**BEST MANAGEMENT PRACTICE GUIDE FOR**

**TEXAS COMMERCIAL AND INSTITUTIONAL WATER USERS**

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**Introduction and Purpose**

The Texas economy is dependent on the continued availability of its limited freshwater resources. The State will need to spend tens of billions of dollars over the next 50 years to maintain existing water and wastewater infrastructure, expand systems to meet growing population and an expanding economy, and to meet the health and environment needs of all Texans. The commercial sectors represent a major component of the Texas economy, and our institutions form the backbone of the necessary services to make the economy work. The majority of Texans, over 80 percent, are employed in these two sectors (Figure 1.). This segment contains many components as illustrated in Figure 2.

Water and wastewater costs are rising more rapidly than electricity, natural gas, and other "utility" costs and overall inflation. These rising costs will impact the economic viability of these segments of the state's economy. Water efficiency is one of the key methods of keeping these rapidly rising costs under control while contributing to the overall sustainability of Texas' limited and precious water resources.

The purpose of this guide is to provide best management practices and technologies that can help reduce water and wastewater costs while conserving our state's most precious resource.

In addition to the commercial and institutional activities mentioned above, many consider public housing, apartments, and group housing to be in the quasi commercial and institutional domain. For this reason, these BMP's should be equally applicable to these residential facilities that operate as a business.

**Applicability**

All BMP’s described in this document are technically feasible and have been used in the past, AND are applicable to all commercial and institutional water users. Many are also applicable to industrial operations where a large number of people are employed. However, it does not mean that each BMP is applicable in all cases. Economic, structural and local water chemistry considerations all need to be taken into account.

**Definitions**

*Alternate water source* is defined as a source of non-potable water that is not suitable for human consumption.  Examples of alternate water sources are: rainwater, stormwater, condensate, treated graywater, process reject water, blowdown, foundation drain water, etc.

*Automatic shut-off device* is defined as an active system that stops the flow of water automatically when a leak is detected or a programmable system that stops the flow of water when the equipment is not in use.

*Closed loop system* is defined as a system that has no contact with the outside environment.

*EPA Energy Star* is defined as a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping to save money and protect the environment through energy efficient products and practices.

*EPA Water Sense* is defined as a U.S. Environmental Protection Agency sponsored partnership program that seeks to protect the future of the nation's water supply by promoting water efficiency and enhancing the market for water-efficient products, programs, and practices.

*Non-potable water* is defined as water that is not suitable for drinking.

*Once through cooling* is defined as water that is pumped through heat exchange equipment and then discharged into the environment.

*Potable water* is defined as water which is fit for consumption by humans and other animals.

*Reclaimed water* is defined as water from domestic or municipal wastewater which has been treated to a quality suitable for beneficial use.

*Recycled water* is defined as water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur.

*Reuse* is defined as treated wastewater that can be used for beneficial purposes.

*Self closing* is defined as a device, usually in a faucet or nozzle, which must be turned on by the user by pushing or pulling and closes when the user releases the handle or tap.

**Description of Best Management Practices**

Commercial and institutional operations use water in a very large variety of ways. Table 1. illustrates some of the more common water uses found in these various sectors. This section contains best management practices for water efficiency that the commercial and institutional sectors can use to reduce water use and cut operating costs

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| **Table 1. Examples or Water Using Technologies** **in the Commercial and Institutional Sectors** |
| **Type of** **End-Use Operation** | **Water Using Technology** |
| **Restrooms & Plumbing** | **Wash-down & Sanitation** | **Pools, Spas, & Fountains** | **Water Treatment Systems** | **Thermodynamic Processes** | **Laundry Equipment** | **Medical Laboratory Equipment**  | **Photo & Film Processing** | **Food Service Equipment** | **Process & Special Uses** | **Vehicle Wash** | **Landscape Irrigation** |
| 1 | Office Buildings | X | X | X | X | X |  | P |  | X |  |  | X |
| 2 | Schools | X | X | X | X | X | X | X | X | X | X | X | X |
| 3 | Restaurants & Other Food Service | X | X | X | X | X | X |  |  | X |  |  | X |
| 4 | Retail | X | X | X | X | X | X |  | P | X |  | X | X |
| 5 | Lodging | X | X | X | X | X | X |  |  | X |  |  | X |
| 6 | Grocery | X | X |  | X | X | X |  | X | X |  |  | X |
| 7 | Hospitals & Medical Clinics | X | X | X | X | X | X | X | X | X | X |  | X |
| 8 | Laboratories (research & medical) | X | X | P | X | X | X | X | X | P | X |  | X |
| 9 | Dental Clinics | X |  |  | P |  |  | X |  |  | P |  | X |
| 10 | Universities | X | X | X | X | X | X | X | X | X | X | X | X |
| 11 | Coin & Card Laundries | X | X |  | X | X | X |  |  |  | X |  | P |
| 12 | On-Premise & Industrial Laundries | X | X |  | X | X | X |  |  | P | X |  | X |
| 13 | Military Facilities | X | X | X | X | X | X | X | X | X | X | X | X |
| 14 | Arts & Crafts | X | X |  | X | X | X |  | X |  | X |  | X |
| 15 | Stadiums, Sports & Entertainment | X | X | X | P | X | X |  |  | X |  | P | X |
| 16 | Parks & Recreation (outdoor & indoor) | X | X | X |  | P | P |  |  | P |  |  | X |
| 17 | Zoos & Aquariums | X | X | X | X | X | X | X | X | X | X | X | X |
| 18 | Printers | X | X |  | X | X |  | X | X | P | X |  | X |
| 19 | Vehicle Washes | X | X |  | X | X |  |  |  |  | X | X |  |
| 20 | Other Equipment Not Listed | P | P | P | P | P | P | P | P | P | P | P | P |

In listing these Best Management Practices (BMP's) it is important to realize that no two facilities are alike. The technical and economic feasibility of each will need to be examined on a case by case basis. The determination of economic feasibility, the benefits and impacts on other resources and related topics are covered in sections following the BMP description.

In this section the following Best Management Practices are described.

1. Metering, Monitoring, and Measurement
2. Plumbing Fixtures, Fittings, and Equipment
3. Landscape Design and Irrigation
4. Food Service Operations
5. Laundry Operations
6. Water Treatment
7. Laboratory and Medical Facilities
8. Cooling Towers, Boilers and Other Thermodynamic Operations
9. Swimming Pools, Spas and Fountains
10. Vehicle Washes
11. Alternate Sources of Water

**I. Metering, Monitoring, Measurement, and Data Management**

The first step in managing any resource is to meter it's use, monitor how and when it is being used, and to be able to measure the effectiveness of any implemented water efficiency practices. The saying (" If you don't measure it, you can't manage it.") is certainly true for the management of water use in a commercial or institutional facility. The basic tool is the meter. It allows the facility to measure use, monitor potential problems, and verify that water saving technologies are working properly.

Most modern water efficiency codes require that larger water uses within a facility or campus be metered separately. A water meter should be installed in buildings connected to a public water system, including municipally supplied reclaimed (recycled) water. Meters should be easily accessible for reading and monitoring. A separate meter or sub-meter should be installed in the following locations:

1. The water supply for irrigated landscape with an accumulative area exceeding 2,500 square feet (232 m2).
2. The makeup water supply to cooling towers, evaporative condensers, and fluid coolers.
3. The makeup water supply to one or more boilers collectively exceeding 1,000,000 British thermal units per hour (Btu/h) (293 kW).
4. The water supply to a water-using process where the consumption exceeds 1,000 gallons per day (gal/d) (0.0438 L/s), except for manufacturing processes.
5. The water supply to each building on a property with multiple buildings where the water consumption exceeds 500 gal/d (0.021 L/s).
6. The water supply to an individual tenant space on a property where any of the following applies:
	1. Water consumption could exceed 500 gal/d (0.021 L/s) for that tenant.
	2. Tenant space is occupied by a commercial laundry, cleaning operation, restaurant, food service, medical office, dental office, laboratory, beauty salon, or barbershop.
	3. Total building area exceeds 50,000 square feet (4645 m2).
7. A makeup water supply to a swimming pool.
8. The makeup water supply to an evaporative cooler having an air flow exceeding 30,000 cubic feet per minute (ft3/min) (14,158.2 L/s).

Where daily total building water use of either potable or reclaimed water exceeds 1,000 gallons a day or alternate sources of water exceed 500 gallons a day, the water meters or submeters should be connected to a common monitoring site so that data can be recorded and accessible for viewing by the property manager or engineer.

Data on water use and energy use should be recorded so that it can be used to track trends to determine equipment efficiency. This type of data is also vital to benchmarking the effectiveness of water conservation efforts.

**II. Water-Conserving Plumbing Fixtures and Fittings**

In Texas, the Texas Commission on Environmental Quality (TCEQ) is responsible for setting minimum standards for water use by various plumbing fixtures under 30 TAC 290.g. Table 2.a. follows that regulation, but also makes additional recommendations based on the US Environmental Protection Agency's WaterSense program and recently promulgated national codes and standards. This includes performance testing of plumbing fixtures.

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| **Table 2.a****MAXIMUM FIXTURE AND FIXTURE FITTING FLOW RATES** |
| **FIXTURE TYPE** | **FLOW RATE** |
| Showerheads | 2.0 gpm @ 80 psi |
| Kitchen faucets residential | 1.8 gpm @ 60 psi |
| Lavatory faucets residential | 1.5 gpm @ 60 psi |
| Lavatory faucets other than residential | 0.5 gpm @ 60 psi |
| Metering faucets | 0.25 gallons/cycle |
| Metering faucets for wash fountains | 0.25 [rim space (in.)/20 gpm @ 60 psi] |
| Wash fountains | 2.2 [rim space (in.)/20 gpm @ 60 psi] |
| Water Closets (tank-type, & pressure and vacuum assist) | 1.28 gallons/flusha |
| Water Closets - Flush Valve | 1.28 gallons/flush(1.6 gpf in remote locations)c  see below. |
| Urinals | 0.5 gallons/flushb |
| a Should also be listed to EPA WaterSense Tank-Type High Efficiency Toilet Specification. b Should also be listed to EPA WaterSense Flushing Urinal Specification. Nonwater urinals are discussed belowc Remote location is where a water closet is located at least 30 feet upstream of the nearest drain line connections or fixtures, and is located where less than 1.5 drainage fixture units are upstream of the water closet’s drain line connection. |

1. **Flushometer-Valve Activated Water Closets.** Flushometer-valve activated water closets should be tested in accordance with Maximum Performance Testing by a MaP approved testing facility to ensure that it flushes more than 350 grams per flush.
2. **Non-water Urinals.** Non-water urinals should comply with ASME A112.19.3/CSA B45.4, ASME A112.19.19/CSA B45.4 or IAPMO Z124.9. Non-water urinals should be cleaned and maintained in accordance with the manufacturer’s instructions after installation. Where non-water urinals are installed they should have a water distribution line roughed-in to the urinal location at a height not less than 56 inches (1422 mm) above finished floor to allow for the installation of an approved backflow prevention device in the event of a retrofit. Such water distribution lines should be installed with shutoff valves located as close as possible to the distributing main to prevent the creation of dead ends. Where non-water urinals are installed, not less than one water supplied fixture rated at not less than 1 drainage fixture unit (DFU) should be installed upstream on the same drain line to facilitate drain line flow and rinsing.
3. **Residential Kitchen Faucets.** The maximum flow rate of residential kitchen faucets should not exceed 1.8 gallons per minute (gpm) (0.11 L/s) at 60 pounds-force per square inch (psi) (414 kPa). Kitchen faucets are permitted to temporarily increase the flow above the maximum rate, but not to exceed 2.2 gpm (0.77 L/s) at 60 psi ( 414 kPa), and must revert to a maximum flow rate of 1.8 gpm (0.11 L/s) at 60 psi (414 kPa) upon valve closure.
4. **Lavatory Faucets in Residences, Apartments, and Private Bathrooms in Lodging Facilities, Hospitals, and Patient Care Facilities.** The flow rate for lavatory faucets installed in residences, apartments, and private bathrooms in lodging, hospitals, and patient care facilities (including skilled nursing and long-term care facilities) should not exceed 1.5 gpm (0.09 L/s) at 60 psi (414 kPa) in accordance with ASME A112.18.1/CSA B125.1 and should be listed to the U.S. EPA WaterSense High-Efficiency Lavatory Faucet Specification.
5. **Multiple Showerheads Serving One Shower Compartment.** The total allowable flow rate of water from multiple showerheads flowing at any given time, with or without a diverter, including rain systems, waterfalls, body sprays, and jets, should not exceed 2.0 gpm (0.13 L/s) per shower compartment, where the floor area of the shower compartment is less than 1800 square inches (1.161 m2). For each increment of 1800 square inches (1.161 m2) of floor area thereafter or part thereof, additional showerheads are allowed, provided the total flow rate of water from all flowing devices should not exceed 2.0 gpm (0.13 L/s) for each such increment.

