# Water Efficient Equipment and Design

A Guide for Non-Residential Construction and Development

Austin Water Utility
Water Conservation Division

## About this Guide

The life cycle cost for water and wastewater services can be significant. Building these savings into the design of the project can be a definite selling point for the property in the future as well as providing reduced operational costs from the start. This becomes even more important as water and wastewater costs continue to rise.

The following guide is intended as a source of information on equipment and design practices that can help achieve additional water savings above code requirements. This guide is targeted at new commercial and institutional construction projects, including major renovations of existing facilities. Where information is available, the estimated percent reduction in water use will be shown in brackets after the measure {##%}.

## Ten Guiding Principles

1. Use waterless technologies where available
2. Maximize use of on-site sources of water
3. Choose equipment that is water and energy efficient
4. Install automatic shutoffs, solenoids and controllers to turn water off when not in use
5. Reuse and recycle water where possible
6. Install flow restrictors where possible
7. Use countercurrent washing technologies where applicable
8. Meter and sub-meter major uses
9. Eliminate once-through cooling
10. Design for energy efficiency

## For More Information

If you have questions, would like assistance with water conservation, or have suggestions for additional water saving equipment and design features that are not listed in this guide please call the author, Bill Hoffman, at 512-974-2893 or e-mail your suggestion, questions, or information to bill.hoffman@ci.austin.tx.us.

Chapter One

# Irrigation Equipment and Landscape Design

Because of the unique nature of each landscape, it is hard to determine the percent of water use reduction that will be achieved by each measure. Even if every design method and equipment selection suggested here were followed, much of the potential savings could be lost if the system is not operated properly. With proper operation, however, commercial customers have documented irrigation savings of 25% to 75% over conventional landscapes.

## Irrigation controllers

- Select a weather-based controller.
- Install pressure regulators when design pressure exceeds manufacturer's recommendations.
- Consider freeze and wind shutoffs. Freeze sensors are required when watering the parkway strips.

*Install controllers that can be programmed to water on a 5-day schedule. Check controllers monthly, and after any power outages.*

## Irrigation equipment and design

- Use drip irrigation for shrub beds.
- Use matched precipitation spray and rotor heads.
- Create hydrozoned areas, with beds and turf watered separately.
- Design systems to maintain manufacturer-recommended pressure to prevent misting and unnecessary pipe wear (excessive velocity).
- In lieu of shrub risers, use surface or subsurface drip irrigation, or low-angle spray heads that direct water to the base of the plant.

## Soil

- Ensure soil depth is no less than 6".
- Enrich soil with 25% to 35% compost.
- Terrace any area that exceeds a 3:1 slope.
- Do not add soil on top of tree roots.

## Mulch

- Use organic, preferably locally derived mulch.
- Limit use of rock mulch due to increased heat and reflection.

## Watershed

- Use berms, swales and other landscape features to capture and direct water to planting areas.
- Where possible, capture rainwater for use on site. A deep soil profile combined with terraces, berms and swales is an effective way to both capture and store rainfall and reduce runoff pollution. These techniques also enhance the site's ability to use irrigation water effectively.

*Even well-designed landscapes using native and adapted plants can waste water if improperly maintained.*

## Plant selection

- Select plants on the Water Conservation Xeriscape Plant list.

## Plant installation

- Consider mature size of plants during installation and design.

A properly designed and maintained landscape helps reduce heat load, thus energy use in surrounding buildings.

Chapter Two

# Alternate On-Site Sources of Non-Potable Water

Alternate on-site sources of water are most economic to capture if included in the original design. Common uses for these sources include landscape irrigation, ornamental pond and fountain filling, cooling tower makeup, and toilet and urinal flushing.

Some of the sources that have been successfully captured for use include:

- Air conditioner condensate;
- Foundation (French) drain system water;
- Harvested rain and stormwater;
- Gray water (water from showers, baths, laundry, and hand washing sinks);
- Water from on-site wastewater treatment systems;
- Swimming pool backwash water; and
- Reclaimed water from a municipal system.

