Pacific Northwest NATIONAL LABORATORY

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Federal Water Management Planning Manual

August 2021

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BM Bersell

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Pacific Northwest National Laboratory
Richland, Washington 99354

Acronyms and Abbreviations

EISA	Energy Independence and Security Act
ESCO	energy service company
ESPC	energy savings performance contract
FEMP	Federal Energy Management Program
gpf	gallons per flush
gpm	gallon per minute
kgal	thousand gallons
kWh	kilowatt-hour
LCC	life cycle cost
LCCA	life cycle cost analysis
NPV	net present value
O&M	operations and maintenance
SIR	savings-to-investment ratio
UESC	utility energy service contract
WUI	water use intensity

Contents

Figures

Tables

1.0 Introduction

The U.S. Department of Energy Federal Energy Management Program (FEMP) assists federal agencies in becoming efficient, resilient, sustainable, and secure by providing key resources and trainings that enable them to reduce energy and water use and find cost-effective solutions to optimize operations. FEMP developed the Federal Water Management Planning Manual to provide a resource on how to design a comprehensive water management program. The manual describes strategies on how to optimize water use at federal facilities, use water balance analysis methods, identify design elements and procurement best practices, and expand use of alternative water.

In addition to this manual, FEMP developed the Directory of Resources as a companion online resource. The Directory of Resources provides links to online documents, resources, and tools that provide detailed information related to the topics in this manual. This Federal Water Management Planning Manual describes a process that will be relevant for years to come, while the Directory of Resources is intended to be a “living” resource that will be updated regularly to provide federal agencies with the latest information.

This manual is designed for personnel who manage a water program at a facility. The term “facility” is used throughout this document and is meant to include a single building or multiple buildings in a campus setting. Typical staff that would likely use this manual are facility managers, water managers, energy managers, and building engineers. For the purposes of this manual, the term “program manager” will be used to describe this role. In addition, the manual is useful for regional and headquarters personnel, providing water key information on water management as it relates to Federal requirements and resources to drive strategic initiatives across organizations.

1.1 How To Use This Manual

This manual is organized into sections corresponding to steps to develop a water management program. The manual walks through the steps to conduct a comprehensive facility water evaluation, prioritize water solutions, and execute projects. The following call-outs are used throughout this manual to draw attention to important information or tips:

Information call-out boxes: Call-out boxes with the ⓘ icon provide additional information or tips related to the content.

Agency level call-out boxes: Call-out boxes with the Ⓐ icon provide guidance on how to apply the information at the agency level.

Directory of Resource call-out boxes: Call-out boxes with the 🖱 icon link to the Directory of Resources, where additional information related to the content can be found.

Example call-out boxes: Call-out boxes noted with “**Example”** illustrate important concepts throughout the manual.

1.2 Federal Water Laws and Requirements

There are several important laws and requirements that federal agencies are required to follow regarding water management. Table 1 provides an overview of the water-related statutory mandates that agencies are required to meet.

For more information on federal water laws and requirements, go to the Federal Water Requirements section of the Directory of Resources.

Table 1. Federal Water-Related Laws and Statutes

Title	Legal Authority	Originating Legislation	Summary
Comprehensive Energy and Water Evaluations	42 U.S.C. § 8253(f)(3)(A)	Energy Independence and Security Act (EISA) 2007 § 432 and Energy Act of 2020 § 1002	Agency energy managers are required to complete an annual comprehensive energy and water evaluation for approximately 25% of agency covered facilities in a manner that ensures that an evaluation of such facility is completed at least once every 4 years.
Implementation Water Efficiency Measures	42 U.S.C. § 8253(f)(4)	EISA 2007 § 432 and Energy Act of 2020 § 1002	Not later than 2 years after the completion of each evaluation under 42 U.S.C. § 8253(f)(3), each agency shall implement any water-saving measure that was identified as life cycle cost (LCC)-effective[1] and bundle individual measures of varying paybacks together into combined projects.
Commissioning and Measurement and Verification	42 U.S.C. § 8253(f)(5)	EISA 2007 § 432	For each measure implemented under 42 U.S.C. § 8253(f)(4), agencies are required to ensure that equipment is fully commissioned at acceptance to be operating at design specifications; equipment and system performance is measured during its entire life to ensure proper operations, maintenance, and repair; and energy and water savings are measured and verified.
Implementation Water Efficiency Measures	42 U.S.C. § 8253(b)(1)	Energy Act of 2020 § 1002	Not later than October 1, 2022, to the maximum extent practicable, each agency shall begin installing in Federal buildings owned by the United States all water conservation measures determined to be LCC-effective.
Building Water Metering	42 U.S.C. § 8253(e)	Energy Act of 2020 § 1002	All Federal Buildings shall be metered for water by October 1, 2022 and to the maximum extent practicable[2], shall be metered with advanced meters that provide data at least daily and measure data at least hourly (in accordance with guidance submitted by FEMP).

[1] Life-cycle cost effective a water conservation measure is defined in 42 U.S.C. § 8253(f)(1) as the estimated savings of which exceed the estimated costs over the lifespan of the measure.
[2] Maximum extent practicable is defined in the Federal Metering Guidance that an advanced meter or advanced metering device would not conflict with other Federal law; would not pose health and life safety issues; would not result in a request for products or materials not available; or would not prohibit accomplishment of agency mission and project objectives.

Title	Legal Authority	Originating Legislation	Summary
Energy Manager Responsibilities	42 U.S.C. § 8253(h)(2)	Energy Act of 2020 § 1002	Agencies are required to designate an energy manager that is responsible for reducing energy and water at each facility; energy managers shall take into consideration the use of a system to manage energy and water at the facility.
Sustainable Design Principles	42 U.S.C. § 6834(a)(3)(D)(i)(III)	EISA 2007 § 433	Sustainable design principles shall be applied to siting, design, and construction of all new and replacement buildings.
Water Conservation Technologies	42 U.S.C. § 6834(a)(3)(A)(ii) & 42 U.S.C. § 6834(a)(3)(D)(vii)	EPAct 2005 § 109	If water is used to achieve energy efficiency in new federal buildings, then water conservation measures shall be applied to the extent that they are LCC-effective. In addition to the use of water conservation technologies otherwise required, water conservation technologies are to be applied to the extent that the technologies are LCC-effective.
Water-Efficient Product Procurement	42 U.S.C. § 8259b(b)	EPAct 2005 § 104	Federal agencies are required to procure ENERGY STAR and FEMP designated products.
Water Conservation at Military Installations	10 U.S.C. §2866		This section of Title 10-Armed Forces lines out the requirements of water conservation at military installations, including water conservation activities, use of financial incentives and water cost savings, and water conservation construction projects.

1.3 Overview of the Comprehensive Water Management Process

This Federal Water Management Planning Manual provides directions on how to develop a comprehensive water management process at the facility level, shown in Figure 1. The manual provides instructions on each of these steps and connects to the Directory of Resources on where additional information can be found.

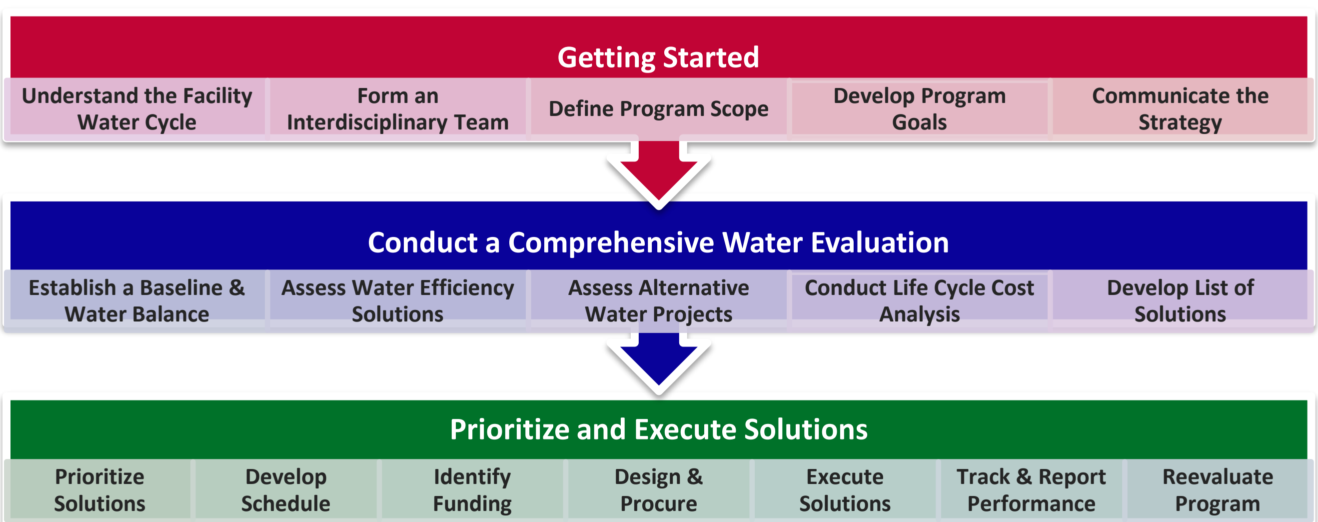


Figure 1. Comprehensive Water Management Process

2.0 Getting Started

Your water management efforts require the right team and clear direction on your goals. Hence, there a few important tasks to consider when getting started.

