

WATER WISE

**A Practical Water Wise Guide
For Hampton Roads
Business, Commercial and Industrial
Water Customers**

**Hampton Roads Water Efficiency Team
(HR WET)**



About HR WET

The Hampton Roads Water Efficiency Team (HR WET) was established in 1994 as a regional coalition of fifteen cities and counties and four major military installations in Southeastern Virginia. It is funded by all Hampton Roads communities through the Hampton Roads Planning District Commission (HRPDC).

HR WET's mission is to develop and implement a regional approach to promoting efficient water use throughout Hampton Roads. The HR WET program has established the following goals:

- Raise public awareness of the region's water supplies and the need to use them efficiently with the objective of changing habits, not lifestyles, regarding water use.
- Reduce per capita water consumption by increasing the number of people using water more wisely.

To achieve these goals, HR WET conducts a comprehensive educational program involving media relations, advertising, demonstrations at festivals and exhibits, and public speaking for civic groups. Other programs include a video, brochures, research on the effectiveness of water-saving kits, a clearinghouse for exchanging information on water-wise practices, and a program that recognizes water-efficient businesses and industries.

Wise water use is becoming a way of life for Hampton Roads' citizens. The region's localities are responding to this situation in the truest spirit of cooperation, reflecting the common bonds that run throughout Hampton Roads.

For more information about HR WET, contact individual member representatives at the numbers listed in Appendix 5, or write to us at the following address:

HR WET
P.O. Box 1834
Chesapeake, VA 23327

About This Guide

This guide is designed to help business, commercial and industrial water customers in Hampton Roads increase water efficiency in their operations. Increased water efficiency means cost savings for the owner, while helping water utilities manage limited water supplies.

The guide reviews typical water use of various users and offers helpful, practical tips on how to reduce water use. In this guide you'll find convenient checklists of water efficiency ideas, technologies and actions for consideration. It provides helpful hints on establishing an employee water-wise program. Highlights of successful water-efficiency programs conducted by the businesses and industries recognized by HR WET in 1996 are also included.

The programs and measures found in this guide are part of HRPDC's Regional Water Conservation Plan for Hampton Roads. They offer a cost-effective approach to managing the Hampton Roads water supplies in an environmentally sound manner. These programs and measures are expected to ensure an adequate and reliable supply of safe drinking water for Hampton Roads' existing population and businesses while fostering continued economic growth.

The information in this guide is based on research conducted and a series of guides published by the City of Phoenix, Arizona. HR WET would like to thank them for providing this information and allowing its adaptation in this guide.

The ideas presented here are not an endorsement by HR WET, nor any of its individual member utilities, of any particular method, process, or product. HR WET recommends buying a sampling of a conservation item and conducting a pilot program to determine its effectiveness before expanding its use.

HR WET welcomes information from you regarding results obtained by using various water conservation methods. We can be contacted through one of our local representatives (listed in Appendix 5) or at the following address:

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Why Water Efficiency?

Limited Fresh Water Supply

You may wonder why a region like Hampton Roads, which averages 45 inches of rain a year, should be concerned about water efficiency. Hampton Roads has miles of shoreline—we are literally surrounded by water. But little of it is suitable for drinking. Consider the following:

- *Limited fresh water sources.*
Groundwater in many areas of Tidewater is brackish (salty), including our primary rivers, such as the Elizabeth, James, Northwest and York Rivers. Most utilities must pump fresh water from miles away, and store it in reservoirs prior to treatment.
- *Significant rainfall, yet still vulnerable to drought.*
This vulnerability is due to the fact that tributary watersheds, i.e., rivers and streams, supplying rain run-off to our reservoirs are small. Additionally, some of the existing reservoirs, created while retrieving shells for the building of roads, were not designed to take advantage of run-off. These reservoirs were dug vertically into the ground and the land surrounding them does not slope toward the reservoir to assist in collection of water. As a result, only the rainwater that falls directly into the reservoir is collected.
- *Increased population straining available water supplies.*
HRPDC's economic projections, to be officially released in spring 1997, indicate that population growth from 1993 through 2018 is expected to increase from 1,496,000 to 1,929,618. This is an increase of 434,618 or 29 percent. (For a copy of the report, please call the Hampton Roads Planning District Commission at 757-420-8300.)

Considering that many of the water utilities in Hampton Roads are now using nearly as much water as they can produce, such a population increase underscores the importance of completing proposed new water projects.

There are several proposed water-supply projects under design, construction, or consideration throughout Hampton Roads. However, completing the permitting process through state and federal agencies is lengthy and complex. Once permits to construct have been obtained,

the construction of large earthen dams, major transmission mains, and treatment facilities takes many more months or years. The major water-supply projects that are in process are as follows:

- *Virginia Beach* began pursuing the Lake Gaston Water Supply Project in 1982. The project consists of a 76-mile pipeline designed to convey 60 million gallons per day (mgd) from Lake Gaston to the Norfolk reservoir system in western Hampton Roads. In 1987 *Chesapeake* signed an agreement to become a one-sixth partner in the project and will receive ten mgd upon its completion. Additionally, *Isle of Wight* and *Franklin* have options to receive one mgd respectively from the project. Expected production date: Mid 1998.
- *Chesapeake* is building a reverse osmosis-membrane plant to treat brackish groundwater and reduce chloride levels in water drawn from the Northwest River, a source of their drinking water. Expected production date: Late 1998.
- *Newport News* is also building a brackish groundwater project, using reverse osmosis to treat salty groundwater. Expected production date: Mid 1997.
- *Newport News, Williamsburg, James City County and York County* are pursuing a regional Peninsula reservoir project known as the King William Reservoir. This project is still awaiting permitting by state and federal agencies. Expected production date: 2005

Water Efficiency is the Law

The agencies that review and permit additional water supply projects require effective water conservation programs to be in place and in use. This applies to surface water projects (reservoir) as well as groundwater projects.

There are several state laws that provide water protection or regulate surface water, such as reservoirs, and groundwater. According to the March 1992, "Water Demand Reduction Opportunities," report published by Malcolm Pirnie, Inc., these include:

- *Virginia Water Protection Permit Act*, which requires a permit for activities needing a Section 401 Certification of the Clean Water Act (a federal regulation) and may require water conservation as part of the permit conditions;
- *Virginia Surface Water Management Areas Act*, required for certain withdrawals within a specified management area, which stipulates a water conservation or management plan be approved by the State Water Control Board (SWCB) and included in permits under this Act;
- *Virginia Groundwater Management Act*, which requires a SWCB-approved

conservation plan as part of a permit for certain withdrawals of groundwater.

Avoid Water Restrictions

Most Hampton Roads water utilities have ordinances to impose water restrictions during water emergencies or severe drought. (Virginia Beach has been under mandatory restrictions since 1992.) Wise use of water can delay or avoid water restrictions in the future.

Avoid Costs

Water rates continue to rise for a number of reasons. Increases reflect the cost of new water-supply projects, maintenance of existing infrastructure and treatment facilities, and the need to meet escalating water-quality regulations. Sewage treatment is also escalating in cost since these charges are based on water consumption.

So, increased water efficiency can save dollars now and minimize the impact of future rate increases for water use.

Developing a Water-Efficiency Plan For Your Business

Getting all employees involved in water efficiency is necessary to assure success. Remember that a successful program includes four important components:

- commitment of top management;
- thorough understanding of your water system;
- comprehensive plan committed to paper; and
- ongoing, active participation of all employees (and tenants where applicable).

Step 1: Commitment of Top Management

A successful program requires support from top management in theory *and* in practice. This includes acceptance of water efficiency as a long-term investment rather than a “quick-fix” budget item. Benefits include:

- reduction of water, sewage, treatment, and energy costs.
- enhancement of the organization’s community relations through promotion of water-efficiency programs; and
- delay of drought restrictions.