*A pond at the Freescale plant is Oak Hill used to harvest stormwater for non-potable uses.*

Including these sources in the design/construction phase is much more cost effective than retrofitting later, especially with the capture of air conditioner condensate and gray water. Sales and property tax exemptions as well as rebates from the City are applicable in many cases for the development of on-site sources of water. (Wells drawing from local aquifers are not eligible for rebates.) Sites using alternative on-site sources must comply with all applicable backflow prevention requirements.

Chapter Three

# Plumbing Fixtures and Practices

*The City of Austin offers free toilets or $110 rebates to help replace inefficient commercial fixtures.*

## Toilets & Urinals

- Ensure all water closets use no more than 1.6 gallons per flush. (See ASME A112.19.2 - Vitreous China Plumbing Fixtures & Hydraulic Requirements for Water Closets & Urinals.)
- Use only toilets on the City of Austin's approved list. The list can be found at: http://www.cityofaustin.org/watercon/toiletrebatelist.htm
- For tank-type toilets, achieve greater efficiency by installing high efficiency toilets (HET's) including: {20%-25%}
    - Dual-flush toilets that use 1.6 gallons per flush for solid waste removal and 0.8 to 1.2 gallons for liquid waste;
    - Pressure-assisted and gravity toilets that use less than 1.6 gallons per flush;
- For flush valve (flushometer) toilets, consider new dual-flush valves (e.g., Sloan) that reduce the liquid waste flush to about 1.1 gallons per flush. {20%-25% when used properly}
- Choose urinals that use only 0.5 gallons per flush. (Urinals are required to use no more than 1.0 gallons per flush.) Current City of Austin plumbing code does not authorize the use of non-water using "waterless" urinals. {50%}
- Use non-potable sources of water for toilet and urinal flushing.

## Faucets

- Install hand washing faucets that use no more than 1.0 gallons per minute. {30%-50%}
- Install sensor controls on hand washing faucets in public restrooms so they provide water only when hands are under the faucet. {10% - 50%}
- Install showerheads that use no more than 2.0 gallons per minute. {15%-20%}

## Outdoor Fountains

- Design all decorative water fountains to be recirculating. {up to 99% over fill-and-drain}
- Install meters on the makeup lines to identify leaks and other problems with large ornamental fountains.

*Recirculating fountains can enhance a facility's appearance while keeping water use low.*

## Plumbing Design

- Insulate all cold water pipes that may be exposed to freezing temperatures.
- Use tankless water heating or other devices that reduce water wasted waiting for the water to get hot where possible. {5% - 20%}
- Equip floor drains with either a flushometer primer or a p-trap primer where primers are needed. Avoid primers that have constant flow or are on a timer.
- If pressure is too high, install pressure regulators that keep pressure to all fixtures below 70 pounds per square inch.
- Where pumps are used, they should have mechanical seals instead of packing glands wherever allowed by code. Packing glands should have some weepage, but limited to ¼ to ½ gallon per minute for most building pumps, higher for larger industrial pumps. As the packing ages, it leaks at a faster rate and thus wastes more water.
- Post prominent signs in all restrooms, shower facilities, laundries, kitchens and other water using areas listing telephone numbers or contact persons to promptly report leaks and other plumbing problems.

Chapter Four

# Metering and Sub-Metering

Metering alone does not reduce water use, but it is key to identifying water use by type of activity and identifying leaks and other operational problems. Any meter used for billing purposes must comply with Austin Water Utility regulations, but for internal metering for your own information, a number of metering devices are available.

*Submeters can help track water use and identify leaks in large complexes and irrigation systems.*