2.1 Understand the Facility Water Cycle

Understanding how water is used within a facility is critical for managing water within the facility. The movement of water into and throughout a facility is referred to as the "facility water cycle." Figure 2 shows an example facility water cycle.[1]

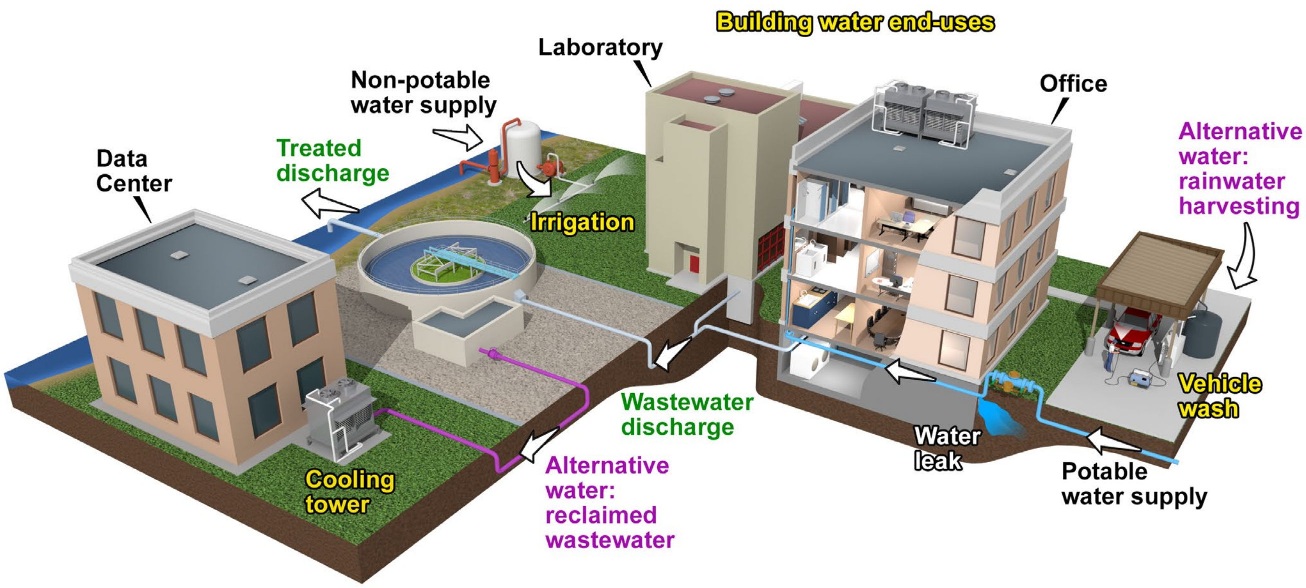


Figure 2. Example Facility Water Cycle

The facility water cycle begins with water being supplied to the facility. There are two types of water sources that can supply facilities: freshwater and alternative water. Freshwater is supplied from surface or groundwater such as reservoirs or aquifers.[2] Alternative water comes from sustainable sources and is not derived from freshwater. Figure 2 shows two types of alternative water (in purple font): harvested rainwater and reclaimed wastewater. Freshwater and alternative water can be treated to either potable or non-potable standards.

Potable water is considered water of sufficient quality for human consumption and is classified, permitted, and approved for human consumption. Typically, treatment is required to meet potable standards, which includes filtration and disinfection of the source water. Most facilities will have a potable water supply, and it is commonly supplied by a local water utility but may also be supplied on site from a local water source. Non-potable water may also be supplied to a facility. Non-potable water is considered not safe for human consumption and is not classified, permitted, or approved for human consumption. Non-potable water is used in applications such

[1] Stormwater runoff is not included in Figure 2 because the graphic focuses on the facility water use and not stormwater management.
[2] Freshwater is defined as having total dissolved solids less than 1,000 milligrams per liter.

as irrigation and cooling towers. Treatment may be required for non-potable water, depending on the intended use.

Water is distributed throughout the facility through a network of pipes and is consumed by end-uses. Water end-uses are equipment (shown in yellow font in Figure 2) that use water (e.g., plumbing fixtures, clothes washers, cooling towers, other mechanical systems such as steam boilers, irrigation, and vehicle wash). As water travels through the distribution system, it can be lost through leaks within the piping infrastructure or at the equipment level. A water leak (shown in white font in Figure 2) is the physical escape of water from the water distribution system or end-uses.

Water can also be reused by different end-uses within the system, whereby water discharged from one process can be recycled within the equipment or reused in another end-use.

An example of water reuse is the discharge from water purification systems, which can be reused within the system or used by another application, such as irrigation.

Ultimately, water is used in applications, lost through evaporation, or discharged to a wastewater treatment facility (shown in green font in Figure 2). Wastewater from some water end-uses (such as plumbing fixtures) is discharged to a wastewater treatment facility and then discharged into a body of water or reclaimed for beneficial use. This is typically done offsite by a local municipal wastewater treatment facility, but may also be done onsite.

Water cycles are facility-specific as they are influenced by the types of buildings, water end-uses within the buildings, and the local climate. Common water-intensive buildings include data centers, laboratories, hospitals, industrial facilities, and residential facilities. Considering the types of end-uses housed in a building is important. For instance, a vehicle maintenance facility may include wash bays with a water end-use that is not present in an office building. However, an office building may include a cafeteria, which may not be present in a vehicle maintenance facility.

Historically, a facility water cycle has been an open system. Water enters the system, is used by the facility, and exits the facility. However, effective water management aims to close this cycle by reusing water that would otherwise be discarded (alternative water sources).

2.2 Form an Interdisciplinary Team

A well-rounded team is crucial for success. Finding new and creative solutions often requires information that crosses disciplinary boundaries. Forming an interdisciplinary team that includes stakeholders from several groups/areas allows for the identification of solutions that might otherwise go unnoticed. This collaboration can help you reduce costs and conserve water, along with optimizing design for convenience, hygiene, and reliability. Consider including the following personnel on your team.

For more information on stakeholder involvement, go to the Getting Started section of the Directory of Resources.

- **Energy manager:** Energy managers are individuals who are responsible for managing both energy and water at their facility. Energy managers play a crucial role in the development of a comprehensive water program and will most likely lead the effort. (Per 42 U.S.C. § 8253(h)(2), agencies are required to designate an energy manager that is responsible for reducing both energy and water at each facility and ensuring that energy and water related requirements are met.)

- **Operations and maintenance (O&M) personnel**: O&M personnel are critical to sustaining a successful water program into the future. The design and placement of equipment, piping, and access points will be important to maintenance personnel in preventing, identifying, and fixing leaks. Grounds crews and custodial staff should also be consulted when developing cleaning plans. Water-saving procedures, such as sweeping sidewalks rather than using a hose, will affect the responsibilities of these teams.
- **Planning professionals**: People who are responsible for planning, such as staff involved in master planning, emergency planning, and operational planning, are important stakeholders to engage. They can help inform water management activities that impact new construction, resilience plans, and long-term O&M activities.
- **Engineers**: There are many different types of engineers that may be helpful to your team, including mechanical, civil, and environmental engineers. Engineers can provide technical expertise on water systems, water quality, and water quantity required for different applications. Engineers can also help you plan, design, and oversee the construction of structures and systems.
- **Landscape professionals**: Landscape professionals can help create a pleasing environment that also requires the least amount of water for irrigation. Their knowledge of hydrology, or how rainwater and stormwater flow on site, can be used to create solutions that not only protect the building from potential water hazards, but also use natural sources to offset water consumption. Their understanding of native or climate-adaptive plants is essential during plant selection.
- **Environmental professionals**: Environmental professionals can provide relevant information on the facility's environmental management system.
- **Contracting officer/procurement professional**: A contracting officer/procurement professional can ensure that all contracting and purchasing activities comply with federal procurement regulations and guidance.
- **Water providers**: Water consumption is regulated at the state level; hence, including your local providers can help to ensure you are compliant with local regulations. Water providers may also be aware of local incentive programs promoting water conservation strategies that could significantly reduce the project's upfront financial investment.
- **Technical experts**: Depending on the solutions to be implemented, additional specialists who bring a specific technical expertise may be helpful to your team. For instance, if you are considering replacing a single-pass cooling system, consult with a professional experienced in single-pass cooling equipment prior to finalizing the decision.
- **Occupants**: Water used by your facility occupants affects performance significantly. Occupants can advise on concerns staff may have about changes and how water consumption initiatives such as signage and reward systems would be received, and can help account for human behavior in your plans.