An organizational policy statement such as the following gives a water-efficiency plan impact and reflects management’s intentions.

“We understand the importance of water and its limitation as a resource. Our organization demonstrates this commitment through developing and maintaining a comprehensive water-efficiency program that helps assure adequate water supplies and increases our cost-effectiveness.”

Step 2: Understanding Your System

Understanding your current water system is necessary to achieve change. Appendix 1 contains an Audit Checklist to help you become more knowledgeable about your water system. We encourage you to use this to begin your water-efficiency program.

Indoor Uses

Indoor uses of water will vary greatly from facility to facility. The person responsible for implementing the water-efficiency plan should perform a detailed audit of each

major water use, each process, machine, and position. Generally these uses fall into three major categories:

1. *Cooling and heating for both climate-control and cooling of equipment.* These uses include cooling towers, boilers, chillers, air scrubbers, refrigeration equipment, and evaporative coolers. For equipment such as cooling towers that use large volumes of water, consider installing submeters for both influent and bleed-off water. Increase cooling tower cycles of concentration as equipment allows. Eliminate all single-pass water use. Investigate all possibilities of water reclamation and re-use.
2. *Process water* (water used in various stages of manufacturing). Target water-saving technologies or conservation modifications specifically geared towards your industry, such as counter-current rinsing, spray systems, flow-reduction devices, solenoid or timer shut-off valves, pH or conductivity probes, and batch processing.
3. *Operations* - This includes any washdown and maintenance that requires the use of water. Eliminate garbage disposals and water-cooled icemakers when possible.

Step 3: Writing Your Efficiency Program

Written commitment of your plan is critical to success. Following are basic elements to consider prior to implementation:

- *Organizational Policy Statement:* Reflects the commitment of top management (as shown in Step 1).
- *Goals:* Set specific, measurable, and achievable goals. State the goal measurement (gallons, percentage, etc.), date to be achieved, area of facility, and action plan.
- *Action plan :* Outline each specific task and support each action with a cost/benefit analysis where applicable. State immediate actions which are no-cost or low-cost, actions requiring capital expenditure and actions requiring changes in water-use habits. Use current or proposed rates to calculate dollar benefit.
- *Employee Awareness Program:* (See Step 4). Decide who will be responsible for plan implementation. Establish a water-efficiency committee with a responsible leader, or, in smaller facilities, one employee who will develop and implement the plan.
- *Implementation, evaluation and revision:* A viable plan is flexible and evolving. Review it periodically and revise when necessary. The original plan should state when reviews take place and how revisions occur.

You'll also find these tips in the form of a checklist in Appendix 1 at the back of this guide.

Step 4: Employee Participation and Public Awareness

Employee awareness and cooperation is critical. The first three steps of plan development will be unworkable without the willing participation of employees. There are several ways to gain their commitment, such as having the head of your company (CEO, president, owner, etc.) write and distribute a letter of support for the program to employees, developing a water-efficiency committee, and instituting a communications plan to keep your employees informed about the new policies and programs.

A checklist of many more ideas has been included in Appendix 1. For additional ideas, contact your local HR WET representative or water utility.

Domestic Water Tips

Domestic water use is water used for sinks with faucets, toilets, urinals, and sometimes showers. Listed below are domestic water uses and opportunities for increased water efficiency, especially in locations where water-efficient fixtures are not installed.

Code Requirements

The Federal Energy Policy Act of 1992 requires that essentially all toilets, urinals, and faucets manufactured after January 1994 achieve maximum-use standards. Since March 1993, the Commonwealth of Virginia requires low-water-use plumbing fixtures in new construction.

The more stringent code requirements only apply to new construction, but several localities (e.g., Virginia Beach) have incentive programs, including rebates, to encourage voluntary upgrades in existing construction.

Current Plumbing Fixture-Flow Standards for Water Use Efficiency

The chart below provides current state code requirements for plumbing fixtures.

PLUMBING FIXTURE OR FIXTURE FITTING	MAXIMUM FLOW RATE OR QUANTITY
Water closet (toilet)	1.6 gallons per flushing cycle
Urinal	1.0 gallon per flushing cycle
Showerhead	2.5 gallons per minute at 80 psi
Lavatory (nonpublic)	2.2 gallons per minute at 60 psi
Lavatory (public)	0.5 gallon per minute at 80 psi
Lavatory (public metering self-closing)	0.25 gallons per metering cycle
Sink faucet	2.2 gallons per minute at 60 psi

Source: Virginia Uniform Statewide Building Code, 1990 Edition - Third Amendment, Effective March 1, 1993.

The chart on the following page is a detailed comparison of the water use of currently required low-flow fixtures and the larger water capacity of fixtures installed prior to the code changes in 1993. Upon review, it is clear that retrofitting water efficient fixtures can yield significant water savings.

POTENTIAL WATER SAVINGS FROM EFFICIENT FIXTURES

Fixture (a)	Fixture Capacity (b)	Water Use (gpd)		Water Savings (gpd)	
		Per Capita	2.7-Person Household	Per Capita	2.7-Person Household
Toilets (c)					
Efficient	1.5 gal./flush	6.0	16.2	na	na
Low-Flow	3.5 gal./flush	14.0	37.8	8.0	21.6
Conventional	5.5 gal./flush	22.0	59.4	16.0	43.2
Conventional	7.0 gal./flush	28.0	75.6	22.0	59.4
Showerheads (d)					
Efficient	2.5 (1.7) gal./minute	8.2	22.1	na	na
Low-Flow	3.0-5.0 (2.6) gal./minute	12.5	33.8	4.3	11.7
Conventional	5.0-8.0 (3.4) gal./minute	16.3	44.0	8.1	22.0
Faucets (e)					
Efficient	2.5 (1.7) gal./minute	6.8	18.4	na	na
Low-Flow	3.0 (2.0) gal./minute	8.0	21.6	1.2	3.2
Conventional	3.0-7.0 (3.3) gal./minute	13.2	36.6	6.4	17.2
Toilets, Showerheads, and Faucets Combined					
Efficient	na	21.0	56.7	na	na
Low-Flow	na	34.5	93.2	13.4	36.4
Conventional	na	54.5	147.2	33.5	90.4

na = not applicable

(a) Efficient = post-1994

Low-Flow = post-1980

Conventional = pre-1980

(b) For showerheads and faucets: maximum rated fixture capacity (measured fixture capacity).
Measured fixture capacity equals about two-thirds the maximum.

(c) Assumes four flushes per person per day; does not include losses through leakage.

(d) Assumes 4.8 shower-use-minutes per person per day.

(e) Assumes 4.0 faucet-use-minutes per person per day.

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Increasing Efficiency in Existing Fixtures

There are many alternatives available for making plumbing fixtures effective and water-efficient:

- Retrofit faucets with aerators to introduce air and regulate flow rate. This creates a smooth, bubbly flow.
- Install low-flow showerheads.
- Install metering faucets, which deliver a measured quantity of water on demand.
- Install spring-loaded faucets, which shut off automatically after use.
- Adjust valves for toilets and urinals or install flow-reduction devices to reduce flow without reducing flushing effectiveness.
- Place a dam or a water-filled plastic container in the toilet tank to reduce the water volume of each flush.
- Install an automatic-control system for toilets, urinals, and faucets that use a beam of infrared light to control flushing or faucet flow. These devices deliver metered flows, only on demand, thus preventing water running at faucets not in use. The design of the controls prevents activation by passersby and resets after use to accommodate the next person. In addition, there is no need for the user to contact an activating device, which may ease use by the handicapped and help prevent the spread of disease.
- All model plumbing codes require a pressure-reducing valve where the water main pressure is greater than 80 pounds per square inch (psi) at the connection to the system. The design of plumbing systems allows for acceptable performance at pressures as low as 20 psi. Installation of a pressure-reducing valve to achieve 60 psi will increase efficiency.

