Indoor Water Use and Improving Performance

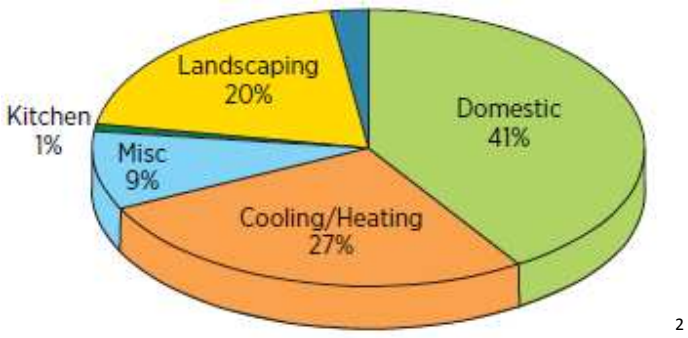
PURPOSE

To inform federal energy and facility managers of ways to measure and monitor water use, diagnose common issues, and reduce water use.

WATER USE

Managing water supply and demand has been a growing concern in the United States over the past few decades. Water use has skyrocketed since 1950, and has been growing at the rate of 150% per capita. As a result, water restrictions on communities have become more and more widespread all around the country, especially during prolonged draughts.

When it comes to energy and water use, office buildings are the worst offenders. U.S. Geological Survey estimates that buildings account for 40% of the country's energy usage and nearly 14% of all potable water use. A typical Federal office building with 200 employees uses 3,000 gallons of water per day.[1]



[2]

Figure 1: Typical Federal Office Building Potable Water Use

The U.S. Department of Energy estimates that restroom plumbing fixtures account for approximately 60 percent of the total water use in office and administrative buildings; the remaining 40 percent is estimated to be used by heating and cooling systems.

A significant amount of water is wasted due to leaks. Figure 2 shows the estimated water loss through leaky fixtures (EPA Water Sense)[3].

[1] http://www1.eere.energy.gov/femp/pdfs/waterefficiency_fedoffices.pdf

[2] http://www1.eere.energy.gov/femp/pdfs/waterefficiency_fedoffices.pdf

Drips per minute	Water wasted per day (gallons)	Water wasted per month (gallons)	Water wasted per year (gallons)
5	.75	22	263
10	1.5	43	526
20	2.9	86	1,051
30	4.3	130	1,577
40	5.8	173	2,103
50	7.2	216	2,628
60	8.6	259	3,154
70	10.1	302	3,679
80	11.5	346	4,205
90	13	389	4,731
100	14.4	432	5,256

Figure 2: Water Loss through Leaky Fixtures

With utility rates on the rise and cost-effective, reliable, water efficient products on the market, every facility is a new opportunity for reducing water consumption. Facility managers have a unique opportunity to make a huge impact on water use and the facility's bottom line.[4]

MANDATES AND GOALS

In recent years, as the environmental and resource impacts of the operation and construction of federal facilities have become more transparent, both the legislative and executive branches of the Federal government have established a series of mandates and orders requiring water, energy, and sustainability performance in Federal buildings.

The Federal mandates require all construction projects to comply with specific requirements. These mandates apply to new and existing buildings and leased space.

These mandates charge individual agencies with demonstrating compliance subject to audit by the Government Accountability Office.[5]

[3] http://www.epa.gov/WaterSense/

[4] http://www.buildings.com/tabid/3334/ArticleID/6461/Default.aspx

[5] Federal Sustainability Mandates: http://www.davislangdon.com/upload/images/publications/USA/Federal%20Sustainability%20Mandates.pdf

The goals of the current Federal mandates are to:

- Employ strategies that in aggregate use a minimum of 20 percent less potable water than the indoor water use baseline calculated for the building.
- Reduce water consumption intensity, relative to the baseline of the agency's water consumption in FY2007, through lifecycle cost effective measures by 2 percent annually through the end of FY2015 or 16 percent by the end of FY2015.
- Give preference, where applicable, to water-efficient products, including those meeting EPA's WaterSense standards (i.e., low-flow bathroom fixtures and toilets should be used wherever possible in all facilities.)

