Community Water System Efficiency and Conservation Best Management Practices Manual

BMP

North Carolina
Department of Environment
and Natural Resources

DWR
Division of
Water Resources

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The N.C. Division of Water Resources has taken extra effort to develop best management practices in order to enhance community water systems' water efficiency and conservation in this manual. However, it would not have been possible without the support and assistance of these individuals and organizations. We would like to extend our special thanks to all of the water systems that tested the Small Water System Water Audit and allowed us to use their current best management practices as case studies to better convey the goal of this manual to other communities.

Most of this material contained in the manual has been reworked extensively, and is difficult to reference precisely. Exact referencing has been attempted when possible, and those documents that have been used, in general, have been included in the reference list.

Introduction

In 2011, the North Carolina General Assembly passed Session Law 2011-374 (HB 609) Section 3.1. G.S. 143-355(l) that mandates improved efficiency of the use of North Carolina's water resources. As part of this mandate, water systems are required to complete and submit a local water supply plan to the N.C. Department of the Environment Natural Resources' Division of Water Resources that includes a plan for the reduction of long-term per capita demand for potable water.[1]

The N.C. Department of Environment and Natural Resources was charged with providing statewide outreach and technical assistance as needed regarding water efficiency, which includes the development of best management practices for community water efficiency and conservation. Although used interchangeably, water efficiency and conservation can have different contextual meanings. Simply put, water efficiency should be thought of as the practice of optimizing the use of available water supply, and water conservation as behavioral practices that result in consumption reduction. The required best management practices include:

- Integrating water efficiency and conservation into local water supply plans.
- Conducting regular water audits to identify revenue and nonrevenue water and water losses.
- Adopting water loss abatement programs.
- Metering and sub-metering of existing residential and multi-unit residential, commercial and industrial complexes.
- Retrofitting residential fixtures (faucets, showerheads, toilets, etc.) and equipment (clothes washers, dishwashers, etc.) to make them more water efficient.
- Landscaping in a manner that conserves water and is regionally appropriate.
- Employing water reuse practices that include harvesting rainwater and using gray water.
- Pricing water to achieve comprehensive conservation and adopting full-cost accounting in line with the recommendation approved by the State Water Infrastructure Commission in November 2010.

[1] The per capita water demand can be calculated by using a water system's annual residential demand and year-round population (annual demand in gallons per day divided by year-round population).

In addition to developing these, the N.C. Division of Water Resources also included best management practices (BMPs) for:

- Water supply contracts between water systems selling water and those purchasing the water.
- A consumer education program that emphasizes the importance of water efficiency and conservation, including measures residential customers may implement to reduce water consumption. This BMP also serves to help water systems become eligible for state water infrastructure funds from the Drinking Water State Revolving Fund, the Drinking Water Reserve, or any other grant or loan of funds allocated by the General Assembly that require incorporating consumer education as mandated by Section 3.2. G.S. 143-355.4(b).
- A school outreach and education program.

The purpose of this BMP manual is to assist water system managers in determining which BMPs would be most effective in reducing their long-term per capita demand for potable water. Water systems are encouraged to objectively view BMPs in this manual, and make decisions that would most benefit their organization and the customers they serve. Although water systems are not required to implement any specific best management practice, there are several that are considered foundational to effective water efficiency plans. The most important is conducting regular water audits to identify revenue and nonrevenue water and water losses. As part of conducting these water audits, metering of all connections is essential to account for all water used. This data will be used as a baseline for comparison against future water use to determine increased efficiency. In addition, adopting leak detection and water loss abatement programs allows systems to act on the water audit information to reduce water loss and lost revenue.

The manual will outline several BMPs that have been successfully used in other water systems throughout North Carolina and the United States. Each BMP will contain the following components:

Applicability – The specific type of water system that could potentially benefit from the BMP is described, as are the general goals for water efficiency that the BMP addresses.

Description – This section provides an explanation of the specifics of the conservation measure(s) included in the BMP. The best available technology that is proven and cost effective is recommended. Often a best available technology may not yet be cost effective to be implemented by all water users. Highly efficient water conservation measures that will produce cost-effective results are mentioned.

Implementation – The basic steps to accomplish the BMP are described. If the description section includes more than one measure to complete the BMP, the implementation section will suggest necessary steps for achieving the water savings.

Schedule – In BMPs with multiple implementation steps, a recommended schedule for implementation is included. In general, planning, data gathering and evaluation steps should be accomplished within 12 months of adoption of a specific BMP.

Scope – For simpler BMPs, the scope is complete when the steps described in the implementation section have been achieved. For more complicated BMPs, the scope discusses the level of implementation and constraints necessary to consider the BMP complete.

Documentation – To track the progress of a BMP, the water system should collect certain data to document progress in implementing the BMP and evaluating actual water savings. This section identifies the recommended data.

Determination of Water Savings – This section specifies information necessary to calculate water savings from implementation of the BMP and may include statistical or mathematical formulas when appropriate.

Cost-Effectiveness – Basic costs of implementing the specific BMP are explained. Due to the wide variety in actual costs based upon the size and location of the program, ranges of costs are given where appropriate. In many cases, costs and expenses can be reduced or spread out when multiple BMPs are implemented. This section primarily serves to remind the users of costs to consider when performing a cost effectiveness analysis.

References – The BMP concludes with a listing of resources for additional information and contact information that can assist a water system in implementing the BMP.

Case Study Example – Each applicable BMP will be followed with an example of how that specific BMP has been successfully implemented by a water system.

As efficiency and conservation practices are implemented, new insights, technological advances and information will become available. In addition, future technologies may improve water savings and reduce costs. Therefore, this manual should be seen as an evolving document that will be routinely updated and modified based on new information or user feedback. The N.C. Division of Water Resources encourages utility managers, efficiency/conservation specialists, planners, policy makers, and others to provide comments and feedback regarding this document, so it can be continually improved to better serve the water systems of North Carolina. For general comments or questions about this BMP Manual, please contact the manager of the Water Supply Planning Branch at 919-707-9024.

By completing the following BMPs, a water system can fulfill several requirements under Section 9 of the Drought Bill. Fulfilling these requirements also will help the water system be eligible for loans under the N.C. Division of Water Resources State Revolving Fund (DWRSRF). For details and further information, see http://www.ncwater.org/pws/srf/Factsheets/DroughtBill_ProcedureMemo.pdf.

Integrating Water Efficiency and Conservation into the Local Water Supply Plan

A local water supply plan (LWSP) is an assessment of a water system's current and future water needs and its ability to meet those needs. By understanding current and future needs, communities will be better equipped to manage water supplies and plan for water supply system improvements. As the population in North Carolina continues to increase, communities should make it a high priority to ensure that their customers are conservation minded and that their water system is operating at peak efficiency. Although used interchangeably, water efficiency and conservation can have different contextual meanings. Simply put, water efficiency should be thought of as the practice of optimizing the use of available water supply, and water conservation as behavioral practices that result in consumption reduction. The LWSP can be a very useful tool in measuring how well a water system and its customers are managing available water supply.

As a result of Session Law 2011-374, water systems must now include a plan to reduce long-term per capita water demand within their jurisdiction as part of their LWSP submittal. As a matter of practicality, the per capita water demand can be calculated by using a water system's annual residential demand and year-round population (annual demand in gallons per day divided by year-round population). The N.C. Division of Water Resources has modified the LWSP to help water systems better track their long-term per capita water demand (see statement below). A chart in Section 5 of the LWSP will track long-term per capita water demand based on year-round population and water demand projections entered by the user. The chart will also be equipped to show a history of per capita water demand. By integrating this feature into the LWSP, systems can see how well their efficiency and conservation plans are working. Although there is no requirement to implement a specific BMP, water systems should consider implementing one or more of the BMPs in this manual, or devise their own BMPs. It should be noted that water savings from the implementation of a particular BMP will not be the same for all systems. Factors such as implementation choice(s), condition of assets, maintenance programs, and customer behaviors will affect the level of water savings realized by each system.

There are several BMPs considered fundamental to an effective water efficiency and conservation plan; however, conducting regular water audits is foundational to an effective plan. Conducting an initial water audit allows a water system to determine baseline efficiencies and set realistic goals for improvement. Subsequent water audits enable a water system to measure milestone achievements and performance of BMPs implemented. Once a water system begins conducting water audits, evaluations can be performed to determine which BMPs are most effective at minimizing losses and reducing long-term per capita water demand.

Regardless of which BMPs a water system implements, there must be a reduction in the long-term per capita water demand. By implementing water efficiency and conservation practices, communities will be better positioned to meet the future water supply needs of their customers.

The statement associated with the tracking chart in the LWSP reads as follows:
Your long-term water demand is xx gallons per capita per day. What demand management practices do you plan to implement to reduce the per capita water demand (i.e. conduct regular water audits, implement a plumbing retrofit program, employ practices such as rainwater harvesting or reclaimed water)? If these practices are covered elsewhere in your plan, or there are no changes from a previous submittal, indicate where the practices are discussed or "No Changes" here.

For comments or questions regarding Integrating Water Efficiency and Conservation into the Local Water Supply Plan, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9002.

Water Audit and Water Loss Abatement Program

Background

Every gallon of water lost or wasted due to system inefficiencies comes at an increasing cost to our communities and natural resources. Water audits and water loss abatement programs, more commonly known as water loss control programs, are valuable water management tools that can improve the efficiency of water production and delivery within all utilities in the state. It is important that water systems focus on the efficiency of their water supply operations while promoting water efficiency and conservation to their customers.

While not currently required by law, an essential tool to determine the efficiency of a water system is the water audit. Water audits are routinely used by utilities and have proven to be extremely beneficial in identifying areas for system improvement. These improvements have saved utilities money and provided customers with a more reliable water supply.

Different types of water audits are used to account for water activity in a system. Two options are the small system water audit, which was developed from the N.C. Division of Water Resources' local water supply plan (LWSP), and the American Water Works Association (AWWA) water loss control committee's free water audit.

The need for a standardized water audit was identified by AWWA, and through the efforts of its members, the free water audit has been made available by going to http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511.

While the AWWA water audit applies to all systems, smaller systems (less than 10,000 people) with more limited resources may wish to complete a slightly less comprehensive audit. DWR has developed an alternative water audit to meet this need. A link to the free software will be on the division's website soon.

Information and technical assistance regarding the use of either of these audits can be found by going DWR's website at htttp://www.ncwater.org.

Applicability

A water audit is the first and most important best management practice a utility should implement, and lays the foundation for any water loss control program. This BMP is intended for all utilities and should be considered by a utility that:

- Needs to ensure its customers are fairly paying for the amount of water they are receiving.
- Needs to reduce water losses to ensure an adequate future water supply for its customers.
- Would like to analyze the benefits of reducing non-revenue water.

- Does not conduct periodic water audits.
- Wants to determine how under-registering meters and unmetered users are impacting revenue.
- Does not have an active water loss control program.

To maximize the benefits of this BMP, the utility should use information from the water audit to implement effective water loss control strategies, revise meter testing and repair practices, reduce unauthorized water use, and improve accounting for authorized, un-billed water users.

Description

Water audits and water loss control programs are effective tools for the accounting and management of all water activity in a system. Performing a reliable water audit is the foundation of proper water resource management and loss control in water systems. Interest has increased in revising and developing water audit procedures to move away from simply considering "unaccounted for water" to a systematic methodology of accounting for all water activity. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The information that comes from a water audit is valuable in setting performance indicators and goals and to cost-effectively reduce water and revenue losses.

<u>The Water Audit</u>

A water audit accounts for water processed by a utility. The audit starts with an accurate accounting of raw, treated and distributed water. In an ideal water audit, the accuracy of the raw water meters and their output should be verified. This production is then compared to authorized consumption, both billed and un-billed, to determine water loss in the system. Water loss is divided into apparent water loss and real water loss.

- Apparent: Water loss due to meter accuracy error, data transfer errors between meter and archives, data analysis errors between archived data and data used for billing/water balance, and unauthorized consumption including theft. The cost of apparent water loss is estimated using a utility's retail water rates.

- Real: Water loss due to leakage and excess system pressure. Real water loss can be reduced by more efficient leakage management, improved response time to repair leaks, improved pressure management and level control, improved system maintenance, and replacement and rehabilitation. The cost of real water loss is estimated using marginal production costs, such as energy and chemicals needed to treat and deliver the water.

The water audit can also analyze billed versus metered consumption, large meter sizing, pump efficiency and economic leakage. The water audit may be expanded or

contracted depending on the size of the system. A utility that wants to improve water efficiency will conduct the water audit every year.

Completing the Water Audit

The water audit is basically accomplished in two steps:

1. Collect data to perform the water audit.
2. Verify data collected.

The collection of data for the water audit is called the top-down approach. The verification of the data used in the water audit is called the bottom-up approach. Both approaches must be completed in order to obtain reliable results from the water audit.

For the top-down approach, a desktop water audit using existing records and estimations is used to provide an overall picture of water losses. Small utilities that have an updated LWSP would benefit from using the small system water audit because they have already gathered a substantial portion of the data needed to complete the top-down approach. If a utility has conducted a water audit using the AWWA M36 Manual, they have already completed a more in-depth process. The small system water audit spreadsheet included in this BMP is only recommended for small utilities with populations below 10,000 people and who do not consider the AAWA water audit appropriate for their system.