Water Efficient Plumbing Fixtures Capital Costs

Consider replacing existing fixtures with water-efficient fixtures. The prices below reflect a wide price range for purchasing replacement plumbing fixtures.

ITEM	COST RANGE
Kitchen faucet	\$20 - 200
Lavatory faucet	\$10 - 135
Lavatory faucet, metering type	\$100 - 165
Faucet aerator	\$2 - \$20
Showerhead	\$6 - 150
Toilet (ultra-low volume; 1.6 gallon per flush)	\$80 - 600
Urinal flush valve	\$75 - \$85
Urinal fixture	\$120 - 350
Infrared faucet control	\$300 - 400
Infrared water closet/urinal control	\$270 - 390

When installing ultra-low volume toilets and urinals, look for improved bowl designs and flushing procedures. The models that use the least water use either a siphon action, air, or vacuum assistance. Keep units with field-adjustable valves properly adjusted to prevent unnecessary water usage.

Preventive Maintenance

We recommend establishing a scheduled program of leak detection and repair as a highly effective water efficiency practice. A leaky faucet can waste up to 20 gallons per day. Toilet leaks can waste up to 200 gallons of water per day.

Domestic Plumbing Checklist

There are many ways to reduce water usage in domestic plumbing. For a checklist, see Appendix 1.

Cooling Systems

Water is the primary element of most cooling systems. Cooling towers, evaporative coolers, and once-through cooling are three common forms of water-cooling use.

Understanding Cooling Towers

Cooling towers use large amounts of water in most sizable cooling systems. Cooling towers pull heat from air-conditioning systems. Some serve the cooling needs for plant equipment with large heat loads.

In a cooling tower, a circulating stream of warm water contacts an air flow, causing evaporation of some of the water. The typical cooling tower evaporates about one percent (1%) of the water flow passing through the tower to achieve a 10°F decrease in recirculating water temperature. The loss of heat by evaporation (latent heat) cools the remaining water. A small amount of cooling also takes place when the remaining water transfers heat (sensible heat) to the air. The water which passes through a cooling tower then circulates through a cooling system, warms, and returns to the tower.

Reducing blowdown to the minimum level consistent with good operating practice increases water-use efficiency. Blowdown is the release of some circulating water to remove suspended and dissolved solids left as pure water evaporates from the system. Reducing blowdown water loss is usually accomplished by treating the cooling water by physical or chemical means.

Evaporative Coolers

The primary use of water by evaporative coolers is to increase the humidity of incoming air drawn into a building and to decrease its temperature. Most evaporative cooling equipment cools air flow for space cooling.

The absorption of water vapor cools the air's ambient, or "dry bulb," temperature. The saturation, "wet bulb," temperature remains constant. After a short time, recirculating water in an evaporative cooler assumes the wet bulb temperature of the entering air. This temperature is ideally the lowest temperature to which the entering air may be cooled.

"Saturation efficiency" is when the dry bulb temperature of the leaving air is the same as the entering air wet bulb temperature. For example, an evaporative cooler with 90 percent saturation efficiency will cool the air the number of degrees equal to 90 percent of the difference between its dry bulb and wet bulb temperature.

Some evaporative coolers are equipped with recirculation pumps. Most coolers have a bleed-off to control concentrations of contaminants in the recirculating water and prevent damage to the cooler's pads. Water use in some evaporative coolers is single-pass.

Evaporative coolers require either a small amount of bleed-off or cleaning to operate effectively. Although some coolers are operated with recirculation of the water that runs off the pads, some coolers operate with a once-through flow of water. This is not good practice for two reasons. Water consumption is unnecessarily high and the cooler does not cool as effectively because the water does not cool to the wet-bulb temperature.

The primary opportunity for water efficiency in evaporative coolers is reduction of the flow of bleed-off water discharged from the coolers. Excessive amounts of bleed-off wastes water and impairs the cooling efficiency of the cooler. This is because the water does not become as cold as possible.

Reuse opportunity: Water bleed-off from evaporative coolers can be used to water landscaping in the vicinity of the bleed-off pipe.

Once-Through Cooling

Many facilities have one or more pieces of equipment cooled by a single-pass flow of water. After passing through and cooling the equipment, the water is discarded. Such equipment includes: degreasers, rectifiers, hydraulic equipment, x-ray machines, condensers, viscosity baths, air conditioners, air compressors, hydraulic presses, welders, and vacuum pumps. More effective water use involves connecting the equipment to a cooling tower system or using the single-pass effluent for some other use in the plant's process or for landscape irrigation.

Regional and State Requirements Regarding Cooling Towers

The Commonwealth of Virginia is authorized by the Environmental Protection Agency to issue permits under the National Pollutant Discharge Elimination System. In Virginia, this program is referred to as the Virginia Pollutant Discharge Elimination System (VPDES). It includes permits for overboard (surface waters and storm sewer) discharge and non-discharge permits called Virginia Pollution Abatement Permits.

The State Water Control Board (SWCB) has developed a VPDES general permit which is in the process of being adopted. The interim policy is as follows:

VPDES Permit (Point Source Discharges to Surface Water)

If the discharge is to be directed into a surface water body, a VPDES permit must be obtained from the SWCB prior to such discharge. The SWCB will issue permits based on water quality standards established for the type of receiving waters.

VPDES Permit (Point Source Discharges to Storm Sewers)

If the discharge is to be sent to the storm sewer system, a VPDES permit must be obtained from the SWCB prior to such discharge. Individual permit requirements will vary for each cooling tower system.

In those localities which have adopted an ordinance regulating discharges to the storm sewer system, discharge of cooling tower effluent will be governed by local government policy.

The Hampton Roads Sanitation District (HRSD) has a policy regarding cooling tower discharge. Please see “Evaporative Cooling Equipment Discharge Routing Policy” in Appendix 3. For more information, contact HRSD at 757-460-2261.

The Hampton Roads Planning District Commission (HRPDC) published, “Cooling Tower Discharge Policy and Guidance Manual,” in November 1992. This manual discusses cooling tower water utilization and conservation. For a copy, please call 757-420-8300.

Helpful Ideas

For a checklist of cooling systems wise water use ideas, see Appendix 1. Appendix 2 offers two surveys: one to problem solve mechanical operations of cooling towers and another to assess water use.

Kitchens and Cafeterias

Many facilities have kitchens and cafeterias. Kitchen equipment using water usually includes sinks, dishwashing machines, garbage disposals, and icemakers.

Dishwashers

The design of commercial spray-type dishwashers allows for cleaning of dishes, flatware and glassware by washing with detergent and water, and sanitizing by application of hot water or chemical solutions. There are several types of commercial dishwashers, for different volumes of dishes and utensils.

- In a stationary-rack machine, dishes are loaded into a rack that fits inside the machine; complete wash and rinse cycles average from 1 to 3 minutes.
- In a conveyor-type machine, dishes are loaded onto a conveyor belt that travels through the machine at speeds from 5 to 8 feet per second (fps). The final dishwashing rinse is accomplished with either hot fresh water or with a chemical sanitizing agent mixed with water.
- Dishwashing machines that use chemical sanitizing agents for the final rinse use about the same amount of water as machines using only hot water for the final rinse.

Water Use Requirements

The National Sanitation Foundation (NSF) established the minimum wash and rinse requirements for dishwashers. Typical water-use requirements are 4.5 to 6.0 gallons per cycle of wash and rinse for stationary rack machines using water for the final rinse and about 2.5 to 3.0 gallons per cycle for similar machines using a chemical sanitizing agent. Commercial dishwashing machines reuse the final rinse water to wash the next rack of dishes.