**Exceptions:**

* + 1. Gang showers in non-residential occupancies. Singular showerheads or multiple shower outlets serving one showering position in gang showers should not have more than 2.0 gpm (0.13 L/s) total flow.
		2. Where provided, accessible shower compartments should not be permitted to have more than 4.0 gpm (0.25 L/s) total flow, where one outlet is the hand shower. The hand shower should have a control with a non-positive shutoff feature.
1. **Bath and Shower Diverters.** The rate of leakage out of the tub spout of bath and shower diverters while operating in the shower mode should not exceed 0.1 gpm (0.006 L/s) in accordance with ASME A112.18.1/CSA B125.1.
2. **Shower Valves.** Shower valves should meet the temperature control performance requirements of ASSE 1016 or ASME A112.18.1/CSA B125.1 when tested at 2.0 gpm (0.13 L/s).
3. **Drinking Fountains.** Drinking fountains should be self-closing.
4. **Emergency Safety Showers and Eye Wash Stations.** Emergency safety showers and emergency eye wash stations should not be limited in their water supply flow rates.
5. **Water Supplied Trap Primers.** Water supplied trap primers shall be electronic or pressure activated and shall use no more than 30 gallons (114 L) per year per drain. Where an alternate water source, as defined by this code, is used for fixture flushing or other uses in the same room, the alternate water source shall be used for the trap primer water supply.
6. **Exception:** Flushometer tailpiece trap primers are exempted from the provisions of this section.
7. **Drainage Type Trap Seal Primer Devices.** Drainage type trap seal primer devices shall not be limited in the amount of water they discharge.
8. **Pressure Reducing Valves:** Proper pressure control in an important water conservation measure. High pressure can damage fixture and equipment valves and cause leaks and if a leak is present, high pressure will cause it to leak faster. Faucets, showers, hoses, and other equipment will also have higher flow rates unless they are of the pressure compensating type. Irrigation equipment also will mist and operate inefficiently if the pressure is too high. All indoor fixtures and appliances will operate at pressures of 60 pounds per square inch.
	* 1. Reduce in-building pressures to 60 psi or less, but keep the pressure above 30 psi.
		2. Follow manufacturers instruction on pressure requirements for water using equipment and irrigation equipment.
9. **Pumps**: In the past, pumps almost always were sealed using packing glands. This packing was designed to "weep" so that it remained moist. This allowed it to seal around the pump shaft to the motor to keep it cool and expanded to form a seal. Weep rates, according to manufacturers specifications are typically less than one gallon per minute, but as the packing wears, these rates tend to increase. Some fire codes require building fire pumps to have packing glands, but most pumps can be converted to mechanical seals that do not weep water. Therefore:
* Use only mechanical seal type pumps unless code requires packing glands.
* Where packing glands are used, locate the pump so that the shaft and gland discharge are clearly visible.
1. **Backflow Devices**: Backflow devices are essential to the protection of potable water supply systems. They must be kept in proper working order to accomplish this. One specific type of backflow preventer is the reduced pressure zone device (RPZ). By code, these devices must be located so that their discharge is visible. A discharge indicates that a backpressure event has occurred. If the device continues to leak a seal has failed and it needs repair.

**III. Landscape Design and Irrigation**

**UNDER DEVELOPMENT**

*The following is a possible outline for the chapter. It brings in the vital concept of soil, and landscape design, and alternate sources to minimize water use before plants, irrigation and maintenance are considered.*

1. **Design Landscape to keep water (rainwater, storm water, and irrigation water) where it falls. Coordinate with stormwater control features to maximize the capture of on-site stormwater.**
2. **Prepare soil shape and content to capture and hold the water**
3. **Design landscape to minimize the need for irrigation water (eliminate irrigation systems where possible)**
4. **Minimize turf areas and choose adapted and drought tolerant plant materials**
5. **Meter or sub-meter installed irrigation systems**
6. **Capture and use on-site sources of water and/or reclaimed water**
7. **Design efficient irrigation system using US EPA WaterSense principles**
8. **Practice proper maintenance**

**IV. Food Service Operations**

Food service operations are found in many commercial and institutional facilities ranging from prison kitchens, to fine dining restaurants. Water use in commercial kitchens includes water use for cleaning, cooking, scullery operations, and related activities. The following list provides guidance for purchasing and using equipment, appliances, fixtures and water using devices in commercial kitchens.

Scullery OperationsAll kitchens must clean plates, pots, pans, utensils and equipment used in the preparation food. The following lists equipment commonly found in scullery operations and provides guidance for their purchase and use.

1. **Commercial Pre-Rinse Spray Valves** The flow rate for a pre-rinse spray valve installed in a commercial kitchen to remove food waste from cookware and dishes prior to cleaning should not be more than 1.3 gpm (0.08 L/s) at 60 psi (414 kPa). Where pre-rinse spray valves with maximum flow rates of 1.0 gpm (0.06 L/s) or less are installed, the static pressure should be not less than 30 psi (207 kPa). Commercial kitchen pre-rinse spray valves should be equipped with an integral automatic shutoff. Once the US Environmental Protection Agency's WaterSense program issues its guidance on pre-rinse spray valves, WaterSense flow rates should replace those recommended in this section.
2. **Ware Washers** Dishwashers are found in many food service operations. Many are leased equipment, especially in restaurants. Institutional facilities tend to purchase such equipment. Weather purchasing or leasing equipment, it is the responsibility of the establishment leasing the equipment to ensure that the equipment is efficient. For leases, the efficiency of the equipment should be stated in the lease. The US Environmental Protection Agency's Energy Star program provides lists of such equipment including information on water and energy efficiency for Under the Counter, Door-type, and Conveyor type ware washers. The Energy Star program recommends the following:

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Rack type dishwashers typically are limited to use in institutional and commercial settings where a large number of people are fed. The US EPA has stated that they plan to rate such equipment in the future. In the interim, it is recommended that flight type machines use no more than 170 gallons per hour for each as specified by the manufacturers for single width machines. In all cases, fill and dump warewashing equipment should not be used.

1. **Disposal for Food Waste** In recent years, all have realized that food wastes are actually "misplaced resources." Composting of food waste has become commonplace is some communities. Composting facilities tend to fall into four categories:
	1. On-site composting,
	2. Off-site composting facilities,
	3. Composting at sanitary landfills and waste disposal facilities, and
	4. Collection and composting of sewage sludge that contains waste from garbage disposal.

Composting is not specifically a water efficiency measure even though compost helps save water in the landscape. The choice of disposal methods, however will influence the food waste handling technology used in the kitchen

Commercial and institutional entities have several choices of how to handle food wastes within their kitchen facilities. The use of scraping into collection bins and the use of strainer baskets to catch food waste instead of using mechanical systems has increased in recent years. Table 2. summarizes the operating characteristics of the options available. In addition to disposal equipment (grinders, mechanical strainers, pulper/compactors, and strainer baskets), troughs that are fed with either fresh or recirculating water are used in place of scraping into garbage receptacles to flush food waste down the drain to the mechanical types of equipment.

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| **Table 2. Summary of Four Waste Disposal Methods** |
| Parameter | Grinder | Mechanical Strainers | Pulper | Strainer Basket |
| Solids to Sewer | Yes | No | No | No |
| Recirculate | No | Yes | Yes | No |
| Strain Solids | No | Yes | Yes | Yes |
| Compost Produced? | Potentially at Wastewa-ter Facility | Yes | Yes | Yes |
| Solid Waste Produced? | No | Yes | Yes | Yes |
| Flow Restrictor? | Yes | No | No | N/A |
| Horsepower | 1-10 | 0.75-7.5 | 3-10 | 0 |
| Potable Water Use (gpm) | 3-8 | 1-2 | 1-2 | 0 |
| Sluice Trough (gpm) | 2-15 | 2-15 | 2-15 | 0 |

Based on information from the State Energy Conservation Office's **WATER EFFICIENCY STANDARDS FOR STATE BUILDINGS AND INSTITUTIONS OF HIGHER EDUCATION FACILITIES** and several national "green plumbing" codes, the following recommendations are made:

1. If applicable, manual scraping and scrapping baskets should be used instead of garbage grinders and disposals.
2. All garbage disposals should be air-cooled.
3. Manual pre-wash units should have shut-off valves that turn water off when nozzle is not in operation.
4. All garbage Food Waste grinders' (disposals) water flow rates should not exceed the minimum water flow rate specified by the manufacturer. A flow restrictor shall be installed on the water supply to limit the water flow rate to the minimum flow as specified by the manufacturer.
5. Disposals (grinders) and mechanical strainers and pulper systems should be equipped with solenoid valves that shut off the equipment every ten minutes. This will require the operator to push the start button, but prevents equipment using energy and water when not in use.
6. Pulpers and mechanical strainer systems shall have potable water flow rates that do not exceed 2.0 gallons per minute.

**Cooking Equipment:** Steamers, combination ovens, pasta cookers, and steam kettles and similar equipment all use water in the cooking process.

1. Steamers: Steamers are used to cook food with steam generated either in an external boiler or from water in a pan with a heating element under it at the bottom of the pan. Boiler type steamers must be connected to both a water supply and a drain to the sewer. Boilerless types do not need such connections, unless they are connected to an automatic refill valve. Boiler type steamers find use in restaurants where the door is opened often and temperature recovery time is critical. Boilerless types do not recovery temperature as fast but are significantly more energy and water efficient.

Boiler type steamers sometimes are required to have cold water lines drain into the sewer to keep temperatures in the sewer drain below 140oF. Many such "tempering water" lines are simple cooper or plastic tubes connected to a valve. Water runs continuously all day. The best practice is to set the discharge from the steamer so that tempering water is not needed. If that is not possible, a solenoid valve that only opens when the boiler is in operation should be installed.

