Public Building Water Auditing Best Practices

Water Audit Objective

A water audit—also called a water evaluation or assessment—is a comprehensive analysis of the current water use of a building or campus, and the subsequent development of a strategy to increase water usage efficiency and identify alternative water resources. The goal of a comprehensive water audit is to reduce the demand on freshwater resources. The multi-step water audit process includes collecting the data necessary to estimate water use at the equipment level, surveying the equipment to understand water consumption, investigating water-conservation opportunities, and conducting an economic analysis to determine the project's effectiveness.

Background Data

The first step of a comprehensive water audit is to collect data on a facility's water use, the water cost, the building occupants, and the existing equipment. The information is used in the subsequent steps to determine water use and identify water-conservation opportunities.

Water Use and Cost Data

Understanding current water uses and costs is essential to a comprehensive water audit. This step involves collecting water and cost data and establishing a baseline that is used to calculate cost savings and to determine the overall water-use reduction potential associated with water conservation opportunities.

Utility information should include the following for potable and non-potable water.

- Contact information for all water and wastewater utilities.
- Current water and wastewater rate schedules and alternative schedules that are appropriate for a specific use or facility type (to ensure that the best rate is used).
- Copies of water and wastewater bills for the past two years (to identify any inaccuracies and apply the appropriate rate structure); if the facility is supplied indoor and outdoor water (e.g., irrigation) separately, make sure to receive all associated bills.
- Information about rebates or technical assistance available from the utilities to help with water-use planning and with implementing water conservation programs for the facility. (Energy utilities often offer assistance with water conservation programs.)
- Contact information for the internal office that pays the water and sewer bills.
- Production information if the facility produces its water or treats its own wastewater, or both.
- Sub-metered water use at the building or equipment level; gather data for the shortest interval available (e.g., hourly, weekly, monthly).

- Categorize the building by type. Building type information can be found on the Environmental Protection Agency (EPA) website: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/identify-your-property-type

After collecting water and cost use data, take the following steps.

- Calculate a baseline annual water use for a specific year or an average water use over several years. If monthly data are available, plot the monthly use over time and identify trends (e.g., water use increasing, decreasing, or remaining steady over time). If indoor and outdoor water is supplied separately, determine distinct baselines for each one.
- Attempt to ascertain the cause of major trends. For instance, seasonal increases in the summer months often are the result of irrigation or cooling water demand during warm weather. Analyzing the data in this manner helps provide an understanding of current water-use trends.
- If water use by specific building is available, use the data to benchmark the buildings. Metrics such as gallons per square feet of building space or gallons per person can be used to benchmark a building's performance. These metrics can be compared to other similar buildings to show their relative water use. The EPA ENERGY STAR Portfolio Manager has compiled water use trends by building type that can be used to benchmark buildings. Find more information at: https://www.energystar.gov/buildings/tools-and-resources/datatrends-water-use-tracking
- Determine the marginal per-unit cost of water and wastewater service to be used in the economic analysis; and the specific water rates for indoor and outdoor water if they are billed separately.
- Verify the appropriate rate structure.
- Identify services the utility might provide to help manage water efficiently, such as rebates.

Building and Equipment Information

In addition to water use and cost information, information on the building and water-using equipment should be gathered, including:

- Number of occupants;
- Estimated gender split (this is important because, in most buildings, the men's restrooms have urinals, which use less water than toilets do);
- Floorplans;
- Hours of operation;
- List of the major water-using equipment, such as a commercial kitchen, cooling tower, and irrigation equipment; and
- Equipment specification sheets.

Building Walk-Through Survey

After reviewing background data, a walk-through typically is performed to record detailed information on each piece of water-related equipment and determine the condition and operation so that the water use can be estimated. The step includes:

- Recording hours of operation and operating schedules,
- Measuring water flow rates,
- Noting equipment condition,
- Recording equipment information such as model number and manufacturer, and
- Identifying efficiency opportunities such as low and no cost measures or retrofit and replacement options.

When compiling an inventory of water-using equipment, remember to include a comprehensive suite of equipment types, including:

- Plumbing fixtures,
- Cooling towers,
- Boilers,
- Irrigation,
- Single-pass cooling,
- Vehicle wash station,
- Kitchen equipment,
- Laundry facilities, and
- Lab/medical equipment.

If possible, measure the flow rate of each piece of water-using equipment. This can be done using a simple "bucket and stopwatch" method, in which the water use is recorded over a given period using a calibrated container that can provide a gallons-per-minute reading. Calibrated flow bags that are specially designed to measure the flow rate of faucets and showerheads also are available.