The size of the team, expertise required, and responsibilities of individual team members depend on the complexity of the facility and the desired solutions. Keep your water management team to a manageable size so you don't get bogged down and timely decisions can be made. Consider using a core team of five to seven people and bring in others as needed. If you don't have the right people on staff, consult outside professionals who have the required expertise. Be sure to clearly articulate the role of each member of your water management team.

2.3 Define Program Scope

After forming your team, the next step is to define the scope of the program. This entails understanding where you are coming from and where you want to go. First, identify the existing plans and strategies that have been developed or are underway that can impact your efforts. A few examples include past agency-wide water strategies, master plans, and past water evaluations. If your agency has developed a strategic plan, the plan's objectives may help you to focus your program's goals. Review any past water evaluations to determine what projects were identified and if they have been implemented. Knowing these past activities is vital for launching a new evaluation.

Knowing the past activities, develop the scope of where you want your program to head. This enables the water management team to focus efforts and resources. The scope can be defined by the following:

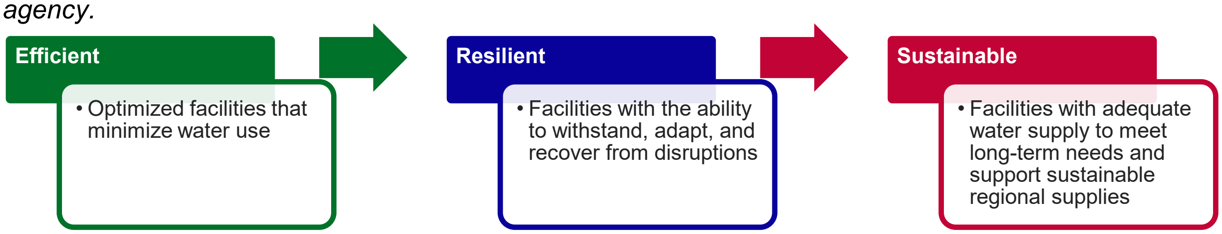
- **Site or operational boundaries**: Delineate the specific area of the facility that will be covered by the program. For example, there may be leased buildings within the campus where water is managed by another organization. If so, these leased buildings likely should be eliminated from the scope.
- **Water supply types**: Define the water sources that will be included in the evaluations. If your site has both potable water and non-potable water, consider evaluating both. If budget or staffing is constrained, consider investigating potable water first and phase in non-potable water at a later date.
- **Integration points**: Determine important requirements to include, such as resilience planning and cybersecurity.

2.4 Develop Program Goals

Along with the scope of the program, develop goals that provide overarching objectives for the water management program and a strategic plan with specific targets. To track performance over time, ensure your goals are measurable and have a specific timeline associated to them.

When developing the scope, it is useful to develop key metrics that help to track performance. Federal agencies are required to track and report annual potable water use intensity (WUI), which is measured in gallons per square foot of facility space. Potable WUI is a metric that helps to track overall performance over time and compare water use across sites. Another performance metric may be water use per person. If facility population data is available, measuring water use in gallons per person can be a useful indicator of performance over time within a facility or across similar facilities, because occupants may have a bigger impact than building size on overall water use.

Consider framing agency goals around the concepts of efficiency, resilience, and sustainability. This framework can help drive a multi-faceted program that achieves crosscutting benefits for your agency.



***Examples** of agency water management goals:*

- ***Efficiency**: Reduce potable WUI (gross square foot) by X% annually over the next Y years.*
- ***Resilience:** Improve the O&M of critical mission equipment by instituting a personnel training program.*
- ***Sustainability**: Use onsite alternative water sources to replace X% of potable water use annually over the next Y years.*

*The FEMP **Technical Resilience Navigator (TRN)** provides a systematic approach to resilience planning. Find the TRN and additional water resilience resources in the Water Resilience section of the Directory of Resources.*

2.5 Determine the Communication Strategy

Develop a communication strategy for your water management program to manage expectations, build consensus, support project timelines, and enhance coordination among all stakeholders. If your facility or agency has communication specialists, they can be very beneficial in helping your team develop a strategy that:

- Engages leadership and encourages commitment to your water management goals
- Communicates your program to internal and external stakeholders
- Reports progress toward goals
- Engages facility occupants

The importance of engaging occupants in your water management efforts cannot be overemphasized: The best technologies in the world won’t work unless people use them correctly. Any program lacks effectiveness if occupants aren’t using water-smart behaviors. Your communication strategy should include efforts to raise awareness about the importance of water-efficient behaviors, especially in restrooms, laundry facilities, kitchens, laboratories and medical facilities, and vehicle washing stations, where large amounts of water are used. Finally, share your success. Not only should you let your building occupants know how much water they are saving, you also want to share the news with your agency. Become a best practice for other facilities to follow!

3.0 Conduct a Comprehensive Water Evaluation

This section describes the steps to complete a comprehensive water evaluation that will:

- Provide a comprehensive account of the current state of water use and costs at your facility
- Establish a facility baseline from which progress and program success can be measured
- Investigate a variety of potential solutions and assess the economic viability of these options

Comprehensive water evaluations are required per EISA 2007. To fulfill the requirement, agencies are required to complete comprehensive water evaluations for 25% of their covered facilities annually. Agencies are required to implement identified LCC-effective measures within 2 years of the evaluation and are allowed to bundle individual measures together into combined projects. (per 42 U.S.C. 8253 §(f)(3))

3.1 Establish a Baseline and Water Balance

The first task in the water evaluation is to understand the facility's current water use and costs, to establish a baseline. Examining current water use and conducting a water balance analysis identifies the largest water end-uses so you can make significant progress on water management.

3.1.1 Identify All Water Sources

Make sure that all data is in the same units. Be aware that water utility billing data may be in different units: such as gallons, thousand gallons, or hundred cubic feet.

Start by identifying all water sources supplied to the facility, including freshwater sources from surface and groundwater, and alternative water, thinking back to the facility water cycle in Section 2.1. Most facilities purchase potable water from a single water utility. However, some facilities may have multiple water sources, both potable and non-potable. Collect potable and non-potable water use data from meters, water utility bills, or water treatment plant/well production data if the water is sourced onsite. This data is typically provided monthly. If possible, collect a few years of monthly data to examine water use patterns. This data is used to determine your baseline. (See Section 3.1.3, Determine Facility Water Use Baseline.)

3.1.2 Collect Facility and Utility Data

It is important to thoroughly understand your facility in order to develop a basic understanding of its water use. Collect data regarding the facility such as building types, building square footage, and occupancy and evaluate its quality for decision-making. This data may be obtained from real property data. Real property data can show the split of building types across the facility, which can help to ensure the evaluation covers a broad range of building types. Identify any intensive water-using facilities such as data centers, hospitals, industrial uses, and laboratories. Use agency benchmarking data if available to compare the water use of buildings across the facility campus. Agencies may keep records of water use by building that can be used for a benchmarking exercise. Benchmarking determines a water performance standard by which similar buildings should be measured. Buildings with higher water use than the benchmark may be good candidates for water efficiency opportunities.

It's also important to develop a thorough understanding of water costs related to potable and non-potable water uses. This information is extremely helpful for identifying and prioritizing potential efficiency improvements and their efficacy for strategic planning. For example, if wastewater rates are high, but potable water rates are low, look for efficiencies that reduce wastewater discharge.

Gather utility information for potable and non-potable water:

- Contact the water and wastewater utilities and request copies of bills for at least the last 2 years.
- Determine if current rate schedules are appropriate for a particular use or facility type to ensure the facility is getting the best rate. Verify the appropriate rate structure is applied. Utilities may charge residential customers different rates than commercial customers. Visit your utility website to check billing rates and schedules.