Utilities that use the small system water audit should first print the definitions to become familiar with the terms needed to complete the water management table. The water management table is the main spreadsheet used to complete the audit. The spreadsheet only accepts values in the non-shaded cells. Cells with red triangles at the top right corner contain instructions. Use your cursor to roll over the red triangle to see the instruction box. The spreadsheet has three major components: water delivered by the utility, water used by customers and water and revenue loss experienced by the utility. Losses are calculated by the spreadsheet using tools such as the Meter Error Table, the Cost to Produce Calculator, and the Retail Charge Calculator that are included as tabs at the bottom of the spreadsheet.

Some records that will be needed to complete the top-down approach include:

- Quantity of water entering the system.
- Customer billing summaries.
- Leak repair summaries.
- Meter accuracy test.
- Meter change-out summary.
- Water production cost.
- Retail rates for water.
- Permitted fire hydrant use.
- Other records that may be kept on water theft and unmetered uses such as line

flushing or street cleaning.

Once the top-down approach is complete, the utility should have an overall picture of apparent and real losses along with its associated revenue loss.

For the bottom-up approach, the process of verifying the data used in the water audit is performed. This process involves a detailed investigation into actual policies and practices of the utility and includes activities such as:

- Checking water consumption values used in the billing system for different user types.
- Performing meter calibrations for a sample set of user types.
- Improving estimates of water consumed by un-billed (i.e. fire department, and public works department) and unauthorized users.
- Properly metering all authorized users.

This part of the audit is phased in during several years and will help shape the objectives and priorities to improve system efficiency.

Tools that can be useful to accomplish the bottom-up approach include models capable of analyzing system pressure, night and zonal flows, and the practice of keeping good leakage repair records that show lag times to repair a known leak. Once the bottom-up approach is complete, a utility should have enough reliable data to establish a baseline for water loss and revenue loss. From here, development or modification of the water loss control program can begin.

Water Loss Abatement Program

In order to reduce water loss and revenue loss due to leakage, a utility should develop and maintain a proactive water loss control program. The program should identify objectives based on results from the water audit, and set goals to reduce water and fiscal losses. A structured approach to leakage management has proven to be successful in limiting losses. Potential elements of an active water loss control program include:

- Conducting regular inspections and soundings of all water main fittings and connections.
- Using a water loss modeling program. A model can range from the AWWA M36 manual water audit spreadsheet to a commercially available statistical model.
- Metering and managing individual pressure zones.
- Establishing district metering areas (DMA) and measuring daily, weekly or monthly flows with portable or permanently installed metering equipment.
- Continuous or intermittent night-flow measurement.
- Installing temporary or permanent leak noise detectors and loggers.
- Reducing repair time on leaks. Long-running small-to-medium size leaks can result in the greatest volume of annual leakage.

- Controlling pressure just above the utility's standard-of-service level taking into account fire requirements, outdoor seasonal demand and requisite tank filling.
- Operating pressure zones based on topography.
- Limiting surges in pressure.
- Reducing pressure seasonally and/or where feasible to reduce loss from background leaks.

If a utility has not had regular leak surveys performed, it will probably need at least three leak surveys performed in consecutive years, or every other year for the following purposes:

- The first survey will uncover leaks that have been running for a long time.
- The second survey will uncover additional long-running leaks whose sounds were masked by larger nearby leaks.
- By the third survey, the level of new leaks should start to approximate the level of new reported leaks.

The utility should make every effort to inform customers when leaks exist on their side of the meter. If customer service line leaks are significant, a utility may want to consider making the repairs itself or shutting off the water until the leak is repaired.

The water loss control plan should address areas such as:

- Customer meter inaccuracy due to meter wear, malfunction or inappropriate size or type of the meter.
- Data transfer error when transferring customer metered consumption data into the billing system.
- Data analysis errors including poor estimates of un-metered or un-read accounts.
- Inaccurate accounting resulting in some accounts not being billed for water use.
- All forms of unauthorized consumption including meter or meter reading-tampering, fire hydrant theft by contractors, unauthorized taps, and unauthorized restoration of water service cutoffs.
- Un-metered municipal connections. Every effort should be made to meter municipal connections in order to better account for water use. Spikes in water use should be reported to the user as this may indicate a leak.
- Field Response and maintenance procedures.

Implementation

To successfully implement this BMP, the utility should start by forming a working group from the following work areas: management, distribution, operations, production, customer service, finance and conservation. Each of these work areas has an essential role to play in implementing this BMP. Smaller utilities may have the same person performing several of these functions; therefore the working group may just be one or two individuals. The utility should also consider a public involvement process to solicit outside input and enhance public relations.

Initially, the working group should focus on gathering relevant data that will form the basis for completing the top-down approach. Some questions that should be addressed during this process are:

- Should we test production meters and how often? Commercial meters more than one inch? More than 2 inches?
- Should we replace or repair ⅝-inch and ¾-inch meters? How often?
- How inaccurate are the ⅝-inch and ¾ inch meters on average when they are replaced?
- How do we estimate total leakage from each leak based on the leakage flow-rate and duration of leakage from time reported to when it is fixed?
  How do we improve this process?
- How long does it take to repair leaks? How do we reduce this time? (The repair logs should be itemized by size of leak).
- How are customers encouraged to report leaks?
- Is our system for tracking the location of leaks and our method to calculate when it is cost-effective to replace mains and service lines adequate? How do we improve this process?
- Do meter readers inspect for and report leaks?
- How do we adjust consumption records when billing records are adjusted?
- How do we improve the optimal use of backwash and other in-plant water?
- How can we improve our theft reduction program?

Based on data collection efforts by the working group, the utility should have enough information to complete the top-down approach, as well as identify ways to improve the information for future audits.

In conducting the bottom-up approach, the working group should focus on evaluating data handling procedures and performing field investigations to improve the quality of data used. Activities can include:

- Checking the customer billing system for water consumption data handling errors.
- Categorizing user types by meter size and consumption volume to check for gross irregularities in consumption.
- Performing meter accuracy tests for a sample set of various user types.
- Performing investigations to identify unauthorized water use among a sample set of various user types.

The top-down and bottom-up approaches to completing the water audit should be incorporated into the working members' job duties in order to maintain a set of good objectives and priorities to be performed through the water loss control program.

Schedule

To accomplish this BMP, the utility should:

- Gather the necessary data to complete the top-down approach, and perform the water audit within the first 12 months of implementing this BMP.
- Begin to make bottom-up refinements in the 12 months immediately following the completion of the top-down approach.
- Begin to develop or modify the water loss control program immediately after making refinements to the water audit. Development of the water loss control program can occur simultaneously while performing the bottom-up approach, but it is advised to obtain the best data reasonably possible before investing substantial capital to address efficiency objectives.

Scope

To accomplish this BMP, the utility should:

- Conduct periodic water audits in accordance with the methodology in this BMP manual, or use the AWWA M36 Manual.
- Develop and perform a proactive distribution system water loss control program and repair identified leaks.
- If the audit warrants, implement:
    - A pressure reduction strategy.
    - A program to reduce real losses including a leak detection and repair program.
    - A program to reduce apparent losses.
- Advise customers when it appears that leaks exist on the customer's side of the meter and evaluate a program to repair these leaks.

Documentation

To track the progress of this BMP, the utility should maintain and have available the following documentation:

- A copy of each annual system water audit and a list of actions taken in response to the water loss control program.
- An annual leak detection and repair survey, including number and sizes of leaks repaired.
- The number of customer service line leaks identified and actions taken to repair these leaks.
- Pressure reduction actions taken.
- Updates made to the billing system.
- Meter change-out efforts.
- Theft elimination efforts.
- Annual revenue increase through water loss reduction efforts.

Determination of Water Savings

Water savings is an integral part of the water audit process and should be revealed in a water audit report. Water savings should become evident after completing the water audit and execution of strategies in the water loss control program. Whether a system chooses to use the DWR's small system water audit or the AWWA free water audit, both audits include metrics that provide for the visualization of actual savings resulting from program enhancements. Total apparent and real water losses can be used as a measure of improvement in volumetric losses, and the cost of apparent and real water losses can be used as a measure of reduction in revenue loss.

Cost-Effectiveness Considerations

Direct costs that should be considered in implementing this BMP include the initial and ongoing costs to perform and update the water audit and the water loss control program, capital costs for items such as leak detection equipment, billing software upgrades and repairs to the system. Utilities may wish to do the work in-house with technical staff or use outside consultants and contractors.

A cost benefit analysis should be incorporated as part of a utility's overall strategy to reduce losses and improve efficiency. The cost benefit analysis should measure the cost of system software and hardware improvements against anticipated benefits in revenue gain. The analysis should also predict when the utility should start seeing a return on investment from actions taken in the water loss control program.

For comments or questions regarding the Water Audit and Water Loss Abatement Program BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9021.

References

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Case Study for a Water Audit and Water Loss Abatement Program

Mars Hill, North Carolina

Background

Mars Hill is a small town in the southern portion of Madison County, North Carolina. The town's history is closely linked to Mars Hill College, the oldest educational institution still in its original location in Western North Carolina. It is part of the Asheville Metropolitan Statistical Area.

The town's population was 1,869 according to the 2010 U.S. Census. According to the 2011 local water supply plan update, the town had a year-round service population of 3,150 people. The total included 1,200 students with 702 residential connections and 124 gallons per connection per day. Mars Hill withdraws their water supply from Popular Cove Reservoir on Big Laurel Creek.

In 2008, the North Carolina General Assembly provided N.C. Department of Environment and Natural Resources with funding for the most drought vulnerable water systems in order to have consultants complete a detailed water audit. Using the AWWA Water Loss Control Committee Free Water Audit, the consultant reported that Mars Hill's had an estimated non-revenue water loss of 38 percent.

In 2012, the town staff believed this figure was reduced to between 20 percent and 25 percent. The consultant provided several valuable recommendations and the town of Mars Hill wants to find and reduce non-revenue water loss and improve their water system in other ways as well.

Water Audit Results

The main recommendation from the water audit was to continue to audit the water system in future years. Most of the original input data was taken from estimates, so metering all water use is a key to more accurate data. Other recommendations included:

- Troubleshoot billing software.
- Replace Mars Hill College (MHC) turbine meters with compound meters.
- Active leak detection for the cross-country transmission line.
- Replace MHC's two 6-in. meters and the 2-in. Madison Manor meter with compound auto-read meters.
- Active leak detection workshops for Mars Hill's staff.
- Develop Unidirectional Flushing Strategy and Valve Inventory/Exercise Program.
- Maintain Standardized Leak Detection/Repair and Flushing Records.
- Add distribution system personnel to support development of leak detection program.

- Develop meter inventory and systematic replacement of meters seven years or older with automatic read meters; target (minimum) between 5 percent and 10 percent replacement each year.
- Perform water rate study.

Actions that have been incorporated into the utility's standard operation procedures to date:

- The town has added distribution personnel, per the audit's recommendation.
- Successful efforts have been made to reconcile outliers and glitches in the software of the billing system.
- Missing accounts were restored and all are metered. Un-billed accounts are now in consumption records.
- The town is setting aside funds (approx. $16,000) to replace the Mars Hill College turbine meters with compound meters (Four 2-inch meters and one 6-inch meter).
- Two 6-inch meters are being priced for replacement.
- The 2-inch Madison Manor meter was replaced.
- The town and a consultant performed leak detection on their cross-country transmission line. Based on finding numerous problems, they are replacing this old, high-pressure line with 8-inch ductile iron in 2012.
- Active leak detection was performed on the Bailey Street line.
- Town staff was trained in active leak detection techniques.
- One of three recommended large pressure-release valves for pressure management will be installed with the new cross-country water line.
- Town staff are now keeping records on leak detection, repairs and flushing.
- Town staff regularly evaluate unauthorized consumption.
- A radio-read meter replacement program has begun; 107 out of 800 meters have been replaced thus far with the oldest meters being replaced first.
- The town did a water rate study and now has an increasing block rate. The town formerly had a fixed flat-rate for water rate structure.

Mars Hill has demonstrated that by undertaking a Water Audit and Water Loss Abatement BMP, they are progressing towards a more efficient water system. As Mars Hill continues to incorporate the recommendations of the water audit, they will continue to reduce their water losses and increase their revenues.

The town manager indicated he would be glad to discuss the Water Audit and Water Loss Abatement Program with anyone regarding the successes they have had in Mars Hill. Mr. Daryl Boone can be contacted at 828-689-2301.

Metering and Sub-Metering of Existing Residential and Multi-unit Residential, Commercial and Industrial Users

Applicability

This BMP is intended for all water systems ("utility") that do not have 100 percent metering of all customer connections. Improved accuracy of meters resulting from increased maintenance efforts should result in increased revenue and reduced water loss. Metering of all new customer connections and retrofitting existing connections are effective methods of accounting for all water usage by a utility within its service area.

Description

Proper installation of meters by size and type is essential for good utility management. Using and maintaining the most accurate meter for each type of connection will help to generate adequate revenues to cover the expenses of the utility, ensure equity among customers, reduce water waste and reduce flows to wastewater facilities. The American Water Works Association (AWWA) provides a number of helpful resources on metering. Those resources are listed in the reference section of this BMP.

The purpose of this BMP is to ensure that all aspects of meter installation, replacement testing and repair are managed optimally for water use efficiency.

