



Best Practices for Industrial Water Conservation

For City of Bellingham Customers

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Best Practices for Industrial Water Conservation

Introduction

This guide is designed to help industrial facility maintenance staff find ways to reduce water use while maintaining or improving the quality of their products. The guide is based on personal experience from conducting hundreds of water assessments in industrial facilities.

Of all the suggested practices in this guide, the most important are to:

- ✓ Create a maintenance guide for all the water using equipment in your facility.
- ✓ Post it in an accessible place.
- ✓ Periodically review it.
- ✓ Carry out the maintenance in a timely manner.

Which measures you include on your maintenance guide will depend on the equipment in your facility. Please review the sample maintenance checklist in this document to get an idea of what to include in your checklist. A lot of water can be wasted from lack of attention to fixes that might be quick and inexpensive. Having a maintenance guide like this in place can remind you to investigate water savings opportunities.

This Best Practices document is not meant to be an in-depth study of all the possible issues and how to fix them. It is an overview of the most common ones, with guidance on how to approach the topic of industrial water conservation. For more detail on the subjects that follow, consult a water efficiency expert, your supplier of water-using equipment, the catalogs and web sites of equipment suppliers, or the following web sites:

Alliance for Water Efficiency: Their Resource Library has information on many types of water-using equipment,
<http://www.allianceforwaterefficiency.org/resource-library/default.aspx>

WaterSense: This organization has helpful information on water saving options for a variety of equipment, and water saving practices,
<https://www.epa.gov/watersense/watersense-products>

Energy Star: Even though the Energy Star web site is focused on energy saving choices for many types of equipment, some of the equipment listed also saves water. Examples include laundry washers, dishwashers, commercial kitchen equipment, and more.
<https://www.energystar.gov/products/energy-star-most-efficient>

General Industrial Water Conservation Concepts

When thinking about how to save water in your facility, consider which areas are the biggest users of water. For many industrial facilities the biggest users include: Cooling Water, Process Water, Boilers, Sanitation, Food Service, Restrooms, Irrigation, and Housekeeping.

Examples of Process Water include washing and rinsing, moving products, as a lubricant, as a solvent, forming a water seal, pollution control, and inclusion in the product.

The table below is a general guide to water efficiency in an industrial facility. Each topic is covered in more depth later in this guide.

Sample Site Water Efficiency Checklist

Topic	Action
Leaks	Walk around your facility at least once a week and check all water-using equipment for leaks. Even a small leak can add up to hundreds or thousands of dollars in water and wastewater charges if left unfixed for a few months or more.
Restroom fixtures	Check toilets and urinals for proper functioning and leaks. Check faucet aerators for blockage.
Rinsing	Check spray valves and nozzles to ensure they are only spraying water where intended. If water is spraying off to the side away from where work will be accomplished, check that nozzles are aimed properly and adjust them if needed. Check the nozzle holes for blockage and remove any found. Check the nozzle holes for wear and replace them if the wasted water is due to worn nozzle holes.
Bottle washing	Look for opportunities to reuse water used for washing, after it is treated in some way.
Clean-in-place (CIP)	For a variety of equipment, including tanks and totes that are typically washed and rinsed a lot, CIP equipment can allow reusing the cleaning water and the cleaning product 4 or 5 times before it is dumped.
Cooling Towers	Most cooling towers have conductivity controllers to control blowdown of water. If yours does not have a conductivity controller, we strongly recommend that you install one. It may save a lot on water and ensure you carry out blow down in a manner that protects your equipment. Most cooling towers have a ball float mechanism to shut off refill (makeup) water in the sump. That ball float can often stick open and waste a lot of water by continuing to allow fill water in and letting it overflow out of the sump.

	<p>If you have a ball float shut off, we recommend replacing it with an electronic level controller which is much less likely to malfunction.</p> <p>Conductivity meters are used in cooling towers to control how much water is drained out of the towers to maintain proper water quality without wasting water. They can get out of calibration over time. This can lead to the tower using too much, or too little, water - either of which can lead to equipment problems. We recommend obtaining a low-cost hand-held conductivity meter to check the accuracy of the conductivity meter on your tower.</p>
Single pass cooling	<p>If you have equipment cooled by a single pass of water, we strongly recommend replacing it with a system that cools with a closed loop of water or cools with air-cooled equipment. This will save a lot. If you can't afford to replace the single pass cooling equipment, at least make sure that the single pass cooling only occurs when the equipment that needs cooling is operating. Also, check that it only has the flow required, and no more.</p>
Irrigation	<p>One or more times per year turn on your irrigation system and walk around to look at each zone in operation to see if there are any water waste problems. If you find any, make note of what the problem is and which zone it is located in. Then give that list of problems to your irrigation maintenance staff or irrigation maintenance company to fix.</p>

Process

This section covers industrial water conservation ideas related to processing in the facility.

Efficiency Opportunities

As you look around your facility for water saving opportunities in your process use of water, it is best to start with the simplest and lowest cost options first and work your way up to the more complex and more costly options. The following list goes from most simple to most complex:

- ✓ Adjust the flow of water
- ✓ Modify equipment or install water saving devices
- ✓ Replace existing equipment with more water-efficient equipment
- ✓ Consider water treatment, recycling, and reuse
- ✓ Change to a waterless process

Examine all processes and determine if less water could be used to accomplish the process. Below are considerations for addressing water usage in your process:

1. Consider cleaning and rinsing techniques that use less water.
2. Look into clean-in-place (CIP) systems (more info below).
3. Consider leaks (more info below).
4. Review your nozzles (more info below).
5. Consider installing submeters and tracking the water use that the submeters measure. This will better document how much water different processes are using and ensure they are not unreasonably using more water than has been used historically for that process.
6. Use valves, sensors and/or timers to control processes, allowing you to obtain more precise control of key processes.
7. Avoid or minimize the use of water softening, reverse osmosis, and deionized water unless these are vital to a process. This is because these water treatments need additional backwash water which is harder to reuse for other non-potable needs. See the Reuse section below for more on that topic.

Reuse Possibilities

When considering whether you have an opportunity for reusing water from one process in another process it is key to match the water quality and quantity needed for one use with a water reuse option that has similar water quality and quantity. The table below can help with the analysis.

Matching Water Quality to Quantity to Determine Water Reuse Potential				
Process	Process Need		Process Discharge	
	Volume	Quality	Volume	Quality
Cooling				
Process				
Boiler				
Sanitation				
Landscape				
Other???				