Common rate structures include:
- *Block rate structures:*
  - *Inclining – rates increase as water use increases.*
  - *Declining – rates decrease as water use increases.*
- *Flat rate – same cost-per unit is applied to all water use.*

- Determine the marginal per-unit cost of water and wastewater service, which is the volumetric cost.
  - Do not include flat fees such as service fees, meter fees, taxes, and late charges, which stay the same no matter the volume used.
  - With an inclining or declining block rate, use the rate charged for the highest water consumption block as the marginal rate. This is important because this rate will be applied to the initial gallons saved by water conservation and efficiency measures implemented.
- Inquire about any services the utility offers to assist with water-efficiency programs.
  - Find out if the services offer rebates related to water efficiency, and if they offer technical assistance with facility water planning and implementing water-efficiency programs.

3.1.3 Determine Facility Water Use Baseline

A water use baseline provides a reference point from which progress can be measured. Determine an annual baseline using data for a specific year or an average baseline using water use data covering several years. If your facility is supplied with both potable and non-potable water sources, develop a water use baseline for each source separately.

Analyze the data to understand current water use trends. Look for major trends such as water use increasing or decreasing over time. If major trends exist, try to determine the cause. If monthly data is available, plot monthly water use over time. Is there a seasonal pattern to water use? For example, increases in water use in the summer may be due to irrigation for water-intensive landscaping, or cooling water demand.

Example: *Figure 3 shows an example of a facility's monthly potable water supply data over a year. Notice the water use increases in the summer months.*

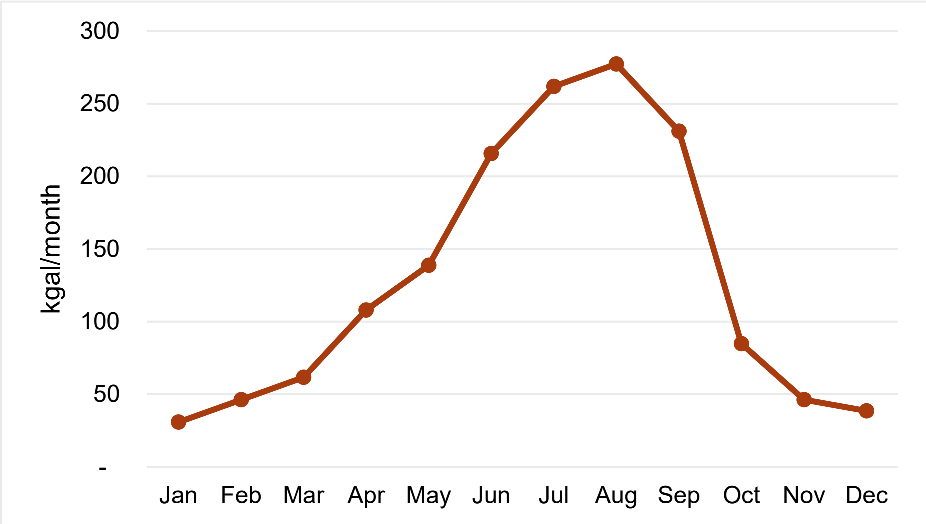


Figure 3. Example of Facility Monthly Water Use Trends

If available, collect and analyze submetered data on buildings and water end-uses (e.g., cooling tower, irrigation) within the facility. Submeters can provide powerful data to help better manage water and to help program managers better understand water use and make informed decisions. Ideally, submeters should be advanced meters that automatically record data at least hourly. High-fidelity data enables staff to quickly respond to operational issues such as leaks. If meters are standard and require manual readings, record meter readings at least monthly.

For more information, go to the Metering section of the Directory of Resources.

*42 U.S.C. 8253 §(e) requires that a*ll Federal Buildings are metered for water by October 1, 2022 and to the maximum extent practicable, are metered with advanced meters that provide data at least daily and measure data at least hourly. It also requires DOE to issue metering guidance by June of 2021, which provides guidance to agencies on meeting the metering requirements and requires agencies to submit a five-year metering plan in accordance with the DOE guidance.

Submetered data analysis improves operations and helps program managers target where to implement water-efficient measures. Submetered data can be used to improve water management through the following tasks:

- **Trend monitoring**: tracking year-to-year consumption to determine progress in meeting water targets or outcomes of water efficiency efforts
- **Process monitoring**: monitoring whether the system or process is operating efficiently and within operating parameters
- **Leak detection**: detecting sudden increases that may be attributed to distribution system and equipment leaks

- **Water use reporting**: providing the information needed to properly report all water data

3.1.4 Conduct a Walk-Through Survey

The next step in the process is to walk through buildings to collect data on each building's water end-uses. The information collected during the walk-through is used to estimate water use for each end-use and is used to develop the facility water balance. During the walk-through survey, collect the necessary information to assess both water efficiency and alternative water opportunities, this includes equipment specifications, flow rates, use patterns, and occupancy.

Before you start, be sure to:

- Make a list of the buildings that will be surveyed. Include a selection of different building types that represent the variety of water uses for the facility, making sure to include water-intensive buildings such as data centers, laboratories, hospitals, and industrial buildings.
- Create an inventory of all systems and equipment that use water in these buildings. (See below for a comprehensive list of common water-using equipment.)
  - Tap the expertise of others at the facility who have direct knowledge of water end-uses to generate a complete inventory.
- Print building floor plan(s) or as-built drawings to help locate water-using equipment.
- Make sure you have all required tools to collect the right data. Useful tools include a device to measure flow rate, tape measure, pressure gauge, and temperature gauge.

When conducting the walk-through surveys, examine the full spectrum of water-using equipment found at the facility. Water end-use categories commonly found at a facility include the following:

- **Plumbing fixtures** include toilets, urinals, faucets, and showerheads. Most federal buildings have faucets in restrooms, kitchens, and laboratories. Many federal installations have showers in barracks, family housing, recreation facilities, and locker rooms.
- **Landscape irrigation** includes turfgrass and mixed beds (variety of vegetation such as shrubs, trees and/or turfgrass) along with the associated irrigation system that applies water to these areas. Landscape irrigation can be found around buildings, golf courses, ball fields, and parks.
- **Boiler and steam systems** are commonly used in large heating systems, institutional kitchens, or facilities where large amounts of process steam are used, and are commonly found in building mechanical rooms.
- **Single-pass cooling equipment** circulates water once through a piece of equipment and is then disposed down the drain. Types of equipment that typically use single-pass cooling include medical scanners, degreasers, hydraulic equipment, condensers, air compressors, welding machines, vacuum pumps, ice machines, X-ray equipment, and air conditioners.
- **Cooling towers** dissipate heat to the ambient air from recirculating water used in cooling equipment. Cooling towers are generally in larger, multi-floor buildings and are typically located behind or on the side of the associated building or on the building's roof top.
- **Commercial kitchen equipment** includes dishwashers, steam cookers, pre-rinse spray valves, food disposals, and ice machines. Commercial kitchen equipment can be found in dining halls, hospitals, and administration buildings.

- **Laboratory and medical equipment** includes water purification systems, sterilization and disinfection systems, photographic and X-ray equipment, vacuum systems, glassware washers, and vivarium equipment. These types of equipment may be found in a variety of building types, especially laboratories and hospital/medical clinics.
- **Washing machines** include single- and multi-load machines and industrial washers such as washer extractors and tunnel washers. Laundry facilities are commonly found in barracks, hotels, medical facilities, and family housing, or can be stand-alone facilities.
- **Vehicle wash systems** include individual in-bay, conveyor-type, self-service, and large vehicle wash facilities. They may be stand-alone facilities or facilities associated with other buildings such as gas stations or vehicle maintenance facilities.

There may be other water-intensive end-uses to consider in the walk-through survey, such as line flushing, dust suppression, fire system testing, ornamental water features, and pools and spas.

Here are the important pieces of information to collect during the walk-through survey:

- Building occupancy
- Equipment flow rates
- Number of typical uses in a given timeframe (daily or weekly)
- Number of days or weeks operated annually

For more information on the walk-through survey, including detailed data collection forms, go to the Water Evaluation section of the Directory of Resources.

Use these tips when conducting walk-through surveys:

- *Collect detailed information on building occupancy during the walk-through survey that can help inform the number of equipment uses for plumbing fixtures.*
  - *Gather occupancy data during periods such as seasonal changes, weekend versus weekday, and large swings in occupancy like training sessions.*
- *Take photos of equipment nameplates to identify the equipment model number.*
- *Collect data on seasonal water uses such as evaporative cooling and irrigation.*
- *Collect data on other end-uses such as fire hydrant testing, street cleaning, main line flushing, and dust suppression.*

3.1.5 Estimate Water End-Use Consumption

After walking through the buildings, use the data collected to estimate water use for each equipment type. Most federal facilities have metered data for total water supply, but because they may have limited or no submetering data on water end-uses, water use is typically calculated using engineering estimates.