EVALUATE WATER EFFICIENCY

Prepare for a Water Audit

A facility water audit or survey is the starting point of any water efficiency program. It is very important to properly prepare for the water audit. As a first step, identify all personnel familiar with the building's plumbing system operation, and form your water auditing team.

Once, you have a team in place, you should start collecting the following information:

- The age and physical size of the facility, including floor space (in square feet)
- Date of last renovation, if applicable
- Plumbing drawings and riser diagrams
- The operating schedule of the facility:
    - Number of employees per shift, if applicable
    - Maintenance shifts and other operating information
- A water use profile (graph) showing the total water use per month for the last three years (one year minimum)
- Copies of the proposed billing rates for energy, water and wastewater for the next two years (if known)
- List of all water-using equipment, including the manufacturer's recommended flow requirements
- Inventories of sanitary fixtures and any water-saving fixtures
- Any previous water and energy survey data
- All water delivery records from water meters, tank trucks, etc.
    - Location and size of all water supply meters from utilities, wells, and other water sources
- Any calibration test results for meters to adjust past meter readings to reflect actual water use

If you have never performed a significant water efficiency study, you may need experienced help from colleagues, local, state or university technical assistance services, consultants, or the utility.

Summarize results

Use your water audit results to prepare a balance diagram to depict all water uses. If unaccounted for water is greater than 10 percent revisit the major areas of water use and take additional measurements.

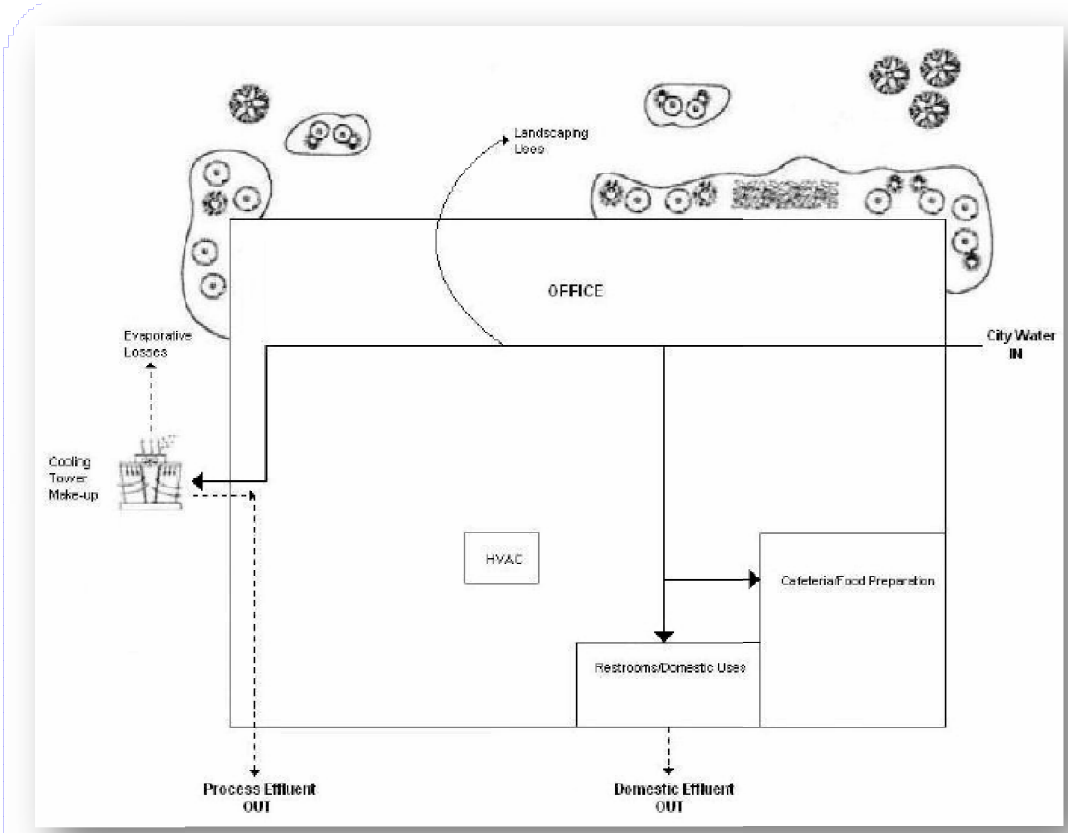


Figure 3: Sample Water Balance Diagram[c]