1. The recommendations for steamers are as follows:
2. Use a boilerless steamer where ever possible. Most institutional facilities can use boilerless steamers.
3. Boilerless steamers should not use more than 2.0 gallons of water per hour per pan.
4. Boiler type steamers should not use more than 5.0 gallons of water per hour per pan.
5. Combination Ovens: Combination ovens, as the name implies can cook in several modes including baking, broiling, and steaming or a combination of the three. Combination ovens should not use more than 3.5 gallons of water an hour.
6. Pasta Cookers: Pasta cookers are used where large volumes of cooked pasta are prepared. They look much like a commercial fryer, but are used to bring water to a boil and cook pasta. They can be continuously filled with some water overflowing to the drain to maintain starch levels in the water. Pasta cookers should be equipped with temperature controls to keep them at a simmer rather than a rolling boil. If overflow is practiced, it should be minimized.
7. Steam Kettles: Steam kettles are used to cook large volumes of food. The steam enters a chamber surrounding the cooking vessel (pot) and condenses. This heats the cooking vessel and its contents. Steam can either be supplied by a remote boiler or by a self contained boiler. In both cases, the steam condensate should be returned to the boiler. Cooking pot valves at the bottom of the cooking vessel are used to drain liquids and cooked foods from the pot. These valves tend to develop leaks if not maintained and should be checked routinely for leaks.

**Refrigeration, Ice Makers, Frozen Custard and Similar Equipment:** All of this equipment uses mechanical refrigeration to remove heat from food products to cool them or freeze them. Three recommendations regarding this equipment will help reduce both water and energy use.

1. All once through (pass through) cooling should be eliminated,
2. All ice machines should be EPA Energy Star Listed,
3. Flake ice machines should be used where possible since they are the most energy and water efficient types,
4. Cube type ice machines and others producing hard ice should use less than 20 gallons per 100 pounds of ice,
5. Air cooled equipment should be used exclusively,
6. Remote systems will reject heat to the outside thus reducing heat load in the building, and
7. Where water cooled equipment is used, it should be connected to a chilled water or cooling tower loop, but water cooled equipment of any kind is strongly discouraged.

An example of why once through cooling is completely discouraged in the use of water cooled ice machines. Based on the latest information from the US Department of Energy, water cooled ice machines reduce electric costs 13.7 cents per 100 pounds of ice made at 10 cents per kilowatt hour, but these machines require from 85 to 200 gallons of cooling water for every 100 pounds (12 gallons) of ice made.

Even at a combined water and sewer cost of $2.50 per thousand gallons, a very low cost, water and wastewater costs far outweigh the energy savings for making ice with water cooled machine. Table 3 illustrates this. Most Texas Cities charge far more than $2.50 for combined water and sewer costs so the savings by using an air cooled machine are even greater.

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| **Table 3. Air Cooled Cost Savings Using** **DOE Latest Recommended Energy Standards for Ice Machines.** |
| **Gallons of water needed per 100 lb. of Ice Made\*** | **Cost of Water and Wastewater Combined *$2.50 per kGal***(Cents/100 Pounds) | **Energy Savings per 100 Pounds With Water Cooled Equipment at *10 Cents per kWh.***(Cents/100 Pounds) | **Net Savings per 100 Pounds with *Air Cooled* Equipment**(Cents/100 Pounds) |
| **85** | **21.25** | **13.7** | **7.6** |
| **100** | **25** | **13.7** | **11.3** |
| **150** | **37.5** | **13.7** | **23.8** |
| **200** | **50.0** | **13.7** | **36.3** |
| *\* Based on a survey of all water cooled ice machines available on the US market.* |

**Other Equipment:**

**Wok Stoves:** A wok stove is a Chinese pit-style stove. In a conventional wok stove, the burner chimney and ring are affixed to the top of the stove; as a result, heat is trapped under the cook top. Water jets are installed to enable cooling water to flow at approximately 1.0 gpm per burner across the cook top to absorb the heat. Waterless wok stoves, a relatively new technology, are cooled with air, and thus do not require the use of cooling water. These wok stoves' function by creating an air gap between the burner chimney and ring and the top of the stove so that the heat can be released directly from beneath the cook top and vented to the kitchen exhaust. Commercial kitchens using woks should investigate using this new technology that saves both water and energy.

**Grease Interceptors.** Grease interceptor maintenance procedures shall not include post-pumping/cleaning refill using potable water. Refill shall be by connected appliance accumulated discharge only.

**Dipper Well Faucets.** Where dipper wells are installed, the water supply to a dipper well shall have a shutoff valve and flow control. The flow of water into a dipper well shall be limited by at least one of the following methods:

1. **Maximum Continuous Flow.** Water flow shall not exceed the water capacity of the dipper well in one minute at supply pressure of 60 psi (414 kPa), and the maximum flow shall not exceed 2.2 gpm (0.14 L/s) at a supply pressure of 60 psi (414 kPa). The water capacity of a dipper well shall be the maximum amount of water that the fixture can hold before water flows into the drain.
2. **Metered Flow.** The volume of water dispensed into a dipper well in each activation cycle of a self closing fixture fitting shall not exceed the water capacity of the dipper well, and the maximum flow shall not exceed 2.2 gpm (0.14 L/s) at a supply pressure of 60 psi (414 kPa).

## Practices and Policies: Simple, effective practices are the cornerstone to sustainability and water conservation. Integrating water efficiency into employee training and company policies set a tone that the organization is committed to sustainability and conservation. Most water conservation practices require simple, low or no cost changes by staff and management that quickly integrate into employee's daily routines. There are literally hundreds of ways to save water in foodservice operations. A few are listed here:

1. Defrost meats in refrigerators rather than under running water. If you must use running water, keep the water flow to a minimum rate that circulates the water. The faucet (using an efficient aerator) does not need to be fully on.
2. Keep lids on boiling water during slow times
3. Use dry cleaning techniques (broom and mop) rather than spraying water to clean floors or use a [waterbroom](http://www.watermiser.com/) instead of a hose
4. Do not use running water to melt ice. Put the ice in the mop sink or dish sink where it will melt during regular use.
5. Implement proper [fat, oil and grease](http://www.sustainablefoodservice.com/cat/fog.htm) handling best practices
6. Serve water to guests only on request

**V. Laundry Operations**

Laundry operations in commercial and institutional facilities generally can be grouped into three types of operations:

1. Self-Service (coin or card operated) laundry equipment found in facilities such as laundromats, dorm, self serve hotel laundry rooms, and at apartment laundry rooms,
2. On-premise laundry equipment found at hotels, hospitals, prisons, nursing homes and other facilities that wash clothing, bedding and food service toweling in a common laundry facility, and
3. Industrial laundry operations that take in laundry from a variety of entities.

**Self-Service** laundry equipment was once dominated by "single load" top loading washers. With the advent of front loading equipment, clothes washers have become much more efficient.

For single load self-service equipment, the US Environmental Protection Agency Energy Star program recommends a Water Factor (WF) of 4.5 gallons per load of clothes per cubic foot of capacity and an energy factor (EF) of 2.2 cubic feet per kilowatt-hour (kWh) per load.

Many laundromats now have multi-load equipment able to wash more than the standard 20 pounds of laundry per load. Equipment meeting a water factor (WF) of 4.5 or less is available. At a minimum, a water factor of 5.5 or less is recommended.

Most self-serve clothes washers are leased from "rout operators." The contract and service agreement with the rout operator should specify that all clothes washers have a water factor of 4.5 or less..

**On-Premise** laundry equipment is rated by the pounds of laundry that can be washed in a single load. Sizes range from 50 pound to 800 pound machines. The common term used to describe these large clothes washers is "washer-extractor" since they both wash and "spin-dry" the clothes. Unlike self-serve equipment that have a set wash cycle, on-premise equipment can be set to the type of laundry being washed. Variable factors include formulation of detergent and chemicals used, number of wash, rinse and additive cycles, water level, water temperature, and wash (dwell) time.

## To maximize the efficient operation of commercial washer-extractor equipment, consider the following:

1. Consult manufactures literature and compare energy and water efficiencies of equipment when leasing or purchasing new washer-extractors;
2. Separate and wash laundry based upon the extent to which materials are soiled and type and color of materials. Set water levels, number of cycles and formulation accordingly. This can have a significant impact on total water use. Highly soiled materials can typically require over 3.0 gallons of water per pound of laundry, while sheets and lightly soiled materials require only about 2.0 to 2.5 gallons of water per pound of laundry;
3. Work with the equipment manufacturer and supplier to provide an ongoing service and maintenance program; and
4. Consult service personnel and the laundry’s supplier of chemicals for the wash equipment to ensure that equipment is operating at optimal efficiency.

**Industrial Laundries** are similar to on-premise systems, but offer laundry services to mainly commercial entities that do not wish to operate on-premise systems. For washer-extractor equipment, the recommendations are the same as that for on-premise laundries. For very large operations, continuously operating tunnel washer can be used in place of washer-extractors. Tunnel washers maximize energy and water efficiency. Dirty clothes are continuously loaded on one end into the "first flush" chamber, while fresh water enters the final rinse chamber at other end. This water is cascaded. These systems are capable of washing over 2,000 pounds of laundry an hour. Even heavily soiled materials use under 2.5 gallons per pound of laundry and overall operations reduces water use to about 2.0 gallons per pound of laundry or less for lightly soiled materials.

Tunnel washers are very efficient, but also very expensive. Each industrial laundry operation will need to conduct a cost - benefit analysis to determine if a tunnel washer is an option for their operations.

**Water Recycle, Reuse, and Ozone Addition** are other ways to reduce potable water use. Recycle refers to recycling water with little treatment. An example of this is the recycle of final rinse water for first flush or for surfactant (soap) cycle. Reuse involves some level of treatment before the water is reused. Ozone is used as a disinfectant and a way of reducing other chemical use.

* Recycle systems are the least expensive type systems. They can be installed on washer-extractors for a few thousand dollars.
* Reuse equipment can treat and reclaim water used by washer-extractors. Some systems only reuse various rinse waters while others treat all water discharged from washer-extractors. Recovery ranges from 20 percent of water use to 85 percent of water use depending on the sophistication of the system. Cost can range from a few $10's of thousands of dollars to hundreds of thousands of dollars for large systems that recover over 80 percent of the water.
* Ozone is a powerful disinfectant and whitener. For lightly soiled clothes, it can reduce water use by reducing the number of wash cycles a washer-extractor must use. Water savings in the range of 20 to 30 percent have been reported. Heavily soiled material, especially cloth solid with grease or oil will still require the use of detergent cycles. Ozone systems can be easily disconnected or left off. Management will have to ensure that workers are trained so that the full benefit of these systems can be realized.

The selection of recycle, reuse or ozone systems is encouraged, but each laundry operation will have to conduct its own cost - benefit analysis.

**VI. Water Treatment**

Water treatment needed in the institutional and commercial sectors to:

* Treat water to improve the longevity and function of water using equipment,
* Treat water that is being recycled,
* Treat alternate sources of water,
* Pre-Treat wastewater to meet discharge standards to a sanitary sewer, and
* Treat wastewater for disposal on site.

