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Water Balance Tool Help

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FEMP Federal Energy Management Program

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Nomenclature or List of Acronyms

BMP	Best Practice Management
CCF	hundred cubic feet
FEMP	Federal Energy Management Program
gpv	gallons per vehicle
kgal	thousand gallons
O&M	operation and management
TDS	total dissolved solids

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1 Introduction

The Federal Energy Management Program (FEMP) developed this Water Balance Tool to provide an automated method for federal agencies to determine potable water consumption, by end-use, of their campuses. A water balance compares the total water supply to the volume of water consumed by water-using equipment and applications; identifies the highest consuming end-uses, which helps to prioritize water-savings opportunities and may identify operation and maintenance issues that need to be addressed; and is an important element in a comprehensive water evaluation, which is required by federal agencies per the Energy Independence and Security Act (EISA) of 2007, Section 432.[1]

This tool focuses on potable water consumption for major water consuming equipment at the campus level. Listed below are the end-uses that are covered in the tool:

- Plumbing
- Commercial kitchen
- Cooling towers
- Steam boilers
- Laundry (washing machines)
- Vehicle wash
- Landscape irrigation
- Other processes.

The output of the tool provides the estimated potable water consumption by each of these end-uses and compares the sum to the total potable water supplied to the campus. See the Water Balance Results section for more information on the tool's outputs.

2 Getting Started

The first step in developing a water balance is to collect information on the major water consuming equipment across the campus, called a walk-through survey. FEMP developed the Water Evaluation Data Tool to provide a method and general instructions for collecting comprehensive water data during a walk-through survey. The Handbook: Performing a Comprehensive Walk-through Water Survey provides descriptions of data that need to be collected and photos of typical fixtures/data collection methods. Use the Water Evaluation Data Tool to organize this important information to feed into the Water Balance Tool.

3 Water Balance Tool Modules

The tool is organized in distinct modules, listed on the top banner of the tool. The following section gives an overview of these modules, additional useful information, and tips on the tool inputs.

[1] EISA 2007 directs agencies to conduct comprehensive energy *and water* evaluations (CEWEs) annually for 25% of the agency's covered facilities, with the goal of having all covered square footage evaluated over a four-year period.

3.1 General Tool Tips

The following provides general tips on how to use the Water Balance Tool:

- Make sure to enter the water supply and water end-uses over the same time frame.
- Carefully enter each data input in the correct units; units are noted in the far right-hand side of the screen of the tool. All water related units are either gallons or thousand gallons (kgal) that produces the total water end-use estimate in kgal per year(kgal]/yr.).
- The tool does not automatically calculate water use so be sure to click “Calculate Water Use” after data has been entered or changed.
- Save your information often! At the bottom of each screen, click the save button to store the data you’ve entered. The tool does not automatically save data so be sure to save data before moving to a new module.

3.2 General Campus Information

This module collects the general campus information, which includes the campus name and the year of the water supply data. This information is required to be entered first before any other inputs may be completed. (Note: All the other inputs may be entered in any order.)

3.3 Water Supply

This module collects the total water supply data for the campus, which establishes a baseline water use and is used to compare to sum of the water end-uses in the water balance results. Collect this data from utility bills or water treatment plant/well production data if water is supplied on the campus.

Annual potable water supply data for a calendar year is entered into the tool. Monthly potable water use for the same time period may be entered as well, if available. This monthly data is plotted to identify any seasonal patterns to water use such as irrigation water or cooling water demands during summer.

The units used in the tool for annual water supply data are kgal. Be aware that water utility bill data may be in other units such as gallons, million gallons, and hundred cubic feet (CCF). Please make sure to convert to kgal (see Table 1).