Water Efficient Opportunities

Here are a few ways to save on water use in dishwashers:

- Operate dishwasher equipment properly, washing full loads, and limiting water-flow rates to those specified by the manufacturer.
- Reuse final rinse water in the following wash cycle or elsewhere for low-grade uses such as prewashes, garbage disposals, or food scrapers. This also offers energy savings.
- Use pressure and flow regulators to maintain the desired flow during periods of high water-supply pressure.
- Equip conveyor-type dishwashers with an automatic shutdown device to deactivate the water pumps when dishes are not passing through the system.

Garbage Disposals

Commercial garbage disposals grind solid wastes into small particles for disposal into the sewer system. The ground garbage passes into a mixing chamber where it blends with water for disposal. In larger systems, a scraping and preflushing system may precede grinding and carry the materials to the garbage disposal. Some larger systems use a conveyor instead of a scraper to transport waste to the disposal.

Garbage Disposal Water Use

Typical water-consumption rates for various garbage disposals and disposals combined with scrapers or conveyor equipment are as follows:

<u>EQUIPMENT</u>	<u>TYPICAL FLOW RATE, gallons per minute (gpm)</u>
Disposal	5 to 8
Scraper/disposal	7
Conveyor/disposal	10

Consider eliminating garbage disposals to reduce water use, and maintenance. Or, consider replacing garbage disposals with garbage strainers. A strainer-type waste collector passes a recirculating stream of water over food waste held in a basket. This reduces waste volume as much as 40 percent by washing soluble materials and small particles into the sewer. The water use for strainers is about 2 gpm, much less than the 5 to 8 gpm requirement of garbage disposals. Strainers can use wastewater from the dishwasher, eliminating added water consumption.

Other Opportunities

- Some scraper and conveyor-type disposals use a recirculating flow of water to move the wastes into the disposal. Recycled water supplies the mixing water in the disposal. Based on a dishwasher flow rate of 1.2
- , this could save as much as 25 to 45 percent of the disposal flow requirement.
- Installation of flow regulators end excess flow due to high water pressure and timers with automatic shut-off limits disposal over-operation.
- A solenoid valve can control water flow to the disposal.

Ice-Making Equipment

There are two types of ice-making equipment: ice cube machines and ice flake machines. The methods used to produce ice cubes and flaked ice are different. Below are descriptions of the machines and their use of water.

- ***Ice Cube Machines***

Ice cube making usually is a batch process. The goal of ice cube machines is to produce clear ice cubes. The design of most ice cube machines results in the washing of the frozen surface of the cube as it forms. The warmer run-off water carries with it the dissolved contaminants. The result is that frozen water in cube ice is purer than the source water.

- ***Ice Flake Machines***

Flake ice production is a continuous process, operated with less concern for the quality of the ice. The flakes are thin, randomly shaped, and mostly white or cloudy. A rotating evaporation drum produces flake ice. It is broken off the drum by an ice cutter and scraped to produce the flakes.

Water Use

Water is used in ice-making machines other than for ice production. In ice cube makers, where the quality of frozen water is important, use of continuous water bleed-offs removes dissolved contaminants. Batch processing, however, uses a batch dump instead. According to manufacturers of cube ice-making equipment, the production of 100 pounds of clear ice cubes requires 20 to 25 gallons of water. Yet, 100 pounds of ice equals about 12 gallons of water. Batch processing saves about 13 gallons of water from becoming a drained by-product.

Some ice-makers use water to cool the refrigeration condenser. Other condenser cooling options include: air cooling, cooling by the plant's chilled-water system, or remote air-cooled condensers. Water-cooled ice-makers are popular. They are less costly than remote-cooled units and do not generate heat in the kitchen or serving area, as air-cooled units do.

Water-cooled ice-makers may use slightly less electricity than the other two types. Most water-cooled ice-makers do not recirculate the cooling water. Typical ice-makers, ranging in capacity from 400 to 1,200 pounds of ice per day, use about 130 to 180 gallons of cooling water per 100 pounds of ice produced.

Water Efficiency Opportunities for Ice-Makers

- Water efficiency during ice-making depends on the bleed rate. Choose a method with the lowest bleed rate. Ice-makers that produce ice flakes use the potable water source with no bleed-off. Ice-cube makers vary regarding water bleed-off per unit of ice produced. Some units recirculate the water until it is frozen, with a set bleed rate. Other units use once-through water flow.
- Pretreatment of the ice-making water to remove hardness reduces water consumption while maintaining ice quality.

- Use zeolite softening for treating cooling-tower water.
- Install flow regulators to prevent excess flows through ice-makers.

Water Efficiency Opportunities for Condensers

- Most water-cooled ice-makers, ice cream and milkshake machines use cooling water on a once-through basis. See page 12 for once-through cooling water efficiency opportunities.
- Replace water-cooled units with air-cooled ones. *Please note:* These units require slightly more electricity for operation and do not produce as much ice as water-cooled units.

More Efficiency Opportunities

See Appendix 1 for a kitchen and cafeteria checklist containing many water-efficiency ideas.

Hospital and Health-Care Facilities

X-Ray Processing

Regulation of silver in wastewater discharges led to research on x-ray processing, changes in operation and equipment, and use of water reclamation and recovery systems.

X-ray processing is a series of complex chemical changes. In general, these processes must develop, stop, fix, harden, wash, bleach and dry the film. Automatic processing equipment contains tanks and dryers which provide the necessary process steps. A transport system moves the film from one tank to the next.

Most automatic processing equipment uses solenoid valves to feed water for wash purposes only during film processing. Proper valve maintenance results in water savings. Regulating valves also limit the flow rate of the wash water to a set quantity. The most advanced machines offer automatic control of flows, chemicals and other process variables adjusted as the equipment checks the product passing through the processing sequence. This type of control may provide the highest quality product for the least water consumption.

Proper Operation

A flow rate of two gallons per minute (gpm) or less is enough for effective processing, but actual rates tend to be as high as three to four gpm or higher. To achieve greater water efficiency while maintaining quality results, adjust a valve to reduce the flow rate to the minimum rate. One approach is to install an inexpensive flow rate meter on the water line feeding each processor. This verifies proper flow rate of rinse water in the processor.

Squeegees

A squeegee removes the liquid from the product surface as it travels from one tank to the next. Carryover reduction due to squeegee typically ranges up to 95 percent.

Water Uses in Laboratories

There is limited potential for increased water efficiency in laboratories. Water uses include mixing solutions and washing glassware and other equipment.

Some wasteful uses of water sometimes occur, such as when water is run as a stream through an aspirator to create vacuum. Some laboratories' instruments, such as some automated analyzers, generate heat and require cooling. Instead of cooling them with a stream of once-through cooling water, consider using chilled water from the institution's recirculating system.

Sterilizers and Autoclaves

Steam sterilizers and ethylene oxide autoclaves are also the site of significant uses of water in a hospitals and other settings. Sterilizers use running water to cool steam discharged to the sewer. In some cases, water is used to draw a vacuum to enhance drying of sterilized items. Confirm with the manufacturer or service contractor the flow rates of water discharged from the sterilizers and autoclaves.

Hospital and Health-Care Facilities Checklist

In Appendix 1 you will find a list of water-saving opportunities for your hospital or health-care facility.

Laundries

Many institutions operate large laundries to clean linens, uniforms, and other washable items. New laundering equipment now available is more water-efficient than the equipment used in the past. Water reclamation equipment is also now commercially available for laundries.

Continuous-Batch Washers

Common in Europe and now available in the U.S. is the continuous-batch or tunnel washer. The conventional washer-extractor found at most laundries has a chamber that fills and empties each time a new step in the wash cycle begins. In a continuous-batch washer, the laundry items pass automatically from one module to the next. Use of the counter-current flows saves up to 60 to 70 percent of the volume of water and steam required by washer-extractors. Additional benefits include:

- *Energy savings* due to recovery of heat from the laundry itself during the rinse cycles;
- *Labor costs* as a result of the automated process;
- *Maintenance costs*; and
- *Reduced chemical usage* in some cases.