Treatment needs range from the need to soften water for laundry operation and commercial dishwashers, to grease traps to pre-treat restaurant wastes, to recycling water at car washes, to treating water at hospitals for kidney dialysis. Table ?? shows examples of water treatment used in example commercial and institutional operations.

|  |
| --- |
| **Examples of Water Treatment** |
| ***Operation*** | **Sediment Filtration** | **Act. Carbon** | **Softening & Ion Exc.** | **Membrane Process** | **Distillation**  | **Disinfection** | **Biological Treatment** | **Other** |
| **Food Service** | **X** | **X** | **X** | **X** |  | **X** |  | **X** |
| **Laundry & Dry Cleaning** | **X** |  | **X** | **?** |  | **X** |  | **X** |
| **Hospital & Laboratory** | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** |
| **Car Wash** | **X** |  | **X** | **X** |  | **X** | **X** | **X** |
| **Cooling Towers & Boilers** | **X** |  | **X** | **X** |  | **X** |  | **X** |
| **Pools, Spas & Water Features** | **X** |  |  | **?** |  | **X** |  |  |
| **Office and Non - Process Uses** | **X** | **X** | **X** | **X** |  | **X** |  | **X** |

When considering treatment of water for commercial purposes, protection of public health should always be a primary consideration. Licensed plumbers, and those licensed to install point of use/point or entry equipment are trained to properly install water treatment devices. For more complicated systems, the services of a licensed engineer may be needed. Treatment of the water should not exceed the level of quality needed for the intended end use. The following best practices will minimize water use. Again, the best conservation method is to not install water treatment equipment if it is not needed for the intended use of that water.

1. Filters: Sediment filters include sand, coated media such as diatomaceous earth, cartridge, bag, and membrane filters(micro and ultra filters). All remove particulates by capturing them on their surface. At some point, the buildup of sediment will have to be removed. Sand and membrane filters are cleaned by backwashing. Coated medial filters are flushed of sediment laden filter material and recoated, and some cartridge and bag filters are removed and washed. For sand and membrane filters:
	* Backwash based on pressure drop, not timers,
	* Size the filter to the need,
	* Consider ways to reuse the backwash water.

For coated media filters:

* choose filters that have a recoat function so that the media (such as diatomaceous earth, perlite, or cellulose) can be "bumped off" and recoated several times before the pressure drop reaches the level needed for backwash.
* Backwash based on pressure drop
* Size the filter to the need
* Consider ways to reuse the backwash water.

For washable cartridge and bag filters:

* Wash based on pressure drop, not timers.
* Minimize water use for the cleaning operation
1. Softening and Ion Exchange: These technologies are used to remove cations and anions. In the case of softening, sodium ions are exchanged for calcium and magnesium cations. Ion exchange devices actually replace cations and anions with hydrogen and hydroxyl ions.
	* Do not use timers to regenerate systems
	* For smaller systems, use flow meters that are set to regenerate base on average water quality. Actuation of regeneration of water softeners shall be by demand initiation. Water softeners shall be listed to NSF/ANSI Standard 44. Water softeners should have a rated salt efficiency exceeding 3400 grains (gr) (0.2200 kg) of total hardness exchange per pound (lb) (0.5 kg) of salt, based on sodium chloride (NaCl) equivalency, and shall not generate more than 5 gallons (19 L) of water per 1000 grains (0.0647 kg) of hardness removed during the service cycle
	* In residential buildings, where the supplied potable water hardness is equal to or less than 8 grains per gallon (gr/gal) (137 mg/L) measured as total calcium carbonate equivalents, water softening equipment that discharges water into the wastewater system during the service cycle should not be used except as required for medical purposes.
	* For larger systems, use analytical equipment to determine when softener or ion exchange beds are nearly exhausted.
2. Reverse Osmosis (RO) and Nanofiltration: Small, under-the-counter units tend to waste a large percent of water processed . Their use should be limited to absolute need. Some such systems will actually repressurize the reject water and reintroduce it into the potable water plumbing for use elsewhere in the building. When purchasing RO and nanofiltration equipment for larger commercial use, larger units should recover at least 75 percent of the feed water. Smaller systems will be less efficient. Careful selection to minimize the percent of reject water will maximize water efficiency. RO and Nanofiltration reject water should be captured and reused for irrigation, cooling tower makeup, and other appropriate uses where ever possible.
3. Distillation systems for water purification should have at least an 85 percent recovery rate for distillated water and not be cooled by once-through-cooling.
4. All other treatment devices should be sized properly. Most do not have reject streams or need backwashing. In the case of wastewater treatment for on-site reuse or recycle, choose equipment that treats to the quality needed. All recycle systems and on-site wastewater treatment systems should follow all applicable regulations of the Texas Commission on Environmental Quality and requirements from local jurisdictions having authority.

**VII. Laboratory and Medical Facilities**

Laboratory and medical facilities include but are not limited to:

* clinics
* hospitals

• dental offices

• veterinary facilities

• medical laboratories

• university & analytical laboratories

• industrial/commercial laboratories

• any operations using similar equipment

Equipment of specific interest include:

1. Vacuum systems,
2. Sterilizers,
3. Instrument and Glassware Washers,
4. Vivariums
5. Exhaust Hood Scrubbers,
6. Large Frame X-Ray Film Developers,
7. Water Treatment Equipment to Produce Ultra Pure Water, and
8. Laboratory and Medical Equipment Cooling

In addition to the equipment listed above, most of these facilities have domestic, food service, cooling, heating, irrigation and related water uses. These uses are discussed in their own sections.

1. **Vacuum Systems**:

Almost all modern laboratories, hospitals, and dental offices have vacuum systems for either drawing vacuum to remove bodily fluids or to draw fluids and gasses. Very high vacuum pump systems find limited use in some special areas and are not the topic of this discussion.

In the past, aspirator or venturi vacuum systems were common. These form a vacuum using the Bernoulli effect. They are extremely wasteful ways to create a vacuum, but have been the mainstay for many chemistry labs since the fumes from organic compounds and acids are immediately mixed with water. The next most common type of vacuum system from the past is the liquid ring vacuum pump. These are mechanical pumps that use water to cool the pump and create the seal for generating the vacuum. For years, most hospitals and dental offices used these pumps.

Modern dry vacuum pump systems are both more energy efficient and eliminate the use of water. With the exceptions of explosive or very corrosive environments, dry vacuum systems should be use for all vacuum purposes. Currently the only exception are medical vacuum sterilizers in the United States. They are limited to liquid ring or venturi vacuum systems according to Federal Drug Administration requirement. However, laboratory and pharmaceutical vacuum sterilizers can us dry vacuum systems. In Europe and elsewhere, dry medical vacuum systems are now being approved.

1. **Sterilizers**:

Based on Federal Drug Administration regulations, sterilizers are divided into medical, pharmaceutical, and laboratory categories. Medical sterilizers are further divided into gravity, vacuum and table type systems. Table top sterilizers are small systems that use little water and should not be of concern. These best management practice recommendations regard large, stand alone gravity and steam sterilizers. These sterilizers require a supply of "high purity" steam which means that the boiler for the sterilizer is fed with distilled water. The two main concerns regarding sterilizers is the way steam trap discharge is handled, and the type of vacuum system used for vacuum sterilizers.

Steam Trap Discharge: For both types, the steam jacket surrounding the actual chamber in which instruments are place is kept hot with live steam. Some of this steam condenses and therefore, several times a day, a small amount of steam condensate (pure water from steam) is discharged. Current plumbing codes require that water entering the sanitary sewer may not exceed 140°F (60°C). In the past, tap water was continuously discharged to the same trap that the steam condensate discharged to. The water never was turned off and significant volumes of water were wasted. There are five methods to reduce this use. They are arranged in the order of maximizing energy and water savings from least savings to most savings. These include:

1. Installing water tempering devices (since 2000 most all systems contain these devices),
2. Using a chilled water loop to cool the condensate prior to discharge,
3. Install sterilizers with self contained boilers that return all steam jacket condensate.
4. Capture waste heat for other uses,
5. Returning the steam jacket condensate to the mail high purity boiler.

Vacuum Sterilizer Systems:

1. Eliminate the use of venturi type vacuum systems,
2. Use dry vacuum pumps and systems for all non-medical vacuum needs, and
3. For medical sterilizers, use liquid ring vacuum systems until dry vacuum systems are approved for use as they are in Europe.
4. **Instrument and Glassware Washers:**

Instrument washer-disinfectors and laboratory glass ware washers are not rated for water use. However, when purchasing such equipment, compare models for water and energy use. The new 2012 Draft for the US Green Building Council's LEED recommendations for washer-disinfectors is no more than 0.35 gals per standard U.S. tray for instruments.

1. **Vivariums :**

Vivariums are found in many laboratory, medical, pharmaceutical, and related research facilities. These can range from laboratory rat and rabbit operations to primate facilities.

Vivariums use equipment and practices specific to animal care, such as automatic animal watering systems. Vivariums and other animal maintenance facilities can consume large volumes of water because of the need for constant flows and frequent flushing cycles. If it is properly sterilized, this water can be recirculated in the watering system rather than discharged to drains. Where this water cannot be recycled for drinking because of purity concerns, if it is sterilized, it is still likely to be acceptable for other purposes, such as cooling water make-up, or for cleaning cage racks and washing down animal rooms.

Cage, Rack, and Bottle Washersare found in vivariums and animal research facilities. The equipment ranges from conveyor washers for mice and rat cages that closely resemble conveyor dishwashers to large compartment washers that can hold carts of cages or large primate cages. The following Best Management Practices information is provided as part of the U. S. Environmental Protection Agency’s "Labs for the 21st Century" program.

* Replace older inefficient cage and rack washers with more efficient models. Look for models that recycle water through four cleaning stages using a counter-current rinsing process. In counter-current rinsing, the cleanest water is used only for the final rinsing stage. Water for early rinsing tasks (when the quality of rinse water is not as important) is water that was previously used in the later stages of rinsing operations.
* Retrofit existing cage and rack washers to make use of counter-current flow system to reuse final rinse water from one cage-washing cycle in earlier rinses in the next washing cycle.
* Use tunnel washers for small cage cleaning operations.
* Sterilize and recirculate water used in automatic animal watering systems instead of discharging water to the drain. Consider using water that cannot be recycled for drinking due to purity concerns in other non-potable applications, such as cooling water make-up or for cleaning cage racks and washing down animal rooms*.*
1. **Exhaust Hood Scrubbers:**

Liquid scrubber systems for exhaust hoods and ducts should be of the recirculation type. Liquid scrubber systems for perchloric acid exhaust hoods and ducts should be equipped with a timer-controlled water recirculation system. The collection sump for perchloric acid exhaust systems should be designed to automatically drain after the wash down process has completed.

1. **Large Frame X-Ray Film Developers:**

Small X-ray film processors such as those found in dental offices use little water and are not of concern. Medical facilities that have not converted to digital systems for large X-rays should be encouraged to do so as soon as possible. Processors for X-ray film exceeding 6 inches (152 mm) in any dimension should be equipped with water recycling units.

1. **Water Treatment Equipment to Produce Ultra Pure Water:**

Water treatment equipment that employees nanofiltration or reverse osmosis (RO) all have reject streams of water from the equipment. The general rule of thumb is that the larger the equipment, the more efficient it is. For this reason, where large volumes of RO water is needed, a single central large RO system that has a product water recovery rate of 75 percent or better can be used. For smaller operations that do not require a central system, product water recovery rates of 50 percent are possible. All systems should be shut down when not in use. Kidney dialysis systems, ultrapure water systems for laboratory use and high purity steam requirements for sterilizers should all be designed using the water treatment best practices discussed in that section.