Source: http://www.allianceforwaterefficiency.org/Manufacturing_Introduction.aspx

Some Possibilities for Reuse

Consider these options:

- Recovering, treating, and reusing filter backwash water.
- Reuse water from one wash to the next.
- Reuse process waters from one process to another process. The quality of the reuse water from the first process must be clean enough or can be made clean enough at reasonable cost for the second use.
- If your facility has a cooling tower and you have some water that is still relatively clean after it has been used in one of your processes, you might consider reusing that water in your cooling tower.

Reuse Savings Examples

Reuse of water can be one of the best investments a facility can make, as these examples show.

We carried out a water assessment of a few industrial facilities where we found ways to reuse reject water from reverse osmosis systems in their cooling towers. In one case it cost \$20,000 to set up the reuse systems with resulting savings of over \$7,000/year.

In another case we suggested reusing reverse osmosis reject water in a scrubber pollution control system. In that case, the setup cost was about \$30,000, and it saved over \$15,000/year.

In another facility, we recommended reusing production tank rinse water in a cooling tower at an installed cost of approximately \$10,000. It saved over \$2,000/year.

In another industrial facility we visited they had already installed a low-cost water reuse system in one of their processes that worked well. So, we recommended installing similar systems in other process areas. The four proposed systems had a total cost of less than \$2,000 but they were projected to save hundreds of dollars per year. We recommend this approach of trying out a new low-cost water reuse system first just on a single process. If it works well, go ahead and install it on other similar systems.

Clean-In-Place

Clean-In-Place (CIP) systems allow for capturing, treating, and reusing cleanup water. CIP systems are automated systems used to clean the interior surfaces of food and beverage equipment without disassembling the process. CIP systems can be used for processing vessels, product transfer lines, fillers, mixers, blenders, dryers, vats, ovens, roasters, homogenizers, spiral freezers, process pipes, tanks, homogenizers, and more. These systems have been used in the following industries: Dairies, Breweries, Bakeries, Distilleries, Meat, Poultry, Seafood, Snack Foods, Prepared Foods, Pet Foods, and others.

It is important to note that CIP Systems can and should be engineered to your specific plant application, layout and utility requirements for effective and efficient sanitary process equipment cleaning.

Clean in Place Savings Example

A brewery in the Seattle area replaced the equipment they used to clean their beer brewing tanks. That equipment made use of CO₂, caustic, and water. The CIP replacement system reused the water and caustic to clean the tanks. The new system reused the water and caustic four times



CIP system example

before it was disposed. The CIP equipment cost approximately \$15,000, but it qualified for a rebate from Seattle Public Utilities of approximately \$7,500, dropping the equipment cost to \$7,500. It saved the company over \$3,000 per year in water and caustic chemicals.

Leaks

Even a small leak can add up to hundreds or thousands of dollars in water and wastewater charges if left unfixed for a few months or more. We recommend that you walk around your facility at least once a week and check all water-using equipment when it is in operation to make sure it does not have any leaks.

Drip Gauge

A drip gauge can be used to measure how many gallons/year will be wasted by a drip in your facility. You hold the gauge under a drip for 5 seconds and it will tell you how many gallons that drip will waste in a year.

We recommend that you obtain a drip gauge like the one in the picture below. You can obtain one here:

<http://www.amconservationgroup.com/products/water-conservation-products/drip-gauge/>



Drip gauge

Nozzles

Nozzles are used in a wide range of applications in industrial facilities including seafood and other food processing lines, vehicle washes, dishwashers, systems for removing ice from some freezers, cleaning equipment, and more. Below are a couple of photos showing nozzles in use.



Spray nozzle example

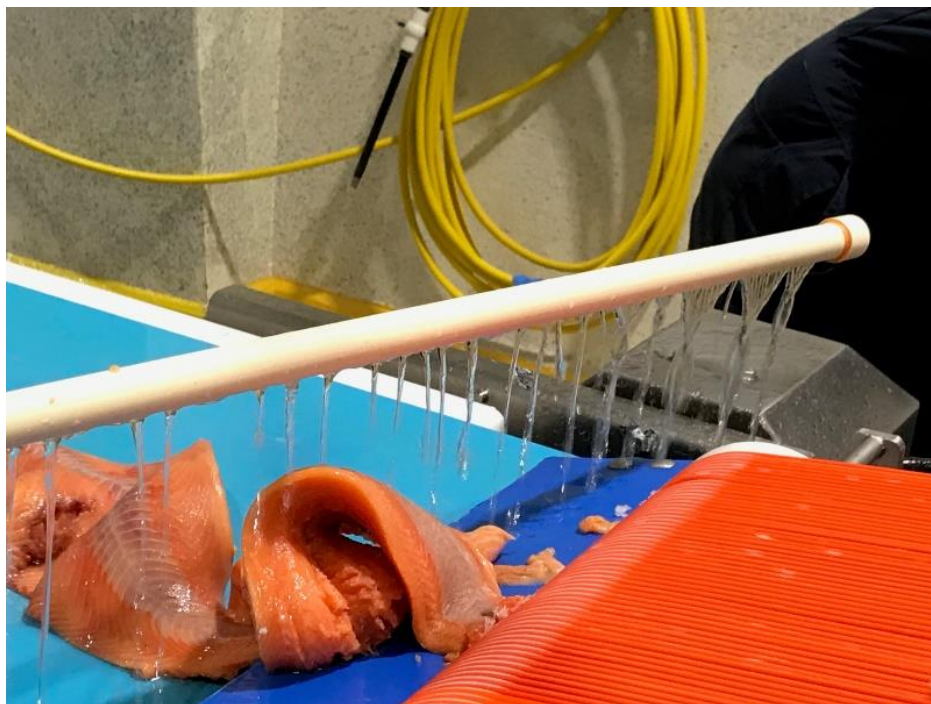


Spray nozzles with different patterns

Preventing Nozzle Water Waste

Check all equipment nozzles periodically to ensure that the water is doing the work it was designed to do. Over time the nozzle orifices can expand due to particulates in the water wearing away the surface - making the nozzle holes larger. This can result in 20% or more water waste because it sprays into areas where it's no longer doing any work. The best way to prevent this is to periodically inspect the flow of water out of the nozzles when the equipment is in operation. If you see evidence of worn out nozzles with misdirected flows, contact the manufacturer about obtaining replacement nozzles. If the manufacturer is unable to provide replacement nozzles, visit the web site of Spraying Systems Company: <https://www.spray.com/> They sell a wide range of sizes and types of nozzles. They will very likely be able to provide the replacement nozzles you need. They can also help you determine the best nozzles for the work you want to do.

Sometimes nozzles are wasting water because the system they are used in has them spraying water that does no work some or even all the time.



Nozzle overspray example

In the picture on the previous page the four streams of water on the right are wasting water because they overspray beyond the conveyor carrying the fish. These nozzles should be blocked off. Please keep your eyes open for inefficient designs like this.