Table 1. Kgal Conversions

Unit	kgal
1 CCF =	0.748
1 gallon =	0.001
1 million gallons =	1,000

If wastewater is metered and monthly data is available, enter the monthly wastewater discharge for the same time period as the water supply into the tool. This input is not required to develop the water balance. If there is not a meter on the wastewater discharge, the campus may be charged for the same amount of wastewater discharge as potable water use. Monthly wastewater discharge provides useful insight, because a campus could be overcharged for wastewater if some potable water is not being discharged into the wastewater system, such as irrigation or cooling tower uses. In the case where monthly potable water supplied to a site is greater than the wastewater discharge during that same month, which cannot be accounted for in irrigation or cooling tower uses, may indicate a leak in the distribution system or other system losses. A meter on this system may help reduce wastewater charges. Also, if there is a wastewater meter, and there is more water exiting the system, it could indicate that a campus is being charged for stormwater entering the system. Stormwater management may help reduce these charges.

3.4 Plumbing

This module of the tool collects data on plumbing fixtures such as faucets, showerheads, toilets, and urinals. These fixtures are found in nearly every building on a campus. Water used by plumbing fixtures is estimated based on occupancy patterns and the water use characteristics of typically installed fixtures.

3.4.1 Occupancy Information

Enter the following information in the tool on the applicable occupancy groups that reside at the campus:

- On-site lodging – This occupancy group accounts for individuals who live on the campus in either temporary or permanent lodging, including barracks, dormitories, hotels, and family housing. Information on total occupancy availability and percent occupied can be obtained from campus housing offices and/or hotels.

- Hospital or Clinic Staff – This occupancy group accounts for on-site staff members who work in a medical facility, including hospitals and medical or dental clinics. Information on staff counts and length of shifts can be obtained from the hospital/clinic administrative offices.

- Hospital or Clinic Outpatients – This occupancy group accounts for individuals who visit a hospital or clinic that do not require an overnight stay. Information on average number of daily clinic visits can be obtained from the clinic administrative offices.

- Hospital Inpatients – This occupancy group accounts for individuals who require an overnight stay in the hospital. Information on the total number of available hospital beds and average percent occupied can be obtained from the hospital administrative offices.

- Overall Campus Population – This occupancy group accounts for the entire population of the campus. This number should not include hospital or clinic occupancies. On-site lodging occupants are not excluded from this population, since most occupants are assumed to be away from the lodging during the day.

3.4.2 Fixture Information

For each occupancy category, enter the estimated typical flow or flush rate for each fixture that was collected during the walk-through survey. See FEMP's Handbook: Performing a Comprehensive Walk-Through Water Survey (Section: Plumbing Fixtures) for information on where to find or how to determine plumbing fixtures flush and flow rates. If there is more than one typical flow or flush rate for a particular fixture type, choose the rate that represents the majority of the fixtures installed for that occupancy category. Also, enter the estimated percentage of occupants that shower daily for the hospital/clinic staff, hospital inpatients, and general campus occupancy groups. Interview facility staff members and occupants during the walk-through survey to understand the general showering patterns of occupants.

3.5 Commercial Kitchen

This module collects data on commercial kitchens, either as a stand-alone facility or integrated into a larger building such as a cafeteria. If the campus has a stand-alone commercial kitchen that is metered, enter the recorded annual water use. (Note: Enter the same year as the water supply data.)

For stand-alone facilities that are not metered and commercial kitchens that are housed in other buildings, enter the number of meals served per year, which can be collected from purchase records or by interviewing the kitchen manager and/or staff. Also enter information on the equipment present in the commercial kitchen and its relative efficiency. The number of meals served combined with the equipment information is then used to estimate water use based the volume of water used per meal served. See [FEMP's Handbook: Performing a Comprehensive Walk-Through Water Survey]() (Section: Commercial Kitchen) for information on water using kitchen equipment.

3.6 Cooling Towers

This module provides inputs for cooling towers, which are commonly found either in central plants or large buildings/building complexes (typically located on the building's roof or near the rear of the building). Cooling towers dissipate heat from recirculating water used to cool chillers, air conditioners, or other process equipment to the ambient air. Cooling towers reject heat to the environment through the process of evaporation. By design, cooling towers use significant amounts of water.