1. **Laboratory and Medical Equipment Cooling:**

Once through cooling should be eliminated except for emergency conditions in medical settings. A detailed discussion of cooling is presented on the sections on Cooling and Boilers. For medical and laboratory equipment, the following best management practices should be followed:

* Use air cooling where possible,
* Connect equipment to chilled water loops,
* Use stand alone chiller systems, or
* Connect to a cooling tower loop.

The type of system selected to eliminate once through cooling will depend on the specific circumstance.

**VIII. Cooling Towers, Boilers and Other Thermodynamic Operations**

***Once-through cooling***, also known as single-pass, or pass-through cooling, *is currently banned by all green codes, standards and green rating systems.* ***Once through cooling should be banned.***

Cooling and heating of living spaces and equipment is commonplace in commercial and industrial operations. The first and most critical consideration is what type of system to use to heat or cool spaces or equipment. For heating living space, there are boilers (steam), hydronic heating, and hot water heat exchanger systems. All of these use water. There are also a number of other space heating systems such as hot air, heat pump and radiant heating.

For cooling spaces, chilled water/cooling tower type air conditioning have been the classic methods to heat larger commercial and institutional space. In smaller spaces, evaporative (swamp) coolers have been used. Both of these evaporate significant volumes of water, but ground-geothermal systems, air cooled variable refrigerant volume (VRV), and direct expansion (DX) systems as well as newer desiccant systems all provide waterless ways to cool a space.

Therefore,

 (1) ***the first best management practice is to not use water intensive cooling or heating methods in the first place.*** Advances in geothermal heat pumps and VRV systems (sometimes called variable refrigerant flow systems) offer real opportunities to avoid cooling tower systems while still being cost effective.

 (2) ***Conduct a life cycle cost/benefit analysis of cooling and heating systems to determine if a waterless systems makes sense***. Keep in mind that water and wastewater costs are now and are projected to continue to rise faster than energy costs.

 If boilers, evaporative cooling, or cooling towers must be used, follow these principles:

**Steam Boilers:**  Large commercial/institutional water heating systems are sometimes called boilers, but do not actually produce steam. Large water heating systems should have cold water makeup meters. These water heating "boilers" are not the subject of these Best Management Practices for boilers that actually produce steam.

Steam boilers require water to be deaerated and for most applications softened prior to use. As they operate, fresh water must be fed to the boiler to replace steam lost through leaks or otherwise not returned to the boiler, and for boiler blowdown to maintain water quality in the boiler. The following represent best management practices for boiler operations:

* Use a hot water heater (boiler) if actual steam is not required. This eliminates losses due to steam leaks, lack of condensate return, and blowdown.
* Meter cold water makeup to the boiler,
* Maximize steam condensate return,
* Practice good energy conservation to minimize steam use
* Install conductivity controllers to determine when blowdown is needed (no timers)
* Minimize water use for blowdown cooling by installing heat recovery systems
* Minimize sampler cooler water and find ways to reuse sampler cooling water.
* Use condensing boilers or retrofit existing boilers with condensing sections to maximize energy recovery. Then use the condensate for cooling tower makeup or irrigation or other uses after pH adjustment.

**Evaporative (Swamp) Coolers:**

Evaporative coolers use wetted pads to cool air drawn through them by evaporating the water. Literature shows that the most significant water efficiency potential is in the control of bleed-off from the sump to control the buildup of dissolved solids and hardness that causes deposits on the pads and corrosion. The US Environmental Protection Agency's 2009 WaterSense Single-Family New Home Specification sets specific standards for evaporative coolers. WaterSense recommendations are as follows:

*Evaporative cooling systems should:*

* Use a maximum of 3.5 gallons (13.3 liters) of water per ton-hour of cooling when adjusted to maximum water use;
* Blowdown shall be based on time of operation, not to exceed three times in a 24-hour period of operating (every 8 hours). Some recommend the use of a dump valve that actuates each time the equipment is started or shut down;
* Blowdown shall be mediated by conductivity or basin water temperature-based controllers;
* Systems with continuous blowdown/bleedoff, and systems with timer-only mediated blowdown management shall not be used.
* Cooling systems shall automatically cease pumping water to the evaporation pads when airflow across evaporation pads ceases.

In addition to the WaterSense Best Management Practices, for large systems of more than 30,000 cubic feet of air per minute, it is recommended that the systems be equipped with the following:

* Makeup meter on water supply
* Overflow alarms for water level in the basin
* Conductivity controllers should be used to blowdown on an "as needed" basis
* Automatic water and power shutoff systems for freezing.
* Locating drain for bleed off where the flow is visible so that leaks and other problems can be easily detected.

Again, evaporative coolers consume water. They also add to humidity and can aggravate mold growth. Their use is limited to the more westerly parts of the state since they do not perform well in most Texas climates.

**Cooling Towers**

The first question to ask is does a cooling tower provide the best life cycle alternative bases on the rapid rise in water and wastewater rates compared to electricity, treatment, labor, liability and water and wastewater infrastructure and supply consideration. Hybrid cooling towers, wet-dry systems, geothermal heat sinks, and newer air cooled equipment such as variable refrigerant volume technologies may become better choices when total lifecycle considerations are evaluated.

If a cooling tower is used, Best Management Practices can be divided into three categories including:

* Operational Considerations
* Vendor Selection
* Design and Equipment Selection

**Operational considerations** are the first consideration in the efficient operation of a tower. For towers larger than 500 tons, a continuous electrical record of operations should be available for downloading. If that record is not available, the operator should maintain a written shift log. A logbook also provides a written shift log. At a minimum, the shift log should contain:

* Details of make-up and blowdown quantities, conductivity, and cycles of concentration;
* Chiller water and cooling tower water inlet and outlet temperatures;
* A checklist of basin levels, valve leaks, and appearance; A description of potential problems.
* Above all, ensure that the employee responsible for the cooling tower operations, is knowledgeable of what to look for when examining records and what to look for when visually examining the cooling tower.

**Choose a Water Treatment Vendor** that will work with your facility.

* Select a water treatment vendor that focuses on water efficiency. Request an estimate of the quantities and costs of treatment chemicals, volumes of make-up and blowdown water expected per year, and the expected cycles of concentration that the vendor plans to achieve. Specify operational parameters such as cycles of concentration (CC) in the contract. Increasing cycles from three to six reduces cooling tower make-up water by 20 percent and cooling tower blowdown by 50 percent.
* Work with the water treatment vendor to ensure that clear and understandable reports are transmitted to management in a timely manner. Critical water chemistry parameters that require review and control include pH, alkalinity, conductivity, hardness, microbial growth, biocide, and corrosion inhibitor levels.

**Design and Retrofit Best Management Practices** include proper instrumentation and tower design and operation.

* Install a conductivity controller that can continuously measure the conductivity of the cooling tower water and will initiate blowdown only when the conductivity set point is exceeded. Working with the water treatment vendor, determine the maximum cycles of concentration that the cooling tower can sustain, then identify and program the conductivity controller to the associated conductivity set point, typically measured in microSiemens per centimeter (US/cm) necessary to achieve that number of cycles. Conductivity controller systems cost from $3,500 to $100,000 depending on the nature of the facility in which it is installed. Possible savings possible depend on the increase in cycles of concentration.
* Install flow meters on make-up and blowdown lines. On most cooling towers, meters can be installed at a cost of between $1,000 and $50,000. Manually read meters can be used for smaller towers, but if the tower is 500 tons or more, meter readings should be automated and be connected to an electronic data management system.
* Install automated chemical feed systems or treatment equipment. These systems minimize water and chemical use while protecting against scale, corrosion, and biological growth.
* Install overflow alarms on cooling tower overflow lines, and connect the overflow alarm to the central location so that an operator can determine if overflows are occurring. This alarm can be as simple as a flashing light in the control area. More sophisticated systems may include a computer alert.
* Install drift eliminator that are capable of achieving drift reduction to 0.002 percent of the circulated water volume for counterflow towers and 0.005 percent for cross-flow towers.
* A biocide shall be used to treat the cooling system recirculation water where the recycled water may come in contact with employees or members of the public.
* The US Green Building Council's draft 2012 LEED for new buildings recommends the following maximum concentrations parameters for cooling tower water quality.

|  |  |
| --- | --- |
| **Parameter**  | **Maximum level**  |
| Ca (as CaCO3)  | 1,000 ppm  |
| Total alkalinity  | 1,000 ppm  |
| SiO2  | 100 ppm  |
| Cl  | 250 ppm  |
| Conductivity  | 3,500 US/ml  |

Additional equipment and systems that reduce water and improve tower and systems efficiency use include:

* Side stream treatment to soften tower water or remove dissolved solids;
* The use of alternate sources of water is strongly encouraged,
* Side stream filtration to remove particulate matter. This may allow for an increase in cycles of concentration, and it will help increase overall energy efficiency by maintaining clean tower and heat exchanger surfaces.
1. ***Swimming Pools, Spas and Ornamental Fountains***

Texas ranks third in the nation behind California and Florida for the number of swimming pools. Based on information from the Association of Pool and Spa Professionals, ninety-five percent of all installed pools, both above and in-ground pools, are residential. The remaining five percent though represent the largest and therefore the largest water users. Places where commercial pools are found include:

* Apartment complexes,
* Hotels and motels,
* Parks and public pools,
* Schools and universities, and
* Certain health facilities.

Reducing water use by pools, hot tubs, and ornamental recirculating fountains depends on four factors:

1. Reducing evaporation,
2. Splash-out loss,
3. Choosing the most efficient filtration equipment ,
4. Providing proper maintenance,
5. Examine the potential for alternate on-site sources of water, and
6. Changing human behavior.
7. **Evaporation** :varies significantly across Texas. Pan evaporation data shows that in East Texas on the Louisiana border approximately 65 inches of water are lost annually through evaporation. This increases to 100 to 120 inches a year in Far West Texas. Heated pools and spas loose even more water to evaporation as the following table illustrates

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| **Evaporation from Heated Indoor Pools** |
| Type of indoor heated pool | Water temp°F | Air temp °F | Evaporation Factor(gal/hr/sq ft) | Activity Factor | Gal/day/Sq ft at 60% humidity | Gal/day/Sq ft at 50% humidity |
| 60% humidity | 50% humidity |
| Residential | 85 | 87 | 0.02 | 0.028 | 1 | 0.06 | 0.08 |
| Hotel | 82 | 84 | 0.019 | 0.026 | 1.3 | 0.07 | 0.10 |
| Hot Tubs | 104 | 88 | 0.071 | 0.079 | 2 | 0.41 | 0.45 |
| Health/Competition | 79 | 81 | 0.018 | 0.023 | 1.6 | 0.08 | 0.11 |
| Heated Public Pools | 85 | 87 | 0.02 | 0.028 | 2 | 0.12 | 0.16 |
| Source: Derived from Dehumidifier Corporation of America, Cedarburg WI |
|  |

Pool covers significantly reduce evaporation, but are often difficult to take on and off and therefore tend to not be used regularly. In recent years, liquid pool covers have become available on the market. These products form a invisible, non-toxic layer on the water surface that is only a few molecules thick. Swimmers are not affected by the thin film and will not notice it. The thin film retards evaporation, but not as well as plastic pool covers. Their advantage is that as long as the liquid is replaced, the reduction in evaporation is continuous.