A quality water audit report should contain the following elements:

- Executive summary of recommendations, quantifying savings, investment costs and payback periods
- Introduction
- Facility description
- Water use history for one or more years

[6] http://hawaii.gov/dlnr/cwrm/planning/wcmshf2007.pdf

- Water use balance
- Efficiency options, technical discussions and savings calculations
- Energy savings, if applicable
- Data normalization for follow-up with suggested timeframe.

It is very important to keep records of the historical water use at all times so that you can see trends and benchmark your facility relative to its past performance.

POTENTIAL ISSUES

Having completed you water audit, you will most likely discover that your water efficiency can be at least moderately or even significantly improved.

Leak Detection

All facilities will experience some leaks, which may range from a fraction of a percent up to several percent of total water use. Telling signs of a leak include low water pressure, stained walls or ceilings, mold, dirty water, as well as unusually high volume of unaccounted for water.

Common locations for leaks are in piping joints, restroom fixtures, pump seals, loose nozzles/shut-off valves, drinking fountains, and processing equipment.

You can identify leaks by visual or audio observations. You should observe water fixtures and/or process equipment both during use and during down time. You can detect under-the-floor or underground leaks through a leak-detection survey using the facility's water meter. To do so, turn off all water-consuming items inside and outside the building. Or, you can perform the survey after the last shift has left and no water is being used in the facility. Observe the water meter for a minute or longer. If the meter dial moves continually during this time, there is a leak. Another method is to record the numbers on the meter and come back in an hour and take another reading, making sure that no water is used during this time. If the meter reading has increased, there is a leak.

If you suspect or detect and underground leak using a water meter, but cannot readily identify its location, it may be necessary to perform a leak detection survey by a service firm. Such firms use state-of-the-art audio systems (i.e. ultrasonic meters) to pinpoint the leak location. The cost of such service can range from $1,000 to $5,000.

Determine Water Loss by Leaks

Determining the volume of water loss by leaks is key to calculating both water and cost savings. One of the simplest ways to determine a leak loss as well as a small drip is the *bucket and stopwatch* method to mathematically estimate leak rate and volume. For

example, if a leak fills a gallon bucket in one minute, then the leak rate is 60 gallons per hour and 1,440 gallons per day.

IMPROVE WATER EFFICIENCY

Fix It

Start out doing the basic system maintenance. Eliminating leaks in usual and obvious places typically includes tightening or replacing fittings. All occupants should be responsible for notifying maintenance personnel of leaks, and maintenance personnel should make leak repair a priority.

Take Advantage of Technology

According to the EPA, water-efficient appliances, including aerators, will help the country save more than 3 trillion gallons of water and more than $18 billion per year. [7]

Installing or replacing existing lavatory and sink aerators may be one of the most effective and economical technological solutions. Aerators are very inexpensive and easy to install, and they can save hundreds of gallons of water every month, and therefore reduce the energy bill. If aerators are installed, check to make sure they are functioning properly. During an examination of water efficiency at the EPA's Wynkoop building in Denver, Colorado, it was discovered that faucet aerators had flow rates of 1.5 gpm, higher than allowed by the U.S. model plumbing codes and LEED-2009, which call for a maximum flow rate of 0.5 gpm. This deficiency was immediately identified that 0.5-gpm units could be installed.

Replacing older, high-flow toilets and flush valves with models that meet current Uniform Plumbing Code (UPC) and International Plumbing Code (IPC) requirements will allow you to achieve even further water savings. While current codes require the lower flow rate for new fixtures, existing buildings often have older, high-flow flush valves.

Utilize dual-flush valves on toilets. Dual flush valves provide a full 1.6-gpf volume for heavy waste and an 0.8-gpf volume for lighter waste.