For a utility's meter program to qualify as a BMP which satisfies the requirements of Session Law 2011-374, it should include:

- Required metering of all connections.
- A policy for installation of adequate, proper-sized meters as determined by a customer's current water use patterns. The use of compound meters for multi-family ("MF") residential connections or other industrial and commercial accounts is recommended.
- Direct utility metering of each duplex, triplex, and four-plex unit whether each is on its own separate lot or whether there are multiple buildings on a single commercial lot.
- Meter all utility and publicly-owned facilities even if it the utility does not choose to bill these facilities. (This helps at the time of a water audit to account for all authorized uses).
- Use construction meters and access keys to account for water used in new construction.
- Require separate meters for all in-ground irrigation systems as per G.S. 143-355.4.
- Review capital recovery fees to determine whether the fees provide any disincentive to developers to use utility metering of apartment units.
- Annual testing and maintenance of all meters larger than 2 inches since a meter may under-register water use as the meter ages.
- Regular testing and evaluation of 5/8 inch and 3/4 inch meters which are 8 to 10

years in service to determine meter accuracy or a periodic, consistent replacement program based on the age of the meter or cumulative water volume through the meter. This program should be based on testing of meters at each utility to determine the optimal replacement/repair period since it depends on the quality of water and the average flow rate through the meter versus the capacity of the meter.

- An effective monthly meter-reading program where readings are not estimated except due to inoperable meters or extenuating circumstances. Broken meters should be fixed within seven days.
- An accounting of water savings and revenue gains through the implementation of the Meter Repair and Replacement Program.
- Meter hydrant flushing and fire use to the extent practicable.

Implementation

To accomplish this BMP, the utility should do the following:

- Conduct a Meter Repair and Replacement Program following the methodology and frequency currently recommended in NCDENR Efficient Metering Recommendations Report, which can be found at http://www.ncwater.org/drought/Efficient_Metering.pdf and/or use current industry practices as specified by the AWWA.
- Develop and perform a proactive meter-testing program and repair identified meters.
- When meters are accurate but customer-side leaks exist, develop a protocol to notify customers. An option would be to repair leaks on the customer's side of the meter or to provide guidance to customers on how to find leaks.

Schedule

To accomplish this BMP, the utility should do the following:

- The utility should develop procedures for implementation of this BMP within the first twelve months. The procedures should include annual or more frequent benchmarks for measuring implementation.
- The program participant should consider procedures for and maintain a proactive Leak Detection and Repair Program (See, System Water Audit and Water Loss Abatement BMP) within the first twelve months.

Scope

To accomplish this BMP, the utility should do the following:

- Develop and implement a metering program based on current North Carolina standards, which can be found at http://www.ncwater.org/drought/Efficient_Metering.pdf and/or AWWA practices

and standards.
- Produce a regular schedule for the utility meter repair and replacement program based upon total water use and the consumption rates of utility accounts.
- Effectively reduce apparent water losses though implementation of the meter replacement and repair programs.

Documentation

To track the progress of this BMP, the utility should gather the following documentation:

- A copy of meter installation guidelines based upon customer usage levels.
- A copy of the meter repair and replacement policy.
- Records of number and size of meters repaired annually.
- Report on the method used to determine meter replacement and testing intervals for each meter size.
- Estimate of water savings achieved through meter replacement and repair program.

Determination of Water Savings

Every year, the utility should estimate its annual water savings from the BMP. Savings can be estimated based upon a statistical sample analyzed as part of the meter-testing program. Water savings can also be realized through application of the water audit. As the percent meter error decreases through program enhancements, there should also be an associated decrease in apparent water loss shown in the audit. The utility should project potential savings into future years and also include water savings targets and goals in their projections.

Cost-Effectiveness

Capital costs to the utility in implementing this BMP may include the costs to install new meters and retrofit older ones, as well as one-time or periodic costs such as the purchase of meter testing and calibration equipment. A replacement meter can cost from as little as $50 for a residential meter to several thousand for larger compound meters. Meter testing and repair can be done by utility staff or by contractors. Smaller utilities could consider sharing testing facilities. A typical residential meter test can be completed at a cost of between $15 and $50. Administrative costs may exist for additional tracking and monitoring of meter replacements.

For comments or questions regarding the Metering BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9021.

References

- Water Loss Control Manual, Julian Thornton, McGraw-Hill, 2002.
- M6 Water Meters – Selection, Installation, Testing and Maintenance, AWWA 4th

Edition, 1999.

- Applying Worldwide BMPs in Water Loss Control, AWWA Water Loss Control Committee, Journal AWWA, August 2003.
- Recommendations for Efficient Metering of Water Use by Local Governments and Large Community Water Systems http://www.ncwater.org/drought/Efficient_Metering.pdf.
- NC DENR-DWR Public Water Supply http://www.ncwater.org/pws/srf/Pages/dwsrf_program.htm.

Case Study for Metering and Sub-metering

Brunswick County Utilities, North Carolina

Background

Brunswick County Utilities is located on the southeastern coast of North Carolina and serves a year-round population of 108,071 people based upon the 2010 Census and a seasonal population of 195,600 people. In 2011, the utility replaced 7,000 meters out of a total of 34,041 metered residential connections.

In 1999, Brunswick County had 10,249 retail water customers. With the explosive growth that has occurred in Brunswick County, the acquisition of one private water system, and assumption of operational responsibility and ownership of three municipal systems, the county has added approximately 24,000 customers to the water system in 13 years.

Brunswick County is the sixth largest county in terms of area in the state and provides retail service throughout the county. Due to the size of the county and complexity of reading each meter on a monthly basis, the county evaluated methods to remotely read its water meters. After a careful evaluation of all the alternatives, the county decided to implement an Advanced Meter Infrastructure (AMI)[2] meter reading system. With the AMI

[2] Due to advancements in technology, systems such as Advanced Meter Reading (AMR) and Advanced Meter Infrastructure (AMI) are now available in the utilities industry. The foundational premise upon which AMR and AMI systems work is the provision of greater efficiency and accuracy in resource accountability. AMR systems can be used to electronically record metered water usage, and transmit the data to a central location for billing and other operational uses. AMR systems provide for a reduction in labor costs, and eliminate operator error in reading and processing water usage data. As a result, application of AMR systems can also reduce apparent water loss. AMI systems have the capability to provide greater flexibility to the utility. These systems can record metered water usage and report the data in near real-time occurrence intervals. AMI systems also provides the utility with the option to remotely send instructions to customer meters such as disconnect/connect or upgrade firmware, and interface with data warehousing systems that store and manage collected data. The communication and to interface capabilities that AMI systems provide allows systems to timely and accurately manage water resources which reduces costs on the supply side, and increases efficiency and revenue on the demand side.

meter reading system, all meters can be read at one central location. The county selected a vendor to supply the AMI system and decided to use its own crews to install the meters during a seven-year period. The replacement of the meters has been taking place for the last three years and will continue for several more years. A full-time in-house team of six staff members spends five days a week replacing meters.

One of the major advantages of the AMI meter reading system is its ability to detect leaks in a customer's system. Since the meters transmit readings back to the central office, constant usage through normal low-flow periods can be detected. The AMI meter reading system has software that will print a daily list of customers with possible leaks. This allows the billing supervisor to flag possible leaks and contact the customer to alert them about the potential problem.

The capital cost of the project is $8,733,076 and will be funded during a period of years. Since the meter change-out is new and a new billing system is being used for the first time this year, no calculations of revenue saving have been made thus far.

Depending on the type of construction, the county allows developers of multi-family projects, including apartment and condominiums, to install either a gang meter assembly, where one meter serves each unit; or a master meter, where one meter serves all of the units. When a master meter is installed, the property owner or Property Owners' Association is responsible for the water charges. When a gang meter is installed, the property owner or renter of each unit is responsible for his or her usage.

Retrofitting Residential Fixtures – Showerhead, Aerator and Toilet Flapper Programs

Background

The typical U.S. family of four uses 280 gallons of water per day. In North Carolina, 80 percent is indoor water use (AWWA website). The average indoor use in a home with water efficient fixtures and appliances is approximately 35 percent less than without these fixtures (Vickers, 2001). This substantial savings makes residential indoor water efficiency an important component to consider in a comprehensive water efficiency plan. Residential indoor water efficiency programs have many aspects, with varying degrees of cost and water savings outlined in this best management practice. They include:

- Residential showerhead, aerator and toilet flapper retrofit programs;
- Residential toilet replacement programs; and
- Residential clothes washer incentive programs.

Applicability

A showerhead, aerator and toilet flapper retrofit program seeks to replace older, inefficient showerheads, aerators and toilet flappers with high quality, low-flow devices. These can either be installed directly by the utility, a contractor for the utility or by the resident or housing management directly.

This BMP is intended for a water system ("utility") that has at least 20 percent of the homes and apartment units it serves constructed prior to 1995, and for which there has not been an active retrofit program for efficient showerheads and aerators. This BMP is often implemented in conjunction with the Residential Ultra Low-flow Toilet Replacement BMP.

Description

Plumbing retrofits usually include showerheads and kitchen and bathroom faucet aerators, but may include toilet flappers as well. Four types of high quality, low-flow devices can be installed under this program: showerheads rated at 2.5 gallons per minute (gpm) or less, kitchen faucet aerators of 2.2 gpm or less, bathroom faucet aerators of 1.5 gpm or less, and if included, toilet flappers that flush the toilet at the designed flush volume for that toilet model.

Studies have shown that many 1.6 gallons per flush (gpf) toilets that have been installed are flushing at more than 1.6 gpf. If the utility decides to do a direct install of the low-flow devices, the flush volume of the 1.6 gpf should be checked and, if needed, adjusted to restore the flush volume to 1.6 gpf. If after the water level in the tank is adjusted and the flush volume is still well above the 1.6 gpf, it is likely that the toilet originally had an

early closure flapper. Using the model number on the inside of the toilet tank, determine which flapper is required. Replace the flapper or provide the customer with the replacement information for the flapper.

Implementation

1. The utility should identify the number of single-family (SF) and multi-family (MF) residences constructed prior to 1995. If there is no data of SF homes existing at the end of 1994 readily available, census data can be used. For the most accurate estimate of SF and MF residents, census data from 1990 and 2000, which includes the number of housing units by type, should be used. This data can be used to estimate SF units at the end of 1994, assuming linear growth.

To estimate the number of residences constructed prior to 1995

(# 2000 SF - # 1990 SF x 40%) + (# 1990 SF) = estimate of end of 1994 SF or detached units

Where # 2000 SF: Number of Single Family Homes or detached units in the 2000 Census data

Where # 1990 SF: Number of Single Family Homes or detached units in the 1990 Census data

The 40% assumes linear growth at 10 percent per year for four years.

A similar calculation can be done for multi-family residences, replacing SF with MF or attached units.

Source: Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

2. Develop a plan for disseminating the retrofit kits, either by directly installing the plumbing devices in single-family homes and multi-family residential facilities, by providing the kits for installation with follow-up inspections, or by distribution directly to customers with no follow-up.
3. If doing a direct install program, include a program to restore the flush volume of 1.6 gpf toilets to the design flush volume, if feasible.
4. After determining the potential number of participants, begin distribution to customers. See *Table 1: Distribution Methods, Potential Participation Rates, and Approximate Costs for Plumbing Fixtures* for more information on various aspects of different distribution methods.

Table 1: Distribution Methods, Potential Participation Rates, and Approximate Costs for Plumbing Retrofit Kit Programs

Kit Distribution Method*	Description	Pros	Cons	Potential Customer † Participation Rates	Approximate Cost ‡ of Program Per Household
Door to Door Canvass	Retrofit kits are delivered directly to households for installation by residents. Follow-up canvassing by trained technicians encourages or assists residents with installation.	High participation rates reported by targeted customers who respond to telephone surveys	Discrepancy between customer-reported installation rates; not all customers who receive a kit can be certain to install it.	50-75%	$13-$20
Direct Installation	Trained technicians are hired to install fixtures directly in homes, helping to ensure that the devices are installed correctly and not wasted. This method is often combined with other indoor and outdoor water-use audit.	Perhaps the most reliable installation technique for achieving water savings with retrofit devices because it is verified by installers; particularly effective for multifamily dwellings where users may not be motivated to install devices themselves	Usually the most expensive installation method.	40-60%	$17-$30
Mass Mailing	Kits are mailed directly to all customers or targeted customers for installation by residents.	Low-cost delivery method gets kit directly to customers who return cards requesting mail-out kit.	No direct contact with customer installation unless they request help of information; not all customers who receive a kit can be certain to install it.	15-60%	$10-$15
Depot Pickup	Customers are notified of depot locations, such as public buildings, libraries, and schools, where they can pick up the free kits.	Low administrative costs and responsibility	May attract only customers who are motivated to pick up a kit; it cannot be assumed that all customers who pick up kits will install the devices.	5-40%	$8-$13
Rebate	Utility provides rebates to customers who install a low-volume showerhead (and possibly other devices or fixtures).	Reward for customers who install conservation devices	May attract only customers who are motivated to install devices; rebate application process may be time-consuming and expensive for both program sponsor and customer without significant water savings if participation rate is low.	5-30%	$15-$20
Kit Requests	Water utility or sponsoring agency offers kits to customers who request them. Kits can be customized for residents' needs.	Minimal program design, management, and administrative responsibilities for program sponsor.	Not all customers who request a kit can be certain to install it. Verifying installation is difficult.	Poor	$7-$12

* Assumes each delivery method provides the same type of kit: two toilet displacement devices, two 2.5 gpm showerheads, two faucet aerators, toilet leak-detection tablets, and water conservation information booklet.
† Range shown is possible but not certain depending on a particular program's design, implementation, and targeted base.
‡ Includes approximate cost of kit and delivery method; actual costs vary according to unit price per kit and program-specific costs for promotion, contract labor, postage, printing, surveys, and other program specifics.

Source: Handbook of Water Use and Conservation, Vickers, 2001, page 99.