1. **Splash-Out:** Splash-out and drag-out occur in all pools as simmers dive, swim, play and get in and out of the pool. Three design features will reduce this water loss. They are:
* Gutters (splash troughs) around the perimeter of the pool that catch splash=out and direct it back into the pool,
* Formed rounded edges that slightly protrude over the edge of the pool, and
* Proper free board.
1. **Filter System Selection**: Choosing the proper filter will determine how much water is used for backwashing. Sand, zeolite and other granular material filters must be backwashed until the media has been washed and cleaned of the debris it filtered out. Precoat filters include conventional diatomaceous earth (DE), cellulose, or perlite filters, as well as regenerative filters that reuse the filter media. Cartridge filters use pleated paper-type material. The filter elements need cleaning only a few times a year. Old, wasteful disposable filter cartridges should not be re-used. However, modern re-usable cartridges need only to be washed off with a hose and returned to the filter housing. Table XX summarizes basic characteristics of the different types of swimming pool and spa filters. The same principles apply to recirculating ornamental fountains.

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| **Table XX. Filter Selection Factors for Pools[[1]](#footnote-1)** |
|  | Sand | Coated Media | Cartridge |
| Frequency of Cleaning | Every week | Every 4-8 weeks | Depends on unit |
| When to clean *(Difference in pressure across filter)* | 5-10 psi | 8-10 psi | 8-10 psi |
| How cleaned | Backwash | Backwash(a) | Take apart & wash with hose |
| Filtration *(microns)* | 20-40 | 5 | 10 (can vary on cartridge) |
| Time between media replacement | 3-6 years | Every backwash | 2-4 years depending on filter |
| Cost of media | $0.50 to $1.00/lb | $0.15 -$0.50/lb | $15-$100 each |
| Residential use | Yes | Yes | Yes |
| Commercial use | Yes | Yes(b) | Not Recommended |
| Backwash flow time | 2-5 minutes(c) | 1-5 minutes(c) | Remove & wash |
| (a) DE and Pearlite filters should be "bumped and swirled” whenever pressure drop across filter reaches 8-10 psi.(b) DE not recommended for apartments, condominiums or hotels since the filters quickly become clogged with the high rate of use. Specially designed DE and Pearlite filters are made for high volume use though.

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| **Table 7. Filter Selection Factors for Pools** |
|  | Sand | Coated Media | Cartridge |
| Frequency of Cleaning | Every week | 4-8 weeks | Depends on unit |
| When to clean *(Difference in pressure across filter)* | 5-10 psi | 8-10 psi | 8-10 psi |
| How cleaned | Backwash | Backwash(a) | Take apart & wash with hose |
| Filtration *(microns)* | 20-40 | 5 | 10 (can vary on cartridge) |
| Time between media replacement | 3-6 years | Every backwash | 2-4 years depending on filter |
| Cost of media | $0.50 to $1.00/lb | $0.15 -$0.50/lb | $15-$100 each |
| Residential use | Yes | Yes | Yes |
| Commercial use | Yes | Yes(b) | Not Recommended |
| Backwash flow time | 2-5 minutes(c) | 1-5 minutes(c) | Remove & wash |
| (a) DE and Pearlite filters should be "bumped and swirled” whenever pressure drop across filter reaches 8-10 psi.(b) DE not recommended for apartments, condominiums or hotels since the filters quickly become clogged with the high rate of use. Specially designed DE and Pearlite filters are made for high volume use though.(c) Typical times. Filter must be backwashed until sight glass is running clear. |

For all filtration systems, the following is recommended:* Do not use timers to automatically backwash filters,
* Backwash based on measured pressure drop across the filter,
* Backwash only when needed,
* Where possible, discharge the filter water to landscape (unless algaecides are being used)

For **sand, granular and zeolite** type filters should have a sight glass on them to determine when the media has been properly cleaned. Operate the backwash cycle only until the water appears clear in the sight glass.For **coated media filters**, choose regenerative type systems. With regenerative precoat filters, the media is periodically “bumped” off of the filter tubes by backflow, air agitation, mechanical shaking, or a combination of the three. It is then recoated onto the filter cloth. Regenerative filters save significant volumes of water and filter media since the media can be recycled up to 30 times before it is ultimately discharged to waste. No water is lost in the recoating process.For large commercial pools, automated precoat, regenerative filter systems are available. Again, pressure drop should be used to determine when to bump and when to actually dump these filters. When dumping and removing the spent coating material, only two or three filter volumes need to be rejected to flush out the spend media. Diatomaceous earth should not be dumped into the sanitary sewer since it will settle out and clog the sewer. Many codes require that the media be captured in a settling device and disposed of as solid waste.For **cartridge filters**, only washable reusable types should be used to reduce the cost of filter replacement and resulting solid waste issues. Again, pressure drop should be the determining factor for when a filter is cleaned. When washing a filter with a hose or pressure washer, allow the water to drain onto the landscape.The operation of any of these filter devices will determine how much water is needed for filter operations. Dirt in the air, pool use, water quality and other factors all impact when a filter must be backwashed or cleaned. For most filter operations, cartridge and coated media filter use much less water, but that is dependent on the operator. The following figure compares water use with different filter types for a hypothetical case. Again, each situation is different, but the graph represents relative water use characteristics. |

1. **Providing Proper Maintenance**,

Keeping pools cleaned and maintaining proper water chemistry and disinfectant levels is vital in providing an attractive pool and reducing the need to dump and refill and backwash. Vacuuming a pool and skimming floating debris off the top are part of this maintenance. For commercial pools, four types of vacuum systems are available including (1) the type that connects to the suction port for the filter, (2) the type that used the discharge port energy to operate a vacuum pump in the water, (3) a stand-alone portable filter system that often uses a cartridge or bag filter, and an electrically powered vacuum system that moves along the bottom of the pool. The first type that connects directly to the suction side of the filter will fill the filter with debris faster than the others and require more frequent backwash.

Another topic of good pool maintenance is maintaining the concentration of dissolved salts and minerals in the water. As water evaporates, minerals remain behind. The traditional way of balancing salt levels is to periodically drain and refill the pool with fresh water.

1. **Alternate Sources of Water**: The reader should also read the chapter on Alternate Sources of Water. For swimming pools, use of filter backwash water for irrigation where possible. Air conditioning condensate, rainwater and other alternate-sources of water can be treated to the levels acceptable for swimming pool use.
2. **Changing Human Behavior**: Proper training and supervision is needed to ensure that commercial and institutional swimming pools are operated correctly. Professional pools companies and local health departments can provide information.
3. **Vehicle Washes**

Vehicle washes include self service equipment such as spray wands and foamy brushes, roll-over (also called express or in-bay) equipment like those found in may gasoline service stations, commercial conveyor type system, and special large vehicle washing equipment. Water recycle systems should be installed on roll-over and conveyor systems. Best management practices for all types include:

* Metering use,
* Minimizing drag-out by installing small humps to direct water dripping from washed vehicles back into the car wash,
* A main shutoff valve so that water to the system can be easily turned off.
* Spot-free reverse osmosis reject water (if used) must be recycled.
* All towel ringers (if applicable) must have a positive shut-off valve.
* Spray nozzles must be replaced annually.
* Where applicable, a 5 second dwell time should be created before the customer’s vehicle exits the bay to enable water to run-off the vehicle into the bay collection pit.

Recommended maximum water use per vehicle for automobiles and pickup trucks are as follows:

* In-bay automatic car washes - 40 gallons (151 L) per car
* Conveyor and express - 35 gallons (132 L) per car
* Spray wands and foamy brushes - 3.0 gpm (0.06 L/s)

For large vehicle washes for trucks and busses, recycle or reuse systems should be installed and the best management practices for all types of systems followed.

1. **Alternate Sources of Water**

The use of alternate sources of water is one of the most dynamic areas in water conservation and resource management today. These sources include both reclaimed water provided by a local wastewater authority and on-site sources. Texas is a national leader with respect to reclaimed water, rainwater, and gray water reuse.

This includes a number of State initiatives including

* Sales tax incentives under the tax law administered by the Office of the Comptroller (Tax Code Section 151.355(1)),
* Property tax relief under the environmental quality law administered by the Texas Commission on Environmental Quality (30TAC 17).

**Underlying Concepts**

Before discussing the best management practices for use of alternate sources, the following must be considered:

1. The use of an alternate on-site source of water is a best management practice (BMP) in and of its self.
2. Alternate on-site sources of non-potable water are freshwater resources and should be used efficiently.
3. Any water source can be treated to meet the needs and conditions of a desired end use. Economics and volume of water available are the major limiting factors.
4. These sources of water are perfect candidates to use in conjunction with potable water, recycled water and self supplied fresh water.
5. The potential of this resource is only limited by the limits of the amount available and the ingenuity of the user.

In addition to reclaimed water, alternate on-site sources can include:

* Rainwater harvesting
* Storm water harvesting
* Air conditioner condensate
* Swimming pool filter backwash water
* Swimming pool drain water
* Cooling tower blowdown
* Reverse osmosis (RO) and Nanofiltration (NF) reject water
* Gray water (shower, bath tub, hand washing lavatories, and laundry water only)
* On-site treated wastewater systems
* Foundation drain water
* Others??????

Just as there are many sources, there are many possible uses of alternate sources of water, including:

* irrigation,
* green roofs,
* cooling tower makeup water,
* toilet and urinal flushing,
* makeup for an ornamental pond/fountain,
* swimming pools,
* laundry,
* industrial process use, and
* any other use not requiring potable water.

At the writing of this document many things are still in the state of change. For rainwater, new Texas legislation in 2011 (allow for even potable use. House Bill 1073 and Senate Bill 1073, and House Bill 3391). House Bill 3391 also directs that:

* financial institutions may consider making loans for developments that will use harvested rainwater as the sole source of water supply,
* New State buildings over 50,000 square feet must install rainwater harvesting systems, and
* Individual homes can use rainwater for potable water supply as long as they obtain the consent of the water utility serving them and follow proper backflow procedures.

House Bill 1073 and Senate Bill 1073 further clarify the use of rainwater harvesting and provide protection to utilities in case of cross connections. The State Board of Plumbing Examiners will also add a rainwater certification and training to its licensing authority and the Texas Water Development Board (TWDB) will provide educational material. is also developing appropriate regulations to implement this legislation.

The Texas Commission on Environmental Quality (TCEQ)regulations for reclaimed water (treated municipal effluent) and for gray water (water from shower, bath tub, hand washing lavatories, and laundry water only) are found in 30 TAC 210. Water quality criteria for reclaimed water is summarized in table AA and for gray water in Table BB.