Consider replacing existing plumbing fixtures with high-efficiency fixtures that exceed UPC and IPC requirements. **Note**: it is recommended that the drainage piping be cleaned to ensure proper drainage flow prior to installing these fixtures:

- *High-efficiency toilets* use 1.3 gpf or less. You will most likely have to replace your fixtures and valves to reduce the chance of clogging.
- *High-efficiency urinals* use as little as 1 pint of water per flush, which is less than 10 percent of current low-flow models.

[7] http://www.earthshare.org/2009/04/how-to-cut-office-water-waste.html

- *Waterless urinals* use a specially formulated liquid instead of water to maintain the trap seal. **Note**: Give careful consideration to style and placement of these prior to installation. Maintenance staff must be specifically trained in the proper cleaning procedures of these units.
- *Ultra-low flow showerheads* typically use 1.5 gpm of water or less. One significant drawback of these showerheads is that, although they allow for significant water savings when compared to other code-compliant models, they don't always receive high marks from users.
- *Use alternative water sources.* Some jurisdictions have or are planning to allow installalation of greywater distribution systems. The water is considered non-potable, but is suitable for use in toilets and urinals. Use of greywater can considerably reduce consumption of domestic water.
- *Bundle*. Retrofitting all system components at once can be cost prohibitive, but bundling water-efficient fixtures with harvesting systems and landscape redesign can lead to significant savings. Optimizing the water system as a whole leads to the greatest reduction in potable water consumption. Utilizing a rainwater harvesting system is a popular way to capture a non-potable resource for toilets and irrigation.

The Federal Energy Management Program offers useful tools for estimating and improving water efficiency. Its online energy and cost savings calculator estimates the 10-year life-cycle cost of toilets and urinals in comparison with current code-compliant models.

Facility and energy managers have a unique opportunity to make a significant impact on water use in existing buildings. By measuring and monitoring water use, evaluating plumbing-fixture types, and implementing simple water-saving measures, you can easily improve your overall water and energy efficiency.

Address Human Behavior

If your building has already replaced older toilet models with dual flush toilets and your water use hasn't gone down as much as you expected, you may want to utilize submeters to monitor water use in lavatories on a single floor to determine whether occupants are utilizing the dual flush appropriately or there are equipment malfunction issues.

Researchers at Wynkoop were reminded that humans are creatures of habit. It turned out that the *down* flush of a dual flush toilet came very naturally to the occupants, however the reduced *up* flush, did not. Therefore, despite the water efficient equipment being available, the desired result of water savings didn't happen. Fortunately, the fix was simple – reverse the handle mechanism to flush *up* for full flush and *down* for reduced.

APPENDIX

Potential Water Meter Issues

The size and accuracy of a water meter is important when accurately accounting for water use. Public buildings generally use compound, high velocity style meters that are usually 2-4 inches in size.

Keep in mind that water meters can become less accurate when the intended water use of a facility has changed or when substantial water conservation activities have been implemented.

If a meter is oversized for the facility's needs, the facility could be paying unwarranted service charges for it.

Even properly selected and sized water meters can become inaccurate due to wear, which is affected by age and water quality. You can use in-place field testing using a pitotmeter for large meters and a portable meter test unit for smaller water meters.

Tips for Measuring Indoor Water Usage

Submetering is an excellent way to accurately account for large water uses in specific areas of the facility. It helps personnel become familiar with water use for all operations and indicates whether equipment is using water when it is not needed.

Temporary meters will indicate whether it is cost-effective to install permanent meters.

Bucket and stopwatch is a simple and accurate measurement tool. To use this method, collect a specified amount of water for specific time period (i.e. one quart per minute, which is equivalent to 0.25 gpm).

Micro-weirs are small hand-held weirs that are used to measure low flows of water (0.5 to six gpm) in tight spaces, such as under lavatory faucets.

TERMS AND DEFINITIONS

Dual flush toilets are those that have two levels of flushing – a higher water use flush for solids and a lower water use for liquids. Dual-flush toilets have been in use for many years in Europe and Australia, where water rationing is very common. Dual-flush toilets are available in tank or flush valve types. They can conserve significant amounts of water but require educating building occupants for optimum water saving results.