Schedule

Based on the approach(es) selected, the following schedule should be followed:

1. Direct Install and Kit Distribution Approach

   In the first 12 months: Plan a program including stakeholder meetings as needed. Locate plumbing contractors or retrofit companies who may be interested in bidding on the program. Determine a plan for educating homeowners, apartment owners and managers, plumbers and realtors about this program. Solicit bids and initiate the program. Include inspections by utility personnel, or a third party, to verify the plumbing devices installation. Each year, 10 percent of eligible single-family homes and 10 percent of eligible multi-family units should be retrofitted to maintain program development. Continue the program until 50 percent of eligible single-family houses and multi-family units are retrofitted.

2. Direct Giveaway of Kits by Customer Request, Targeted Giveaways and/or General Public Outreach Events.

   In the first 12 months: Plan a program to target general distribution of the retrofit kits to neighborhoods of single-family and multi-family residences that were built before 1995. For information on strategies for retrofit kit distribution directly to customers, see Table 1. For years 2-5, continue with the distribution of the retrofit kits.

Scope

To accomplish this BMP, the utility should:

- Develop and implement a plan to distribute or directly install high quality, efficient plumbing devices to single-family and multi-family units constructed prior to 1995.
- Implement the distribution or installation programs to achieve retrofits on at least 10 percent of eligible single-family units and 10 percent of eligible multi-family units each year. Utilities with more than 200,000 connections should retrofit at least 20,000 eligible homes and units each year.
- Within five years of implementing this program, retrofit at least 50 percent of eligible single-family houses and multi-family units with the specified devices. For utilities with more than 200,000 connections, at least 100,000 eligible homes and units should be retrofitted within five years.

Documentation

To track the progress of this BMP, the utility should gather:

- An inventory of the number of single-family and multi-family buildings prior to 1995, which are targeted by this BMP.
- For each year of implementation, maintain records of the number of single-family and multi-family units retrofitted;
- For each year of implementation, maintain records of the number of showerheads, bathroom faucet aerators, kitchen faucet aerators and toilet flappers (by category) installed in single-family and multi-family units;
- If kits are given directly to customers without follow-up installation verification, the utility should maintain records of the number and type of plumbing devices distributed.

Determination of Water Savings

Calculate water savings as follows:

Water Savings = Number of Devices Retrofitted x Device Savings

- Device Savings may be found in Table 2: Retrofit Device Savings Table
- Number of Devices Retrofitted = 1.0 x Number Devices Installed (when using Direct Installation Approach) OR
- Number of Devices Retrofitted = 0.3 x Number of Devices Installed (when using Kit Distribution Directly to the Customer Approach)

Source: Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

Table 2: Retrofit Device Savings Table

Device	**Initial Savings** (gallons per day or gpd per device	**Device Life Span** (Savings)
Showerheads and Faucet Aerators	5.5 gpd	Permanent*****
Toilet Flapper	Up to 12.8 gpd ******	Five years

Notes:
(*) The actual device life span is five to 15 years; the savings are permanent because inefficient equipment can no longer be purchased. In 1992, Congress passed the Energy Policy Act of 1992 which, among other things, mandated maximum flow rates for toilets, urinals, showerheads, and faucets.

(**) Residential End Use Study 5 average for toilet leakage was 9.5 gpcd, which can be translated to gpd per toilet by multiplying by average household size (2.7) and dividing by average number of bathrooms (2) Per single-family house. The utility should try to estimate actual savings based on measured leakage rate. (9.5gpcd x 2.7) / 2=12.8 gpd per toilet
Source: Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

The showerheads and faucet aerators should result in 5.5 gallons per day savings for between five years and 15 years. If the toilet flapper program is also used, then approximately up to 12.8 gallons per day could be saved for around five years.

Cost-Effectiveness

The significant expenses associated with this BMP will be the costs of purchasing the devices, the distribution costs and administrative costs. Usually contractors have been hired to conduct kit installation and door-to-door distribution programs. Labor costs are usually bid based on a unit cost per showerhead, aerator or flapper installed or per kit delivered. Labor costs exist for utility staff to bid the project, oversee the contractor, and conduct spot inspections of the contractors' work.

Utilities often have programs where customers pick up the kits. Labor costs range from $10 to $30 per single-family customer for showerhead and aerator installation and an additional $5 to $20 per toilet replacement. Multi-family residences will usually have their own staff for installation.

High-quality showerheads purchased in bulk are available starting at less than $2 each with aerators costing less than $1 each. Flappers range in cost from $3 to $10. When choosing between models of equipment that have varying degrees of water efficiency, only the incremental cost of the more water efficient device should be compared with the benefits to the utility in order to determine the maximum water efficiency benefit.

Administration of the program can be conducted by utility staff or contracted out. Marketing and outreach costs may range from $5 to $10 per single-family customer. Administrative and overhead costs range from 10 to 20 percent of labor costs. If this program is combined with the Residential Ultra Low-flow Toilet Replacement BMP, there should be efficiencies in these costs. If the distribution of kits through public outreach events is the sole option undertaken, then only the costs of the devices, staff time, and cost of attending the event would be incurred.

For inclusive overall costs per household, please see *Table 1: Distribution Methods, Potential Participation Rates, and Approximate Costs for Plumbing Fixtures* on Pg. 24.
For comments or questions regarding the Retrofitting Residential Fixtures BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9009.

References

- Handbook of Water Use and Conservation, Amy Vickers, Waterplow Press, May 2001.
- DrinkTap.Org, AWWA – Water Use Statistics http://www.drinktap.org/consumerdnn/Home/WaterInformation/Conservation/WaterUseStatistics/tabid/85/Default.aspx.
- Tampa Bay Water Potable Water Conservation BMPs, January 2010.
- Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.
- Legislative Report – Recommendations for Water Efficiency Standards for Water Using Fixtures in Residential and Commercial Buildings, NCDENR, January 2009. http://portal.ncdenr.org/c/document_library/get_file?uuid=5cddf8ca-cf3d-41f3-a84f-6e4985ba1f43&groupId=38322.

Case Study for Retrofitting Residential Fixtures Program

The average indoor use in a home with water efficient fixtures and appliances is approximately 35 percent less than without these fixtures (Vickers, 2001). Many water systems choose to work with residential customers as part of their water reduction efforts to bring these water savings to the residents and the water system. Methods for delivering these services, however, vary depending on the staff and funds available.

Direct Installation – Raleigh, North Carolina

In 2007 and 2008, Raleigh, N.C. experienced a drought of record. The city responded by developing a conservation plan that included retrofitting residential fixtures such as showerheads, as well as offering rebates for the purchase of High Efficiency Toilets (HETs). As part of that program, the city recognized that many low-income families were living in rented, water-inefficient housing. Because traditional rebate programs do not take into account the burden that overhead costs have on low-income communities and renters, a different approach was needed to reach those audiences.

The City of Raleigh Public Utilities Department partnered with the Raleigh Housing Authority and AmeriCorps VISTA members to design a program that would tackle the issues of these community members, while creating a high return on investment (ROI) for the participants. This comprehensive program included:

- Replacing 5,000 3.5 gallon per flush – 5 gallon per flush toilets with new WaterSense labeled ones;
- Replacing 1,000 old showerheads with new 1.6 gallons per minute ones;

- Constructing a water efficiency checkup program with audits and instructor training;
- Engineering a WaterWise Landscaping & Gardening program with a demonstration garden;
- Promoting annual water savings events;
- Compiling brochures and educational presentations.

The program was highly effective. Many, if not all, water bills showed a significant decrease in water consumption, a few by as much as 50 percent. All the public events were well-attended, and the garden still serves as an educational tool for water conservation and efficiency. For more information on this unique partnership or other aspects of their program, please contact the Water Conservation & Efficiency Specialist with the City of Raleigh at 919-996-3468.

General Distribution – Greensboro, North Carolina

As early as 1993, Greensboro recognized growing water supply vulnerabilities and an increasing need for enhanced water efficiency. As part of a comprehensive plan, Greensboro's Water Resources Department partnered with organizations to distribute free water saving showerheads, faucet aerators and toilet flappers to Greensboro customers at all Greensboro libraries, recreation centers, the Farmer's Curb Market and Water Customer Service. From 1996 to 2003, more than 165,000 total pieces of hardware were distributed. Customer rebates of $4 were credited to 1,488 Greensboro water customers, who purchased closing flappers between 1995 and 1997. For more information about this method of distribution or other aspects of this program, please contact the Water Education Program Coordinator at 336-373-4601.

Retrofitting Residential Fixtures – Ultra Low Flow Toilet Programs

Applicability

Water use by toilets is typically the largest source of indoor residential water demand, averaging 26.7 percent of indoor water use (Vickers, 2001). The residential toilet replacement program seeks to replace higher flush volume toilets with ultra-low flush toilets that use 1.6 gallons per flush or less in order to decrease water use. These toilets can either be installed directly by the utility, a contractor for the utility, or by the resident or housing management.

This BMP is intended for a water system ("utility") that has at least 20 percent of its homes and apartment units in its service area constructed prior to 1995, and for which there has not been an active retrofit program to replace high flush volume toilets with 1.6 gallons per flush toilets, or Ultra Low Flow Toilets (ULFT). This BMP is often implemented in conjunction with the Retrofitting Residential Fixtures – Showerhead, Aerator, and Toilet Flapper Program BMP.

Description

ULFT replacement programs are an effective method of achieving water efficiency in the residential sector. ULFTs are toilets that use 1.6 gallons per flush (gpf) or less including dual flush toilets that can flush either 1.6 gpf or 0.8 to 1 gpf. Federal requirements prohibit installation of new toilets using more than 1.6 gpf. Under this BMP, the utility would develop and implement a program to replace existing toilets using 3.5 gpf or more in single-family and multi-family residences.

According to Vickers, successful toilet rebate and replacement programs must include:

- Identification of potential participants, potential water savings, program benefits and costs, schedule, and program budget and human resource requirements.
- Program outreach and marketing strategies targeted to specific customer groups and subgroups.
- Attractive financial incentives – a rebate, water bill credit, or fixture giveaway, for example.
- Installation guidance (e.g. printed instructions, call-in technical assistance, referrals to certified plumbers) or assistance (e.g. direct installation service, particularly for the elderly and disabled).
- Purchasing information about 1.6 gpf toilets, such as a description of types available for various applications, along with the names and model numbers of fixtures reported to be reliable in consumer surveys and technical studies.
- Rebate application forms.
- A convenient inspection process.
- Timely rebate processing and payment.
- Evaluation and reporting of program results.
  (Source: Water Use and Conservation, Amy Vickers, 2001, p. 42.)

Implementation

The ULFT replacement programs should offer free toilets or rebates for toilet replacement. If offering rebates, the utility needs to provide a list of eligible toilet models (i.e. WaterSense models). Incentives and promotion of the program should be sufficient to retrofit at least five percent of eligible homes per year. In addition, ULFT models that are used in retrofit programs should maintain 2 gpf or less, regardless of what replacement flapper is used.

Identify the number of single-family and multi-family residences constructed prior to 1995. If there is no data of single-family homes existing at the end of 1994 readily available, U.S. Census data can be used. For the most accurate estimate of single-family and multi-family residents, census data from 1990 and 2000, which includes the number of housing units by type, can be used. This data can be used to estimate single-family units at the end of 1994, assuming linear growth. Refer to calculation box in the Retrofitting Residential Fixtures - Showerhead, Aerator and Toilet Flapper Programs BMP to estimate residences.

Schedule

In the first 12 months: Plan a program including customer involvement as needed. Identify plumbing contractors or retrofit companies who may be interested in bidding on this program if applicable. Develop a plan for educating homeowners, apartment owners and managers, plumbers and realtors about the program. Solicit bids if using outside contractors and initiate the program. Include inspections by utility personnel or a third party to verify installation. In order to effectively implement this program, five percent of eligible single-family homes and five percent of eligible multi-family units should be retrofitted every year.

In the second year and after: Each year, target five percent of identified eligible single-family homes and multi-family units to be retrofitted. Continue the program until 50 percent of eligible single-family homes and multi-family units are retrofitted in order to achieve reasonable water efficiency benefits.

Scope

Annually, the ULFT replacement program should replace at least five percent of the estimated number of eligible toilets within the service area.

In order to accomplish this BMP, the utility should:

- Develop and implement a plan to distribute or directly install high quality ULFTs to eligible single-family and multi-family units;
- Implement the distribution or installation programs to achieve ULFT retrofits on at least five percent of eligible single-family units and five percent of the multi-family

units each year. Utilities with more than 100,000 eligible connections should retrofit at least 5,000 eligible homes and units each year.

- Within 10 years of implementing the program, retrofit at least 50 percent of eligible single-family homes and multi-family units with ULFTs. For utilities with more than 100,000 eligible connections, at least 50,000 eligible homes and units should be retrofitted within 10 years.

Documentation

To track this BMP, the utility should collect the following information:

- The eligible number of single-family residences and multi-family units in the service area.
- The average number of toilets per single-family residence; the average number of toilets per multi-family unit.
- The average persons per household for single-family residences; the average persons per household for multi-family units.
- The number of ULFT installations credited to the replacement program, by year, including brand and model of toilets installed.
- A description of the ULFT replacement program, if applicable.
- The estimated cost per ULFT replacement, if applicable.
- The estimated water savings per ULFT replacement.