- Install separate master and irrigation meters at each new commercial site or campus, in accordance with City Code. Campuses with multiple buildings or tenants should install separate sub-meters to aid in the detection and location of leaks or abnormal water use.
- Install a separate meter and keep monthly records for all major water-using functions such as ornamental outdoor fountains, pools and spas, cooling towers, major process equipment, and individual buildings. This is a key safeguard to determine equipment malfunction or leaks.
- Test all sub-meters annually to ensure that they are still operating properly. For smaller meters, the bucket and stopwatch method at both a high and low flow rate is adequate. For other test methods, refer to the manufacturer or call Austin Water Utility - Water Conservation at 974-2893 for suggestions. Austin Water Utility guidelines must be followed on meters used for wastewater billing or the evaporation credit programs.
- Where applicable, use wastewater meters. Austin Water Utility has both an evaporation credit program for cooling towers and a wastewater metering program. When officially participating in either program, the facility does not have to pay wastewater charges for water that is evaporated or consumed. For additional information, contact the taps office at 512-972-0036 or visit their web site at www.cityofaustin.org/water/tapforms.htm
- Place the wastewater cleanouts in a convenient location so that wastewater flows can be observed to detect leaks of flows of unknown origin that need to be investigated.

Chapter Five

# Heating, Ventilation, and Air Conditioning Equipment

For cooling towers and boilers to operate efficiently, they must first have conductivity (TDS) controls and meters that allow the operator to monitor their function.

## Cooling Towers

- Eliminate all once-through cooling, replacing with an air-cooled system or a cooling tower. {95% to 100%}
- On cooling towers, install both makeup and blowdown meters that comply with the City of Austin's Evaporation Credit Program and have conductivity controllers that activate the blowdown valve for dissolved solids control.
- Equip cooling towers with overflow sensors on the overflow pipes to alert the operator to problems that can waste thousands of gallons daily.
- All cooling towers should achieve at least five (5.0) cycles of concentration. {15-35%}
- Install side-stream softening and filtration equipment to help increase the cycles of concentration in cooling towers.
- Remember that design that reduces heat load also reduces cooling tower water use.

*Typical cooling tower*

## Boilers

- Equip boilers with makeup meters and conductivity controllers for blowdown control.
- Reuse or return steam condensate to the boiler wherever possible.
- Install makeup meters on all recirculating closed water loops used for heating and cooling systems so that leaks in these recirculating systems can be easily detected.

Chapter Six

# Water Treatment Equipment

## Water Softeners

- The City of Austin water is softened to approximately 95 milligrams per liter of hardness as CaCO3. Therefore, additional softening should not be necessary for most operations.
- If softeners are used, they should be recharged based on volume of use or by a hardness controller. Softeners with timers should be avoided.

## Filtration Equipment

- Filtration equipment should be used only where necessary. The backwash systems should be instrumented to actuate on pressure drop to avoid unnecessary backwashing.
- Reverse osmosis (RO) and nanofiltration equipment should be used only where absolutely necessary. Where used, the water reject rate should be less than the volume of filtered water produced.
- Filter backwash water and RO or nanofiltration reject water should be reused beneficially wherever possible (see Chapter 2, Alternate On-Site Sources of Non-Potable Water.)
- If pumps are part of the treatment process, they should have mechanical seals instead of packing glands.

*Efficient water treatment equipment can help reduce water consumption.*

Chapter Seven

# Pools and Spas

## Pool Design

- Design the overflow so it can be easily plugged or blocked when large groups swim in the pool to prevent water loss through the line due to sloshing water.
- If the pool has splash troughs, make sure that they drain back into the pool system.
- Minimize the use of fountains and waterfalls; aeration loses a significant amount of water to evaporation.
- Use shrubs and fences to reduce water losses due to wind evaporation.
- Install pool covers to reduce evaporation and keep water cleaner so that the number of backwashes and shock treatments are reduced.

*Proper pool maintenance and operation practices can result in lower water use.*

## Pool Operation and Maintenance

Backwashing uses hundreds to over a thousand gallons of water depending on the pool size, filter type and its operation. It is illegal in the City of Austin to discharge filter backwash water into either the sanitary sewer or the storm sewer.

- Recover filter backwash water for reuse on landscaping or other beneficial uses.
- Use water-saving equipment such as filters with cartridges where feasible. For filters that have a backwash, choose pool filter equipment that includes a pressure drop gauge to determine when the pool needs to be backwashed.
- Filters should have a sight glass so the operator can determine when to stop the backwash cycle.
- Meter makeup water for keeping the pool full and track use to determine if leaks are occurring.
- Monitor pool filling to prevent overflow.