If the campus has cooling towers that are metered, enter the recorded annual water use. (Note: Enter the same year as the water supply data.) For cooling towers that are not metered, the tool estimates water use using the chiller nameplate tonnage, the cooling tower cycles of concentration, and the number of days the cooling tower is operated annually, which are entered into the tool. The following provides information on each of these inputs:

- *Cooling tower Tonnage*: This information is available in manufacturer's literature or on the cooling tower nameplate. Using the drop-down menu, select the tonnage value that is closest to the published rating of the cooling tower. (If the campus has smaller evaporative systems such as swamp coolers, see Section 3.11 "Other Processes".)

- *Cycles of Concentration*: Cycles of concentration refers to the ratio of total dissolved solids (TDS) of the discharge water being purged from the cooling tower to the fresh supply water feeding the system[2]. This value is an indication of how many times the cooling tower is cycling water through the system. Higher cycles of concentration require less water for replacement. This user input is intended to indicate the allowable level of TDS in the system. Typically, maintenance will set a certain level of cycles of concentration to control the water used by the cooling tower. Using the drop-down menu, select the cycle of concentration that is closest to what is used at your site. For more information on this value, go to the FEMP Cooling Tower Best Management Practice web-page: https://www.energy.gov/eere/femp/best-management-practice-10-cooling-tower-management

- *Number of days per year the system is operating*: It is important to collect information on days of operation to help estimate cooling tower water consumption. The facility manager, operating logs, or connected controls systems can provide information to determine the number of annual operating days.

3.7 Steam Boilers

This module provides inputs for steam boilers. Steam boilers are commonly used in large heating systems, institutional kitchens, or in facilities where large amounts of process steam are used and are commonly found in building mechanical rooms. This equipment consumes varying amounts of water depending on system size and the amount of condensate returned.

If the campus has steam boilers that are metered, enter the recorded annual water use. (Note: Enter the same year as the water supply data.) For steam boilers that are not metered, the tool allows water use to be estimated in two ways: 1) using the performance of a softener system, if included as part of the steam boiler, or 2) using the steam generation rate. Information is provided below to clarify the inputs for these two methods. For both

[2] A single cycle of concentration refers to the TDS of water in a system (assuming the water is fresh supply water). As water evaporates from a cooling tower, it leaves any dissolved solids behind. If the system water is completely evaporated and replaced with new fresh supply water, the new fresh water will bring its own "cycle of concentration" of TDS and accumulate the residual TDS from the evaporated water, thus reaching two cycles of concentration.

methods, operational parameters, such as operating hours per week and number of weeks in operation, can be typically obtained from the facility manager.

Inputs for Steam Boilers Using the Softener Method:

- *Amount of water used between regenerations*: Steam boiler systems often include a softener system, placed upstream of the boiler. The purpose of the softener is to remove hardness from the boiler feedwater, generally via ion exchange utilizing resin beads. The softener system is preprogrammed to regenerate after providing a specific volume of water. Regeneration is a process that cleans the resin beads by flushing out collected solids and drawing in fresh brine (saturated saltwater) to recharge the resin beads. Information on how regenerations are programmed can be found in manufacturer's literature, by contacting the manufacturer directly, or by asking the facility manager.

- *Number of times the system regenerates weekly*: This information may be available from maintenance logs, other recorded information, or from the facility manager.

Inputs for Steam Boilers Using the Steam Generation Rate Method:

- *Steam generation rate*: Amount of steam generated by the system, measured in pounds per hour (also monitored as the "flow rate"). Typically, this value is logged and tracked to verify the system is supplying the necessary amount of steam and can typically obtained from maintenance logs or the facility manager.

- *Percent of condensate returned*: This is the percentage of the overall steam generation rate, which is likely tracked either by facility staff or as part of a building control system. For institutional facilities, a typical condensate return rate is 80%. If there is a condensate return system in place, but you do not know the return rate, use this default of value of 80%.