FEMP offers an online water balance software tool that calculates end-use consumption using data collected in the walk-through survey. It can be found in the Directory of Resources under Water Evaluation Tools.

The basic method to estimate water consumption is as follows:

Flow rate method:

Annual water use (gallons per year) = equipment flow rate (gallons per minute) × minutes per use × total uses per year

***Example**: Flow rate*

During the walk-through survey, the following data was collected: A kitchen faucet in a lunchroom uses 2.2 gallons of water per minute and the average person uses the faucet 2 minutes per day to fill coffee pots, wash dishes, etc. There is an average of 20 occupants in the building per weekday and the building is open 49 weeks per year.

20 people per day × 5 days per week × 49 weeks per year = 4,900 total uses per year

2.2 gallons per minute × 2 minute per person per day × 4,900 total uses per year = 12,560 gallons per year

Batch method:

Annual water use (gallons per year) = water use per batch (gallons per batch) × number of batches per year

***Example**: Batch example*

During the walk-through survey, the following data was collected: A vehicle wash system uses a pressure washer that supplies 9 gallons of water per minute. Three vehicles are washed per day for 25 minutes each. The wash system is open 5 days a week, 49 weeks per year.

3 vehicles per day × 5 days per week × 49 weeks per year = 735 vehicles washed per year

9 gallons per minute × 25 minutes per vehicle × 735 vehicles washed per year = 165,375 gallons per year

Use these tips when collecting the data to determine water use:

- *Pick a consistent timeframe for analyzing water use. Typically, water use is determined annually.*
- *Make sure your water supply data and estimated water end-uses are all in the same units (e.g., hundred cubic feet [ccf], thousand gallons [kgal]).*
- *Use the make and model number to find the equipment specification sheets online; these often include data such as flow rate.*
- *Account for any equipment that recycles a portion of the water (e.g., vehicle wash).*

3.1.6 Develop a Water Balance

Find resources in the Water Balance section of the Directory of Resources, which includes an online tool for conducting a water balance.

The next step in the water evaluation is to develop a facility water balance using the annual water supply data collected along with the water end-use consumption in the previous steps. The first step of the water balance is to simply subtract the sum of the water end-use consumption from the total supply, as shown in this formula:

Water Balance = Water Supply - $\sum$ End-Uses

If the difference between the two is a positive number, this value is called the "unknown," and it indicates system losses or inaccuracies in the water balance analysis. If the difference is negative, this represents either an overestimation of end-use consumption or an underestimation total water supply. A variety of factors may influence this value:

- Accuracy of the engineering estimates used to determine equipment water use
- Accuracy of the building-level data collected in the walk-through survey
- Accounting errors that result in inaccurate data, such as data from poorly calibrated meters
- Water leaks in the distribution system or equipment
- Size of the campus (accuracy tends to go down with a higher number of buildings because the end-use estimates require more assumptions)

If the water balance produces a negative number, revisit the total water supply data and the data used to estimate end-use consumption. Look for the data inputs that have a large influence on the water use, such as the number of occupants or number of equipment loads. Have any of these inputs been overestimated? Start with the end-uses that are the biggest consumers.

For a water balance that produces a positive "unknown" number, use this value to draw insights on the facility water use. For example, an unknown water component of less than 10% indicates fairly accurate end-use estimates with likely minimal system losses. A water balance that results in an unknown greater than 10% may indicate larger system losses or other accuracy issues such as incorrect application of the methods used to estimate water use.[1]

If issues with the water balance are identified, correct and recalculate the water balance to see if it improves. If, after checking the end-use inputs and water supply data, there is still a large unknown portion of water use, the facility might potentially have a high loss rate. Performing a leak detection survey is a recommended next step. See Section 3.2.3, Investigate Leak Detection and Repair, for more information.

Another important outcome of the water balance analysis is the identification of the highest-consuming end-uses. By knowing the end-uses that represent the largest consumption, you can prioritize water-efficiency opportunities that will likely result in large cost-effective savings.

Example: *Water utility data shows that 1,540 kgal are supplied to the facility. The facility has four water end-uses: plumbing, cooling towers, irrigation, and vehicle wash. Table 2 provides the estimated water consumption for each end-use in the example. Figure 4 shows each as a percentage of the total water supply.*

[1] These examples are based on common results of multiple water balance analyses conducted by Pacific Northwest National Laboratory.

Table 2. Example Water Balance Results

Water End-Use	Estimated Annual Water Use (kgal)
Plumbing	394
Cooling tower	151
Irrigation	615
Vehicle wash	165
Unknown	214
Total	**1,540**

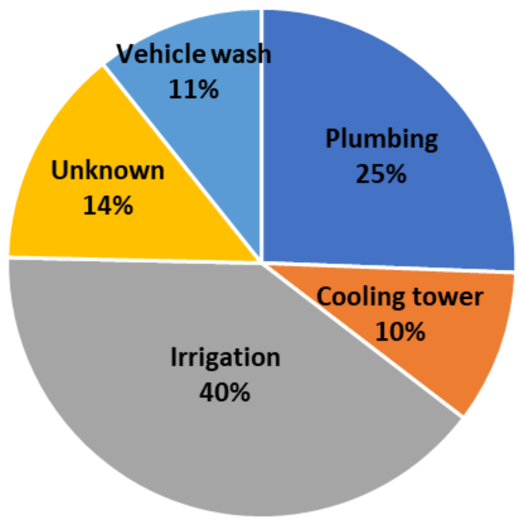


Figure 4. Example Percentage of Water Use by End-Use

In this example, irrigation is the largest water end-use at 615 kgal/yr, representing 40% of the total water supplied. Plumbing is the next largest consumer at 394 kgal/yr (25% of the total water supplied). These two end-uses are likely a good starting place for investigating efficiency measures. Fourteen percent of the facility's water use is unknown. This level of unknown signifies a fairly "balanced" water balance, but it may be a useful exercise to update the water balance annually. If the unknown water use goes up, it signals potential leaks or other losses and might warrant further investigation.

3.2 Assess Water Efficiency Solutions

After determining the water baseline and conducting a water balance analysis, the next step is to investigate ways to optimize water use and increase water efficiency to reduce water use. Begin by assessing efficient measures that target the areas you identified as larger water consumers in the facility's water balance. Using the example above, irrigation represents the largest end-use, followed by plumbing. In this case, the assessment would start by looking for ways to increase efficiency in landscape irrigation and plumbing fixtures across the facility.

Be inclusive when assessing opportunities. Don't just focus on replacing equipment; look for a set of solutions that approaches water management from different angles. For example, include ways for occupants to conserve water and evaluate O&M improvements to optimize water use.

3.2.1 Consider Water Awareness and Education

For more information, go to the Water Awareness and Education section of the Directory of Resources.

Water-efficient equipment alone will not guarantee success. Any project will lack effectiveness if building occupants are not aware of water smart behaviors. The goal of a water awareness and education program is to promote water conservation within a facility by educating, enabling, and engaging staff.

Use your water awareness and education efforts to communicate the following:

- Changes being made and why
- How behaviors help to conserve water
- How staff are helping to save water, and if possible, by how much
- Who to contact to report issues (e.g., leaks) and recommend conservation ideas

Since many water-efficiency measures produce savings only when used properly, proper operation of the equipment is important. Additional signage may help educate occupants on how to use high-efficiency toilets and urinals and automatic faucets. Bulletin boards, newsletters, and staff meetings should regularly discuss the progress of the water management program and might also attempt to change occupant water use overall.

It is also important to keep two-way lines of communication open with your occupants. The water users will typically be the first to know if equipment is not working well. Provide a mechanism for occupants to report problems such as a phone number or e-mail to help ensure that repairs can be made quickly.

In addition to regular communications, consider engaging occupants through reward and recognition programs associated with water conservation. You could hold water conservation competitions, such as giving rewards or recognition to the building with the greatest water reduction or to staff who provide water conservation ideas that are implemented.

3.2.2 Investigate Water Efficiency Options

For more information on best practices and water technologies, go to the Water Efficiency section of the Directory of Resources.

One of the most important tasks in a comprehensive water evaluation is to investigate solutions to optimize systems and increase efficiency. There are three main solutions to assess:

- **O&M changes**: improvements to how water-using equipment is operated and maintained that can help to optimize and increase the life of the equipment
- **Retrofit**: adjustments and additions to an existing fixture or equipment to increase water-use efficiency

- **Replacement**: installation of new equipment to replace the existing with high-efficiency models

Table 3 provides an overview of typical equipment and O&M, retrofit, and replacement best practices for common water end-uses.