Determination of Water Savings

Average Daily Savings = SF x ((10.5 x Hs)/Ts) + MF x ((10.5 xHm)/Tm)

SF= Number of SF toilets retrofitted
MF = Number of MF toilets retrofitted
Hs = Number of people in average single family household
Ts = Average number of toilets per SF house
Tm = Average number of toilet per MF unit

For Single-family homes:
10.5 = gallons saved per capita per day if all toilets replaced in each household
Dual flush ULFTs increases savings by 25 percent

For Multi-Family Units:
10.5 = gallons saved per capita per day if all toilets replaced in each unit
Dual flush ULFTs increase savings by 25 percent

Cost-effectiveness

The rebates to the customers for installation of ULFT toilets are the most significant costs of this program. If the rebate cost for the toilet is set too low, only those customers already planning to retrofit will do so. If the rebate is set too high, the utility will be overpaying for customers to retrofit. Most utilities have found a rebate to work effectively if set between $70 and $100. Some utilities find it is more effective to provide the toilets free of charge to their customers. Toilets can be purchased from wholesalers by the truckload for $50 to $70. There may be additional costs for storage and distribution of the toilets.

Administration of the program can be conducted by utility staff or contracted out. There will be labor costs for application processing and inspections to verify installation, to determine if the tank is properly set and to discourage fraud. Inspection costs will be lower per toilet per multi-family retrofit due to the higher volume of toilets per application, but generally, labor costs range from $10 to $40 per toilet. Marketing and outreach range from $5 to $20 per toilet. Administrative and overhead costs range from 10 percent to 20 percent of labor costs. If this program is combined with the showerhead, aerator, and flapper retrofit BMP, there will be efficiencies in these costs.

To calculate the total cost per unit, total all costs and divide by the number of units being retrofitted.

For comments or questions regarding the Retrofitting Residential Ultra Low Flow Toilets BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9009.

References:

- Handbook of Water Use and Conservation, Amy Vickers, Waterplow Press, May 2001.
- Tampa Bay Water Potable Water Conservation BMPs, January 2010.
- Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

Retrofitting Residential Equipment – Clothes Washers

Applicability

A typical family of four washes a little more than one load of laundry per day, which accounts for approximately 22 percent of residential indoor water use (Vickers, 2001). While the average clothes washer in the United States uses 41 gallons of water per load, the new high efficiency clothes washers use between 11 and 25 gallons per load. A Residential Clothes Washer Incentive Program BMP would encourage customers to purchase water efficient clothes washers through a direct discount at the time of purchase or a rebate after the purchase. This BMP can be implemented by any Water User Group ("utility") that has residential customers.

Description

Under this BMP, the utility would develop and implement an incentive program to encourage customers to purchase efficient clothes washers. Water efficiency for clothes washers is best described by using water factor (WF) terminology. WF is calculated by dividing the gallons of water used to wash a full load of clothes by the capacity of the washer tub in cubic feet. As of Jan. 1, 2011, the U.S. Department of Energy requires that all Energy Star washing machines have a maximum WF of 6.0, which is the highest ratio that the Consortium of Energy Efficiency (CEE) will consider as an efficient model of washing machine. For more information, go to http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=11628.

For this BMP to be the most effective, the incentive offered should bridge at least one-half of the gap in the price difference between the efficient machines and conventional ones. As with any incentive program, the amount of the incentive will impact the participation in the program. Fully featured inefficient machines cost approximately $400, while the least expensive efficient machines cost between $600 and about $1000. For the least expensive machines, the price difference is around $200. The price difference is the most important factor of the buying decision for low-income customers. In addition, low-to-moderate income customers would be more likely to purchase the efficient washer if they received the incentive in the form of a discount at the time of purchase, rather than waiting between four weeks and six weeks for a rebate.

A clothes washer incentive program can be more effective if offered in conjunction with local gas and/or electric utilities because the incentive can be increased and the marketing reach should expand. The energy savings is a result of using more efficient motors, less energy required for heating hot water because less hot water is used, and a shorter drying time because the spin cycle on efficient washers remove more water.

Incentives should only be given to those customers who install washers that qualify as water efficient. A list of efficient washers is maintained and regularly updated by the Consortium for Energy Efficiency (CEE); please see CEE website at http://www.cee1.org/. CEE, a nonprofit public benefits corporation, develops national

initiatives to promote the manufacture and purchase of energy-efficient products and services. The U.S. Department of Energy and U.S. Environmental Protection Agency support CEE through active participation and funding. The CEE has ratings based on water and energy efficiency. This list has been used by many utilities as the source of qualifying washers to receive an incentive.

The utility may want to give higher rebates or discounts to customers purchasing the most WF efficient CEE Tier III models, slightly less to those purchasing Tier II models, and the lowest incentives to those purchasing Tier I models.

Implementation

Develop and implement a clothes washer incentive program designed to increase the market share of efficient clothes washers to 20 percent of the installed units by the second year of implementation. The program should be offered to customers in single-family homes and in multi-family units that have in-unit washer connections. Approach the local gas and/or electric utility to join in a partnership to implement the program. Organize stakeholder meetings. Develop a marketing plan for educating customers, appliance stores, and realtors about this program. Initiate the program.

Schedule

The following schedule should:

- Plan, implement and market an efficient clothes washer incentive program within six months of adopting this BMP.
- Continue marketing efforts to achieve at least 20 percent market penetration for efficient washers by the end of the second year after implementing this BMP.

Scope

In order to accomplish this BMP, the utility should:

- Develop and implement a plan to offer incentives for the purchase of efficient clothes washers.
- Within two years of implementing this program, increase the market share of efficient clothes washers to at least 20 percent of local clothes washer sales.

Documentation

To track the effectiveness of this BMP, the utility should:

- Calculate the number of single-family homes and multi-family units with in-unit washer connections.

- Calculate the average number of persons per household for single-family and multi-family residences.
- Calculate the number of efficient clothes washer incentives issued each year, by year, including brand, model and water factor of each efficient washer.
- Estimate water savings per efficient washer.
- Average total washer sales per year in the service area.

Determination of Water Savings

Savings = EWS x 5.6 x Hs + EWM x 5.6 x Hm

EWS = Number of single-family efficient washer incentives
EWM = Number of in-unit multi-family washer incentives
Hs = Number of people in average single-family household
Hm = Number of people in average multi-family household

Or

Single-Family: 5.6 = gallons saved per capita per day

Multi-Family In-Unit: 5.6 = gallons saved per capita per day

The rebates to the customers for installation of water efficient clothes washers are the most significant costs of this program. If the rebate cost for the clothes washer is set too low, only those customers already planning to buy an efficient washer will do so. If the rebate is set to high, the utility will be overpaying the customer to retrofit. Most utilities that implement this BMP have found a rebate to work effectively if set between $50 and $100 per efficient clothes washer. If partnering with an energy utility, the gas or electric utility rebate could add an additional $50 to $100. Some utilities have started offering tiered rebates based on the efficiency of the washer; the highest rebates are offered for the most-efficient washers in the lowest water factor tier.

Administration of the program can be conducted by utility staff or contracted out. Washer inspections are sometimes performed in order to verify installation and discourage fraud. Labor costs range from $15 to $35 per clothes washer. Marketing and outreach costs range from $5 to $15 per clothes washer. Administrative and overhead costs range from 10 percent to 20 percent of labor costs.

To calculate the total cost per unit, total all costs and divide by the number of units being retrofitted.

For comments or questions regarding the Retrofitting Residential Clothes Washers BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9009.

References:

- The Department of Energy: http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=11628)
- Handbook of Water Use and Conservation, Amy Vickers, Waterplow Press, May 2001.
- Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.

Public Information Programs

Applicability

Public information programs can be an effective outreach tool to inform customers about water efficiency and ways they can conserve water. This BMP should be incorporated into all other BMPs as a way to reach your targeted audience regarding other water efficiency or water conservation measures the water system is undertaking. Outreach opportunities include direct interaction with the public, water use histories on bills, and a water efficiency/conservation webpage on the system's website. This BMP is intended for all water systems ("utility") with residential customers.

Description

Under this BMP, utilities would implement a public information program to promote water efficiency measures, including other BMPs being implemented and water efficiency-related benefits. The program should include various aspects of the following:

- Use the customers' bills as outreach tools.
    - Water use for the last billing period compared to the same period the year before, including a bar graph.
    - Use the bill to advertise any other programs (e.g. rebate or incentive programs) or restrictions underway.
    - Direct people to your website for more water efficiency information, if you include the website in a prominent place on the bill.

- Directly interact with the public.
    - Provide speakers for community groups.
    - Have booths with staff and exhibits at community festivals and events.
    - Co-sponsor adult education and training programs on water efficiency and conservation topics (e.g. water efficient landscaping, making your own rain barrel, and how to do your own home water audit). These programs could be done in conjunction with local gardening clubs, soil and water conservation districts, homeowners' associations and similar organizations.

- Utility In-House Media
    - Maintain a regularly updated water efficiency webpage as part of the utility's website. Include any water efficiency rebate or incentive programs, watering restrictions, and links for more information on water efficiency topics.
    - Record "on hold" messages with conservation information for utility or municipal phone lines.
    - Produce brochures, handouts and giveaways that can be distributed at public events and at public buildings.

- Traditional/Social Media
    - Produce television and radio spots for larger water efficiency or conservation measures the utility is undertaking.
    - Develop and maintain a regularly updated water efficiency Facebook page, MySpace page, Twitter feed, postings to YouTube, etc.

Implementation

Although utilities will choose to implement different components of this BMP, implementation should consist of at least the following:

- Determine if the current billing system allows for water use history for the last billing period compared to the same period the previous year and whether it can add graphs. Determine if bills can be updated with other outreach information. If this information cannot be added to the bill, determine if a new billing system may be required. Determine if it is fiscally viable to implement this BMP.
- Create a program for direct interaction with the general public. At a minimum, this should include speaking with community groups and exhibiting at community festivals.
- Create and maintain a regularly updated water efficiency and conservation webpage as part of the utility's website.
- Create a plan for disseminating information about drought status accompanied by appropriate conservation and efficiency messages.
- Produce brochures, handouts and giveaways that can be distributed at public events and at public buildings.

Schedule

- Research if the current billing system allows for water use history for the last billing period compared to the same period last year and whether it can add graphs. Research if bills can be updated with other outreach information. If the bills cannot be altered, research billing options that will allow for these changes. If there are no fiscal barriers, this change should be completed within the first 12 months.
- In the first three months, begin planning your public events. Research local festivals and inquire about participating. Create a water efficiency display and publications for these events. Remember to include other BMPs that your water system is implementing. Contact local organizations about collaborating to facilitate water efficiency related workshops. Begin public engagement within the first six months and continue throughout the year.
- In the first six months, plan a water efficiency webpage as part of the utility's website. Remember to include other BMPs that your water system is implementing. If necessary, locate contractors who may be interested in bidding for this project. Within the first 12 months, create and launch the webpage. Update the webpage at least every three months.

- Within the first six months, determine whether the utility and/or municipal phone systems have recorded messages or music for phone calls placed on hold. If so, record several water efficiency messages that play while on hold. Remember to include other BMPs that the water system is implementing. This project should be completed within 12 months and updated every three months or sooner if needed.
- Within the first six months, engage in social media outlets such as creation of a Facebook or MySpace page, sending Twitter feeds or creation of YouTube videos.

Scope

To accomplish this BMP, the utility should do the following:

- If fiscally possible, within 12 months of implementing the program, develop and implement a plan to make customers' bills an outreach tool by providing water use history for the last billing period compared to the same period the previous year.
- Within 12 months of implementing this program, the direct public engagement aspect should be fully implemented. The utility should strive for at least four public speaking engagements and/or public events per year.
- Within 12 months of implementing this program, the webpage, social media and recorded messages should be fully implemented. The utility should strive to update these at least every three months (Some information such as water status or drought restrictions should be implemented much more often, especially during drought).

Documentation

Utilities will differ in what aspects of this BMP they implement. To track progress of this BMP, the utility should gather and have available the following documentation:

- Document the research for the billing system, including estimates on replacing billing software with software that provides water use histories, graphs and water efficiency information directly on the bill if the current system does not have the ability to add them.
- The number of public speaking engagements that utility staff has attended, including the estimated number of people in attendance.
- The number of public events that utility staff has attended with a display or exhibit. These should include the estimated number of people in attendance.
- A list of brochures and handouts created for or used to provide information to the general public about water efficiency, water efficiency benefits, other BMPs that the system is currently undertaking and/or other water efficiency related topics.
- A completed water efficiency webpage and any social media projects, schedule of past updates and changes made during the updates.

- The number of phone lines that have water efficiency “hold” messages, and the content of the messages, the schedule of past updates and the content of the changes.

Determination of Water Savings

Water savings for public information programs are difficult to quantify and therefore estimated savings are not included in this BMP. This BMP, however, is critical to the success of the other BMPs undertaken, as it serves as the promotional and educational portion of those BMPs.

Cost-effectiveness

A true cost-effectiveness analysis cannot be determined without a measure of water savings. This BMP, however, is an integral part of many best management practices, so it should be considered foundational to a successful water conservation program. In addition, by implementing this BMP, the utility will enhance its public image and increase customer goodwill.

For comments or questions regarding the Public Information Program BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9009.

References:

- California Urban Water Council, Memorandum of Understanding Regarding Urban Water Conservation in California, as Amended Sept. 14, 2011.
- Texas Water Development Board report 362, Water Conservation Best Management Practices Guide, November 2004.

Case Studies

Direct Interaction with the General Public

<u>Greensboro, North Carolina</u>

As early as 1993, water supply vulnerabilities in Greensboro increased the city’s need for a water demand strategy, water supply augmentation, water restrictions and a comprehensive public educational program. Greensboro created and has maintained a substantial public education program by using a variety of approaches to educate the public.