Tips for a successful walk-through survey

- Audit in pairs—one person can take photos while the other takes notes.
- Take photos of the model number—use a good camera that can zoom in on the nameplate.
- Pay attention to drain lines that are plumbed to floor drains in the building's mechanical spaces and utility chases; trace these back to the originating equipment to make sure they are taken into account.
- Use a digital watch with a stopwatch to record seconds for estimating flow rate.
- Bring a flashlight—some equipment information is posted on the back of the unit which can be a dark area.
- Wear closed-toed shoes and clothes that allow you to get on your hands and knees—you might need to look under equipment to find drains.
- Note the gender split in buildings.
- Observe occupant behavior to begin to determine the overall awareness of water conservation in the building. Ask occupants simple questions about their experience with water-efficient technologies. Occupants will have important observations about the building in which they work.

Water Balance

After collecting information on each piece of water-using equipment, the next step is to develop a water balance. A water balance compares the total water supply baseline to water that is used by equipment and applications. A water balance collects information from multiple sources to examine how water is used at the facility.

Estimate Water End Uses

Determining water use at the equipment or application level can be challenging. The following five steps outline the process for determining water use at the equipment level.

1. Create an inventory of all water-using activities. Often, maintenance and operation staff at the facility have direct knowledge of building mechanical systems and process equipment that can be used to generate a complete inventory.

2. Document the results of the walk-through survey for each equipment type, including the operating schedule, flow rate, model number, and condition of each piece of equipment.

3. Obtain any available equipment sub-metered data to quantify the particular use.

4. Evaluate seasonal patterns in the monthly water-use data (*see* Water Use and Cost Data) and compare them to the inventory of uses. The seasonal pattern of water use can help quantify water uses that are typically seasonal, such as irrigation or evaporative cooling systems.

5. For unmetered water end uses, create engineering estimates of water use.

    - Water use from plumbing fixtures (i.e., toilets, urinals, faucets, and showerheads) can be estimated based on the flow rate/flush rate of the fixture and the number of occupants and daily use per occupant.
    - Cooling tower water use can be estimated based on cooling capacity and load factor.
    - Irrigation water use can be estimated based on irrigated area and inches of water applied by the equipment.
    - Kitchen and laboratory equipment water use can be estimated based on water use per cycle and the frequency of cycles.

For additional information on estimating the water consumption of specific equipment types, see the Department of Energy's Federal Energy Management Program (FEMP) website for estimating methods, at https://energy.gov/eere/femp/estimating-methods-determining-end-use-water-consumption.

Develop the Water Balance

The next step is to create a water balance with the quantified water uses by major equipment type. Compare the sum of the end-use water consumption to the total supply. The difference between these two values represents the unknown water uses in the system, which could be a result of:

- Water leaks in the distribution system or equipment,
- Inaccuracies in the engineering estimates used to determine equipment water use, and

- Accounting errors, such as poorly calibrated meters or unit-conversion problems.

If the unknown amount in the water balance is more than 10% of the total water supply, further investigation probably is warranted to find the cause of the imbalance. This can include a comprehensive leak-detection program. Additionally, the water balance will uncover the high water-use activities, which will help in prioritizing water-saving opportunities.

Water Conservation Opportunity Assessment

Based on the outcome of the water balance, the final step in a comprehensive water audit is to identify ways to increase water efficiency and supply alternative water sources to ultimately reduce freshwater use. The Federal Energy Management Program (FEMP) has developed a set of best management practices (BMPs) that provide operations and maintenance, retrofit, and replacement options for:

- Distribution system audits, leak detection, and repair;
- Water-efficient landscaping;
- Water-efficient irrigation;
- Toilets and urinals;
- Faucets and showerheads;
- Boiler and steam systems;
- Single-pass cooling equipment;
- Cooling tower management;
- Commercial kitchen equipment;
- Laboratory and medical equipment;
- Other water-intensive processes; and
- Alternative water sources.

These FEMP BMPs can be found here: https://energy.gov/eere/femp/best-management-practices-water-efficiency

The EPA WaterSense Program also has a BMP document with comprehensive information on commercial water equipment: https://www.epa.gov/watersense/best-management-practices

After identifying water conservation opportunities, perform an economic analysis to determine whether the projects are life cycle cost-effective. In this analysis, use the marginal water and sewer rates identified in the first step. Be sure to also include other related costs—such as energy and operations and maintenance changes—which resulted from the measure. For example, faucet and showerhead retrofits save energy by reducing hot water use. Also determine the annual escalation rate of the marginal cost of water and wastewater to escalate water costs in the future.

The findings of the water audit should be compiled into a report that provides the outcome of the water use analysis, water balance, conservation opportunities, and economic analysis results. The final report should provide specific information on the recommendations including low and no cost operational

changes and retrofit equipment. These details will provide the type of information needed to prioritize the implementation of the measures.

Additional Resources

The following resources provide additional information on water auditing.

- FEMP's Water Efficiency Program: https://energy.gov/eere/femp/water-efficiency-federal-buildings-and-campuses
- Alliance for Water Efficiency: http://www.allianceforwaterefficiency.org/
- EPA WaterSense Commercial Building Program: https://www.epa.gov/watersense/commercial-buildings