LEED - Leadership in Energy and Environmental Design is redefining the way we think about the places where we live, work and learn. As an internationally recognized mark of excellence, LEED provides building owners and operators with a framework for identi-

fying and implementing practical and measurable green building design, construction, operations and maintenance solutions. Click here for further details.

Water Balance diagram will help your organization to understand water use and may help you to reduce water costs. The diagram will: include known water use, help to identify leaks, overuse and areas where efficiency improvements could be made. This could include the installation of meters (sub-metering) at significant points in the system.

WaterSense is a partnership program (sponsored by EPA) that makes it easy for consumers to identify water-efficient products and learn water-saving behaviors. You can find WaterSense labels on plumbing fixtures that use less water but still perform as well or better than conventional models.

SUPPLEMENTAL RESOURCES

Water Efficiency and Management for Commercial Buildings

Federal Water Efficiency Best Management Practices:
http://www1.eere.energy.gov/femp/program/waterefficiency_bmp.html

On-line water drip calculator:
http://www.mrrooter.com/AskTheExpert/Drip%20Calculator.aspx

Massachusetts Water Resources Authority:
http://www.mwra.state.ma.us/04water/html/bullet4.htm

Estimated Use of Water in the United States in 2005:
http://pubs.usgs.gov/circ/1344/

Below is the list of mandates with which you should be familiar:

- Energy Independence and Security Act (EISA) of 2007: http://www.energystar.gov/ia/products/lighting/cfls/downloads/EISA_Backgrounder_FINAL_4-11_EPA.pdf
- Executive Order (EO) 13423, Implementing Instructions, and EO13514 mandates for water user reduction and water efficient product requirements
- FAR, Subpart 23.2 – Energy and Water Efficiency and Renewable Energy requirements on water efficiency
- GSA's WaterSense and Water Efficient Products Instructions

Water Use Field Research and Baseline Assessment, U.S. EPA Wynkoop Building, Denver, Colorado, Project 58807 of the ARRA High Performance Green Building Program, July 2011 – DRAFT REPORT

Federal Energy Management Program
http://www1.eere.energy.gov/femp/technologies/procuring_eeproducts.html

Comparison of Plumbing Fixture Flow Rates:
http://www.facilitiesnet.com/ms/graphics/ms0810a.pdf

Improving Water Efficiency in Your Building
http://www.buildings.com/tabid/3334/ArticleID/6461/Default.aspx

Water Efficiency, Auditing Methodology and Tools
http://portal.ncdenr.org/c/document_library/get_file?uuid=bb724c74-c5f6-443a-b9f2-5f21b49e630d&groupId=38322

Federal Sustainability Mandates
http://www.davislangdon.com/upload/images/publications/USA/Federal%20Sustainability%20Mandates.pdf

Water Use It Wisely website:
http://wateruseitwisely.com/index.php

Handbook of Water Use and Conservation
http://www.waterplowpress.com/

EPA's Water Sense Program:
http://www.epa.gov/WaterSense/

How to Cut Office Water Waste:
http://www.earthshare.org/2009/04/how-to-cut-office-water-waste.html

Water Auditing Master Series
http://www.foresteruniversity.net/webinar-water-auditing101.html

Water Efficiency Self Assessment Guide for Commercial and Institutional Building Facility Managers
http://my.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/water_efficiency_improvement_self_assess_guide.pdf

US Federal Water Conservation Related Organizations

- EPA - Surf Your Watershed: http://www.epa.gov/surf/
- U.S. Department of Agriculture - Water Quality Information Center: http://www.nal.usda.gov/wqic/
- U.S. Department of the Interior /Facilities Energy Management & Water Conservation Plan: http://www.doi.gov/pam/enerplan.html
- U.S. Geological Survey - water resources: http://water.usgs.gov/

- U.S. Navy Water Conservation Ashore - includes a military water conservation handbook and a water fixtures spreadsheet Water Efficiency Program, EPA WAVE program and Guidelines for Water Conservation Plans: https://navyenergy.navfac.navy.mil/management/WaterWeb.html
- WaterShare - Department of the Interior - US Bureau of Reclamation: http://www.usbr.gov/mp/watershare/