location of the leak.

Thermal imaging is another technique for determining leaks in large distribution lines (16 inches or greater). Multispectral and thermal aerial photography are used by aerial surveillance. An airplane passes over buried distribution lines and takes thermal imaging photographs that show ground temperatures. Areas of cooler temperatures reveal possible water leaks because the saturated area will be cooler than the surrounding soil. As shown in the thermal image below, the areas of cooler temperature are in pink and blue, indicating a leak along the distribution line (shown as the blue line). This technique works best during warmer seasons and in arid areas because these spots are much easier to pinpoint since the water table is typically deep from the surface. Also, another indicator of a leakage in arid climates is dense vegetation growth.



**Thermal image showing an area of cooler temperatures (pink and blue) along a distribution system line (blue line)**

# Federal Energy Management Program Fact Sheet

## For Additional Information on Water Efficiency:

Area	Organization	Website
Federal Guidance	Federal Energy Management Program (FEMP)—Water Efficiency	<a href="http://www.eere.energy.gov/femp/technologies/water_efficiency.cfm">www.eere.energy.gov/femp/technologies/water_efficiency.cfm</a> This page offers guidance to federal agencies on water-efficiency improvements and related water reduction goals as part of Executive Order 13123.
Federal Guidance	Energy Center of Expertise—Water Management Guide	<a href="http://www.gsa.gov">www.gsa.gov</a> directions to get to file: Under the Buildings tab click on Environmental Programs, click on Energy & Water Conservation, then click on Energy Center of Expertise Library—link to pdf file is in the list of documents. A comprehensive handbook for the federal facility manager on water conservation. Download for free! entire link: <a href="http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/water-guide_new_R2E-c-t-r_0Z5RDZ-i34K-pR.pdf">www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/water-guide_new_R2E-c-t-r_0Z5RDZ-i34K-pR.pdf</a>
Federal Guidance	Navy Water Conservation	<a href="http://energy.navy.mil">energy.navy.mil</a> click on Water in left-hand column. This website offers resources to the Navy regarding water conservation.
Federal Guidance	Air Force Water Conservation Program	<a href="http://www.afcesa.af.mil/CES/cesc/water/cesc_watercons.asp">www.afcesa.af.mil/CES/cesc/water/cesc_watercons.asp</a> This website provides resources for the Air Force in water management and meeting Executive Order 13123.
Water Efficiency and Conservation	Water Wiser: The Water Efficiency Clearinghouse	<a href="http://www.awwa.org/waterwiser">www.awwa.org/waterwiser</a> A cooperative project of the American Water Works Association, the U.S. Environmental Protection Agency and the Bureau of Reclamation. This website offers a broad range of information and links to water-efficiency technologies, practices, and services.
Water Efficiency and Conservation	California Urban Water Conservation Council	<a href="http://www.cuwcc.org">www.cuwcc.org</a> The CUWCC is a statewide water conservation awareness program in California that has developed urban water conservation Best Management Practices.
Water Efficiency and Conservation	Environmental Protection Agency Water Efficiency Program	<a href="http://www.epa.gov/owm/water-efficiency/index.htm">www.epa.gov/owm/water-efficiency/index.htm</a> EPA's Water Efficiency Program's website provides efficiency tips on agriculture, residential water use, drought management, water recycling, and much more.
Water Resources Education	Water Education Foundation	<a href="http://www.water-ed.org">www.water-ed.org</a> Educational organization to increase awareness of water issues.
Water Resources Education	Learning to Be Water Wise & Energy Efficient	<a href="http://www.getwise.org/">www.getwise.org/</a> A youth education resource developed by the National Energy Foundation.
Water Resources Information	American Water Works Association	<a href="http://www.awwa.org">www.awwa.org</a> Provides all information on AWWA's activities, programs, conferences, publications, and useful links.

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**O&M First!**—FEMP is pleased to present this series of fact sheets as a way to promote energy efficiency by first applying O&M best practices. It is our hope that the experiences shared will provide federal facility managers with strategies they can apply to their own facilities, as well as introduce the FEMP O&M program to federal site staff.

A copy of the FEMP O&M Best Practices Guide can be downloaded at [www.eere.energy.gov/femp/operations\\_maintenance/om\\_best\\_practices\\_guidebook.cfm](http://www.eere.energy.gov/femp/operations_maintenance/om_best_practices_guidebook.cfm). This guide, which covers a full range of facilities O&M topics, provides the rationale for a proactive O&M program; identifies O&M management issues and their importance; explains the various O&M program approaches; introduces maintenance technologies; and explores O&M procedures for the predominant equipment found at most federal sites.



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### For More Information

#### EERE Information Center

1-877-EERE-INF or  
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### FEMP O&M Resources

FEMP is committed to providing federal facility staff tools and knowledge to help optimize their O&M programs. Visit the FEMP homepage for information on O&M and other FEMP programs and activities at [www.eere.energy.gov/femp](http://www.eere.energy.gov/femp).

FEMP also offers the workshop Operations and Maintenance Management. To find out more about this course, visit [www.eere.energy.gov/femp/services/training\\_om.cfm](http://www.eere.energy.gov/femp/services/training_om.cfm).

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