- *Cycles of concentration*: Cycles of concentration refers to the ratio of total dissolved solids (TDS) of the discharge water being purged from the cooling tower to the fresh supply water feeding the system.[3] This user input is intended to indicate the allowable level of TDS in the system. The cycles of concentration are generally set as part of the system maintenance and can be supplied by the facility manager.

3.8 Laundry (Washing Machines)

This module of the tool collects data on laundry facilities that are commonly found in barracks, hotels, medical facilities, and residential buildings, or can be stand-alone facilities. Data can be obtained during a visual inspection of the equipment during the walk-through survey and gathered from the building occupants, laundry operators, or staff members that manage the buildings. The following types of washing machines are covered in the tool:

- Single/Multi-load Machines:
    - Single-load machines: residential-style washing machines that wash approximately 12 to 20 pounds of laundry per load.
    - Multi-load washers: larger capacity than single-load machines that wash up to 80 pounds of laundry per load. Although multi-load washers are considered industrial, because they are rated based on tub capacity and water factor, inputs are included with single-load machines.

[3] A single cycle of concentration refers to the TDS of water in a system (assuming the water is fresh supply water). As steam evaporates from a steam system, it leaves any dissolved solids behind. If the system water is completely evaporated and replaced with new fresh water, the supply water will bring its own "cycle of concentration" of TDS and accumulate the residual TDS from the evaporated water, thus reaching two cycles of concentration.

- Industrial Washers:
  - Washer extractors: machines that use centrifugal force to remove water and detergent from the clothes. These washers can have capacities ranging from 30 to 800 pounds of laundry per load.
  - Tunnel washers: continuous-batch washers where the laundry moves through a series of compartments. These type of washers are used in very large, institutional operations (e.g., hospitals, prisons). Tunnel washer capacities are around 2,000 pounds of laundry per hour.

3.8.1 Single-load and Multi-load Washer

For single-load machines, there are two types designated in the tool: ENERGY STAR and non-ENERGY STAR washing machines. ENERGY STAR machines are identified with a label on the machine. For these types of machines, enter the following inputs into the tool:

- Typical capacity: The *capacity of single-load and/or multi-load machines is the volume of the machine, measured in cubic feet, which* is typically noted on the name plate or available on the manufacturer's website using the model number.

- Typical water factor: A water factor is the gallons per cycle, per volumetric capacity of the machine, measured in gallons/cycle/cubic foot. Front- and top-loading machines with capacities greater than 1.6 cubic feet and less than 8.0 cubic feet are eligible to earn ENERGY STAR certification. The maximum federal standard water factor for front-loading machines is 5.5 gallons/cycle/cubic feet and 8.5 gallons/cycle/cubic feet for top-loading machines. ENERGY STAR washing machines are required to have a lower water factor to be eligible for the ENERGY STAR label, as shown in Table 2. The w*ater factor of single-load and/or multi-load machines (gal/cycle/cubic foot)* may be found by looking up the model number online on the manufacturer's website.

The make and model number of machines can be found on a sticker that is located either at the top edge on the back of the washer, inside the door (front loaders), or at the top of the wash bin (top loaders).

Table 2. Energy Star Washing Machine Water Factors

Washer Type	ENERGY STAR Criteria (as of February 2, 2018)
Residential Front-loading (>2.5 cubic feet)	≤3.2 gallons/cycle/cubic foot
Residential Top- loading (>2.5 cubic feet)	≤4.3 gallons/cycle/cubic foot
Residential (≤2.5 cubic feet)	≤4.2 gallons/cycle/cubic foot
Commercial Front-loading	≤4.0 gallons/cycle/cubic foot

If the campus has a mix of small- and large-capacity washers, the predominate type should be selected in the tool.