ⓘ *When identifying O&M changes, ensure that plans to replace worn parts and adjust mechanisms meet manufacturer guidance. Also, assess the preventative maintenance schedules of equipment. Preventative maintenance helps keep equipment working and catch water waste before it impacts water use.*

Table 3. Water Efficiency Opportunities

End-Use	Typical Equipment	O&M Best Practice Recommendations	Retrofit Best Practice Recommendations	Replacement Best Practice Recommendations
Toilets	1.6 gallons per flush (gpf)	Tank: Replace the fill valve if toilet is running. Flush valve: Clean or replace worn gaskets if flush cycle is greater than 6 seconds.	Not recommended because retrofit devices can negatively affect operation.	Install WaterSense labeled tank and flush valve toilets.
Urinals	1.0 gpf	Flush valve: Clean or replace worn gaskets if flush cycle is greater than 6 seconds.	Not recommended because retrofit devices can negatively affect operation.	Install WaterSense labeled urinals.
Public-use faucets	0.5 gallons per minute (gpm)	Establish a protocol to fix leaks immediately once they are found.	Retrofit with 0.5-gpm aerators if existing has higher flow rate.	Install faucets with 0.5-gpm flow rate.
Private-use faucets	2.2 gpm	Establish a protocol to fix leaks immediately once they are found.	Retrofit with WaterSense labeled aerators.	Install WaterSense labeled faucets in major renovations and new construction.
Kitchen and laboratory faucets	2.2 gpm	Establish a protocol to fix leaks immediately once they are found.	Retrofit with 1.5-gpm aerators if existing has higher flow rate.	Install faucets with 1.5-gpm flow rate.
Showerheads	2.5 gpm	Replace and install with vandal-proof fixtures if necessary.	Retrofit with WaterSense labeled showerhead.	Install WaterSense labeled showerhead in major renovations and new construction.
Landscape	Non-native species including turfgrass	Periodically review the current landscape maintenance practices (aeration, mowing, mulching, amendments, and weeding).	NA	Install adaptive and native vegetation that is well suited for the location and requires less water.

End-Use	Typical Equipment	O&M Best Practice Recommendations	Retrofit Best Practice Recommendations	Replacement Best Practice Recommendations
Irrigation system	Standard rotor and pop-up spray heads	Periodically walk the grounds to check for standing water and leaking and broken equipment; repair as needed. Look for irrigation professionals certified by a WaterSense labeled program to assess your system for efficiency opportunities.	Retrofit existing sprinkler bodies with WaterSense labeled spray sprinkler bodies or install system-wide pressure regulator.	Replace existing irrigation system with optimized design, to include drip irrigation, WaterSense spray sprinkler bodies, and other efficient components. Consult with an irrigation professional certified by a WaterSense labeled program.
Irrigation control	Manual or clock-based controls	Regularly monitor irrigation schedule to ensure it is set for appropriate water needs of the landscape and weather conditions.	NA	Replace manual or clock-based controls with WaterSense labeled weather-based irrigation controllers. Consider installing rain sensor.
Boiler and steam systems	Manual blowdown and chemical feed systems	Implement routine inspection and maintenance of systems.	Install a condensate return system. Automate blowdown and chemical feed systems. Optimize cycles of concentration.	Reducing the size of the boiler system can reduce water requirements. Perform an energy audit to reduce heating loads and ensure that the system is sized appropriately.
Single-pass cooling	Once-through cooling systems typically found in laboratories and hospitals	Insulate piping, chillers, and/or storage tank. Keep coil loops clean and perform regular valve maintenance.	Modify system to recirculate water or add an automatic control to shut off system when not needed.	Replace with air-cooled equipment, multi-pass cooling tower, or closed loop system.
Cooling tower	Cooling towers without automated controls or filtration	Calculate, understand, and maximize cycles of concentration. Perform regular coil cleaning and maintenance.	Install a side-stream filtration system. Install a make-up water or side-stream softening system. Install automated chemical feed systems on larger systems.	Get expert advice to help determine if a cooling tower replacement is appropriate.
Commercial kitchen	Standard non-ENERGY STAR equipment	Repair or replace any broken components and repair any leaking connections. Clean coils and remove any lime scale or deposits that may have developed.	Ice machines: Eliminate single-pass cooling with a closed loop system. Disposals: Install a timer to stop the flow of water after a designated time.	Replace with ENERGY STAR labeled equipment.
Laboratory steam sterilizer	Standard equipment that does not monitor tempering water (tap water that cools discharged steam)	Repair leaks and replace worn parts. Shut off units when not in use. Run washing equipment only when full.	Install a condensate retrofit kit that eliminates the flow tempering water when not needed.	Choose systems with a higher recovery rate, designed to recirculate water or systems that do not require water.

End-Use	Typical Equipment	O&M Best Practice Recommendations	Retrofit Best Practice Recommendations	Replacement Best Practice Recommendations
Washing machines	Non-ENERGY STAR machines	Regularly check for leaks and repair broken connections and components. Run machines with only full loads.	Retrofit equipment to recycle rinse water for the next wash cycle.	Replace with ENERGY STAR machines.
Vehicle wash	Open hose	Repair or replace broken or leaking components, hoses, and system connections.	Replace open hoses with high-pressure washing system.	Install a wastewater recycling system on larger systems.

ⓘ *WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency, and is both a label for water-efficient products and a resource for helping people save water.*

3.2.3 Investigate Leak Detection and Repair

If the water balance resulted in a large portion of "unknown" water use (greater than 10% of total water supply), it is important to conduct a thorough leak detection survey and repair program.

ⓘ *A simple way to verify system losses is to monitor water use during non-working or "off" hours. For example, for a facility with little water-using activity during nighttime hours, read the main facility water meter at the end of the workday and then again at the start of the next workday. If there is significant recorded use during this time, it can likely be attributed to leaks in the distribution system or losses at the equipment level.*

Identifying and locating distribution system leaks can be difficult. However, targeting problem areas for repair or replacement is critical for effective management. If significant leaks are suspected, it may be best to obtain the services of a leak detection specialist to determine the sources of the leaks and the best correction options.

For more information, go to the Leak Detection and Repair section of the Directory of Resources.

3.3 Assess Alternative Water Projects

After lowering water demand and reducing overall water use through efficiency measures and reducing system losses, the next step is to evaluate potential alternative water sources. Alternative water sources are from sustainable supplies that offset the demand for freshwater.

FEMP provides a series of maps to help identify locations across the U.S. that are good candidates for specific alternative water sources. Find this resource in the Alternative Water section of the Directory of Resources.

Examples of alternative water sources include:

- **Harvested rainwater**: the collection of rainwater from rooftops/other covered surfaces to divert and store for later use

- **Harvested stormwater**: precipitation runoff over ground-level surfaces that has not infiltrated into the ground and has not entered a waterway such as stream or lake and is stored for later use
- **Reclaimed wastewater**: water discharged from a building or processes, treated, and then reused in end-uses
- **Graywater**: lightly contaminated water that is generated by bathroom sinks, showers, and clothes washing machines and reused in other end-uses; graywater does not include wastewater from toilets, urinals, or kitchens
- **Captured condensate**: water that condenses on the cooling coils of mechanical equipment, such as packaged or rooftop units, dedicated outdoor air units, and air handling units (when humid air contacts these cool surfaces), is captured, and is stored for later use
- **Atmospheric water generation**: water vapor extracted directly from the air, in the form of humidity, via condensation or pressurization, which is captured and stored for later use [1]
- **Water purification concentrate**: water rejected from water purification processes that contains the filtered impurities, which can be captured, treated if necessary, and reused
- **Foundation water**: water that collects around the foundation and basement/crawl spaces from groundwater or drainage from stormwater runoff, which can be stored for later use

Blowdown water: water that is drained from cooling towers and boilers to remove mineral buildup that develops during water evaporation cooling or steam production, which can be stored for later use

At the agency level, alternative water is an important component of any overarching water management program. Prioritize locations with high potential for the alternative supply (e.g., adequate rainfall for harvesting rainwater/stormwater) and high water demand for the applications that can use the alternative source (e.g., landscape irrigation).

Implementing alternative water projects requires careful planning to ensure that the right water sources are collected for the most appropriate uses.