The Greensboro Water Resources Department disseminates public information in several ways. To spread the conservation message, they distribute promotional items at various special events in the community. Several brochures covering topics such as how to have a WaterWise Home, WaterWise Landscaping and WaterWise Lawn Care have been created. Customers typically receive public education materials through their water bills, at presentations, workshops and by visiting the customer service informational kiosk. The Greensboro contact center provides customers with advice on how to fix a leaky toilet, report environmental issues such as pollution, flooding and storm drain blockage. In addition, new customers receive an information packet that contains various resources.

Multiple awareness campaigns have been produced through the collaborative efforts established between Greensboro and High Point. The Greensboro Water Resources Department also collaborates with the North Carolina Cooperative Extension Service in Guilford County on several projects to address issues affecting the community. Throughout the year, the cooperative extension service holds Carolina Yards and Neighborhood Program workshops for residents that deal with issues such as proper planting techniques, water conservation and protecting water quality. In addition, the agency manages the rain barrel distribution program the city promotes.

For more information on the Greensboro Water Conservation Program, please see the following link at http://www.greensboro-nc.gov/index.aspx?page=2259.

Cary, North Carolina

During non-drought times, Cary primarily communicates with residents through its monthly utility newsletter (BUD), the town's website, Cary TV 11 Conservation Corner, and the distribution of brochures at venues such as Earth Day at Spring Daze. Displays, print ads in the local newspaper, and postcards are used primarily for annual campaigns, such as Beat the Peak and Fix a Leak Week. In its recent Water Conservation Survey of 2011, the town asked customers how they would prefer to receive water conservation information. The customers preferred getting information through the utility newsletter by a large margin (83.2 percent). Other important sources were direct mail via postcards (67.5 percent), Cary's email list service (60.2 percent), Cary's website (59.3 percent), Cary News (55.5 percent), and homeowners' associations (52.5 percent).

In addition to its public outreach, Cary works with local businesses and community groups to help communicate its water conservation message whenever possible. Providing information to customers from many sources increases awareness of the many water conservation programs the town offers. For example, making sure that plumbers and home improvement stores know about the availability of high-efficiency rebates or free toilet dye tablets, for example, is an important point of contact for customers. Providing information at local garden centers and through irrigation contractors are other opportunities for businesses and water purveyors to work together to share conservation messages.

For more information on the Cary Water Conservation Program, go to http://www.townofcary.org/Departments/Public_Works_and_Utilities/Conservation/Water_Conservation.htm.

Using the Customers' Bills as Outreach Tools

Durham, North Carolina

The Durham Department of Water Management wanted to be able to show customers how much water they were using as compared to previous billing cycles. While usage was shown on each bill (bi-monthly for residential customers), there was no bill-to-bill point of comparison. When the city converted from the mainframe billing system to the Enterprise Resource Planning System (ERP) based billing system in January 2009, one of the major selling points was the ability to provide billing history on the bill itself. Water management has received numerous compliments from customers for providing this useful information.

In addition to the usage history, there is a small box just under the usage graph for newsworthy information. Staff has used the box to announce the implementation of year round watering restrictions, information about the tiered rate structure and notices of drought stages. All messaging directs customers to the DurhamSavesWater.org website for additional information. Used in concert with notification in the Citizens' Newsletter and other city-wide public information tools, both the usage graph and the information box have been received positively by Durham's customers, providing them the necessary tools to take ownership of their water usage.

Durham has seen a relatively flat demand during the last few years even with an increase in customers. City staff gives partial credit to information provided in the customers' bills, since it was used as a public outreach tool. The graphs on the water bill encourage on-going attention to usage and customers pay special attention during the summer months. Seasonal usage has not spiked as much in the post-drought years as had been anticipated, thanks in part to the usage graphs and the odd-even watering schedule. The decreasing number of seasonal watering violations is also a result of keeping the message in front of customers. Durham attributes the relatively flat demand to a number of factors, such as best management practices instituted by the city during the last few years.

For more information on the Durham's Water Conservation Program, go to http://www.durhamnc.gov/departments/wm/water_cons.cfm. For an example of Durham's water bill with a consumption graph, please see below.

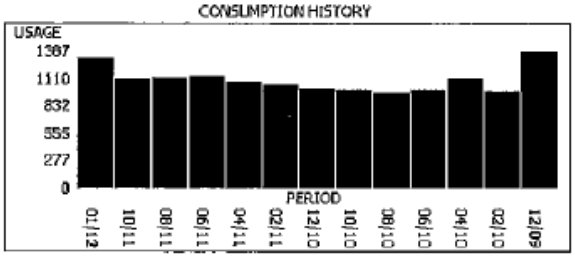
City of Durham
101 City Hall Plaza
Durham, NC 27701
919-560-1200
www.durhamnc.gov

City of Durham Utility Bill

Account Number	Customer Name	Service Location	Apt/Unit	Billing Date
999999999999	Doe, John	0000 No Name St		01/12/2012

PREVIOUS BILL AMOUNT	$96.77
PAYMENTS 11/28/2011	$96.77 CR
ADJUSTMENTS	$0.00
BALANCE BROUGHT FORWARD	$0.00
WATER USAGE INSIDE CITY	$31.78
WATER SERVICE FEE 5/8" MTR	$11.12
SEWER USAGE INSIDE CITY	$47.17
SEWER SERVICE FEE	$12.98
Balance Forward Due Per Previous Bill	**$.00**
Total Current Charges Due By 02/08/2012	**$103.05**
Total Amount Due	**$103.05**

CONSUMPTION HISTORY



Parcel ID	Account Type	IA Amount/ERU's "see back"
999999	Residential	99999

Meter Number	Previous Read Date	Present Read Date	Number of Days	Previous Reading	Present Reading	Usage in hundred cubic feet	Usage equivalent in gallons
99999999	10/28/2011	12/28/2011	61	54998	56323	1325	9911

Important: Please return this portion with your payment so that the return address shows in the envelope window. If paying in person, bring this bill.

Bill Number	Bill Date	Account Number
9999999	01/12/2012	999999999999

Charge Description	Due Date	Amount Due
Past Due Balance		$.00
Current Charges	02/08/2011	$103.05
Total Amount Due		$103.05
Enter Payment Amount		

A late payment fee of 1% will be added to all unpaid charges after 02/08/2012.

0000604201230999999980000010305 0

SL: 0000 NO NAME ST

DOE, JOHN
0000 NO NAME ST
DURHAM, NC 27701

City Of Durham
P.O. Box 30041
Durham NC, 27702-3041

School Education and Outreach

Applicability

A school education and outreach program should provide age-appropriate water efficiency and conservation lessons with background information. In addition, the lessons should be correlated to the North Carolina Essential Standards. These programs can be offered as professional development workshops to teachers or as programs conducted directly with students.

This BMP is intended for a water system ("utility") that serves schools and or students as part of its customer base. Before deciding whether this BMP is necessary, review existing curricula to see if the local school district is already offering water efficiency and water conservation related curriculum.

Description

School education programs, while not related to an equipment change may result in short and long-term water savings. Ideally, a school education program should reflect issues that are age appropriate, hands-on, and local in scope. Any suggestions for behavior changes should be things that a child in that targeted age range can accomplish on his or her own in order to create a lasting behavior change and positive environmental self-efficacy in the child.

A quality water efficiency and water conservation program for schools provides teachers with materials that contribute to interdisciplinary learning while educating the students about water efficiency, water conservation and local water resources. There are many state and national programs that include water efficiency, water conservation and water audits as part of a comprehensive water education curriculum, including Project WET (Water Education for Teachers) and the Environmental Protection Agency. Local issues can be incorporated into these lessons to help create a more locally appropriate curriculum.

Another option beyond offering a supplemental curriculum is to offer an education entertainment show for grades 1 through 5. These shows can be popular with teachers and often do not have the same requirements for material to meet the N.C. Essential Standards. In addition, the percentage of students that can be reached is often higher than for adoption of a curriculum.

To evaluate the effectiveness of the education materials, presentation or show, the utility should use an evaluation tool such as a pre- and post-test, or a survey.

Implementation

Implementation should consist of at least the following:

- Evaluate local, regional, state and national resources available to determine applicability to the utility's local water conditions. Consider creating an advisory committee of local educators to assist in choosing or creating the curriculum.
- Provide environmental education professional development for utility staff that will be working with school education and outreach. For example, workshops offered through the N.C. Office of Environmental Education and Public Affairs, such as the Basics of Environmental Education and Methods of Environmental Education, provide an overview of how to effectively work with various age groups. Additionally, Project WET workshops offered through the N.C. Division of Water Resources give the participants activities to use with different audiences.
- Implement a school education program to promote water efficiency, water conservation and water conservation related benefits. Programs include working with school districts and private schools in the water supplier's service area to provide instructional assistance, educational materials, and classroom presentations that identify urban, agricultural, and environmental issues and conditions in the local watershed and water service area. When possible, educational materials should meet the N.C. Essential Standards.

A water oriented curriculum that is focused on conservation and resource issues should be made available for all grades and should include the following:

- Teacher professional development specifically targeted to certain grades is an effective approach to implementing a lasting water education presence in the schools. If possible, you should work directly with the school system to set up free, professional development training on a teacher workday. Correlate the agenda to the N.C. Essential Standards that the targeted educators teach. When possible, provide curricula and materials for them to take back to their classroom that they can implement easily. In addition, periodic follow-up with the teachers to ask how the utility can help them incorporate water education into their classrooms will result in greater implementation now and in the future.
- Grade appropriate programs and/or materials should be implemented for grades 1 through 5 initially. Alternatively, a presentation or educational show can be offered for some or all of these grade levels. Some utilities also sponsor day-long water festivals that incorporate water efficiency, water conservation and other water resource issues for 5th grade students in a school.
- For grades 6 through 8 and high school students, the utility may do one of the following: distribute grade appropriate materials for science, math, or other appropriate classes; present assembly type programs; sponsor science expositions with emphasis on water resources; or implement education programs with community groups such as Girl and Boy Scouts and 4-H clubs.

The utility can meet this BMP by focusing only on teacher training or direct student interaction.

In conjunction with the Showerhead, Aerator, and Toilet Flapper BMP, consider providing a water audit unit as part of the curriculum where the students take flow

measurements of showerheads and faucet aerators at their homes. If the showerheads and faucets are higher than current standards, the students can have their parents sign a request for replacement form to receive an efficient showerhead and faucet aerators to install with the assistance of their parents. This unit can be successfully implemented in grade 5.

Schedule

Depending on the program option(s) selected, the following schedule should be followed:

- In the first year, find the appropriate teacher professional development curricula and materials that meet the needs of both the teachers' and the utility. You may also want to meet with your local Soil and Water Conservation Education coordinator or the Project WET State Coordinator to help facilitate the workshop. Meet with school administration and ask for help in coordinating the training on a teacher work day. Trainings should be grouped by ages taught, for example, elementary, middle and high school. In the second year, begin facilitating the workshops.
- The utility should adopt or develop the program in the first year and start implementation in the second year for grades 1 to 3.
- The utility should adopt or develop the program in the second year and start implementation of the program in the third year for grades 4 to 5.
- The utility should adopt or develop the program in the third year and start implementation in the fourth year for grades 6 to 8.
- The utility should adopt or develop the program in the fourth year and start implementation in the fifth year for grades 9 to 12.

It is important that follow-up contact with teachers and schools that participated in the past be initiated annually. It will serve as an impetus to ask questions or arrange speakers or programs for their students for the following year.

Scope

The utility has three choices within the scope of this BMP. Select item 1, or items 2 and 3, or item 4 below. The utility should strive to reach 25 percent of teachers with professional development training by the third year of implementation.

1) The utility should strive to reach 10 percent of students in grades 1 to 5 with a presentation or lesson each year by the third year following the schedule above.
2) The utility should strive to reach at least 10 percent of students in grades 6 to 12 with a presentation or lesson each year by the third year of implementation following the schedule above.
3) Alternatively, this BMP will be met if the utility only focuses on grades 1 to 5 or 6 to 12. The program would be developed in the first year and implemented in the second year for either alternative. The utility should strive to reach either 15

percent of students within grades 1 to 5 each year by the third year of implementation, or 15 percent of students in grades 6 to 12 by the third year of implementation.

4) The utility can count students reached through clubs and other educational events as participants and students impacted by utility sponsored programs outside the utility service area.

For smaller utilities, or those in which service area boundaries overlap school district boundaries with another water utility, jointly operated or funded programs should be considered.

Documentation

To track the progress of this BMP, the utility should gather and have available:

- The number of school presentations made during the reporting period.
- The number and type of curriculum materials developed and/or provided by the water supplier, including confirmation that curriculum materials meet N.C. Essential Standards and are grade-level appropriate.
- The number and percent of students reached by presentations and curriculum.
- The number of students reached outside the utility service area.
- The number of in-service presentations or teachers workshops conducted during the reporting period.
- The number of students reached by teachers trained at the above workshops.
- The results of evaluation tools used, such as workshop feedback forms, pre- and post-tests, student surveys and/or teacher surveys.
- Copies of program marketing and educational materials.
- Annual budget for school education programs related to conservation.

Determination of Water Savings

Water savings for school education programs are difficult to quantify and therefore estimated savings are not included in this BMP. If the retrofit kit is distributed, water savings can be calculated as described in the Retrofitting Residential Fixtures – Showerheads, Aerators, and Toilet Flapper Programs BMP. A 1991 study conducted for The Harris Galveston Coastal Subsidence District found an average savings of 18 percent or 1,400 gallons per month in homes where the students and parents had installed efficient showerheads and aerators on bathroom and kitchen sinks.