Nozzle Savings Examples

We carried out water assessments in a few industrial facilities where we found flows on several spray nozzles were higher than needed. It cost only a few hundred dollars to install lower flow nozzles that got the job done well, and the lower flow nozzles saved at least \$1,000/year. That is a typical cost and payback for lower flow nozzles.

In a 2019 visit to an industrial facility in Bellingham we found some spray nozzles on a food production line were running on average 8 hours/day at 3 gallons per minute. The process didn't require such a high flow. We recommended a replacement with similar nozzles that had a flow of only 1.5 gallons per minute. The estimated installed cost was just under \$2,000, and estimated savings were over \$2,000/year. This is an example of the great investments possible with water conservation.

Water Brooms

A water broom consists of a spray system with multiple nozzles that can clean a swath that is 1 to 2 ½ feet wide. If you currently use a spray hose to clean your facility's floor, consider switching to a water broom instead. The advantage of a water broom is that it can clean a wider swath of the floor than a single nozzle hose. It can save both water and time.

Typically, a hose used for cleaning might have a flow of 4 gallons per minute or more. A water broom might have a flow of only 2 gallons per minute. Plus, because of its design, it can usually clean more space per hour than cleaning done with a hose.

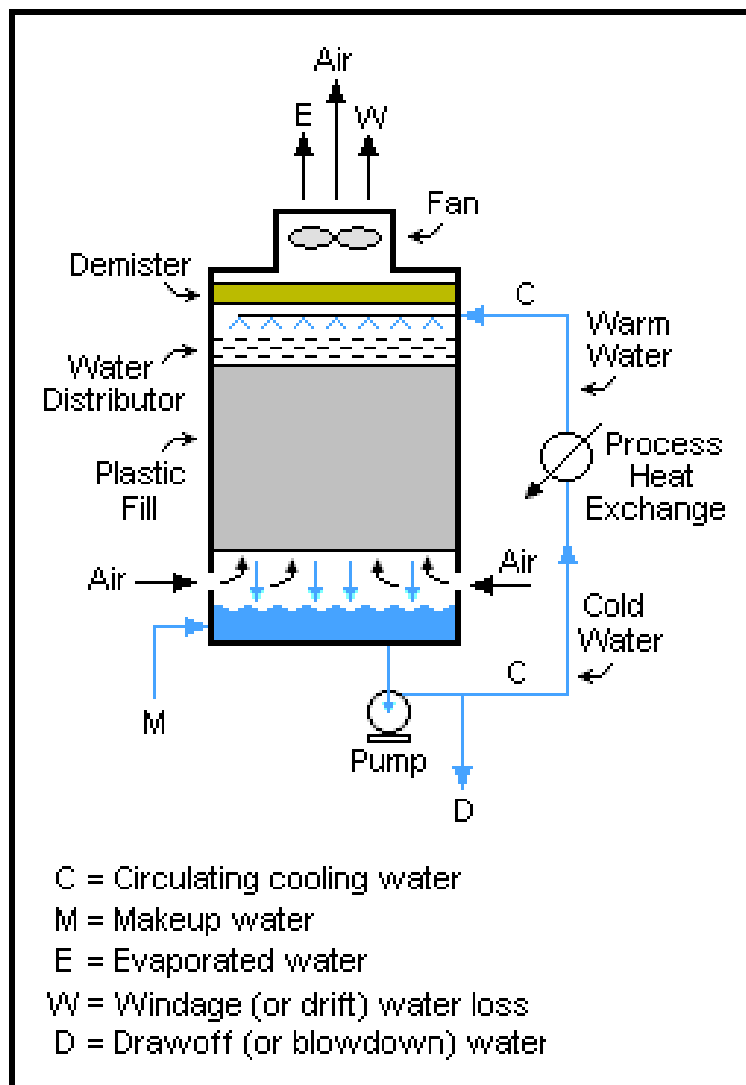


water broom

These high-pressure water brooms are designed to be used for cleaning floors and sidewalks. They can also help clean decks, patios, driveways, pool decks, and parking lots.

Cooling Towers

Cooling towers regulate temperature by rejecting heat from air-conditioning systems or by cooling hot equipment. They re-circulate a stream of warm water that is brought into contact with airflow in the cooling tower. This causes some of the water to evaporate, thereby cooling the remaining water. The cooled water then circulates through the warm equipment, absorbs heat and returns to the tower. Cooling towers use significant amounts of water. Thermal efficiency, proper operation and longevity of the water-cooling system all depend on the quality of water and its reuse potential. The diagram below shows how a cooling tower works.



Cooling tower diagram

The circulating water picks up heat from a chiller or other piece of equipment. Then this warm water is pumped to the cooling tower where it is sprayed from above. Some of the water evaporates and some of it may be cooled by the outside air. The water that doesn't evaporate is

now cooler than before. It drops down into the basin at the bottom of the tower. It is then pumped back to the equipment to pick up more heat and returns to the tower to get rid of some of that heat.

Ways to Improve Cooling Tower Operation

There are a few ways to improve the operation of a cooling tower. Several of these are covered in this section.

1. Replace cooling tower ball float level control with an electronic level controller

The photo to the right is of a sump basin in a cooling tower. This is one way to replace water lost to evaporation in a cooling tower. The black ball is a float that works like an older style flush toilet. Once enough water has entered the system it shuts off the water flow. This type of shut off system is prone to sticking open leading to an excess flow of water into, and then out of, the cooling tower.



Sump basin in a cooling tower with ball float control



Electronic water level control

The photo to the left is of part of a different type of makeup water control system. This is part of an electronic level control for a cooling tower. These electronic systems have a better track record of working properly. Some allow remote tracking of the filling and shut off of water into the tower.

2. Cooling Tower Electronic Level Controller Savings Examples

A number of facilities in Western Washington have recently installed electronic level controllers on their cooling towers. Typical installed costs for this equipment were about \$8,000. The water savings ranged from \$1,150 - \$4,600/year.

At City of Bellingham water and wastewater rates, if your tower has had a tendency for the level float to get stuck and lead to overflowing wasted water, the cost of an electronic level controller will often be paid back in 3 years or less through water savings.

3. Cooling Tower O&M Opportunities

Cooling water typically needs treatment and some disposal to ensure that scale, corrosion, and biological growth are properly controlled. Periodically, water needs to be blown down to reduce buildup of chemicals and solids. With soft water like that provided by the city of Bellingham, the ratio of solids in the blowdown water to the level of solids in the makeup water should typically be maintained at 10 cycles to save water and chemicals. This ratio is known as the Cycles of Concentration. With hard water the ratio will need to be lower because hard water from the utility starts out with a higher amount of solids in the water. Cycles may have to be reduced if lower quality water is used. If you reuse water from another operation and add it to your cooling tower water, you might have to reduce the cycles of concentration.