There are several criteria to consider when making these selections:

- **Use alternative water in multiple applications**: Alternative water systems are most effective if they supply multiple end-uses, such as cooling tower make-up water, vehicle wash, landscape irrigation, and dust suppression.
- **Size the system based on water demand**: When sizing a system, it is important to accurately estimate the water demand by the application type and to size the storage requirements based on the amount of water needed for that application.
- **Evaluate needed water treatment for the application**: Carefully consider the water quality required for the application types when determining the treatment requirements.
- **Consider water resilience as a main driver**: Select sites with high water risk and critical functions so that alternative water systems can help to reduce water risk and provide a

[1] As air passes over cooled coils or the pressure is increased, the moisture content changes from vapor to liquid, condensing it.

redundant water supply to applications that are necessary to minimize interruption of the facility function.

- **Plan early for required permitting**: Alternative water systems may require local or state permits. Work closely with the local permitting office early to give ample time to complete this process.
- **Integrate an O&M program into the project**: Having trained, onsite personnel or a maintenance contract in place to perform ongoing O&M is critical.

For more information on important considerations for investigating alternative water projects, go to the Alternative Water section of the Directory of Resources.

For each alternative water project identified, determine the cost of the project and the amount of alternative water that will offset the freshwater source.

3.4 Conduct Life Cycle Cost Analysis

After assessing water efficiency and alternative water opportunities, perform a life cycle cost analysis (LCCA) to determine the LCC effectiveness. LCCA helps decision makers prioritize the options that are most appropriate and cost-effective for the facility. An LCCA determines the cost effectiveness of a solution by comparing the total cost of operating and repairing the total initial replacement cost and long-term costs associated with operating the replacement components over the life of the system. This provides a means to objectively compare options based on the cost over the life of the project, rather than just on the initial upfront costs.

For more information, go to the Life Cycle Cost Analysis section of the Directory of Resources, which an LCCA tool and information on price escalation.

The essential components of LCCA include:

- **Initial capital cost:** cost associated with design, engineering, purchase, and installation to replace or retrofit the system components; if a rebate is available to offset money spent from the facility's budget, subtract it from the initial cost, as it will make the project more cost-effective.
- **Water costs**: cost associated with the existing equipment and replacement equipment over the life of the equipment.
- **Other related costs:** O&M costs (e.g., chemicals, filters, or other components) and energy costs associated with existing equipment and replacement option over the life of the equipment. For example, faucet and showerhead retrofits lower energy costs by reducing hot water use.
- **Marginal rates:** volumetric cost of water and wastewater, typically in dollars per thousand gallons. Marginal water and wastewater rates are identified in Section 3.1.3.
- **Equipment life:** the expected number of years that the replacement equipment will be operational.
- **Water and wastewater rate escalation:** future price escalation projected for water and wastewater. This allows you to properly project future cost increases.

- **Replacement costs**: costs to replace system components during the life cycle of the equipment. For instance, a valve may need to be replaced every 5 years.
- **Residual value**: estimated equipment value if the equipment is sold as salvage at the end of the life.

3.4.1 Determine Costs and Savings

For each water efficiency and alternative water solution identified, determine the cost of the measure, water savings, and other associated savings such as energy and total cost savings. Use the same method described in Section 3.1.5 to calculate the water use of the O&M, retrofit, and replacement options. Multiply the water savings by the marginal cost of water identified in Section 3.1.2 to determine the cost savings.

Remember to include other savings streams.

- *Include wastewater savings if the amount of water discharged to the system is reduced.*
- *Determine energy savings when installing high-efficiency equipment that reduces the use of hot water, such as faucets and showerheads.*
- *Include any labor savings that may occur in terms of reduced maintenance (e.g., installing automated controls).*
- *Conversely, also consider any additional labor costs that might be incurred (e.g., O&M requirements for a rainwater harvesting system).*

With this information, compute the LCC for each option that was determined in the water efficiency opportunity and alternative water project assessments. Then compare the overall costs to determine which has the lowest LCC and is therefore more economical in the long run.

The Life Cycle Cost Analysis section of the Directory of Resources provides a tool that can be used to perform an LCCA.

Common outputs of LCCA include:

- **Savings to investment ratio (SIR)**: SIR is the ratio of the total project savings to the total costs of the measure over the life of the project (in present day value); an SIR of 1 indicates a breakeven point, revealing that the project's lifetime savings is equal to the costs.
- **Net present value (NPV):** NPV is the difference between the total value of the savings and the total costs over the lifetime of the project (in present day value); a negative NPV indicates the present value of the costs exceeds the savings.

42 U.S.C. § 8253(f)(3) requires that agencies implement any water-saving measure that was identified as life cycle cost (LCC)-effective and bundle individual measures of varying paybacks together into combined projects.

3.5 Develop a List of Solutions

Finally, document the results of the water evaluation, detailing the results of the assessments and LCCA. Compile a list of all of the solutions that were identified, including the water efficiency solutions (O&M measures, retrofit, and replacement projects) and alternative water projects.

Ⓐ *Federal agencies are required to report data on water measures as part of the EISA requirement for comprehensive water evaluations.*

Consider bundling solutions that are not LCC effective with solutions that are. Table 4 shows that all solutions are LCC effective (SIR > 1.0) on their own except for the rainwater harvesting system, which has an SIR of 0.3. Bundling all the solutions together now makes the overall project LCC effective with an SIR of 1.3.

Example: *Continuing with the facility examples previously described, Table 4 provides a list of example solutions with the key results from the evaluation and LCCA. This data is necessary to prioritize solutions for implementation.*

Table 4. Example Water Summary of Solutions

Solution Description	Water Savings (gal/yr)	Energy Savings (kWh/yr)	Capital Cost	Water Cost Savings ($/yr)	Energy Cost Savings ($/yr)	Simple Payback (yr)	SIR
Plumbing fixture retrofit – high-efficiency fixtures	228,000	3,370	$17,833	$2,657	$479	5.7	2.6
Cooling tower – conductivity controller	52,800	0	$1,849	$615	$0	3.0	5.0
Irrigation – weather-based controller	233,800	0	$498	$2,725	$0	0.2	81.4
Distribution system – leak detection and repair	170,000	0	$3,480	$1,981	$0	1.8	8.5
Alternative water – rainwater harvesting	161,800	0	$95,700	$1,886	$0	50.7	0.3
Total	**846,400**	**3,370**	**$119,360**	**$9,865**	**$479**	**11.5**	**1.3**

4.0 Prioritize and Execute Solutions

After completing a comprehensive water evaluation, the next step is to develop a prioritized list of the identified solutions. This list will reveal the solutions that will have significant impact on meeting overall strategic goals and targets. After that, it is time to take the projects into the execution phase, procuring the best technologies and executing the projects.

4.1 Prioritize Solutions

Agencies can set priorities that provide facilities with guidelines for selecting solutions-based criteria important to the agency.

Prioritizing identified water solutions allows you to assess the potential benefits and costs, and to rank them in order of priority to obtain the biggest impact to your facility. Consider key criteria (see bulleted list below) to rank them. Tie criteria to the goals established early in the process or in strategic plans for the facility (see Section 2.4). The high-priority projects should be those that will best meet your strategic objectives, goals, water management targets. During this process, be sure to engage with your team of stakeholders to prioritize solutions (see Section 2.1). Include staff from operations, grounds, engineering, and master planning, for example. A broad team provides perspectives on the solutions that might otherwise be missed. Keep in mind that projects can be re-prioritized as related factors change.

Consider the following ranking criteria to prioritize solutions:

- **LCCA results**: Projects with a high SIR could be given high priority for implementation because they have a good potential for cost reduction. Per 42 U.S.C. § 8253(f)(4), LCC-effective measures may be implemented no later than 2 years after the completion of the water evaluation.
- **Sustainability**: Solutions with large potential water savings can help meet water reduction goals and secure water supply for the long term.
- **Resilience**: Solutions that help to increase a site's resilience may be given higher priority. For example, an alternative water source may provide a backup supply for a critical function at the facility, which in turns helps the site adapt and recover more quickly from an outage.
- **Level of effort**: Solutions that require less effort to implement could be ranked higher in priority, resulting in a "quick win," which can help get buy-in from stakeholders and momentum rolling for the program.

4.2 Develop a Schedule

After choosing the solutions to pursue, develop a schedule. While some measures may be implemented in a few hours or days, others may require several months or longer depending on the scope of the solution. Examine the scope carefully to determine the time necessary to complete each measure. If additional funding is required, you will need to consider when the funding will be available. (See Section 4.3 for information on identifying funding.)

Your schedule should provide a clear plan of action and tasks to accomplish. Use the prioritization developed to inform the schedule. Options include starting with easier and lower-cost items or perhaps starting with the most cost-effective solutions. It is often useful to assign team members to be accountable for different aspects of the schedule. Your schedule should include regular progress checks with the stakeholders.