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| **Table AA. TCEQ Chap. 210 Water Quality Requirements for Reclaimed Water** |
| **Parameter** | **Comments** | **Type I** | **Type II****W/O Pond** | **Type II****With Pond** |
| **BOD5 or CBOD5**  | **Mg/l - five day biochemical oxygen demand or carbonaceous BOD** | **5** | **20 BOD or 15 CCOD** | **30** |
| **Turbidity**  | **NTU - nephelometric turbidity units** | **3** | **N/A** | **N/A** |
| **Fecal Coliform (E. Coli)**  | **CFU/100 ml - 30 day geometric mean** | **20** | **200** | **200** |
| **Fecal Coliform (E. Coli)**  | **CFU/100 ml - maximum single grab sample** | **75** | **< 800** | **< 800** |
| **Enterococci**  | **CFU/100 ml - 30 day geometric mean** | **4** | **35** | **35** |
| **Enterococci**  | **CFU/100 ml - maximum single grab sample** | **9** | **89** | **89** |

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| **Table BB. TCEQ Chap. 210 Water Quality Requirements for Gray Water** |
| 1. Applied where public has access:
	* Geometric Mean - Fecal Coliform <20 colony forming units/100 ml
	* Single Grab Sample - Fecal Coliform <200 colony forming units/100 m
2. Applied where public not present:
	* Geometric Mean - Fecal Coliform <200 colony forming units/100 ml
	* Single Grab Sample - Fecal Coliform <800 colony forming units/100 ml
 |

New national level codes and standards that provide code guidance for implementing the use of all types of alternate sources have been developed in the last two years. These include:

* International Association of Plumbing and Mechanical Officials (IPMO) **Green Plumbing and Mechanical Code Supplement**, 2012,
* International Association of Plumbing and Mechanical Officials (IPMO) **Green** International Code Council (ICC), **International Green Constriction Code**, 2012.
* NSF/ANSI Standard 350: *On-site Residential and Commercial*

*Water Reuse Treatment Systems*, NSF International,

2011.

* NSF/ANSI Standard 350-1: *On-site Residential and*

*Commercial Graywater Treatment Systems for Subsurface*

*Discharge*, NSF International, 2011.

When considering using an alternate source, it is important to keep in mind that each type of source is different. Table CC. summarizes some of the water quality characteristics that the various sources may have.

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| **Table CC. - Water Quality Consideration for****Alternate On-site Sources of Water** |
| **Possible****Sources** | **Water Quality Considerations**  |
| **Sediment** | **(TDS)** | **Hardness** | **Organic (BOD)** | **Pathogens**  | **Other considerations** |
| **Rainwater** | **1-2** | **1** | **1** | **1** | **1** | *None*  |
| **Storm water** | **3** | **?** | **1** | **2** | **2** | *Pesticides &* *fertilizers*  |
| **Air conditioner condensate** | **1** | **1** | **1** | **1** | **2** | *May contain cooper when coil cleaned*  |
| **Pool filter backwash** | **3** | **2** | **2** | **1** | **2** | *Pool treatment chemicals*  |
| **Cooling tower blowdown** | **2** | **3+** | **3** | **2** | **2** | *Cooling tower treatment chemicals*  |
| **RO & NF reject water** | **1** | **3+** | **3** | **1** | **1** | *High salt content*  |
| **Untreated Gray water** | **For subsurface application only. May need lint screening** | ***Detergents and bleach***  |
| **On-site wastewater treatment** | **3** | **2** | **2** | **3+** | **3+** | *Human waste*  |
| **Foundation Drain Water** | **1** | **?** | **?** | **2** | **2** | *Similar to stormwater*  |
| **Other Sources** | **?** | **?** | **?** | **?** | **?** | *Depends on source* |
| *The use of pass-through (once-through) cooling water is also a possible source of on-site water, but should be discouraged because of its huge potential to waste water, but it does provide a very clean source of water. For that reason, it is not included in this list.*  |
| 1. Low level of concern
2. Medium level and may need additional treatment depending on end use
3. High concentrations are possible and additional treatment likely

? Dependent on local conditions  |

When deciding on the type of treatment for an alternate source of water, remember that it is necessary only to treat to the level needed for that application. Table DD summarizes treatment methods that may be employed for various end uses of these sources.

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| **Table DD. - Types of Treatment That May Be Employed** **Depending on Intended End Use Quality Needs** |
| **Source** | **Filtration** | **Sedimentation** | **Disinfection** | **Biological Treatment** | **Softening & Other** | **Other Considerations** |
| **Rainwater (non-potable)** | ? |  | ? |  |  | Depends on end use |
| **Rainwater (potable)** | x |  | x |  |  | Follow local code |
| **Storm water** | X | ? | X | ? | ? | Oils and heavy metals |
| **Air conditioner condensate** | ? |  | X |  | ? | Copper? and bacteria  |
| **Pool filter backwash** | X | ? | X |  | ? | Sediment, bacteria, & pool chemicals, salts |
| **Cooling tower blowdown** | X |  | X |  | X | High dissolved solids, bacteria, sediment |
| **RO & NF reject water** |  |  | ? |  | ? | High dissolved solids |
| **Gray water** | X | X | X | ? |  | Bacteria, BOD, sediment |
| **On-site wastewater treatment** | X | X | X | X | ? | Bacteria, BOD, sediment |
| **Foundation Drain Water** | X |  | X |  | ? | Hardness, bacteria, sediment |

The Texas Water Development Board, Texas Commission on Environmental Quality, the Texas State Board of Plumbing Examiners and many local jurisdictions are currently developing new rules, information, and guidance regarding these alternate sources of water. Application of this best management practice will continue to grow in the future.

**Implementation Scope and Scheduling**

The implementation of best management practices for the commercial and institutional sectors must consider steps needed by (1) water and wastewater utilities wishing to implement commercial and institutional water conservation programs and those steps that (2) the actual commercial and institutional water user should take to implement these savings in their facility.

For the utility, the following steps are needed to develop and implement a water conservation plan:

**Utility Implementation Plan**

1. **Scoping opportunities:** The first activity should be to find out who the ICI customers are, who are the big users in each category of use and to develop statistics that help us identify opportunities. Data could include monthly use, submetering information if available, type of user (hotel, school, etc.), size of user (square feet, number of people, number of rooms, etc.) and any information on the use of irrigation systems, cooling towers etc. The basis for much of this analysis was included in the last water conservation plan. We need to expand on it and get more specific.
2. **Evaluating Program elements:** This is the "how to" of the program. The utility will need to list all of the ways that an ICI program could be structured. From this a list of possible program elements will be derived
3. **Funding, rebates and Buy-Back opportunities:** The utility will need to analyze all possible incentive programs that they could implement. The utility should also analyze the benefits such a program could have on delaying the need for future treatment construction. With commercial, institutional and industrial customers, utilities can consider water efficiency programs as ways to buy-back capacity in the system.

In examining opportunities, utilities should look at all aspects of encouraging water efficiency including, rebates, tax incentives, free equipment such as free pre-rinse spray valves, as well as the public relations value to the customer. Coordination with other incentive programs offered for economic development or energy conservation can significantly enhance the effectiveness of the program

1. **Working with commercial and institutional customers:** The utility's commercial and institutional are stakeholders in the process. At this point, it is most helpful to bring them into the process as the utility's commercial and institutional plan is being developed.
2. **Plan Development**: Stakeholder input will significantly benefit the development of the plan. The utility will need to consider steps 1. through 4. above to determine what is feasible for their operation. The final product will be a plan of action with all utility costs, staffing needs and program elements considered.
3. **Implementation:** The final step is implementation. The reader is referred to the Municipal BMP for additional input.

**Commercial and Institutional Implementation Plan**

Developing a water conservation program at the facility level is a multi-phase process. The first steps to take are to ask what the goals are. For most entities, reducing costs are the key consideration, but presenting a “green” image, supporting community needs and public relations potential can also motivate commercial and institutional facility managers and owners. To begin the process, facility managers should take stock of current water and wastewater use, costs associated with water use including energy costs such as water heating, chemical cost associated with water use, labor costs and needs associated with operations that also use water, and of course, the cost of these inputs.

Once records are gathered, it is important to physically walk through the facility and talk to all staff involved in operations that use water in any way. The following seven questions are very helpful in this effort. They are also the seven questions that will need to be asked when an actual plan of action is developed. The questions are:

* **How much is used for this activity?**
* **Where is it used?**
* **When and how long is it use?**
* **How is it used?**
* **Who controls its use?**
* **Why does water have to be used?**
* **What can be done to eliminate the need for water in this operation?**

The next step is to develop and implement a plan of action. Steps in this process include:

* **Organizing Metering and Records**
* **Record Location & Type of Use**
* **Obtain information on Time and Volume of Use**
* **Determine Possible Measures**
* **Calculate Cost of Use vs. Benefit**
* **Consider Alternate Supply**
* **Put it to Paper**
* **Implement the Plan** *(A plan on paper does not save water, implementation of the program does)*
* **Evaluate and Make Changes** *(No plan is perfect and situations change. Programs must change accordingly over time).*

**Cost Effectiveness Considerations**

Much has been reported on the rise of energy costs, but most will be shocked to find that water and wastewater costs are rising at 2.8 times the rate of electricity and general inflation and that in the last two years, natural gas prices have actually declined.

This is dramatically illustrated in the Figure XX. This graph shows the price of the major utilities used by commercial entities indexed to the consumer price index. Clearly, water and wastewater costs are rising much faster than electric and natural gas energy prices - in fact, over 2.5 times faster than electric rates!



Many areas of Texas and the United States have, or will soon experience limits to conventional water supplies. In many areas of the Southwest, conventional water supplies are or are nearly tapped out. But, who would have thought of Georgia and Florida having water shortages a few years ago. This means that more costly sources such as sea water desalinization will be the future for supply. One recent Federal Budget Office study shows that 36 states may face shortages of some kind in the near future. These shortages are being seen world wide as water needed to fuel economic and population growth outstrips local water supplies.

Infrastructure costs are also certainly to rise. The American Society of Civil Engineers in it 2009 report on infrastructure gives our aging water and wastewater infrastructure a grade D-. The Black and Veatch report of the cost of water and wastewater services for the top 50 cities in the United States (www.bv.com/Downloads/.../rsrc\_EMS\_Top50RateSurvey.pdf) shows that commercial water and wastewater rates have risen at an average of 5.6 percent since 2001. They predict that this rate of inflation will continue in the near future. The cost of upgrading existing system along with more stringent water and wastewater standards couples with more costly raw water sources will all contribute to rising water and wastewater costs rising.

By contrast, natural gas prices are projected to stabilize or even decrease relative to inflation and electric costs will rise at a rate of about two percent over the next ten to twenty years according to the U.S. Energy Information Administration (http://www.eia.gov/forecasts/aeo/er/). The bottom line is that water and wastewater costs will continue to rise faster than energy costs for commercial buildings.

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| **Table 5 Water and Sewer Rate Increases for** **Selected Cities Between 2007 and 2008***NUS Consulting Group* |
| **City** | **Percent Increase** | **City** | **Percent Increase** |
| New Orleans, LA | 51.9% | St. Louis, MO | 32.4% |
| Fort Smith, AR | 29.6% | Sioux Falls, SD | 18.2% |
| Los Angeles, CA | 17.9% | Binghamton, NY | 16.6% |
| Kansas City, MO | 16.3& | San Francisco, CA | 15.8% |

Figure x compares combined average commercial and sewer rates in the United States to selected Texas Cities. Nationally, commercial water and sewer rates rose 29.5 percent between 2005 and 2010 according to Black and Veatch's survey of water rates.

In order to perform the tasks outlined in audit process (Figure 1.), the person performing the audit must complete the following five tasks:

1. Calculate the Unit Value of Water Used;
2. Identification of Water Using Equipment, Fixtures and Operations and
3. Determination of Applicable Water Efficient Practices and Equipment;
4. Determine Possible Water Savings; and
5. Calculation of the Savings Associated with Conservation Actions and the Cost of the Actions.