3.8.2 Industrial Washer

Industrial washers, such as washer extractors and tunnel washers, are often found in facilities with large washing need (e.g., hospitals, hotels, prisons). For industrial washing equipment, enter the water use per pound of laundry. To help determine how much water is used, determine what is the predominant type of industrial washer the campus has. If you are unsure about how much water is used by the washers, the following information can provide some default values to use:

- Typical water extractors use about 3 to 4 gallons of water per pound of laundry, but if water recycling capabilities exist, water use may be less than 2.5 gallons per pound. Older models may use more water per pound (e.g., 3.5 gallons/lb.), where newer models tend to use less (e.g., 2.0 to 2.5 gallons/lb.).
- Tunnel washers use approximately 2 gallons of water per pound of laundry.[4] The water use per pound accounts for water that is recycled, as recycling is a design element in tunnel washers.

3.9 Vehicle Wash

This module provides inputs for four types of vehicle wash systems. These wash systems may be stand-alone facilities or associated with other buildings such as gas stations or vehicle maintenance facilities. The following information provides a summary of each wash system type and data that is entered into the tool. The data may be obtained by interviewing the system operators or on the equipment (e.g., name plates) during the walk-through survey.

3.9.1 Individual In-bay Automated Vehicle Wash

Individual in-bay automated washing equipment moves around a stationary vehicle. These systems can come with and without water recycling capability. If the campus has in-bay systems that are metered, enter the recorded annual water use. (Note: Enter the same year as the water supply data.) For in-bay systems that are not metered, typical systems use approximately 45 gallons per vehicle (gpv)[5] (ranges from 30 to 60 gallons). If the gpv is not known for your system, 45 gpv is a good default value to use in the tool.

If there are multiple individual in-bay automated wash systems on the campus, enter an average gpv used.

Enter the average percent of water recycled/reused by the system(s). Some wash systems may reclaim water during the wash cycles and reuse it during the next use. This reduces the amount of overall fresh water use of the system.

3.9.2 Conveyor-type Friction Washing or Frictionless Washing Vehicle Wash

Conveyor-type wash systems move the vehicle along a path, washing it as it moves through the system. There are two types of conveyor systems: friction and frictionless. Friction washing is when washing equipment touches the vehicle and frictionless is when only water and cleaning liquids touch the vehicle.

If both friction and frictionless washers are on the campus, enter data for the predominant type.

If the campus has friction and frictionless systems that are metered, enter the recorded annual water use. (Note: Enter the same year as the water supply data.) For friction and frictionless systems that are not metered, these systems typically use approximately 66 gpv and approximately 85 gpv[6], respectively. These values may be used as default values in the tool if this information is unknown.

Enter the average percent of water the system(s) recycle/reuse. Some wash systems may reclaim water during the wash cycles and reuse it during the next use. This reduces the amount of overall fresh water use of the system.

3.9.3 Self-service Wash Pad: Open Hose or Pressure Washer

Self-service wash pads are areas where vehicles are washed, either using a hand-held open hose or pressure washer. An open-hose system may be similar to a garden hose with or without a nozzle. A pressure washer is one in which the water enters the system under low pressure and is sprayed out of a nozzle under higher pressure. If both open hose and pressure washers are used on the campus, enter the nozzle rating for the predominant type. See FEMP's Handbook: Performing a Comprehensive Walk-Through Water Survey

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[4] Gallon per pound of laundry from the Alliance for Water Efficiency.
[5] Brown, Chris 2017. *Water Use in the Professional Car Wash Industry*.
[6] Brown, Chris 2002. *Water Use in the Professional Car Wash Industry*. Prepared for International Carwash Association.

(Section: Vehicle) for information on where to find and how to determine flow rates of open hoses or pressure washers.

3.9.4 Large Vehicle Wash Facilities (Semi-Trucks, Tracked Vehicles or Aircraft)

Large vehicle wash facilities can be common at campuses with tactical operations such as military installations (commonly referred to as a central vehicle wash facility). These systems are used where it is not feasible to wash in the above washing systems, and they may require additional cleaning requirements and treatment of the wastewater. If the campus has large wash systems that are metered, enter the recorded annual water use. (Note: Enter the same year as the water supply data.) For systems that are not metered, enter an estimated gpv used by the system. If there are multiple large vehicle wash systems on the campus, enter an estimated average gpv.