Schedule tasks logically. For example, replace the toilets that get the most use before replacing less frequently used toilets. It would also be logical to postpone retrofitting plumbing fixtures if the facility is planned for remodeling or demolition in the near future.

Do not plan projects so closely together that a delay in implementing one project throws the entire schedule off. You may want to quantify the cost of a delay if the schedule is not met so that stakeholders understand the importance of the schedule. If implementing all your projects will take several years, it may be useful to plan the first year in detail, and then monitor your progress and savings. As you develop a sense of the progress, you will be better able to plan future years with adequate detail. This will help ensure that subsequent years reflect the realities of actual progress.

4.3 Identify Financing Sources

Identifying funding for projects is often a major hurdle in the planning process. For smaller projects, determine if the project can be funded through the facility's operating budget. Also, look to leverage funding from other facility projects with similar plans or goals, such as the energy management program.

Larger projects will often require capital funding. There are two major ways to secure funding for major federal projects: direct congressional appropriations and performance contracts. Most agencies provide direct appropriations for funding water projects and related solutions. Funding sources may include O&M, environmental programs, or emergency preparedness. Each agency will have its own processes to follow.

For more information on ESPCs and UESCs, go to the Project Financing section of the Directory of Resources.

You may be able to finance water projects with little or no upfront capital costs or special appropriations through energy savings performance contracts (ESPCs) and utility energy service contracts (UESCs). ESPCs are a partnership between a federal agency and an energy service company (ESCO), while UESCs are a partnership between a federal agency and an energy utility. Both provide a means to pay for water-related upgrades without diverting funds from the capital budget or other programs. ESPCs and UESCs typically evaluate both energy and water measures, and these measures can be bundled together to form a large, comprehensive project for the facility.

After being selected for a potential award, the ESCO or utility conducts a comprehensive energy and water audit and investigates both energy and water improvements. In consultation with the agency, the ESCO or utility designs and constructs a project that meets the agency's needs and arranges financing for the project. After the contract ends, all cost savings accrue to the agency.

Tips to ensure ESPCs and UESCs evaluate water comprehensively:

- *Early in the contracting process, request that specific water end-uses be covered in the assessment. Be specific! List the water technologies you want to be evaluated.*
- *Require comprehensive water surveys in the investment grade audit performed by the contractor.*
- *Require a water balance analysis be performed as part of the evaluation.*
- *Require specific water efficiency expertise by the contractor, including certifications and years of experience.*

It is unlikely that direct appropriations, ESPCs, and UESCs will pay for all of your water management projects. Also look for additional funding opportunities:

- Consider leasing larger, more expensive equipment from a technology vendor. ENERGY STAR provides information on a variety of lease types for energy-using equipment, many of which might apply to water-using equipment, such as commercial laundry systems or water purification systems.
- Look for rebates and incentive programs offered by the local water or energy utility. Utilities also have rebates and incentives available to support projects that provide associated savings (e.g., laundry replacements). Rebate and incentive programs include free product distribution, partial rebates on purchases of water- and energy-efficient products, financial incentives based on total gallons of water saved from implementing large-scale projects, and billing offsets based on submetered water use that can account for water that is not being sent to the sewer (e.g., water reused for irrigation or water evaporated from a cooling tower).

4.4 Design Solutions and Procure Equipment

An important part of executing solutions is developing proper designs and procuring the best equipment to ensure the solutions meet the intended outcomes. Professional engineers and contractors are recommended to design and implement the solutions identified in the comprehensive evaluation. If you are executing solutions through an ESPC or UESC, the ESCO or utility performs the design work. Make sure to require expertise from the contractor for the specific water solutions. For example, if a rainwater harvesting system is an identified solution, contract with a company that has experience and proven results in designing these systems.

For more information, go to the Project Design section of the Directory of Resources.

Sustainable design principles are to be applied to the design of new construction and modernization projects per 42 U.S.C. § 6834(a). The Guiding Principles for Sustainable Federal Buildings include water-related sustainable design in the “Protect and Conserve Water” principle.

Along with design, carefully specify equipment requirements. Procurement methods depend on the needs and complexity of each project. Many agencies have developed policies and procedures for procuring equipment. Work closely with your agency’s contracting officers and procurement professionals to ensure project expectations are met. Consider developing standard boilerplate equipment specifications that target water-efficient products, so they are automatically purchased for retrofits, renovations, and new construction.

For information on FEMP acquisition guidance, go to the Equipment Procurement section of the Directory of Resources.

FEMP maintains acquisition guidance for Federal agencies on a variety of product types including water efficient products, including plumbing fixtures, irrigation technology, commercial kitchen equipment, and clothes washers.

4.5 Execute Solutions

Now it is time to put all of this information together and execute the solutions. It is helpful to have an implementation plan that compiles the pertinent information on the prioritized solutions.

Example*: Continuing with the previous example, Table 5 provides an example implementation plan that shows the solution cost, funding source, and how the solutions will be phased in over 4 years.*

Table 5. Example Four-Year Implementation Plan

Solution Description	Capital Cost	Funding Source	Years of Implementation			
			Year 1	Year 2	Year 3	Year 4
Water awareness and education campaign	$5,000	Facility operations	✓	✓	✓	✓
O&M improvements	NA	NA	✓	✓	✓	✓
Distribution system – leak detection and repair	$3,480	Facility operations		✓		✓
Bundled water efficiency measures – irrigation, plumbing, and cooling tower measures	$20,180	ESPC *(Note: ESPC water measures are typically a part of a larger project that includes energy measures)*		✓	✓	
Rainwater harvesting system	$95,700	Emergency preparedness			✓	✓

4.6 Track and Report Performance

A key element of a good water management program is tracking performance. All water equipment and system performance must be measured throughout its life to ensure proper operations, maintenance, and repair. In addition, water savings must be measured and verified. Use the same methods for determining the water baseline discussed in Section 3.1. This includes reviewing water bills and meter and submeter readings to verify that the expected water savings are achieved. Compare each year's water use to the baseline established, evaluate trends, and investigate unexpected deviations in water use. Determining if the expected savings are achieved is an important exercise to ensure that projects are operating as expected.

For more information, go to the Performance Tracking section of the Directory of Resources.

When reviewing performance data, remember that at the same time your water consumption is changing, other things may be changing, such as the weather and facility attributes. If factors such as number of occupants, equipment, or operating hours have changed, account for this in your evaluation. If consumption is increasing with no known factor to influence the uptick, look for waste, adherence to maintenance schedules, and leaks.

A useful technique for tracking performance is benchmarking. Compare water performance between similar buildings at your facility or to other like facilities. When benchmarking, make sure you are comparing your facility to a facility with similar characteristics, such as facility type, building size, and operating hours.

Establish a regular review cycle of your water management program. This review allows you to evaluate progress, set new goals, and continually improve. Specific areas to focus on include ensuring your strategic goals, objectives, and targets are still realistic; measures are implemented and are still appropriate; and no new costs or technologies exist.

To maximize the opportunity for success, consider performing the following throughout the life of the project:

- Review progress toward goals quarterly against strategic plan.
- Ensure that the necessary resources (i.e., time, money, personnel) are available to complete the solutions.
- Complete identified solutions in order of priority or adjust the priorities if factors influencing the priorities change.
- Promote key components of the implementation plan to senior leadership, staff, and other relevant stakeholders to gain support.
- Closely monitor your projects to ensure they run smoothly and are progressing as expected.
- Follow up regularly with O&M personnel. Ensure that equipment is regularly checked and serviced.
- Create incentives to encourage staff or those responsible for specific projects and practices to do their part to help achieve water management goals.
- Be creative and consider other resources that may be available to assist in implementation, such as other employees, utility and government programs, interns, or engineering students.
- In the event of a drought or other water emergency, implement measures as specified in the emergency contingency section of the plan.

4.7 Reevaluate the Program

A sound water management program is not a “one and done” activity. It is important to continually examine ways to improve the program. Reevaluate key items that may influence the direction of the program, such as:

- Changes in federal water requirements
- New agency goals and objectives
- Emerging water technologies
- Changes in water risk and availability

There are plenty of ways to learn more about water management! Find training resources in the Water Management Training section of the Directory of Resources.

Use the process outlined in this manual approximately every 4 years, concurrent with the required water evaluation cycle per EISA 2007, to ensure that you are continually progressing toward the program goals. Thoroughly document the program improvements that can be used to inform leadership for continued success.

Ⓐ *Agencies are required to conduct comprehensive water evaluations of their facilities every 4 years per EISA 2007 and the Energy Act 2020. To fulfil the requirement, agencies are required to complete comprehensive water evaluations for approximately 25% of their covered facilities annually.*

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