1. Calculate the Unit Value of Water Used: To determine the cost of water, first obtain the unit cost of water. This is usually expressed in dollars per thousand gallons or dollars per 100 cubic feet. Do the same for wastewater if it is charged based on the volume of use. Add these together to obtain the total cost of water. If costs are expressed in 100's of cubic feet (CCF), it can be converted to gallons by multiplying by 0.748. In simplified terms that is CCF X 0.748 = Use in thousands of gallons.

***EXAMPLE 1:***

***Question - The small facility used 52 CCF in a month. Convert to gallons***

***Answer - 52 X 0.748 = 38.9 thousand gallons or 38,900 gallons a month***

To convert the cost of water or wastewater in dollars per CCF, divide the cost by 0.748.

*EXAMPLE 2:*

*Question - Water cost $2.50 per CCF. What is that cost in dollars per thousand gallons?*

*Answer - $2.5/ 0.748 = $3.34 per thousand gallons*

If the water is to be heated, determine the type of energy used to heat the water (gas, electric, etc.) and its cost per unit (Cents per kilowatt hour, or dollars per therm, or dollars per MCF[thousand cubic feet] of natural gas) etc. Figures 2. and 3. show the cost of heating one thousand gallons of water with either electricity or natural gas for water which has it temperature raised either 55oF or 120oF, typical of water heated either for domestic use (Figure 2.) or for high temperature use in a commercial dishwasher (Figure 3.) in Texas.

If the gas is billed in therms, the cost can be converted to dollars per MCF of gas by multiplying the cost of the gas in therm by 10 to convert it to dollars per MCF.

If propane is used, one MCF of gas contains approximately one million BTU's which is equivalent to approximately 11 gallons of propane. Therefore, if propane cost $2.00 per gallon, it would be equivalent to natural gas costing $22.00 and MCF!

*EXAMPLE 3*:

*Question - Natural gas cost $0.60 per therm. What does it cost to heat water by 55oF?*

*Answer - $0.60 X 10 = $6.00 per MCF. From Figure 2., that is equal to approximately $3.50 per thousand gallons.*

Additional costs for softening the water, or other treatment must also be estimated. For example, for softening, the cost of the salt per month can be divided by the amount of water treated by the softener.

*EXAMPLE 4:*

*Question - Water cost $2.50 per CCF and wastewater cost $3.00 per CCF. The water is used for domestic hot water. The water is heated with electricity at 10 cents a kilowatt hour. What does it cost to heat water by 55oF?*

*Answer - The water cost a total of $5.50 per CCF($2.50 + $3.00). This is equal to $7.35 per thousand gallons. {$5.50 / 0.748 = $7.35}*

*Using Figure 2., the cost of heating the water by 55oF is approximately $14.20 per thousand gallons. Therefore total water costs include energy costs plus water and wastewater costs.*

*Total Cost = $7.35 + $14.20 = $22.55 per thousand gallons or 2.255 cents a gallon {=($22.55 X 100 cents a dollar) / 1,000 gallons = 2.255 cents a gallon}*

*This can be rounded off to 2.3 cents per gallon for use in estimating savings.*

*If natural gas were used from Example 3., the total cost would be $7.35 + $3.50 = $10.85 per thousand gallons. That is 1.085 cents per gallon.*

*EXAMPLE 5*

*The small facility uses 52 CCF per month. The determine that 70 percent is only cold water and the other 30 percent is hot water. They heat with gas. The hot water use is to wash equipment and a two percent (2%) chemical cleaning solution by weight that costs $18.00 per pound. How much does the use of hot water actually cost?*

*From example 4, hot water costs $10.85 per thousand gallons. Thirty percent of the total use of 52 CCF is hot water with chemical added.*

*Hot water use = 52 X 748 gallons per CCF = 11,668.8 Gallons a month. It costs $10.85 per thousand gallons so the cost per month = [11,668.8/1,000] X 10.85*

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| **Dollars per Year for Toilet Flushing*****$6.45 per 1,000 gallons or $4.82 per CCF*** |
| **Gallons per Flush** | **Cents per Flush** | **Type of Facility** |
| **Home****6 flushes per day** | **Office****35 flushes per day** | **Restaurant****75 flushes per day** |
| **5** | **3.27** | ***$72*** | ***$418*** | ***$895*** |
| **3.5** | **2.29** | ***$50*** | ***$292*** | ***$627*** |
| **1.28** | **0.84** | ***$18*** | ***$107*** | ***$229*** |

Another way to look at cost is to compare annual cost for use of fixtures with different flow rates. Table ?? shows a comparison of annual cost to operate a toilet in various settings over a 365 day year.

**Developing the Benefit/Cost Estimate**

When determining whether a BMP is cost effective, the customer will need to assess the financial costs and benefits of implementing the BMP. A variety of financial metrics may be used to determine whether a particular BMP makes economic sense from cost/benefit perspective. Some important considerations when calculating the costs of BMPs are:

* Water and wastewater savings
* Cost of the measure
* Expected usable life of the measure
* Energy costs decrease or increase
* Chemicals costs or savings
* Waste disposal costs associated with water treatment or use
* Labor costs or savings
* Liability
* Usable life of equipment or processes

Costs are typically calculated for each recommended BMP within a comprehensive CII water conservation audit.

There are several ways to calculate cost/benefit ratios for business/customer implementation of BMPs. When discussing cost/benefit analyses, some common terms used include "payback period,” “return on investment”: (ROI), and “internal rate of return” (IRR). These analyses provide guidance in the short term, and help to determine if a proposed modification is worth the investment. Longer-term analyses also consider lifecycle factors, such as net present value, inflation, and amortization.

The payback period is the time required for an investment in efficiency to pay for itself. The simple payback is calculated by dividing the total costs (including installation, capital, permitting, and equipment costs) by the annual benefits, giving a simple payback in terms of years. A two-year payback is generally considered to be extremely cost effective; many firms may choose a 3-4 year payback period. If a business using a more efficient device does not own the building or the equipment, some issues with the economics of payback become more challenging.

Another metric which is similar to payback is **Return on Investment (ROI).**

 The return on investment (ROI) is the percent of payback the BMP produces per year. In the case of a one-year payback, the ROI is 100%. If the payback is in 1.6 years the ROI is equal to ($100%/1.6) or 62.6% a year.

The internal rate of return, or IRR, provides an indication of the efficiency of an investment. It is defined as the effective annual interest rate at which an investment accrues income. The IRR can be compared to the interest rate on borrowed funds or the rate of return that is possible from other investments. If IRR is higher than the agency's rate of return, then the investment is deemed to be worthwhile.

A business may also want to analyze the costs and benefits over the economic life of the BMP, particularly for large investments that may have longer payback periods. This analysis may be appropriate if the time for return on investments does not justify making the improvements in the short term and there is a long-term investment involved. A lifecycle analysis will take into consideration the costs and savings over the full life of the BMP device being installed. In this type of analysis the business would consider the time value of money, savings through the life of the equipment, and the costs of water, energy or sewage disposal over the life of the equipment. This analysis may also include labor, tax, and insurance savings.

Net Present Value (NPV) is among the most common financial metrics used in doing a life cycle analysis. It sums all of the costs and benefits over the lifetime of the device and reports their value at the beginning of the project.. A positive NPV indicates that the benefits of the project exceed the costs over the life of the device. This approach has not been as commonly used by business as the ROI or payback approach, but may become more applicable in the future.

When making a decision to invest in water use efficiency, businesses may also consider other risk factors and benefits that are less quantifiable, such as potential future mandates, reliability of water supply, or reputational risks and benefits. They may also upgrade to more water and energy efficient equipment when making a business decision to replace outdated equipment.

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**Determination on Other Resources**

There are many sources of assistance regarding water conservation for commercial and institutional water users to draw from. Many local utilities have water conservation professionals that can provide assistance. At the State level, the Texas Water Development Board and the Texas Commission on Environmental Quality have professional water conservation staff that can provide information and assistance. Companies that specialize in all aspects of water conservation are also available. Some called Water Service Companies can even offer funding and performance contracting. These companies can perform detailed audits of all aspects of water use and corresponding associated energy use. There are also a number of organizations and governmental agencies that have excellent resources available on their web sites. Examples of these web sites include:

* H2O Conserve - [*www.h2oconserve.org/*](http://www.h2oconserve.org/)
* Water – Use it Wisely - [*http://www.wateruseitwisely.com/*](http://www.wateruseitwisely.com/)
* Food Service Technology Center - [*www.fishnick.com*](http://www.fishnick.com/)
* Consortium for Energy Efficiency - [*www.cee-1.org*](http://www.cee-1.org/)
* Bureau of Reclamation - Water Conservation - *http://www.usbr.gov/waterconservation/*
* Arizona Department of Water Resources - [*www.azwater.gov/conservation*](http://www.azwater.gov/conservation)
* Food Service Technology Center - [*www.fishnick.com*](http://www.fishnick.com/)
* Consortium for Energy Efficiency - [*www.cee-1.org*](http://www.cee-1.org/)
* Bureau of Reclamation - Water Conservation - *http://www.usbr.gov/waterconservation/*
* Alliance for Water Efficiency - [*www.allianceforwaterefficiency.org*](http://www.allianceforwaterefficiency.org/)
* EPA Water Sense and Energy Star Programs - [*www.epa.gov/watersense*](http://www.epa.gov/watersense)[*www.energystar.gov*](http://www.energystar.gov/)
* California Urban Water Conservation Council - [*www.cuwcc.org*](http://www.cuwcc.org/)
* Texas Water Development Board - [www.twdb.state.tx.us](http://www.twdb.state.tx.us/)
* Texas Commission on Environmental Quality -www.tceq.state.tx.us/

### [Save Texas Water](http://www.savetexaswater.org/) - www.savetexaswater.org/

* [Texas Water Foundation](http://www.google.com/url?sa=t&rct=j&q=texas%20water%20foundation&source=web&cd=1&sqi=2&ved=0CF4QFjAA&url=http%3A%2F%2Fwww.texaswater.org%2F&ei=Z5e_T4OdHrKHsAKBucDtCQ&usg=AFQjCNEfZMxhd0RQ0EDZLtuWi3oIdDzr-Q) - *www.texaswater.org/*
* Conserve Florida Water Clearinghouse - http://www.conservefloridawater.org/

Professional organizations can also provide assistance. Examples include:

* **American Society for Healthcare Engineering (ASHE)**
* **Association of Facilities Engineers (AFE)**
* **International Facility Managers Association (IFMA)**
* **Building Owners & Managers Association (BOMA)**
* [Texas Sales Tax Exemptions for Water Related Equipment with Application](http://www.twdb.state.tx.us/conservation/municipal/commercial-institutional/doc/SalesTaxExemption.pdf) (A sales tax exemption was created in 2001, to encourage water conservation.)
* [Application for Water Conservation Initiatives Property Tax Exemption](http://www.window.state.tx.us/taxinfo/taxforms/50-270.pdf) (A property tax exemption is allowed for all or part of the assessed value of a property on which water conservation modifications have been made. Check with your local county appraisal district for guidance.)
* [Sales and Use Tax Bulletin 94-123 Water and Wastewater Systems](http://www.twdb.state.tx.us/conservation/municipal/commercial-institutional/doc/WastewatertaxExemption.pdf)

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**Acknowledgements**

*OUR SUBCOMMITTEE FOR COMMERCIAL AND INSTITUTIONAL WATER*

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