Your cooling tower should be set up to automatically blow down water to maintain the cycles of concentration at a safe level determined by the type of cooling tower you operate, and the quality of water provided to the tower. This automatic blow down system is controlled by what is called a conductivity controller. The conductivity controller measures how well electricity conducts through the cooling tower water. There is a direct correlation between how much electricity can be conducted through the cooling water and the solids in the water.

We recommend purchasing a hand-held conductivity meter to test the accuracy of your automatic conductivity controller. Prior to use of the hand-held conductivity meter please make use of the calibration fluid that comes with it to calibrate the equipment. You can obtain a sample of water from the tower in a safe manner. Then take a conductivity reading. At the same time, check to see what the conductivity reading is at the automatic conductivity controller on the tower. Hopefully the readings are very similar. If they are more than 20% different, we suggest that you make an effort to recalibrate your cooling tower conductivity controller. You can easily waste hundreds or thousands of dollars per year or risk damage to the cooling tower if you continue to operate a cooling tower with a conductivity controller that is not properly calibrated.

Drift eliminators reduce the amount of water removed from the system by wind. Make sure they are installed and functioning properly.

Ensure the tower is drained and cleaned once a year. Otherwise, scale and corrosion can reduce the operating life of the cooling tower. Work with the heat exchanger

manufacturer or reputable tower chemical treatment vendor to develop a suitable chemical treatment program.

4. Cooling Tower Maintenance Checklist

Use this checklist to keep your cooling tower working well and efficiently.

- ✓ Inspect the spray nozzles. Remove the primary header and remove all debris.
- ✓ Perform water treatment analysis for a closed system.
- ✓ Treat as needed to ensure proper water chemistry.
- ✓ Remove any sludge from the collection basin and check for corrosion that could develop into leaks.
- ✓ Inspect and clean the chemical injector device.
- ✓ Clean inside the standpipe of the electronic water level controller.
- ✓ Check for leaks in tower basins or casings, flexible connections, pump gland seals and control valves.
- ✓ Ensure the fill media within the tower is in good condition to obtain optimum water cooling.
- ✓ Check the blowdown valve: clear debris and ensure that it is operative.
- ✓ Check drift eliminators and ensure they are in good working order.
- ✓ Set and closely monitor targets for water use, chemical use and cycles of concentration.
- ✓ Install a non-return valve on the delivery side of the pump to minimize water overflow on tower shutdown.
- ✓ Fit drift eliminators or arrestors.
- ✓ Install a building control system to easily control building temperature needs.
- ✓ Request reports on water conductivity tests, chemical use, and leaks after each service by your water treatment specialist. Keep a log of water and chemical use.

5. Increasing Cooling Tower Cycles, Concentration Ratio

When talking about cooling towers, cycles and concentration ratio are two terms for the same thing. The concentration ratio is the total dissolved solids that the cooling

tower is set to maintain divided by the total dissolved solids in the incoming water. For example, if the total dissolved solids are set at 1,000 ppm and the incoming solids are averaging around 100 ppm, the concentration ratio (cycles) is $1,000/100 = 10$. Increasing the number of cooling tower cycles can significantly reduce the water use in a cooling tower. The table below shows how much.

Percent of Make-Up Water Saved												
Initial Concentration Ratio (CR _i)	New Concentration Ratio (CR _n)											
	2	2.5	3	3.5	4	5	6	7	8	9	10	
	1.5	33%	44%	50%	53%	56%	58%	60%	61%	62%	63%	64%
	2	--	17%	25%	30%	33%	38%	40%	42%	43%	44%	45%
	2.5	--	--	10%	16%	20%	25%	28%	30%	31%	33%	34%
	3	--	--	--	7%	11%	17%	20%	22%	24%	25%	26%
	3.5	--	--	--	--	5%	11%	14%	17%	18%	20%	21%
	4	--	--	--	--	--	6%	10%	13%	14%	16%	17%
	5	--	--	--	--	--	--	4%	7%	9%	10%	11%
	6	--	--	--	--	--	--	--	3%	5%	6%	7%

Water savings from increasing cycles in a cooling tower Source: N.C. Department of Environment and Natural Resources

The table above shows the percentage of savings that you can achieve in a cooling tower by increasing the concentration ratio in a cooling tower. For example, if you start out looking at the vertical column on the left and you begin with an existing concentration ratio of 2 and you read across on the table and stop at the cell under a concentration ratio of 4, you can see that you would save 33% of the water used in the cooling tower by increasing the concentration ratio from 2 to 4. A substantial savings that can be achieved just by changing the setting in the conductivity controller for your cooling tower.

It is important, when increasing the cooling tower cycles, that close attention is paid to the chemistry of the water. The ideal goal for cooling tower operation is to set the concentration ratio at a level that does not waste water but that is also able to help reduce the development of scale and biological growth that could come with too high a concentration ratio.

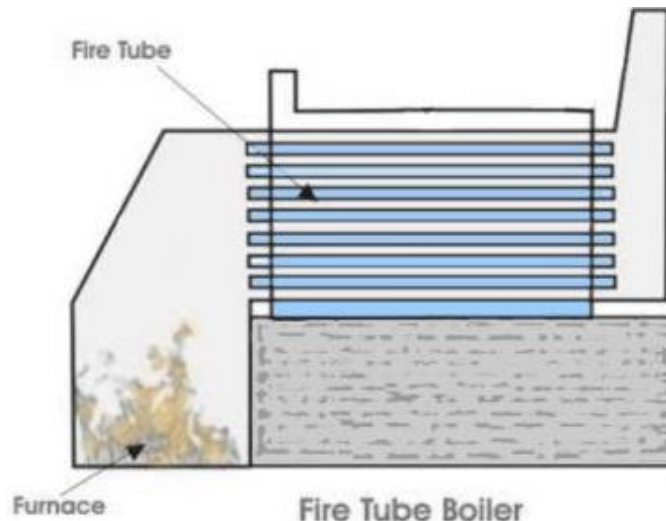
Boilers

Boilers are used to create steam.

A fire tube boiler is a boiler where the fuel used to heat the water burns inside tubes in the boiler. The water heated by the burning fuel is outside the tubes. A *water* tube boiler is one where the water is in the tubes and the burning fuel is outside the tubes.