Some wash systems may recycle water during the wash cycles and reuse it during the next use. This reduces the amount of overall fresh water supplied to the system. Enter the percentage of water that is recycled in the system.

3.10 Landscape Irrigation

This module provides inputs for landscape irrigation and can be found throughout the campus grounds such as landscape around buildings, golf courses, ball fields, and parks. Landscape irrigation can potentially be a high-water use activity, depending on factors such as how much irrigated landscape exists, the condition of the system, and irrigation management (e.g., amount and timing of the water applied). If irrigation is metered, enter the annual metered water use for the same year as the water supply data. (Measuring actual water use through flow meters is the surest method of determining the amount of irrigation water used.) If irrigation is not metered, data collected during the walk-through survey provides the necessary information to estimate irrigation using the evapotranspiration method[7]. This method calculates the amount of water needed to maintain a healthy landscaped area for a given location, based on the amount of water transpired from the plants and evaporated, called evapotranspiration.

Information is obtained during a visual inspection of the equipment and irrigated grounds during a walk-through survey and gathered from the grounds or building manager and the staff members that irrigate and manage the grounds.

The following provides information on each input.

Landscape mixed beds or turfgrass: mixed beds are areas consisting of a variety of plantings such as shrubs, trees, and turf; turfgrass are areas consisting of primarily grass such as ballfields and parks. The tool allows for multiple landscape areas; therefore, areas can be broken out into multiple sub-areas depending on landscape type.

<u>Mixed beds: for mixed beds, enter the following information:</u>

General level of supplemental irrigation needed by the mixed bed area: select the irrigation needs based on the predominant type of plants in the mixed bed:

- Low – Plants are native or well adapted/drought tolerant to the specific area and do not require much water over the growing season to stay healthy.
- Moderate – Plants that require some additional water to stay healthy over the growing season and are not native or adaptive to the area.

[7] For other methods to estimate irrigation use (irrigation audit method), see the Irrigation Associations website.

- High – Plants that need ample supplemental water to stay healthy.

Mixed bed plant density: select the appropriate level of planting density (if the area has more than one type, choose the predominant type):

- Low – Sparsely planted landscape.
- Moderate – Full coverage, but predominantly one vegetation type.
- High – Mix of plant types with that are compactly planted covering the whole landscape.

Mixed bed microclimate: select how protected/exposed the plants are to heat, wind, and sunlight, using these three categories (if the area has more than one type, choose the predominant type):

- Protected – Areas shaded from sunlight and protected from wind and heat gain.
- Open – Areas in an open, flat field.
- Intense exposure – Areas exposed to high heat or windy conditions.

<u>Turfgrass: for turfgrass, enter the following information:</u>

Turfgrass species: select the type of turfgrass[8]:

- Cool-season grass – Thrives in cooler climates and generally requires more water than warm-season grass to thrive; generally has dark green, thin blades that are densely packed. Examples include Kentucky bluegrass, fescue, and ryegrass.
- Warm-season grass – Better suited for hot summers and generally more drought tolerant than cool-season grasses; generally has lighter green, thick blades that are less densely packed. Examples include bermudagrass, St. Augustine, and zoysiagrass.

<u>Enter the following general information for all landscape areas:</u>

General appearance/condition of the landscape: select the general level of landscape condition:

- Stressed – Landscape appearance is not a priority and may be under-watered at times during the growing season.
- Average – Landscape is kept green but not lush throughout the growing season.
- High quality – Landscape is kept green and lush during the entire growing season.

Soil type: select the general type of soil found in the landscape:

- Sandy – Soil will not form a ball.
- Loam – Rich soil that is a combination of sand and clay; soil will form a well-shaped ball that will break apart easily.
- Clay –Soil will form a well-shaped ball that does not break apart easily.