Remember to schedule loads to reduce resetting of equipment controls when using continuous-batch machines.

Reclamation Systems

There are different systems available to reclaim wastewater from commercial laundries. These systems can reduce the cost of water, soap, energy for heating, and sewerage fees.

One low-maintenance system consists of a mixed media filter containing plastic beads, anthracite coal, and silica, an activated-carbon column and an ion-exchange unit. The ion-exchange unit requires frequent regeneration and the monthly replacement of the activated carbon. The system allows about 75 percent reuse and is available as a packaged unit.

Another reclamation system uses settling, high-rate ultrafiltration, and fixed-bed carbon adsorption processes. The use of pretreated hydrated lime in dry-powder form assists the ultrafiltration treatment.

There is a commercially available package treatment system that claims savings in water costs of 70 percent, water heating savings of 50 percent, softening chemicals about 70 percent, and alkali-chemicals about 35 percent. The patented system includes dissolved air flotation (DA-F), flow equalization, filtration (macro and micro), and flocculation.

More Water-Efficiency Ideas

A checklist containing water-efficiency ideas for laundries can be found in Appendix 1.

Landscaping

Basic Steps to Achieve Water Efficiency

Planning & Design

Landscape planning and design is a critical step in water-wise landscaping. Zone your garden into areas of high moisture use, moderate use and drought-tolerant use. *TIP: Plants native to our area have lower water requirements, fewer pest problems and need less fertilizer than many imported plants.*

Soil Improvement

Soil preparation is one key to success. Evaluate planting soil to determine soil additives and improve water-holding capacity. Add organic matter to soils to boost nutrient content. *TIP: To increase plant health and conserve water, till in four inches of organic materials around flowers and shrubs, but not around trees and turn areas.*

Practical Turf Areas

Turf is beautiful but it also requires more water and maintenance than any other part of the landscape. Use only where necessary. Consider replacing some turf with patios, mulched areas, ground covers or other low-water users. Select a turf grass that is adapted to the site and is drought-resistant. *TIP: Grass that grows tall will grow slower and need less water.*

Appropriate Plant Selection

Select plants that fit the site and the environmental stresses. Zone according to water needs. Also consider growth rates, maturation size, and temperature tolerances when selecting and locating plants. *TIP: Keep your planted areas clear of weeds, which soak up water.*

Efficient Irrigation

Make every drop count by watering efficiently to prevent runoff or evaporative loss. Let plants tell you when they need water.

If mandatory restrictions are in effect, or whenever possible, use groundwater wells for irrigation. Sprinkler or drip-irrigation systems can save water and promote healthy turf, trees, shrubs and flowers. *TIP: New trees should have a shallow ditch around them to hold water.*

Use of Mulches

Mulches hold in moisture while reducing weed growth, cooling the soil, slowing erosion and providing landscape interest. Replace turf with mulched planting beds to lower your water use. Use organic, non-matting mulches such as pine straw, pine bark mulch, shredded hardwood bark or cypress mulch. *TIP: Drip irrigation is more efficient than overhead sprinklers.*

Appropriate Maintenance

Keep your plants healthy. Once they are established, apply less nitrogen. To avoid plant stress, mow properly, thin shrubs, and control weeds and pests. Learn how and when to water, efficient ways to water, and the water needs of Virginia's ornamental plants. *TIP: For the best water for plants, capture rain with a barrel at your down spout. Remember to cover the barrel to avoid mosquitoes.*

Additional Information

For additional information and printed materials on water-efficient landscaping, contact any of the following Virginia Extension offices:

Chesapeake

Virginia Cooperative Extension
City of Chesapeake
Agriculture Department
310 Shea Drive
Chesapeake, VA 23320
PH: 757-382-6349
FX: 757-382-6665

PH: 757-727-6447
FX: 757-727-6523

Isle of Wight

Virginia Cooperative Extension
Isle of Wight County
P.O. Box 74
Isle of Wight, VA 23397
PH: 757-365-6261
FX: 757-357-9610

Gloucester

Virginia Cooperative Extension
County of Gloucester
P.O. Box 156
Gloucester, VA 23061-0156
PH: 804-693-2602
FX: 804-693-1383

James City County

Virginia Cooperative Extension
County of James City
P.O. Box 69
Toano, VA 23168
PH: 757-566-1367
FX: 757-566-8413

Hampton

Virginia Cooperative Extension
City of Hampton
136 Kingsway
Hampton, VA 23669

Newport News

Virginia Cooperative Extension
City of Newport News
12388 Warwick, Suite 307

Newport News, VA 23606
PH: 757-591-4838
FX: 757-591-596-2057

Norfolk

Virginia Cooperative Extension
City of Norfolk Health Department
401 Colley Avenue
Norfolk, VA 23507
PH: 757-683-2816
FX: 757-683-2300

Suffolk

Virginia Cooperative Extension
City of Suffolk
P.O. Box 218
Suffolk, VA 23439
PH: 757-925-6409
FX: 757-925-6406

Virginia Beach

Virginia Cooperative Extension
City of Virginia Beach
Building #14
Municipal Center
Virginia Beach, VA 23456
PH: 757-427-4769
FX: 757-426-5684

Williamsburg

(covered by James City County)

York County

Virginia Cooperative Extension
York County Extension Office
P.O. Box 532
Yorktown, VA 23690-0532
PH: 757-890-3730
FX: 757-890-3315

More Water-Saving Ideas

See Appendix 1 for a landscaping checklist of more water-efficiency hints.

**Appendix 1:
Water-Efficiency Checklists**

Understanding Your System^{3/4} Audit Checklist

General

- Locate and identify each water meter and record the numbers. Determine the destination and use of the water from each meter. Log meter consumptions monthly.
- From past bills, track consumption of each meter for the past twelve months. Note peaking characteristics for different times of the year.
- Separate sewage costs from water charges.
- Calculate total annual cost of water including water, sewer, heating, pumping, treatment and disposal; divide by annual consumption to determine real water cost. Consider seasonal costs (summer consumption rates) and consumption variations (swimming pools) that could impact your calculation.
- Walk through the facility during working hours to locate broken pipes, leaks, faulty hoses, etc. Check meter during shutdown for indication of leaks.

Once you understand your expected costs throughout the year, it's time to determine opportunities for no-cost or low-cost water savings, as well as areas needing capital expenditures. Here's a checklist with ideas to help you save water and money:

Domestic

- Check all bathrooms regularly for leaks. In tank toilets, conduct dye leak tests.
- Install low-flow showerheads.
- Install low-flow faucet aerators at all sinks. When replacing, consider spring-loaded faucets.
- For tank-type toilets with 3.5-gallon or greater flush, install toilet dams or low-flow flapper valves to decrease consumption per flush. On flushometer-type toilets, check with a plumber to see if your valves have reversible conserving rings or if you can install a restrictor. Consider replacing toilets with 1.6-gallon ultra-low flow models.
- Do not run eye-wash stations and water fountains continuously.
- Check timing cycles and volumes for automatic water-flushing systems in urinals and toilets. Coordinate automatic systems with work hours so they don't run continuously.
- Audit kitchen, cafeteria, laundry, dishwashing, washdown areas and janitor closets.
- Audit research and laboratory areas.
- Educate people not to use toilets for garbage disposal.
- Develop an employee (or tenant) education program to increase awareness of the importance of water efficiency.