Water loss can occur from leaks in the steam system and blow-down water loss. Blow-down water losses can be reduced by similar means as those used in the efficient operation of cooling towers:

- Professionally maintaining the water chemistry which can include acidification of the water, side-stream filtration, magnetic pulse technology, and/or inhibitors.
- Maintain the boilers, steam lines and steam traps.
- Monitor water use and chemistry.
- Minimize blowdown by only carrying out the level of blowdown that maintaining water quality requires.
- Maintain make-up water quality.
- Tune-up annually.
- Insulate piping and storage tank.
- Clean and inspect tubes.
- Locate and repair leaks promptly.
- Read meters.

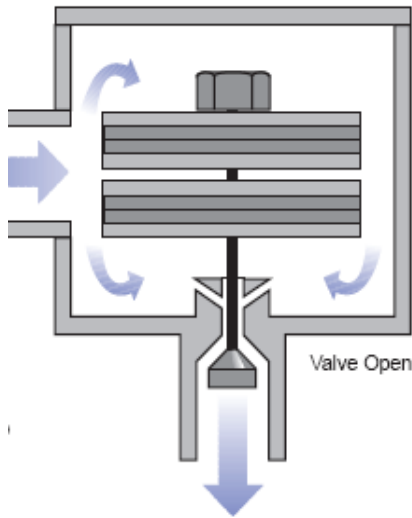


Fire tube boiler

Boiler Steam Traps

A **steam trap** is a device used to discharge condensates and non-condensable gases with negligible consumption or loss of live steam. Most steam traps are nothing more than automatic valves. They open, close or modulate automatically.

Boiler steam traps are another source of water loss and are a common place for leaks to occur.



Steam trap example

There are many types of steam traps. The illustration to the left shows just one type. They can sometimes leak and let steam out into the air which is wasted water and potentially a safety hazard. If you have a steam system and you have steam traps it is vital to check them for leaks on a regular basis; at least once a year. Many people use infrared cameras to check for leaks because the leakage is not always visible.

Recommendations for maintaining boiler steam traps:

- Check traps annually for leaks and proper operation.
- Clean traps regularly.
- Monitor trap temperature.
- Repair leaks promptly.

Water Saving Opportunities with Boiler and Steam Systems

If you want to cut down the water used by your boiler and steam system, consider these options:

- Install condensate return lines, if you don't already have them.
- Use conductivity controls to control blowdown.
- Use flow meters to monitor water use. If the use appears excessive, investigate the system to determine if there is a leak or another problem.
- Don't use cold water for cooling down condensate before it is sent to the sewer. Either reuse it in the boiler, use it in other equipment on site, or store the condensate in a tank to let it cool down before draining to the sewer.

Refrigeration and Other Cooling Systems

Cooling systems provide ample opportunities to save water, especially single pass cooling systems.

Single Pass Cooling and Alternatives

Single pass cooling is the use of a flow of water run past equipment to cool it. It consists of just one single pass of water that does the cooling and is then rejected to the wastewater line. Single pass cooling can be used to cool vacuum packing equipment, air compressors, sterilizers, stand-alone air conditioning equipment, furnaces, walk-in coolers, walk-in refrigerators and a variety of other equipment.

If you have a single pass cooling system, you will save a lot by replacing it with either a closed loop of cooling water or an air-cooled system.

Replacing Single Pass Cooling with Closed Loop Cooling

A closed loop can pick up the heat you need to reject and transfer that heat first to a chiller and then to a cooling tower. Or it can transfer the heat to a system that rejects the heat to the outside air. In either case there would likely be a closed loop of water that is continuously cycled past the equipment to pick up heat and then rejecting that heat to a chiller or another piece of equipment. It saves a lot of water and money because instead of huge volumes of water running down the drain in a single pass system, in a closed loop system the water never runs down the drain.

If there is already a chiller and cooling tower system in place, the savings from installing a closed loop cooling system can be substantial.

Single Pass Cooling Considerations

If the chiller and tower approach does not look cost effective for your situation, at least make sure that the volume of single pass water is only as much, but not more than, what is needed to cool the equipment. In other words, if after carrying out the proper engineering heat rejection calculations or after talking to your equipment vendor, you determine that you only need 3 gallons/minute to cool the equipment but you currently have a flow of 5 gallons/minute, make an adjustment to the flow by adding a valve or another type of control to reduce the flow to what is needed.

Also make sure that the flow of single pass water is only running when the equipment needs to be cooled.



Single pass cooling

The photo to the left shows examples of single pass cooling water flows. Those flows use a significant amount of water, especially if they run all day long, every day of the year, which is often the case. If you have any single pass cooling in your facility that is running all or most of the day, it will almost always save a lot of money to switch to another type of cooling system.

Refrigeration and Cooling Savings Examples

We recently visited a fish processing facility in Western Washington that used a single pass cooling system to cool their vacuum packing equipment. We recommended switching to a system that makes use of a small chiller and small cooling tower to reject the heat. We expect significant savings from this change.

During a visit we made to a fish processing facility in Bellingham we examined their conveyor system, which runs through a freezing tunnel. We noticed that the coils used for freezing developed a build-up of ice that needed to periodically be melted off with an automated spray of water. We encouraged staff to examine all the nozzles used to spray the ice-melting water to make sure that they did not have excessive wear, which could cause more water to be sprayed than necessary.

Restrooms

Toilets, urinals, and faucets are the common water-using items in restrooms.

Toilets

As of May 2019, the code for toilet flush volumes in Bellingham was 1.6 gallons per flush. But there are now high quality, low water use toilets that only average 1.1 gallons per flush or less. Opportunities exist for water savings in this area. We found some toilets in industrial facilities in Bellingham that were still using excessive volumes of 3.5 gallon per flush.

How to Determine Flush Volume

You can sometimes determine the flush volume of a tank toilet by looking at the space where the toilet seat meets the tank or inside the tank of the toilet. You can sometimes determine the flush volume of a flushometer style toilet by looking at the bottom side of the connection between the incoming water and where the diaphragm is located. Also, for flushometer toilets, you can check the flush volume that is marked on the diaphragm replacement kit for that toilet, as these photos illustrate:



Flush volume 2.4 gallons per flush kit



Flush volume 1.6 gallons per flush kit

The photos above show examples of the boxes that contain the diaphragms for flushometer toilets. Like it says on these boxes, most boxes containing replacement diaphragms tell how many gallons per flush these diaphragms will use when installed in a toilet. If you are not sure how much water your flushometer toilet uses check to see what it says on the box of your replacement diaphragms. Note: this will only work if the replacement diaphragms are the correct replacement diaphragms for your toilets.