[8] See FEMPs Handbook: Performing a Comprehensive Walk-Through Survey (Section: Landscape Irrigation, Table 1. Examples of Turfgrass Season Type) for a list of cool and warm season grasses.

Irrigation equipment type: select the predominant type of equipment found in the landscape:

- Rotor – Sprinkler system that deliver water in a rotating stream. Typical for large irrigated areas.
- Spray – Sprinkler system that deliver water in fan shaped pattern. Typical for small landscape beds.
- Micro-spray and drip – Small emitters that deliver water at lower pressures directly to the root zone of the plant. Typical for small landscape beds
- Manual – Water delivered with hoses, nozzles, and/or aboveground sprinklers.

Irrigation controls: select the irrigation control type:

- Manual – The irrigation system is manually controlled, with the grounds manager determining the irrigation schedule.
- Clock – The irrigation system is controlled via a clock or timer.
- Weather-based – The irrigation system is controlled automatically based on weather and soil condition that precisely schedules the irrigation based on the actual needs of the plants.

Note any observations on irrigation efficiency and system operation:

- Puddles observed in and around the landscape area—note if there are many, few, or no puddles in and around the landscape, which may be caused by overwatering or uneven watering of the irrigation system.
- Runoff observed in and around the landscape area*—note is there is runoff in and around the landscape area during or directly after irrigation.
- Sprinkler head leaks observed—note if there are many, few, or no leaks from the irrigation equipment. These may be observed as water seeping from sprinkler heads.
- Broken equipment observed*—was there broken landscape equipment observed? Example observations include missing sprinkler heads that cause a geyser (spraying large amounts of water not commensurate with the other heads), or malfunctioning valves that do not shut off the irrigation zone whereby the irrigation system continues to run.
- Impervious surfaces being watered*—are impervious surfaces such as sidewalks and roadways being watered by irrigation system.

  *These observations are best determined by observing the irrigation system in operation. Request the irrigation system to be turned on by the grounds maintenance staff during the walk-through survey.

This information is used in the tool to estimate the system's efficiency. System efficiency is an expression of what portion of the irrigation water consumed by the turfgrass and/or plants compared to the total water supplied to the irrigation equipment. The system efficiency is based on the type of irrigation equipment installed, maintenance and scheduling of the system. A perfect system, operating at 100% efficiency, would have no leaks, losses, or waste. But no system is 100% efficient; for example, water is lost though runoff, leaks, and evaporation. Efficiency can also be affected by poor maintenance, such as broken sprinkler heads or pipes, or caused by scheduling problems such as watering during windy periods.

3.11 Other Processes

This tool has a module that allows users to enter individual water processes that are not included in the other modules. Examples include laboratory and medical equipment such as disinfection/sterilizing equipment, vacuum systems, glassware washing equipment, and vivarium equipment. Additional miscellaneous water using equipment include water purification systems, water softening equipment, and small evaporative cooling equipment ("swamp coolers"). These types of equipment may be found in a variety of facilities but are especially common in laboratories, clinics, and hospitals. Annual water use for these processes should be determined individually but will appear in the water balance combined as "other processes". Information on water used by this equipment may be on equipment nameplates or may be obtained from manufacturer literature using the equipment make and model included on the nameplate.

This module in the tool allows the entry to two equipment types:

Batch process: a specified volume of water is used each time a process is completed. For batch processes, enter the following information into the tool:

- If the system is metered, enter the recorded annual water use (for the same year as the water supply data.)
- If the system is not metered, enter:
    - Average batches per week obtained by interviewing staff responsible for the equipment.
    - Number of weeks the system operates per year obtained by interviewing staff responsible for the equipment
    - Water use per batch, obtained via the model number from the equipment nameplate; lookup the water volume per batch from the manufacturer's specification (typically found online).