Landscaping

- Plan and design your landscape for the most efficient use by grouping plants with similar water needs.
- Decrease turf areas, keeping only those areas that are beneficially used for activities.
- Select drought-resistant ground covers.
- Landscape with indigenous/native plants. A list of these plants is available from the Virginia Cooperative Extension Service.
- Improve soil's water-holding capacity by adding organic materials.
- Mulch generously to retain moisture and reduce weeds.
- Irrigate efficiently and deeply to prevent run-off and evaporation.
- Time automated landscape watering systems for early morning or late evening use
- Consider installing a drip irrigation system.
- Water only as frequently as necessary. This is generally every third day in summer and less frequently in winter. The local Virginia Cooperative Extension also provides guidelines for watering.
- Don't water after rainfall; consider installing rain or soil moisture sensors to indicate when watering is necessary..
- Maintain your plants and gardens properly to keep them healthy.

Checklist for Writing Your Efficiency Program

Written commitment of your plan is critical to success. Following are basic elements to consider prior to implementation:

- Create an Organizational Policy Statement** reflecting the support of upper management.
- Set goals.** Be sure to use specific, measurable, and achievable goals. State the goal measurement (gallons, percentage, etc.), target date, area of facility, and action plan.
- Write an Action Plan.** Outline each specific task and support each action with a cost/benefit analysis where applicable. State immediate actions which are no-cost or low-cost, actions requiring capital expenditure and actions requiring changes in water-use habits. Use current or proposed rates to calculate dollar benefit.
- Develop an Employee Awareness Program.** Decide who will be responsible for plan implementation. Establish a water-efficiency committee with a responsible leader, or, in smaller facilities, one employee who will develop and implement the plan.
- Implement, evaluate and revise as necessary.** A viable plan is flexible and evolving. Review it periodically and revise when necessary. The original plan should state when reviews take place and how revisions occur.

Checklist for Generating Employee Participation and Public Awareness

Employee awareness, understanding, and participation lead to commitment to a water-wise program. There are several ways to gain their commitment:

- Start your program with a letter to all employees from the head of the company—CEO, president, owner, etc.—showing full support of the concept of a plan.
- Consider establishing a water-efficiency committee to develop your plan.
- Use bulletins, newsletters and paycheck stuffers to communicate policies, programs, ideas, announcements, progress reports and special achievements.
- Hold meetings to communicate your water-efficiency plan and results.
- Promote a suggestion/incentive system and recognize people who have water-saving ideas. A suggestion program that rewards employees with a percentage of the first year's direct savings has proven to be a very successful motivational vehicle.
- Distribute water-efficiency booklets.
- Promote slogan and poster contests.
- Publicize national, regional and local water events to highlight water's importance.
- Two or three times a year, feature a water-efficiency display in common areas to highlight water-efficiency programs.
- Offer home water-saving devices to employees free or at cost. Sponsor demonstrations of these devices by suppliers.
- Post water-efficiency stickers and signs in bathrooms, kitchens, and cafeterias.
- Use audio-visual programs and use outside speakers for employee meetings.
- Send members of your water-efficiency team to community seminars.
- Circulate information about what others in your industry are doing to conserve water.
- State savings in relevant terms such as dollars, earnings per share, or annual consumption
- Establish a system for employees to notify the proper parties about leaks, dripping faucets, broken sprinklers or other occurrences of water waste.
- Place signs on your drought-tolerant landscape identifying plant types. Establish a public demonstration water-wise garden.
- Develop displays to place in public reception areas outlining your organization's water-efficiency policy.
- Publicize your water savings through a public relations program. Interview with local radio and TV stations, as well as newspapers, about your water-efficiency efforts.
- Maintain a library of equipment specifications. Ensure equipment is operating in accordance with the manufacturer's performance standards.
- Perform periodic research into new water-saving technology.
- Subscribe and make available water resource literature (*U.S. Water News, Water Environment & Technology*, etc.)

Domestic Plumbing Checklist

- Use dye-tablet tests to check tank toilets for leaks. Place the dye tablets (or use food coloring) in the toilet tank, wait a few minutes and see if the color appears in the bowl. If so, there is a leak. Toilet leaks can result in extensive water waste and cost, so repair leaks promptly.
- Install low-flow showerheads which use 2.5 gallons of water per minute or less.
- Retrofit faucets with aerators to reduce flows to 2 gallons per minute or less.
- Consider using metering faucets (which stay open a pre-set period), self-closing faucets (which close upon release of the knob), and automatic sensor-controlled faucets.
- Retrofit tank-type toilets with dams or water-filled plastic containers as displacement devices to reduce water volume per flush. (Do not use a brick, which crumbles.)
- Consider replacing existing (3.5-, 5- or 7-gallon) toilets with new low-flow models. These use only 1.6 gallons per flush or less.
- For toilets and urinals equipped with flush valves, retrofit them with insert orifices or replacement kits to reduce the volume of water used per flush.

Cooling Systems Checklist of Wise Water Use Ideas

To Begin...

- Prepare an inventory of each cooling tower you have, its cooling capacity, and the equipment or processes that it serves.
- Meter and record the amount of make-up water added to each tower, and the amount of blowdown water discharged from each tower.
- You may be able to have a credit for evaporation deducted from your sewerage bill, if you properly meter your cooling tower's water losses as described above. If you wish to receive this deduction, be sure to check with Water and Wastewater Departments in your community. Follow their instructions to set up your metering program in accordance with the departments' requirements.
- If you purchase chemicals for the treatment of the recirculating cooling tower water, have the chemical vendor explain the purpose and action of each chemical.
- Have your chemical vendor provide a written report of each service call with explanations of the meaning of each analysis performed, as well as the test results.
- Tell your chemical vendor that water conservation is a priority at your facility. Ask your vendor to tell you about alternative programs that could reduce the amount of water that is bled-off from the towers.

Water Efficiency Opportunities

- If you are using conventional water treatment, work with your chemical vendor to increase your cycles of concentration, thereby decreasing the amount of water bled off.
- Set up performance-based specifications, and request proposals from vendors for your facility's cooling-tower water treatment. Require vendors to commit to a predetermined minimum level of water efficiency. Have them provide projected annual water and chemical consumption costs.
- Consider incorporating sulfuric acid in your treatment program. This could enable you to reduce carbonate scale and achieve significantly higher cycles of concentration. If you use sulfuric acid, use proper safety precautions.
- Ozone is another alternative for cooling water treatment. Ozone can help remove dissolved minerals and act as a biocide. Again, use safety precautions.
- If available, use reclaimed water as a source of cooling tower make-up water. Be sure the water is sufficiently clean for use in your system.
- Reuse blowdown for lower-grade non-potable uses.

Evaporative Coolers

- Be sure your coolers have pumps to recirculate the water through them.
- Check to make sure you are not bleeding off an excessive amount of water. For a typical small cooler, anything more than a few gallons per hour may be excessive.
- Pipe the bleed-off from your coolers to help water a landscaped area.

Once-Through Cooling

- Stop all uses of water for once-through or “single-pass” cooling, unless you can reuse the water for another application.
- Consider replacing water-cooled equipment with air-cooled models.
- Connect to a recirculating cooling water loop (such as the plant-chilled water system) instead of using once-through cooling.

Kitchen and Cafeteria Checklist

- Check your dishwasher to be sure that it is not using an excessive flow of water. Experiment with a modest reduction (about 10 percent) in the flow rate of water to your dishwasher to see if any problems result. If no problems occur, continue to operate at the reduced-flow rate. Consult with the equipment manufacturer or your service contractor before making major changes.
- Reuse wastewater from your dishwasher for a low-grade purpose such as prewashing, or in garbage disposals.
- Be sure the flow of water through the dishwasher stops when the flow of items being washed stops.
- Reduce the amount of fresh water used for prewashing before the dishwasher.
- Use wastewater from other kitchen operations (such as the dishwasher) for garbage disposal and trash-trough flushing.
- Be sure that the flow of water through the garbage disposal stops when the disposal motor stops. Many disposals have two water-supply lines, one to the bowl and one to the grinding chamber. Be sure to check both.
- Consider reducing use of garbage disposals and disposing of wastes by other means. This may also reduce maintenance labor and cost.
- Consider replacing garbage disposals with garbage strainers which use less water.
- Experiment by gradually reducing the flow rate of water through the disposal. If no problems arise, continue to operate at the reduced flow rate.
- End use of once-through (“single-pass”) cooling of ice-making machines. Consider replacing water-cooled units with air-cooled models, or supply cooling water for the ice-maker from the plant’s recirculating chilled water system. Otherwise, reuse the cooling water for some other purpose, such as landscape watering.
- Repair leaks in steam, hot water, and cold water lines.
- Avoid thawing frozen foods with running water. Thaw in the refrigerator or defrost in microwave oven.