Types of Toilets

There are many types of toilets on the market today. Here are the most common ones in the United States:

- High Efficiency – From 1.28 gallons per flush down to less than 1 gallon per flush.
- Dual flush – A higher flush volume for solid wastes and a lower volume to be used for liquid waste. Usually operating by moving the flush arm up for one volume and down for another.
- Flushometer – Toilet style commonly seen in many commercial buildings where instead of a toilet tank it has a metal flushing mechanism.
- Gravity – Toilet that most people have at home. It has a tank located behind the seat of the toilet.
- Pressure assisted gravity – Looks like a typical gravity toilet but it contains a pressure tank inside the tank of the toilet. This pressure tank creates a blast of pressurized water when it is flushed and that helps ensure that the waste makes it out of the toilet bowl and down the waste line.
- Waterless Compost – A toilet that makes little to no use of water. It is used like a regular toilet, but it usually does not require flushing. It does require adding wood shavings or some other material to help with the composting process. If operated and maintained properly it can create a safe fertilizer that can reduce landscape fertilizer costs and reduce water use associated with regular types of toilets.
- Sensor flush – Toilet that uses a sensor to notice when you have stepped away from the toilet and then it flushes. It requires regular maintenance to ensure that the sensor operates properly. We do not recommend automatic flushing toilets because the sensors often malfunction, and it can lead to excessive water use.



Compost toilet

Toilet Replacement Considerations

Drain Line Plugging

Some buildings have wastewater drain lines that were not installed with the slope required by code. These buildings may encounter drain line plugging



Flushometer style toilet

when lower flush volume toilets are installed. This happens especially if there is little water use in the building upstream from the toilets. Another issue that might contribute to drain line plugging is use of extra strength toilet paper.

Toilet Retrofit Considerations

We recommend replacing high volume toilets with lower volume toilets that use 1.1 gallons per flush or less instead of trying to properly retrofit higher volume toilets with devices to reduce their flush volume. Retrofitting can lead to the toilets not functioning properly.

Toilets Savings Example

In 2019 we visited an industrial facility in Western Washington. Sixty-four people worked at the facility and it had five toilets. All five toilets used 1.6 gallons per flush. We found that by replacing these 1.6 gallon per flush toilets with models that use only 1.1 gallons per flush they would save over \$800/year on their water and wastewater bill. The estimated cost of installing the more efficient toilets was about \$2,500, with a payback of just over 3 years.

Urinals



Waterless urinal

Urinal Operation and Saving Opportunities

When replacing higher flush volume urinals with lower flush volume urinals you may not see large savings if the urinal does not visibly use a lot of water for each flush. If you notice that your urinals do use a lot of water for each flush, we recommend replacing them with low water-use urinals that require only 0.5 gallons per flush. If you have a urinal trough system with continuously flushing, we recommend replacing that system with urinals that have a manual flush system. We do not recommend automatic flushing urinals because the sensors often malfunction, which can lead to excessive water use.

Waterless Urinal Operation

- Proper and trouble-free operation of waterless urinals requires special maintenance practices that include using only those cleaners recommended by the manufacturer and pouring warm water down the drain line every day to reduce the buildup of urinal crystals.
- They require signage to make people aware of how they are different from typical water-using urinals.
- They require training of maintenance staff.
- They require a good wastewater drain slope.
- They are best for high use situations.
- We generally do not recommend this type of urinal. We instead recommend the 0.5 gallon per flush urinals.


Faucets

Restroom faucets and many other faucets often have flows of 2.5 gallons per minute or greater. Significant water savings can be had by replacing their high-water use aerators with ones that use 1 gallon per minute or less. Most faucets provide all the cleaning that is needed at these low flow rates. We do not recommend replacing the aerators on kitchen faucets or other faucets where a high flow is needed for filling containers or other uses. For these cases you could consider installing an adjustable flow aerator. This can reduce the flow when high volume isn't necessary.

The single most important action to take with faucets is to make sure they don't have excessive flows. In most cases the flow for a restroom faucet only needs to be one gallon per minute or less to wash hands after using the restroom. To determine the flow of the faucets in restrooms and the flow of other faucets, we recommend measuring the flows by using a flow bag.

A flow bag can be used to measure a wide range of water flows. You hold the bag under the flow for five seconds and then look to see what the reading is on the bag in gallons per minute (gpm). You can obtain a flow bag here: <https://amconservationgroup.com/browse-products/water/water-devices>

Other faucets besides restroom faucets may require more than 1 gallon per minute. We suggest that you consult product information or the product rep to determine what flow is needed for each faucet or other equipment to make sure you aren't using more water than needed. For faucets that you determine have excessive flows, contact the City of Bellingham Water Conservation office to obtain some of their .5 gallon per minute faucet aerators to reduce the flow on your faucets. If the .5 gallon per minute faucet aerators would reduce the flow lower than you need, we recommend that you obtain an aerator with a higher flow, either by visiting a local hardware store or by visiting AM Conservation Group at



How Much Can You Save?
Save water and energy (energy used to heat your hot water) and money with high efficiency lower flow shower heads and aerators.

Determine the flow at showers and sinks.
Flow is measured as volume per minute. This handy tool will show you the flow in gallons and liters per minute, and help guide you to saving water, energy and money.

Easy Instructions on how to test your showers and faucets.

- 1) Turn on the fixture to be tested - shower head, faucet, or hose. Adjust the flow to how you would normally use the fixture.
- 2) Hold the bag open and place under the fixture for exactly FIVE seconds.
- 3) Remove from the flow, hold the bag up and read the flow rate measurement on the bag. Pour water out and repeat. It is important to get the FIVE seconds correct. Practice counting with a watch. Repeat the test to check your results.
- 4) Below we have indicated efficient shower heads, kitchen aerator and bathroom aerator guidelines.

NOTE: These are maximum recommendations. You can always go lower if you are comfortable with the performance at the lower flow. The lower the flow, the more water, energy and money you will save.

Showerheads

Compare the water level for your shower heads to the efficient ones. Look in the Potential Savings column to see how much you can save by installing a new shower head. The most efficient shower heads are available at www.nrideas.com.

Water Level	Flow Rate		Potential Savings on your utility bills
	Gallons (US)	Liters	
— 5 GPM	19 LPM	\$207/year	
— 4 GPM	15.2 LPM	\$124/year	
— 3 GPM	11.4 LPM	\$41/year	
WaterSense Guideline — 2 GPM	7.6 LPM		
— 1.5 GPM	5.7 LPM		
— 1 GPM	3.8 LPM		
— .5 GPM	1.9 LPM		

Calculations assume 2 people per household, 2.2 gpm shower head. Excludes per shower & shower per person each week. Water, sewer and energy savings rates are all included.

Faucets (Bathroom and Kitchen)

Compare the water level for faucets to the efficient one. Look in the Potential Savings column to see how much you can save with a new faucet aerator. The most efficient aerators are available at www.nrideas.com.