Continuous process: water continually flows through the equipment. For continuous process equipment, enter the following information into the tool:

- If the system is metered, enter the recorded annual water use (for the same year as the water supply data.)
- If the system is not metered, enter:
    - Average hours per week the process operates obtained by interviewing staff responsible for the equipment.
    - Number of weeks the system operates per year obtained by interviewing staff responsible for the equipment
    - Typical water flow rate obtained via the model number from the equipment nameplate; lookup the water volume per batch from the manufacturer's specification (typically found online).
    - Percentage of water recycled in the system, obtained from facility staff or manufacturer's information.

4 Water Balance Results

The water balance results provide a pie chart with the percent breakout by end-use and a bar chart that shows the total volume of water used annually for each end-use. In addition, the pie and bar charts show the amount of "unknown" water use. This unknown water use is the difference between the total water supplied to the campus and the sum of the end-uses. One likely contributor to this discrepancy are the assumptions the user makes in rolling up values in the tool. For example, the tool requests a single entry for faucet flow rates, but if the user encountered a wide range of faucet flow rates during the walk-through, an assumed value that best represents overall faucet flow rate must be entered according to the user's discretion. If there is a high degree of variability across multiple end-use categories, the expected margin of error for the estimated water use is likely to be much higher. Users should approach the water balance with an expectation for the margin of error. If the unknown component exceeds the expected margin of error, it could indicate accounting errors in water supply data, water leaks, etc.

If the unknown is greater than 20% in the pie chart, do the following:

- Revisit the inputs entered in the tool to make sure they are reasonable estimates of actual water use. Look for entries that make a big impact on the water use such as the number of occupants, number of loads, and number of meals.
- Check the water supply data to make sure the correct units were entered.

If, after checking the end-use inputs and water supply data, there is still a large unknown portion of water use, the campus might potentially have a high leak rate in the distribution system. Performing a leak detection survey is a recommended next step. Go to FEMP's Best Management Practice (BMP) on Distribution System Leak Detection and Repair to find information on getting started.

If the sum of the end-uses is greater than the total water supplied to the campus, the data entries need to be revisited:

- Look for entries that make a big impact on the water use such as the number of occupants, number of loads, and number of meals. Have any of these entries been overestimated? Start with the end-uses that are the biggest consumers.
- Check the units. Have you entered any data that may be in the wrong units?
- If the campus has a master meter that measures the total water supplied to the campus, has it been calibrated recently? The total water supply may be underestimated if the meter is out of calibration. Contact the water utility to see if they can provide you with a calibration report.
- Once the entries have been revised, rerun the tool and see if the water balance has improved.

5 Next Steps – Water-Efficiency Operations and Maintenance and Retrofit/Replacements

Using the water balance results, the next step is to evaluate operation and maintenance (O&M) improvements and water-efficiency retrofit opportunities for the fixtures and equipment observed. Use FEMP's BMPs as a starting place for O&M improvements, as well as retrofit and replacement ideas. A retrofit analysis is often performed to determine whether upgrading to higher efficiency fixtures or equipment is cost effective. Using data collected, such as actual flow and flush rates, occupancy patterns, and utility rates, coupled with other available data, including replacement fixture/equipment costs and labor rates, can help determine whether a higher efficiency piece of equipment will save money over time.

FEMP has developed the below resources on water efficiency and water management.

- Streamlined O&M guidelines for the common water-using equipment: https://www.energy.gov/eere/femp/technical-operations-and-maintenance-guidelines-common-water-equipment

- Screen for water-efficiency projects using the Water Project Screening Tool: https://www.energy.gov/eere/femp/water-efficiency-federal-buildings-and-campuses
- Water-efficiency BMPs to increase water efficiency: https://www.energy.gov/eere/femp/best-management-practices-water-efficiency
- Water-savings technologies that offer opportunities for significant water savings potential: https://www.energy.gov/eere/femp/water-efficient-technology-opportunities

The Environmental Protection Agency's WaterSense program developed, "WaterSense at Work," which discusses a variety of water-efficiency BMPs.

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