## Chapter Eight
# Laundry Operations

- Large volume commercial operations should consider using tunnel washers.
- Consider water recovery or ozone systems in large commercial operations to minimize use. {20%-35%}
- Large commercial equipment should be easily programmable to use no more water than is required for the degree of soiling of the items being washed. {20%-40%}
- Large commercial operations should consider installing high recovery water recycle equipment. {70%-95%}
- Choose smaller clothes washers (under 4.0 cubic feet) that have a water factor of less than 6.5 gallons of water use per cubic foot. {30%-50%}
- Purchase residential equipment equal to or better than the 2007 standard set by the National Energy Policy Act. {30%-50%}
- Choose dryer equipment with dry lint collection systems.

*Water recycling equipment can reduce water use by as much as eighty percent.*

Chapter Nine

# Vehicle Washing

■ Where feasible, include water reuse equipment on vehicle washing equipment. {50%-80%} City Code now requires that new facilities be designed for easy retrofit of reuse equipment in the future.

■ Choose new rollover and conveyor equipment that uses less than 35 gallons per vehicle for automobiles and light trucks and less than 75 gallons per vehicle for bus and large truck washes. {50%-80%}

■ Select handheld spray wand equipment, foamy brush and similar systems that use no more than 3.0 gallons per minute for automobile washing and no more than 3.5 gallons per minute for bus and large truck washes.

■ Include positive shutoff valves on handheld spray wand, foamy brush and similar systems so water will not run when the equipment is not in use.

*Spray wand with 3.0 gpm nozzle*

## Other Water-Using Equipment

■ For new softeners installed at carwash facilities, use control instruments that measure volume of water treated or the actual quality of the water being softened.

■ Reuse reverse osmosis or nanofiltration reject water for vehicle washing in all rollover and conveyor type systems.

■ Use self-closing valves on chamois wringers.

Chapter Ten

# Food Service

## Equipment Selection

- Eliminate all water cooled equipment using once-through cooling. {95% to 100%} City Code now prohibits once-though cooling for new equipment.
- All water-cooled equipment should be eliminated unless it uses a chilled water or cooling tower loop. This includes ice makers, refrigeration equipment, and ice cream machines.
- Install 1.0 gpm hand-washing faucets. {25%-50%}
- Operate all other equipment in the most efficient way possible and select ENERGY STAR rated appliances where possible.

## Food Disposal

- Eliminate garbage disposals and sluice trough systems in favor of garbage cans and strainer baskets. {50%-100%}
- The use of strainer baskets also eliminates the need for a pulper system, thus eliminating both water and energy use for disposal.

*Typical pot and pan washing facility with power soaker*

## Dishwashing Equipment

- Ware washers (dishwashers) should use less than 1.2 gallons per rack for fill-and-dump machines and less than 0.9 gallons per rack for all other types of machines. For under the counter machines, water use should not exceed 1.0 gallons per rack for high-temperature machines and 1.7 gallons per rack for low-temperature machines. {15%-50%}
- A new state law requires that pre-rinse spray valves use 1.6 gallons per minute or less. {25%-60%}
- Ensure that ice cream scoop faucets use no more than 0.5 gallons per minute.
- Power soakers (Metcraft) for pots and pans can help reduce cleaning effort, but they consume 80 to 85 gallons per fill and 30 kWh per day.

## Food Preparation

- Use connectionless steamers. They do not need either a water supply or a wastewater drain. Most boilerless steamers are also efficient, but those that have a water connection and a drain are not.{80%-95%}
- Select ice machines that use no more than 20 gallons per hundred pounds of ice made. Flake ice machines are more water-efficient (12 gal/100 lbs) and should be used where possible. {15%-50% if replacing an air-cooled unit and 85%-95% if water-cooled}
- Use waterless (air cooled) wok system where possible. {100%} If a water cooled wok systems or water curtain system is absolutely necessary, the flow should be limited to less than half a gallon per minute.
- Provide sufficient refrigerator capacity to minimize thawing of food under running water. {100%}

*Air-cooled ice machines save water.*

## Floor Washing

The kitchen should be designed for easy cleaning and the easy use of squeegees and mops.