Water Level	Flow Rate		Potential Savings on your utility bills
	Gallons (US)	Liters	
— 5 GPM	19 LPM	\$16/year	
— 4 GPM	15.2 LPM	\$11/year	
— 3 GPM	11.4 LPM	\$6/year	
WaterSense Guideline — 2 GPM	7.6 LPM		
— 1.5 GPM	5.7 LPM		
— 1 GPM	3.8 LPM		
— .5 GPM	1.9 LPM		

Calculations assume 2 people per household. Potential Savings are for two 2.2 GPM use in the kitchen and one in the bathroom. Water, sewer and energy savings rates are all included.

EPA WaterSense Flow • Showers: 2.0 gpm, Bath Faucet: 1.5 gpm

Flow bag

the link below. They have aerators with flows ranging from 0.5 to 2 gallons per minute.
<https://amconservationgroup.com/browse-products/water/aerators>

Faucet Aerator Savings Example

In a 2019 visit to a small industrial facility in Western Washington we measured the average flow on their faucets to be 3 gallons per minute. We recommended replacing the high flow faucet aerators with low flow aerators allowing one gallon per minute or less. The water utility provided the aerators for free, and we estimated that the savings from that change would be approximately \$900/year, beginning immediately.

Food Service/Kitchens

There are many opportunities for water savings in the food service industry in general, and kitchens in particular. Below we cover the most important ones.

Pre-rinse Spray Valves



Using a pre-rinse spray valve in a commercial kitchen

Prior to loading a dishwasher, plates and dishes are often manually sprayed (pre-rinsed) to remove loose or 'sticky' food. The water used in this pre-rinsing operation is often twice the volume of water used by the dishwashing equipment. One can greatly improve water efficiency by using a pre-rinse spray valve (PRSV).

Many industrial facilities also make use of pre-rinse spray valves for rinsing in other types of operations separate from food service.

The photo to the right are of pre-rinse spray valves often used in commercial kitchens and in some industrial settings where there is a need to spray things off to clean them. You can use the flow bag to measure the flow of your existing pre-rinse spray valves. If they use 2 gpm or more you can replace them with models that use 1.6 gpm to save a lot of water at low cost.

The time it takes to successfully pre-rinse dishes or other items is a function of how well the PRSV works. Better valves clean dishes in less time. The effectiveness of the PRSV is the amount of force the water exerts on the food residue. This force is based on two factors; mass and velocity. The mass is derived from the volume of water; the velocity is derived from the speed the water is ejected from the nozzle onto the food residue. The same force can be obtained by reducing the volume of water and increasing the velocity.



Pre-rinse spray valve

A traditional pre-rinse spray valve uses high volumes of water, usually 2 to 5 gpm. The US national standard requires these valves to use no more than 1.6 gpm. A high-efficiency version uses less than 1.3 gpm and removes food and other residue faster than the traditional pre-rinse spray valve. Not only is the water flow rate reduced, the operator spends less time rinsing the same number of dishes or other material. Efficient models cost around \$50 but can save hundreds of dollars per year on water, wastewater, and energy bills.

Pre-rinse Spray Valve Savings Example

In a 2019 visit to an industrial facility in Bellingham we found a pre-rinse spray valve used for cleaning that had a flow of 5 gallons per minute. We recommended replacing it with one that had a flow of 1.4 gallons per minute or less. The cost of the new pre-rinse spray valve was estimated at around \$100. Even though it was only used for about 30 minutes per day the estimated savings were over \$300/year, for a payback of about 4 months.

Garbage Disposal



Commercial garbage disposal

Garbage disposals can use a fair amount of water.

If you use a commercial garbage disposal, we recommend that you switch to composting your food waste instead. This will allow you to save on your water and wastewater bills.

If you are considering composting your food waste and would like a commercial service to pick up your food waste, please look at the following web site to see the options available in Whatcom County:

<https://www.cob.org/services/environment/pages/recycling.aspx>

If you have decided that you need to continue use of your garbage disposal here is how you can reduce its water use:

- Make sure that the water to the garbage disposal only flows when the unit is on.
- If your garbage disposal is fed by other water in addition to the faucet that can run into it, take a look inside the garbage disposal when it is turned off. With the aid of a flashlight look for any flowing water. If you see any, check and change the controls for that flow to ensure that the flow shuts off when the garbage disposal shuts off.
- When you operate the garbage disposal, make sure that you run it only as long as necessary.

Connectionless Steamers

If you have a steamer in your kitchen area that is fed by a boiler it is likely using a lot more energy and water than necessary for steaming food. Consider replacing it with a connectionless steamer that uses a lot less water and energy and can often cook the food better than the boiler-fed steamer.

Connectionless steamers do not require steam lines because they generate their own steam inside the unit.

Other considerations for saving water with steamers:

- Most steamers pre-heat in 15 minutes, so don't switch on the machine until right before it is needed.
- Maintain door gaskets and hinges to save on steam escaping from the steamer.
- Make use of controls that allow putting the steamer in idle mode when it won't be used for an hour or more.



Boiler fed food steamer

Boiler fed food steamers usually waste a lot of energy and water because they pipe steam from a boiler often located far away from the kitchen.

This is an example of a connectionless steamer that saves energy and water by recycling the steam for many hours or all day. Plus, they do a great job of cooking food.

For additional information on commercial kitchen equipment water efficiency check out the following web sites:

- Food Service Technology Center, <https://fishnick.com/>, provides a wide range of information on water and energy efficiency opportunities with commercial kitchen equipment.
- Energy Star Guide for Cafes, Restaurants, and Institutional Kitchens, https://www.energystar.gov/sites/default/files/asset/document/CR%20ES%20Restaurant%20Guide%202015%20v8_0.pdf. Even though the main focus of this guide is energy savings, there is a lot on water savings.



Connectionless food steamer

Irrigation

This section is to help irrigation maintenance staff find ways to reduce irrigation water use while maintaining or improving the look of their landscapes. The guide is based on work carrying out hundreds of irrigation assessments.

Suggested Irrigation Practices for Water Conservation

Create an Irrigation Zone Guide to Place Inside the Controller

This is the most important practice one can do. The goal here is to create a guide to the ‘what and where’ of each irrigation zone. This irrigation zone guide will have information on the location, irrigation equipment, and plant material for each zone. Once you create it, place a copy of the guide inside the controller. A guide like this will save a lot of time when trying to find the location of irrigation zones. That saved time can be used to investigate the irrigation system for savings opportunities.

Conduct A Basic Walk-Around Irrigation Assessment

This should be done at the same time as creating the irrigation zone guide, and repeated weekly during the irrigation season.