Checklist for Hospitals and Health-Care Facilities

X-Ray Processing

- Equip x-ray processors with shut-off valves to stop the flow of water when processing is not taking place.
- Reduce the flow rate of water through the processors to the minimum consistent with quality performance. Many hospitals' x-ray processors use a higher flow rate than is necessary. Often a flow rate of two gallons per minute or less is sufficient.

Laboratories

- Avoid running water for aspiration of liquids or other purposes.
- Replace single-pass water-cooling of instrumentation or analyzers; supply this from the plant's chilled water system.

Laundries Checklist

- Consider the use of continuous-batch washers for new laundries or major expansions of existing laundry operations.
- Explore the potential for use of laundry water reclamation systems in your facility.
- Be sure to launder full loads only.
- Work with your laundry chemical supplier to reduce water consumption. Inform your chemical supplier that water conservation is a priority in your laundry operations.

Landscaping Checklist

- Plan and design your landscape for the most efficient use by grouping plants with similar water needs.
- Decrease turf areas, keeping only those areas that are beneficially used for activities.
- Select drought-resistant ground covers.
- Landscape with indigenous/native plants. A list of these plants is available from the Virginia Cooperative Extension Service.
- Improve soil's water-holding capacity by adding organic materials.
- Mulch generously to retain moisture and reduce weeds.
- Irrigate efficiently and deeply to prevent run-off and evaporation.
- Time automated landscape watering systems for early morning or late evening use
- Consider installing a drip irrigation system.
- Water only as frequently as necessary. This is generally every third day in summer and less frequently in winter. The local Virginia Cooperative Extension also provides guidelines for watering.
- Don't water after rainfall; consider installing rain or soil moisture sensors to indicate when watering is necessary..
- Maintain your plants and gardens properly to keep them healthy.

Appendix 2:
Cooling Tower Mechanical and Water Surveys

Owner's "Quick Start" Cooling Tower Mechanical Survey

1. Does the belt squeal during operation? If so, tighten belts.
2. Check motor amp draw and voltage.
 - If voltages are off, check with Virginia Power.
 - If too low, check for collapsed fill or blockage.
 - If too high, check water distribution header, nozzles, and flow rate of pump in gallons per minute (gpm).
3. Does the tower have excessive vibration? If so, then:
 - Check fan wheels for cleanliness. Clean, balance or replace as necessary.
 - Check bearings and lubricate.
 - Check belt tightness and adjust.
 - Realign the shaft.
4. Is the tower free of debris? If not, clean.
5. Clean the sump strainer.
6. Check the integrity of the fill deck and eliminators. (Older towers may contain asbestos components.) Contact the manufacturer if problems are apparent.
7. Check for full flow bypass if one is used.
8. Check for Variable Frequency Drive on the cooling tower water pump.
 - A cooling tower will not operate properly on a variable, or varying water supply, unless the reduction in flow is limited to the manufacturer's minimum recommended flow for that cooling tower.
 - The fan motors may be operated on a Variable Frequency Drive.
9. Ensure that the cooling tower discharge is not drawn into the building ventilation or make-up air system.
10. Ensure that boiler stacks or steam vents do not discharge into the tower. If they do, then:

- Raise the stack.
- Block airflow from the stack to the tower.

Owner’s “Quick Start” Cooling Tower Water Survey

1. Does water overflow during steady-state operation? If so, then:
 - Reset sump water level lower.
 - Equalize flow in multi-cell installations.

2. At shut-down of fan/pump, does water overflow? If so, then:
 - Reset the water level lower.
 - Install a check valve in the supply line.

3. Does the tower leak at its seams? If so, then seal according to manufacturer’s recommendations.

4. Does the entering water basin at the top of the tower overflow (applicable to crossflow-systems only)? If so, then:
 - Check for clogged metering orifices.
 - Adjust flows to balance levels in both basins.

5. Does water drip from the fan scroll weep-hole (applicable to centrifugal fan-forced draft systems only)? If so, then:
 - Reduce sump water level.
 - Run fans whenever the pumps run, using pony motors or capacity control dampers.

6. Does water spray from the top of the tower? If so, then:
 - Adjust the eliminators if upside down or skewed, and replace if corroded or broken.
 - Check the water flow rate.
 - Check fan RPM.
 - Check fan pitch (induced-draft systems only).
 - Reduce water level.

7. Does the make-up valve leak? If so, then:
 - Replace the valve seat or valve.
 - Install a pressure-reducing valve set at 25-30 psi.
 - Install an electric make-up valve.
8. To what should the overflow and drain lines be connected?
(This will vary at each facility, depending on in-house policy subject to applicable local, state, and federal regulations.)
9. Does the pump leak? If so, replace the seals.
10. Is a conductivity (Total Dissolved Solids - TDS) meter with a purge valve installed?
 - Ensure there is no overflow at the tower.
 - There is a conductivity TDS meter with a purge valve on most systems. Whether cooling tower water is treated chemically or non-chemically, a conductivity meter will reduce water waste.

Appendix 3:
Evaporative Cooling Equipment Discharge Routing Policy

Evaporative Cooling Equipment Discharge Routing Policy

Evaporative Cooling Equipment Discharge Decision Matrix

The following matrix has been designed to assist the local inspector in determining the correct disposal option for evaporative cooling equipment discharges. If the effluent is determined to be within all required parameter guidelines listed in column A of the matrix for its size and treatment type, then discharges must be routed to the storm drainage system. If the effluent is determined to be within any of the required parameter guidelines listed in column B of the matrix for its size and treatment type, then discharges should be routed to the Hampton Roads Sanitation District (HRSD) system in accordance with Section 301 of *HRSD's Industrial Wastewater Discharge Regulations* and the *Cooling Tower Discharge Policy and Guidance Manual*. New equipment may be routed to the HRSD system. However, subsequent analysis will be required and may necessitate subsequent re-routing of the discharge to the storm drainage system or surface waters.

Wastes generated as a result of system start-up, periodic maintenance, or system shut-down should be handled on a case-by-case basis in accordance with Section 301 in HRSD's *Industrial Wastewater Discharge Regulations*.

Notes:

1. *Sampling and analysis for privately owned evaporative cooling equipment must be performed by an independent laboratory, unless the facility has the capability of performing the required sampling and analysis in house. Publicly owned evaporative cooling equipment may be sampled and analyzed by HRSD at cost.*
2. *pH and COD analyses may be performed using EPA-approved field testing methods.*

Background

Evaporative cooling equipment discharges represent a potential problem to water quality in Hampton Roads. State and federal regulations require local governments to manage and/or regulate the discharges from evaporative cooling equipment in an environmentally sound manner. To this end, local governments throughout Hampton Roads, in conjunction with the Hampton Roads Sanitation District, the Hampton Roads Planning District Commission (HRPDC), and the Virginia Department of Environmental Quality (DEQ), have agreed on standard criteria for determining the correct method for handling routine evaporative cooling equipment discharges and wastes generated as a result of system start-up, periodic maintenance, or system shut-down.