- Good: Use hoses with self-closing nozzles.
- Better: Use pressure washing equipment.
- Best: Use self contained spray and vacuum systems similar to carpet cleaners but designed for food service use.
- Consider new enzyme floor cleaning products.

Chapter Eleven

# Medical Facilities and Laboratories

Large hospitals operate facilities that in large part are similar to hotels with food service. All of the above items applicable to these types of operations should be considered. Medical facilities also have many unique types of equipment that use water. The following is a list of some of the more water-intensive operations and equipment found in these facilities.

## X-Ray Equipment

- For large frame X-ray equipment, install water saver kits on the cooling water loops of the film developers to eliminate continuously flowing cooling water. {75% to 95% of cooling water}
- Digital X-ray equipment eliminates all water use associated with film development. This also eliminates the need for backflow preventers.{100%}.

*Dry vacuum pump systems eliminate water use and save energy in medical and dental applications.*

## Vacuum Pumps

- For medical and dental vacuum pump systems, choose dry vacuum systems to eliminate water use and save energy. This also eliminates the need for the installation and annual inspection of reduced pressure zone backflow preventers.{100%}
- Eliminate venturi aspirator vacuum systems by using mechanical dry vacuum equipment. {100%}

## Sterilizers

Sterilizers can represent a significant water use in a medical facility. There are several categories of sterilization equipment: table top units, non-steam using equipment such as peroxide, radiation, ethylene oxide units, and large steam sterilizers. Hospitals and similar facilities have historically used either steam or ethylene oxide. Equipment that does not use steam is often used where heat would damage the items being sterilized such as plastic parts.

There are two types of ethylene oxide equipment. One type uses an ampoule of ethylene oxide placed in a plastic bag with the instruments in it. The bag is placed in a special cabinet that ventilates and removes the gas when done. The second type uses a stream of water to remove spent ethylene oxide and can use a continuous stream of water to create a vacuum. These use from 0.5 to 2.0 gallons per minute and can consume huge volumes of water over time. Because of health, safety and environmental issues relating to ethylene oxide use, ethylene oxide equipment is being phased out where possible. Where vacuum is needed, mechanical dry vacuum systems will eliminate water use, but the dry vacuum systems must be explosion proof since ethylene oxide is an explosive gas.

By far the most commonly used sterilization equipment used is the steam sterilizer. These include table top and freestanding units. Table top units use very little water and should be used where ever possible, but they have limited capacity and capabilities. The free standing units can be further divided into gravity and vacuum type units.

Both types of freestanding units use steam. When the steam condenses, it is discharged to the sewer through a steam trap. In accordance with the plumbing code, water being discharged to a sanitary drain can not exceed 140 degrees Fahrenheit. The condensate temperature must therefore be tempered either by mixing it with cooler water or by passing it over a heat sink. Older models and some current models use a continuous flow of potable water into the sewer to temper the steam trap discharge which only occurs for a few seconds every hour or so. This continuous flow can waste thousands of gallons a day and should be avoided.

The vacuum unit also uses a venturi ejector system to create a vacuum in the chamber to speed drying. These ejectors have flow rates of five to 10 gallons per minute. When purchasing any new equipment, be sure to get those features that minimize water use in tempering the steam trap discharge water to the drain.

Many new models offer a recirculation system for the venturi ejector that reduces water use significantly. This type of autoclave should be chosen when purchasing new units. There are also retrofit kits that achieve significant water savings for models without tempering water or ejector recirculation equipment. One company offers a system that

can be retrofitted to a steam sterilizer that eliminates water use for steam trap tempering and for venturi use entirely. {30% to 100%}

## Hood Systems

- For laboratory exhaust hoods, use dry systems wherever possible. {100%}
- Where exhaust hood scrubber systems are used, adjust flow rates to minimize water use. Incorporate recirculating systems and use alternate sources of water wherever possible. {10%-75%}
- Include self-closing valves on fume hood wash down systems for special applications such as perchloric acid hoods to limit water use.