Cost-effectiveness

A true cost-effectiveness analysis cannot be determined without a measure of water savings. By implementing this BMP, the utility will enhance its public image, increase

customer goodwill, and increase the viability of its overall water efficiency and water conservation efforts.
School education costs vary widely due to the varying types of programs. Curriculum units can be developed and implemented for between $1 and $3 per student. Teacher education workshops can be facilitated for between $20 and $30 per teacher. Educational entertainment programs can be developed or contracted out for between $2 and $5 per student. There are prepackaged contractor programs with extensive features that cost up to $35 per student. Most programs will require utility staff oversight and outreach efforts to schools and students.

If the showerhead and aerator kits are distributed as part of this BMP, the costs for the kits will be similar to those described in the Retrofitting Residential Fixtures – Showerheads, Aerators, and Toilet Flapper Programs BMP.

References:

- Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.
- Beyond Ecophobia, David Sobel, Volume 1 Orion Society Nature Literacy Series.
- Project WET (Water Education for Teachers): http://www.projectwet.org.
- NC Project WET: http://www.ncwater.org/Education_and_Technical_Assistance/Project_WET/.
- U.S. Environmental Protection Agency Waterkids: http://water.epa.gov/learn/kids/waterkids/watered2.cfm.
- North Carolina Essential Standards: http://www.dpi.state.nc.us/acre/standards/new-standards/.

Case Study for a School Education and Outreach Program

Greensboro, North Carolina

The Greensboro Water Resources Department has many tiers to its school education and outreach program. The city directly provides youth education in the form of classroom presentations, special events and programs. Presentations are provided for school age children on a variety of topics such as general water supply awareness, conservation and water quality. In addition, each year, more than 300 5th grade students participate in the water festival. Students learn about the importance of water while visiting eight different hands-on water activity sites.

The Greensboro Water Resources Department also maximizes its education and outreach efforts by partnering with local agencies. The Greensboro Kathleen Clay Edwards Family Library branch offers a host of environmental programs and workshops for Greensboro residents. Educators can take advantage of Project WET (Water Education for Teachers), Wonders of Wetlands (WOW), and Planning of Wetlands (POW) training workshops. The Water Resources Department pays for the cost of the curriculum guides, so workshops are provided for free to teachers in the Guilford County School System at least once per year. Participants increase their knowledge of watersheds, wetland design, water quality and water conservation. They then take these activities back into their classrooms, thereby reaching the students as well.

In addition, a collaborative effort with North Carolina Cooperative Extension allows students in Grades 1-4 to participate in their annual poster contest. The contest is held in two categories: water conservation and water quality. Winners receive a prize and recognition at a local city council or county commissioners' meeting.

Retrofitting Irrigation Systems/Landscape Water Use Efficiency

Applicability

This BMP is intended for use by water systems ("utility") with a substantial percentage of customers using automated landscape irrigation systems and is targeted to customers who have automated irrigation systems. Each water system has the potential for substantial water savings with the implementation of this BMP. For the maximum water-use efficiency benefit, the utility should adhere closely to the measures described below.

Description

Landscape irrigation conservation practices are an effective method of accounting for and reducing outdoor water usage while maintaining healthy landscapes and avoiding runoff. Using this BMP, the utility provides non-residential and residential customers with customer support, education, incentives and assistance in improving their landscape water-use efficiency. Incentives include rebates for purchase and installation of water-efficient equipment. There are three approaches a water system can explore, water-use surveys, metering, and budgeting; landscape design; and minimum standards and upgrades. Successful implementation of this BMP will be accomplished by performing one or a combination of the approaches listed.

<u>Water-Use Surveys, Metering, and Budgeted Water Use</u>
If the utility chooses the survey approach, the utility develops and implements a plan to promote landscape water-use surveys to all of its accounts. The water-use surveys, at a minimum, include: measurement of the landscape area; measurement of the total irrigable area; irrigation system checks and distribution uniformity analysis; review of irrigation schedules or development of schedules as appropriate; and provision of a customer survey report and information packet. When cost-effective, the utility should offer the following: landscape water-use analyses and surveys; voluntary water-use budgets; installation of dedicated landscape meters; acceptance of site conservation plans; and follow-up to water-use analyses and surveys.

At the start and end of the irrigation season, irrigation systems should be checked, and repairs and adjustments should be made as necessary. Notices should be included in bills to remind customers of seasonal maintenance needs. For accounts with water-use budgets, the utility should provide notices with each billing cycle showing the relationship between budgeted water usage and actual consumption. When soil conditions allow, and landscape managers are familiar with the use and maintenance of soil moisture sensors, water budgets can be allocated based upon soil moisture status, thereby providing a closer estimate of actual conditions.

In an effort to increase water system efficiency and water use awareness North Carolina general statute 143-355.4 was passed in the 2009 session of the General Assembly.

It mandates that as of July 1, 2009 all local government water systems and large community water systems must require separate meters for new in-ground irrigation systems that are connected to their water system. Large community water systems are defined as those with at least 1,000 connections or serving at least 3,000 people. According to the League of Municipalities, the actions needed by the water system to achieve this mandate include:

- Determine whether to split existing taps, add additional taps, or a combination of the two.
- Adopt a local ordinance stating, at a minimum, the requirements of the state general statute.
- Decide whether a change in the rate structure and/or fee schedule is necessary.

Landscape Design

If the utility chooses the landscape design approach, the utility should provide information on climate-appropriate landscape design, as well as efficient irrigation equipment and management for new customers and change-of-service customer accounts. To serve as a model, the utility should install climate-appropriate, water-efficient landscaping at water agency facilities and landscape meters where appropriate. Municipalities with ordinance-making powers should consider adopting ordinances that require all new apartment complexes and commercial buildings to install a water conserving landscape. This can often be accomplished by amending an existing commercial landscape ordinance. Please refer to the BMP entitled, *Regionally Appropriate Landscaping*, for detailed information regarding the measures individual landowners and land managers can do to implement responsible water efficient practices on their landscape.

Minimum Standards and Upgrades

Irrigation system design, associated maintenance components, and even landscape design could be improved through use of municipal ordinance-making powers where possible. Minimum water efficient design features can be mandated for new construction, while existing systems or landscapes are offered incentives to upgrade. Precipitation sensors, evapotranspiration (ET) estimation sensors, soil moisture sensors, irrigation controllers, and pipe specifications for zoning of irrigation systems are all potential elements of an irrigation systems ordinance. Size and scope of hydrozones, surface water buffer zone vegetation, and turfgrass species selection are potential elements of landscape design ordinances. Buffer or median areas represent additional savings when all landscaped areas less than five feet in any dimension are restricted to drip or other surface or subsurface (non-spray) irrigation system or no irrigation system.

Implementation

The utility should consider offering a landscape irrigation program to customers with large landscapes first as a means of rapidly increasing cost-effectiveness and water savings. Marketing the program to the customer via bill inserts will allow the utility to

target the largest summer peak users first. The utility should consider also approaching local weather announcers, gardening show hosts, and newspaper columnists, as well as any other means of establishing communication with the public concerning the program. Public/private partnerships with non-profits such as gardening clubs, Cooperative Extension offices and/or with green industry businesses, such as landscape and irrigation maintenance companies, are potential avenues to market the program and leverage resources.

Incentives can include rebates for irrigation audits and systems upgrades, recognition for water-efficient landscapes through signage and award programs, and certification of trained landscape company employees and volunteer representatives who can promote the program. Utility staff can also be trained to provide irrigation audits which can include resetting irrigation controllers with an efficient schedule.

The initial step in assisting customers with landscape irrigation systems is a thorough evaluation or audit of the existing landscape area and irrigation systems. This includes:

- Customers with large landscapes, a list of landscape areas, measurements, plant types, irrigation system hydrozones and controllers.
- A list of existing irrigation policies or procedures, including maintenance and irrigation schedules.
- A distribution uniformity analysis on irrigated turf areas.
- A review of water bills with attention to the ratio of summer to winter use.
- An initial report summarizing the results of the evaluation.
- Ensure that landscape irrigation system specifications are coordinated with local building codes and contractor licensing requirements.

The water customer who participates in this program needs to maintain and operate its irrigation systems in a water-efficient manner. Maintenance programs include pre-irrigation system checks, adjustment of irrigation timers when necessary, installation of rain sensors, regular review of irrigation schedules and visual inspection of the irrigation system. When landscape management companies are used, contracts should include a required report showing regularly scheduled maintenance and seasonal adjustments to irrigation systems controllers. The utility should consider implementing a notification program to remind customers of the need for maintenance and adjustments in irrigation schedules as the seasons change.

Approximately one year after conducting an irrigation audit, the utility should consider conducting a customer-satisfaction survey. The objective of the customer-satisfaction survey is to determine the implementation rate of recommended modifications and to gauge customer satisfaction with the program.

When appropriate, the utility should consider offering:

- Training in efficiency-focused landscape maintenance and irrigation system design.

- Financial incentives, such as loans, rebates, and grants, to improve irrigation system efficiency and to purchase and/or install water efficient irrigation systems.
- Financial incentives to replace high-water use plants with low water use ones.
- Rebates and incentives to purchase rain sensors or soil-moisture sensors.
- Notices at the start and end of the irrigation season, alerting customers to check irrigation systems and to make repairs and adjustments as necessary.

Evaluations and/or rebate processing could be done by the utility staff or be outsourced. If a utility chooses to perform the evaluations using in-house staff, they may take advantage of irrigation evaluation training programs provided by North Carolina State University-Turf Management Cooperative Extension. For more information on these trainings, go to http://www.turffiles.ncsu.edu.

An outsourcing option for the non-residential sector is to use or recommend a water-based performance contractor. Performance contracting is a financing technique that uses cost savings from reduced water and sewer consumption to repay the cost of installing water conservation measures. This technique allows for the development of a water-savings program without significant up-front capital expenses on the part of the customer. Instead, the costs of water-efficiency improvements are borne by either the contractor or a third party lender who recoups cost and shares water savings with the user.

Goals

- Realize the scope of this BMP within 10 years of the date implementation commences.
- Develop and implement a plan to target and market landscape water use surveys to all accounts by the end of the first year from the date implementation commences.
- Develop and implement a customer incentive program by the end of the first year from the date implementation commences.
- Follow up with the participating customer approximately one year after a water use survey has been conducted and/or a rebate processed.

Scope

To accomplish the goals for this BMP, the utility should do the following:

Landscape Irrigation System Management Programs

- Within one year of implementation date, develop and implement a plan to market water-use surveys to Industrial-Commercial-Institutional (ICI) accounts with mixed-use meters.
- Within one year of the implementation date, develop and implement a customer incentive program.
- Within 10 years, contact and offer landscape water-use surveys to all accounts with separate irrigation meters. A minimum response rate for the surveys should be 15 percent.

- Within 10 years, contact and offer landscape water-use surveys to all accounts with summertime monthly use of greater than four times the annual average. A minimum response rate for the surveys should be 15 percent.

Ordinance Approach

- In the first 12 months: Plan a program, including customer input as needed. Consider offering rebates for all or a portion of the time this program is in place. For example, offer rebates for only the first five years to encourage customers to take advantage of rebates and retrofit early in the program.
- Develop a plan for educating real estate agents, landscape companies and irrigation installers about this requirement. Plan a follow-up inspection program after retrofit. Develop and pass the ordinance. Implement the ordinance and tracking plan for the number of units retrofitted.
- In the second year and all subsequent years: Continue implementation; continue outreach program for real estate agents, landscape companies and irrigation system installers; and continue verification inspections.

Documentation

To track this BMP, the utility should gather:

- The number of dedicated irrigation meter accounts.
- The number of dedicated irrigation meter accounts for which water budgets have been developed.
- Aggregate water use for dedicated landscape accounts with budgets.
- Aggregate budgeted water use for dedicated landscape accounts with budgets.
- The number of mixed-use accounts.
- The number of surveys offered and number of surveys accepted and completed.
- The number, type and dollar value of incentives rebates and loans offered to and accepted by customers.
- The estimated water savings achieved through customer surveys.
- The estimated landscape area converted and water savings achieved through low water landscape design and conversion program.
- The cost of administering program.

Determination of Water Savings

Landscape surveys as described in this document should result in at least a 15 percent reduction in water demand for landscape uses by surveyed accounts. The utility should provide estimates of water savings from landscape irrigation survey programs based on actual metered data.

For comments or questions regarding the Retrofitting Irrigation Systems/Landscape Water Use Efficiency BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9005.

References

- Texas Water Development Board Report 362, Water Conservation Best Management Practices Guide, November 2004.
- *Handbook of Water Use and Conservation*, Amy Vickers, Waterplow Press, May. 2001.
- Legislative Report – Recommendations for Water Efficiency Standards for In-ground Irrigation Systems, NCDENR, January 2009.

Case Study for an Outdoor Water Use Conservation Program

Cary, North Carolina

Background

Cary is a large town in west-central Wake County, North Carolina. The town's history is closely linked with the development of Raleigh and the Research Triangle Park.

The town population was 135,234 at the 2010 U.S. Census. According to the 2011 Local Water Supply Plan update, the town had a year-round service population of 159,898 people with 9,545 residential connections. The daily per capita water usage in 2011 was 61.4 gallons. Cary withdraws their water supply from Jordan Lake at the confluence of the Haw and New Hope rivers.