For more information contact:

Agency	Contact	Phone Number
Hampton Roads Sanitation District	Industrial Waste Division - Southside	757-460-2261
Hampton Roads Sanitation District	Industrial Waste Division - Peninsula	757-874-6602
DEQ - Tidewater Regional Office	Permits Program (Water)	757-552-1840
City of Chesapeake	Department of Public Works - Stormwater	757-547-6312
City of Franklin	Department of Public Works	757-562-8585
City of Hampton	Department of Public Works - Engineering	757-727-6388
City of Newport News	Department of Public Works	757-247-8611
City of Norfolk	Department of Public Works - Stormwater	757-441-2408
City of Poquoson	Department of Engineering & Utilities	757-868-3530
City of Portsmouth	Department of Public Works - Engineering	757-393-8592
City of Suffolk	Department of Public Works	757-925-6390
City of Virginia Beach	Department of Planning - Permits & Inspections	757-427-4211
City of Williamsburg	Department of Public Works & Utilities	757-220-8144
County of Gloucester	Office of Community Development & Codes Compliance	804-683-1219
County of Isle of Wight	Department of Public Works	757-357-3191
County of James City	Office of the County Administrator	757-253-6626
County of Southampton	Office of the County Administrator	757-653-3015
County of York	Department of Environmental Services	757-890-3750

Parameters Requiring Analysis Based on Equipment Size and Treatment Type			
Treatment Type*	Evaporative Cooling Equipment Size (Tons)		
	≤100	> 100, ≤ 500	> 500
No Treatment	pH COD	pH COD	pH COD
Magnetic Descaling and/or Disinfection	pH COD TP	pH COD TP Zn	pH COD TP Zn
if Cu/Ag anodes; add	Cu	Cu	Cu
Chemical Treatment	pH COD TP Zn	pH COD TP Zn TSS	pH COD TP Zn Cu TSS

*Note: Any treatment type other than those noted above will be evaluated on a case-by-case basis.

Discharge should be routed to the storm drainage system if analysis shows that all of the required parameters are within the guidelines in the following column (A). **DEQ must be notified prior to connection in order to obtain an appropriate permit.**

- A**
- pH - ≥ 6 and ≤ 9
 - COD - ≤ 60 mg/l
 - TP - ≤ 2.0 mg/l
 - Zn - ≤ 1 mg/l
 - Cu - ≤ 1 mg/l
 - TSS - ≤ 30 mg/l

COD - Chemical Oxygen Demand
 TP - Total Phosphorus
 Cu - Copper
 Zn - Zinc
 TSS - Total Suspended Solids

Discharge should be routed to HRSD if analysis shows that any of the required parameters are within the guidelines in the following column (B). **(HRSD must be notified prior to connection.)**

- B**
- pH - ≥ 5 and < 6, or >9**
 - COD - > 60 mg/l
 - TP - > 2.0 mg/l
 - Zn - > 1 mg/l
 - Cu - > 1 mg/l
 - TSS - > 30 mg/l

Note: All system start-up, shut-down, or other periodic cleaning discharges into HRSD's system should be handled on a case-by-case basis in accordance with Sec. 301 of HRSD's *Industrial Wastewater Discharge Regulations*.

** If pH is < 5 or if Zn or Cu concentrations exceed HRSD limitations, pretreatment will be required prior to discharge.

Appendix 4:
HR WET Business and Industry Recognition Program
1996 Recognized Organizations

HR WET Businesses and Industry Recognition Program 1996 Recognized Organizations

Amoco Yorktown Refinery, Grafton, Yorktown, VA

Established Variable Incentive Plan that shares with employees the savings from reduced variable expenses such as water use. They initiated annual training program to increase employee awareness of water use. Results: Employees have submitted proposals for water conservation projects in various areas. They also formed a Water Loss Committee in late 1995 that is using problem-solving methods to systematically: (1) analyze water use; (2) analyze potential water savings from capital projects; and (3) assess alternative water sources.

Baxter's Food Court and Dairy Queen, Hampton, VA

Chose air-cooled (rather than water-cooled) cooling systems for soft-serve ice cream and yogurt machines. Result: Avoided 14,600 gallons of water use, per ice-cream machine, per month.

Heron's Point Apts., Virginia Beach, VA

Replaced conventional toilets with ultra low-flow models, and installed low-flow showerheads in 96 rental units. Result: Reduced water consumption by 21% for a savings of more than one million gallons annually.

Naval Weapons Station, Yorktown, VA

Replaced air-compressor system's "once-through" cooling system with a closed loop cooling system. Upgraded steam distribution system to eliminate leaks and reduce amount of water required. Result: Reduced water consumption by more than 1.7 million gallons of water annually.

Old Dominion University, Norfolk, VA

In coordination with the Virginia Energy Plan, Old Dominion University has a comprehensive Energy Management Plan to reduce all utilities usage including water consumption. Results: Reduction of water consumption in building air conditioning cooling towers was accomplished by installing devices that treat condenser cooling water, while reducing the need for "blowdown" water. Usage of water in restrooms was reduced by installing automatic valves on sinks, urinals and toilets. Flush cycles have been shortened in toilets by installing spacers in water valves. Sources other than potable water supplies are being researched to irrigate playing fields and campus plant life. Expansion of these techniques to all the facilities is estimated to save over one million gallons of water per year.

Portsmouth General Hospital, Portsmouth, VA

Installed water-saving devices in 130 toilets and replaced 85 conventional showerheads with water-efficient models. Result: Expect to reduce water usage by over seven hundred thousand gallons annually.

Ramada Inn, Williamsburg, Williamsburg, VA

Repaired leaks, replaced all toilet flappers and is currently rebuilding tub faucets and replacing all sink faucets in 163 bathrooms. Requested guests to consider foregoing daily linen changes when possible during stays of more than one day. Result: Reduced water use by an average of 17% over the past year.

Union Camp, Franklin, VA

Created water conservation teams with short-term focus and long-term focus to identify water conservation projects throughout the plant. Results: Implementation of water conservation projects identified by the teams has resulted in a 25% reduction of water use over the past 20 years despite increase in production of 100%.

Virginia Beach General Hospital, Virginia Beach, VA

Installed recirculating system that captures and reuses water circulated to create a vacuum seal in hospital's medical fluid suctioning system. Result: Reduced water use by one million gallons annually.

Appendix 5:
HR WET Representatives

HR WET Representatives

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**Appendix 6:
Internet and Printed Resources**

Internet and Printed Resources

Internet

- <http://www.awwa.org>

This home page of the American Water Works Association offers resources regarding studies and other publications including books such as:

Water-Efficient Landscape Guidelines by Richard E. Bennett and Michael S. Hazinski.

How Much is Enough: Controlling Water Demand in Apartment Buildings by Peter H. Judd.

- <http://www.greenhotels.com>

Program that assists hotels and bed and breakfasts to conserve energy and reduce use of resources, including water.

- <http://www.waterwiser.org>

Lists over 160 studies and reports regarding industrial and commercial water conservation programs; also lists other biographical resources.

- <http://www.wef.org>

This home page for the Water Environmental Federation has information that includes wastewater discharge and watershed protection.

Printed - contact...

- Hampton Roads Planning District Commission (HRPDC) for *Cooling Tower Discharge Policy and Guidance Manual*, The Regional Building, 723 Woodlake Drive, Chesapeake, Virginia 23320 or call 757-420-8300. Fax: 757-523-4881.
- Hampton Roads Water Efficiency Team (HR WET) for additional water conservation information, P.O. Box 1834, Chesapeake, Virginia 23327 or contact through local utilities listed in Appendix 5.
- WAVE (Water Alliances for Voluntary Efficiency) is a non-regulatory, water-efficiency partnership created and supported by the U.S. EPA. WAVE's mission is to encourage commercial businesses and institutions to reduce water consumption and increase efficiency, profitability and competitiveness. For more information, contact WAVE Program Director, U.S. EPA, 401 M St., S.W., Mail Stop 4204, Washington, DC 20640. Or call 202-260-7288. Fax: 202-260-1827.