Possible problems to look for:

- ✓ Possible leaks and breaks in the irrigation lines and equipment.
- ✓ Irrigation schedule not well matched to irrigation equipment, plants, soil, and other site conditions.
- ✓ Improperly functioning equipment.
- ✓ Some plants no longer need irrigation.
- ✓ Beds lack mulch.
- ✓ Irrigation heads blocked by foliage.
- ✓ Irrigation heads spraying pavement.

Change Watering Schedules to Match Changing Weather

Possible problem to be solved:

- ✓ Typically, the peak watering needs for a landscape are in the long hot days in July. But many people set their irrigation controller zones once and use that setting for the entire irrigation season. This wastes water because typically in the beginning and end of the irrigation season, in rainy and cool periods, less or no irrigation is needed as compared to what is needed in a typical July.

- ✓ One of the best ways to address this changing weather issue is to replace your irrigation controller with one that is designed to automatically change the watering schedule as the weather changes. This type of controller is called a weather-based controller. It typically receives daily information on the changing weather from either weather instruments on-site or a signal from an off-site weather station.



Weather based controller

If the controller is installed and set up properly this signal will automatically change the watering schedule to match the changing weather. To find a high-quality weather-based irrigation controller check out the irrigation controller section of the Water Sense website: <https://www.epa.gov/watersense/irrigation-controllers>

Consider the Soil

Possible problems to solve:

- ✓ You may have soil that varies in different parts of your irrigated landscape. Some areas may be sandy, others may have hard clay, and some might have nice loamy soil. You may be wasting water because the best way to water will vary between these different soil types.
- ✓ For example, it is best not to water for too much time at once on a sloped, clay soil because some of the water will run off. But loamy soil can hold more water so a longer run time may not waste water there. Another area with sandy soil will tend to drain some of the water away quickly, so sandy soil should also not be watered for too many minutes at once.

Remedy:

- Use a soil corer to check out the soil around your irrigated landscape. Make note of the soil types in each area and how deep the soil is.
- For the areas with sandy soil, you can add compost to convert them to more loamy soil that can hold on to and make better use of water. Clay soil can also be improved with the addition of compost, but it may need to be broken up first to allow the compost to blend in.



Soil corer

Choose Plants Wisely

Possible problems to be solved:

- ✓ High water needs plants have been chosen, resulting in excessive use of water.
- ✓ Mixing high and low water need plants in the same zone leads to a situation where the zone is either watered too much for some plants which might result in disease and other plant health problems or too little for some plants which will make it difficult for them to survive.
- ✓ Plant varieties have been chosen that are more prone to disease and pest problems.
- ✓ Plants have been planted in soil or sun locations that are not a good match to what they need, and the plants are not showing good growth.

Remedy:

Consult the following web sites for information on native and drought tolerant plants:

- Washington Native Plant Society List of plants that are native to Whatcom County:
http://www.wnps.org/plant_lists/counties/whatcom/whatcom_county.html
- Great Plant Picks Plant Lists, many of the lists are for drought tolerant plants:
<http://www.greatplantpicks.org/plantlists/search/>
- Saving Water Partnership Plant List:
http://www.savingwater.org/cs/groups/public/@spu/@conservation/documents/webcontent/spu01_003855.pdf
- Northwest Native Plant Guide:
<https://green2.kingcounty.gov/gonative/index.aspx>

Mulch

Possible problems to be solved:

- ✓ Soil is drying out often, leading to the need for excess watering.
- ✓ Soil is getting hardened by heat and drying from sun which makes it harder for water to penetrate.
- ✓ Staff are spending many hours weeding or making use of herbicides that can be harmful to the plants you want to keep and to the beneficial soil organisms.

Remedy:

- Maintain 2" or more mulch on beds. It will keep the soil moist, reduces water needs 50% in annual gardens and wide-spaced shrub/perennial beds. Mulch keeps soil loose and absorbent, and smothers weeds that steal water from desirable plants.

Stop Low Head Drainage



Example of low-head drainage

Possible problems to solve:

- ✓ Low head drainage is the leakage problem that sometimes occurs at the bottom of sloped irrigation zones. In some cases when the irrigation zone is turned off, water leaks out of one or more of the lowest heads in the zone, because of all the pressure built up from the water uphill from that spot.
- ✓ This can waste many gallons each time a zone runs / shuts down.

Remedy:

- Replace lowest sprinklers in affected zones with sprinkler bodies that have check valves and powerful springs.

Use Efficient Nozzles

Possible problems to solve:

- ✓ In many irrigation zones, there are nozzles that spray water out in a range of patterns. Some might put the water out in a 90-degree range, others at 180 degrees, and some at 360 degrees. Unless the nozzles have what is called 'matched precipitation rates', the water coming out of the 90-degree nozzle puts out 4 times as much water per square foot as the 360-degree nozzle. This means that if a zone with 360-degree nozzles needs to be run 4 times longer than zones with 90-degree nozzles.

Remedy:

- Install matched precipitation rate nozzles that will even out how much water comes out, though the nozzles may vary from 90 to 360 degrees in the arc they put the water out at.



Efficient nozzle example

Install Master Valves



Example of too high-water pressure

Possible problem to solve:

- ✓ Hidden leaks can waste water because they leak water all day until you learn about the leak and fix it.

Remedy:

- Installing a Master Valve can ensure that when the system develops a break or leak that it only wastes water for the hour or two each day that it is running until you find and fix the leak or break.

Reduce Excessive High Pressure

Possible problem to be solved:

- ✓ High pressure can waste 10-20% of water through misting and wears out equipment.

Remedy:

- A pressure-reducing valve in the right place can solve misting problems inexpensively.

The photo to the right is an example of too high pressure leading to water blowing away before it reaches the ground.

Install Flow Sensors

Possible problem to be solved:

- ✓ Leaks, breaks, and stuck heads go undetected.

Remedy:

- Flow sensors will send a signal to let you know that there is a problem in the irrigation system that needs attention now. Without this equipment and without checking meters and billing, water waste from a problem could go on for years.

Install Drip Irrigation Where Appropriate

Possible problem to be solved:

- ✓ Pop-up spray heads in planting beds can waste up to 50% of the irrigation water.

Remedy:

- Convert pop-up spray head zone to drip irrigation.
- Consult Dripworks online to get further information on drip irrigation and to obtain drip irrigation equipment. <https://www.dripworks.com/>



Kit to retrofit spray to drip



Drip irrigation spray



Drip lines in a raised bed

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- **Water Sense web site**, Great guidance on choosing the most efficient toilets, showerheads, faucets, urinals, pre-rinse spray valves, irrigation controllers, and irrigation spray sprinkler bodies. <https://www.epa.gov/watersense/watersense-products>