## Water Filtration Equipment

The water used in kidney dialysis equipment can be produced by using deionization resins or by a combination of reverse osmosis and deionization. Deionization resins are often regenerated off-site by resin supplier/contractors thus eliminating water use at the clinic or hospital. These off-site regeneration operations are often more water efficient. When reverse osmosis (RO) is used at the medical facility, a reject stream equal to 25% to 60% of the incoming water volume is produced. Select RO equipment that minimizes water rejection. The product water from the RO unit should be able to be stored and used on demand as opposed to some older systems that produce RO water and continually dump the portion that is not used. {30%-100% for off-site resin regeneration}

Follow similar considerations for intravenous fluids and other medical fluids that require pharmaceutical grade water. {30%-100% for off-site resin regeneration}

## Equipment Selection

Use air-cooled medical and laboratory equipment where possible. If a cooling water system must be used, use a chiller or a closed loop system such as chilled water or cooling tower water loop instead of a single pass water cooling system. See examples of equipment that might use single pass (once-through) cooling water below. {100%}

*Recirculating cooling equipment saves huge amounts of water in laboratories.*

## Examples of Water Cooled Medical and Laboratory Equipment

Air Compressors

Centrifuges

Diffusion pumps

Electron Microscopes

Extractors

Gas Chromatography/Mass Spec.

Ion implantation equipment

Rotary Evaporators/Concentrators

Spectrometers of all types (FTIR, ICP, etc.)

Stills

Turbo Molecular Pumps

Vacuum Systems

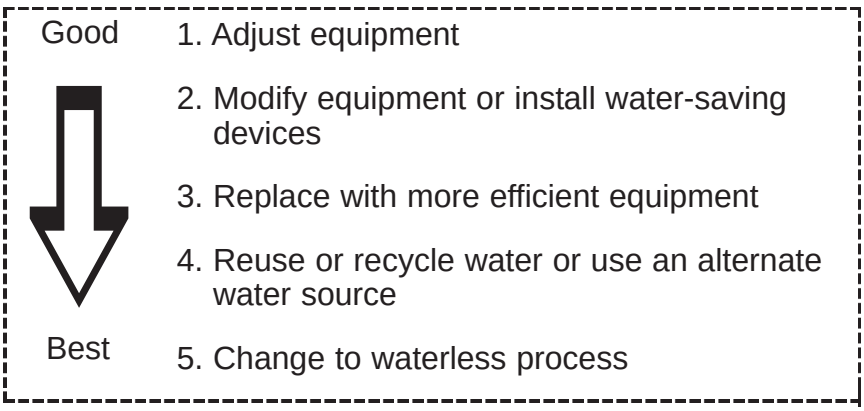
Water Cooled Optics & Lasers

X-Ray Equipment

Chapter Twelve

# Special Considerations for Other Types of Facilities

When examining any piece of equipment or water-using process, follow the ranking of measures below to ensure maximum optimum savings.




## Film Processing

The use of commercial roll film processing equipment is decreasing as digital cameras become the standard home and commercial media. In the past, film processing mini labs found in drug, grocery, and department stores used significant volumes of water. Some older equipment is reported to have used as much as 20 gallons of potable water per roll of film developed.

Almost all new roll film development equipment being installed today uses plumbingless technology. This new technology reduces chemical use and silver pollution, while reducing the amount of water needed to only a few gallons a day which is added by hand by the attendant.

- Choose "plumbingless" mini laboratory equipment that does not require a fill line with a reduced pressure zone (RPZ) backflow preventer and drain line. {99%)
- Strongly encourage digital technologies that eliminate water use and the discharge of pollutants. {100%} However, it should be pointed out that even if the picture is digital, some water will be used if conventional prints of the pictures are produced.

## Dry Cleaning

Currently, almost all dry cleaning establishments use perchloroethylene as the cleaning agent in their dry cleaning process. However, the use of perchloroethylene is being phased out due to new air quality standards. There are three competing technologies vying for the replacement market. These are supercritical carbon dioxide, silicone based technology, and a wet wash process. The wet wash process uses water in significant quantities and is not recommended. As for the other two technologies, water can be used for cooling and condensing, but air cooled equipment such as remote head condensers is commonly used, readily available, and recommended. {100%}

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