WaterWise Landscape Program

Cary began their WaterWise landscape programs in earnest in 1998 and this program has played a significant part in Cary's overall 20 percent per capita water reductions. Cary's outdoor landscape water efficiency and conservation program has three components: educational outreach initiatives, financial incentives, and regulations. WaterWise landscape practices are addressed by specific programs within each of those categories. Below are actions that have been incorporated into the utility's standard operating procedures.

Educational Outreach:

- Free WaterWise landscape workshops.
- Detailed information on the Town of Cary's website that covers fundamental landscape practices to reduce water use and maintain desired conditions.
- Beat the Peak campaign, which focuses on providing tips for WaterWise irrigation practices and landscapes during especially dry periods. Included in the Beat the Peak campaign is an online video game. To see the campaign visit, http://www.townofcary.org/Departments/Public_Works_and_Utilities/Conservation/Water_Conservation.htm.

- Free irrigation audits, which include free precision-spray nozzles as part of the 2012 campaign.

Financial Incentives:

- Turf Buy Back Program. This program provides a one-time financial compensation to utility customers who agree to convert at least 1,000 square feet of historically irrigated turf to natural area or warm-season grass.
- Tiered water rates.
- Water budgets.
- Rain barrels for sale at cost throughout the year.

Regulations:

- Alternate day watering and other irrigation scheduling options.
- Separate irrigation meter requirements.
- Irrigation sensor and ordinances intended to discourage wasteful outdoor water use such as, the irrigation of impermeable surfaces.
- Irrigation system design standards as part of the Land Development Ordinance (LDO)/Appearance Standards.
- Drought-tolerant plant material requirement as part of the LDO.
- Use of reclaimed water for irrigation where it is readily available.

WaterWise Program Assessment

Assessments have been conducted on some of Cary's programs to estimate water use savings since their implementation. One of these is the Turf Buy Back (TBB) program, which involves incentivizing the replacement of cool season turfgrasses with warm season grasses or natural areas. It has been estimated that this initiative has saved approximately 722,678 gallons in the 2011 fiscal year. In fact, it was so well received by the public that the interest in participating exceeded the appropriated funds available. In addition to and in conjunction with the TBB, Cary has begun conducting free irrigation audits to homeowners that includes the retrofitting of more water-efficient spray nozzles. This program has only begun within the past year, so water savings totals are unavailable, but the potential water savings are substantial.

A 2011 survey conducted by CH2M Hill for Cary found that residents are generally supportive of the town's outdoor water conservation programs and efforts. The questions in the survey were based upon a nine-point scale, which examined the degree of satisfaction respondents had with the town's water conservation program. Some highlights from the 2011 Water Conservation survey include:

- The respondents were first asked about their satisfaction with how the town implements their water conservation programs. There was a relatively high level of satisfaction expressed by the respondents with a mean of 6.97 and 74.2 percent replying on the "satisfied" side of the scale, including 30.4 percent answering very satisfied.

- The respondents perceived that the most effective tool to encourage water conservation were regulations, such as alternative day watering. The mean was 7.46 with 81.4 percent of the responses falling on the “effective” side of the scale, including 45.3 percent answering it was very effective. There were only 6.1 percent of the responses for this subject on the “ineffective” side of the scale. Overall, this was believed to be the most effective of the tools examined by a significant margin.
- The respondents viewed tiered water rates, financial incentives, such as toilet rebates, and the towns’ website as the three next most effective tools. The mean response for tiered water rates, which ranked second was 6.46 with 67.4 percent of the responses on the “effective” side while 14.6 percent were on the “ineffective” side.
- The use of a financial incentive ranked third with a mean of 6.41 and with 61.3 percent of the respondents on the “effective” side, while 16.9 percent were on the “ineffective” side. Although the mean was slightly lower than tiered water rates, there was a higher percentage who felt it was very effective (32.6 percent versus 26.7 percent, respectively) indicating its importance to residents.

Cary has demonstrated that by undertaking these measures they are progressing towards a more efficient water system while maintaining desired landscape conditions. As Cary continues to incorporate additional water conservation measures and programs, it is expected they will continue to reduce their outdoor water use and maintain a stable water supply for continued growth.

For more information regarding the Cary’s WaterWise Landscape Program, please visit the town’s website at:
http://www.townofcary.org/Departments/Public_Works_and_Utilities/Conservation/Water_Conservation.htm.

Regionally Appropriate Landscaping

Applicability

This BMP is intended for use by water system customers who wish to reduce their water supply needs and reap the biological benefits of establishing a water efficient landscape. This information should be disseminated by the water systems and the recommendations should be encouraged through the larger local water conservation and efficiency program.

Description

This category involves residential and commercial water customers who use some portion of their water expenditures for irrigation of outside vegetation. These include automated and manual above- and below-ground irrigation systems as well as “watering by hand” using a hose or container. Even though managed landscapes that include automated irrigation systems are often larger and use greater volumes of water, these best management practices are intended to be inclusive to all users of outdoor irrigation. If used efficiently, outdoor irrigation can provide desired and attractive landscapes while maintaining adequate water supplies for other uses of municipal water.

There are four general categories of BMPs for outdoor irrigation water use:

- Planning and design.
- Vegetation selection.
- Efficient irrigation system.
- Soil analysis and amendments.

These categories include many subjects and are not intended to treat one category more preferentially than another. In fact, once properly implemented, the BMPs from all categories should work in concert with one another to require minimal water use for maintaining a beautiful and functional landscape. It must be stressed that all of these BMP’s require some level of continual maintenance to ensure their optimal effectiveness in regards to water efficiency. The information contained in this BMP is general in nature; therefore, it may be helpful to consult with a landscape contractor to achieve maximum water conservation benefits. However, outdoor water conservation is ultimately the responsibility of the owner of the landscape, as a professional can only advise the owner.

<u>Planning and Design</u>

To optimize water conservation efforts, the landscape should be planned and designed with water use in mind prior to any changes. This process should at least include the following aspects:

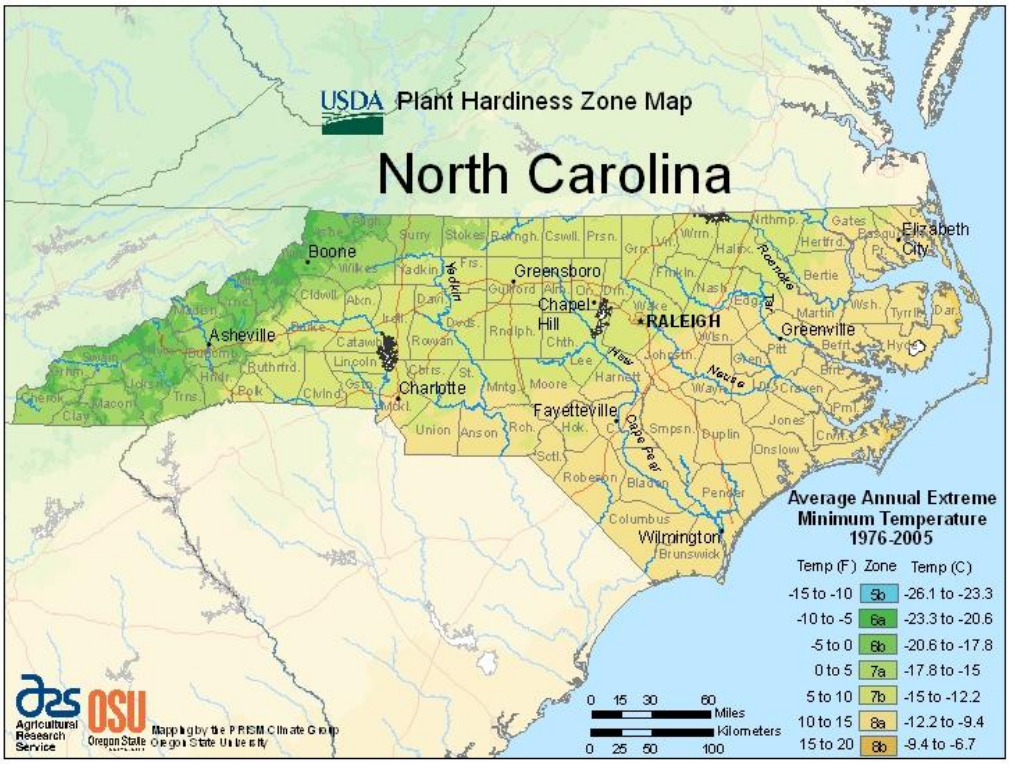
- Survey the land area with a transit or level. Use this information to produce a map with the elevation contours, as well as, all trees, structures, rocks and any permanent above-ground utilities.
- Use the existing contours while protecting any trees, structures or utilities from erosion.
- Use the contouring of the landscape to create “zones” where plants of similar water, sun and soil amendment needs are kept together.
- Minimal earthwork will reduce soil compaction, thereby increasing the infiltration into the soil.
- All grading activities should be conducted with the goal of reducing flow velocity and runoff. Engineering schemes such as, plunge pools, increasing channel or flow zone length through sinuosity, and widening of the flow zone should be considered to achieve this goal.
- Understand where the water is likely to flow during heavy rainfalls and use berms or vegetation such as multiple-stemmed bushes to reduce the velocity of this flow. A visit to the area during and immediately after a heavy rain is an important step to understanding the location and velocities of water flow onsite.
- Inspect the entire landscaped area regularly, especially immediately following heavy rains. Rills or small gullies can form during and immediately after these rainfall events. These should be immediately filled to avoid further soil erosion and plant losses. Once filled, alterations in the surface drainage of the landscaped area may be needed to avoid this type of erosion from reoccurring. Simple drainage barriers, such as strategically placed mulch tubes, rain gardens or simply larger, thicker grasses, could serve to reduce the concentration and velocities of water during and after a rainfall. These solutions also help avoid costly and time-intensive grading activities.
- Use turf only where needed.

Vegetation Selection

Once the design plan has been drafted with specific watering “zones,” the proper selection of desired vegetation based upon the plant climate region is critical. This was achieved on a national level by the creation of the Plant Hardiness Zone Map by the United States Department of Agriculture (USDA). The intention of the USDA’s establishment of plant hardiness zones was to provide a general idea of which plants are suitable to certain regions in an attempt to avoid unnecessary plant mortality. The introduction of the Plant Hardiness Zone Map in 1990 succinctly summarizes the original concept by stating, “All plants must be placed in an environment that meets their basic requirements (USDA, 1990).” The specific differences in plant hardiness zones are based upon the length of day, anticipated solar radiation, temperature, initial timing and frequency of frost, heat, rainfall and soil pH.

North Carolina contains several USDA Plant Hardiness Zones from Zone 5 to Zone 8. The zones range from 5b in the higher elevations of the mountains to 8b in the far outer Coastal Plain regions, with Zone 7 predominating across the state (Figure 1).

Figure 1. USDA Plant Hardiness Zones for North Carolina (USDA, 2012)



The North Carolina State University's Department of Horticultural Science has produced many publications for shrubs and trees that provide detailed suggestions, including the hardiness zones, for which plants are appropriate to plant in North Carolina. The link for these detailed publications can be found in the references section of this BMP (NCSU, 2012c). For more detailed information, please consult your county's cooperative extension agent or local garden center to assist in the proper selection of plants based on the plant hardiness zone, landscape placement and water needs.

Once a list of the plants has been determined, these plants should be grouped together based on water, shade and nutrient requirements. These vegetation groupings are the basis for landscape zonation as described in the planning and design section. This also provides the installer an opportunity to determine if any of the desired plants are inappropriate for the landscaped area. Consultation with a landscape contractor, arborist or county cooperative extension agent is advised for reasonable alternatives to any desired but inappropriate plants.

Turfgrass

Turfgrass is the most widely-grown ornamental crop in the southern United States. Of the 2 million acres of turfgrass grown in North Carolina, single family homes account for about 60 percent, primarily in areas serviced by a public water supply system. Other locations of turfgrass within areas serviced by a public water system include athletic fields, golf courses, parks, schools, churches and commercial buildings.

If the landscaped area being designed contains areas of turf, then an appropriate turfgrass type must be selected. There are many different types of turfgrasses known to thrive throughout North Carolina and a trip to your local agricultural supply or hardware store can be confusing if you are not fully prepared. Each species of turfgrass grown in North Carolina has positive and negative aspects. As a developer of the landscape, the individual must decide when they want or need the turf to be at its greenest and when it can be dormant.

North Carolina sits in the transition zone for cool and warm-season turfgrasses. Cool-season turf species are those with optimum growth at temperatures between 60 degrees and 75 degrees Fahrenheit, whereas warm-season turfgrasses have optimum growth between 80 degrees and 95 degrees Fahrenheit. By far, the most commonly-grown species in North Carolina is the cool-season grass tall fescue, followed by warm-season Bermudagrass. In addition to tall fescue, the cool-season grasses include creeping bentgrass, fine fescue, Kentucky bluegrass and ryegrass. The normal time for renovation of tall fescue and Kentucky bluegrass lawns in most of North Carolina is early September. High temperatures can cause cool-season grasses, such as tall fescue, to become stressed.

Warm-season grasses include bahiagrass, carpetgrass, centipedegrass, St. Augustinegrass, and zoysiagrass and bermudagrass. These grasses are generally better able to survive prolonged periods of dry conditions, but may still be severely damaged from chronic drought. Heat alone is generally not problematic with warm-season turfgrasses unless there is low soil moisture. The time to renovate warm-season grasses is normally in spring/summer.

Table 2. Characteristics of commonly grown turfgrasses in North Carolina (NCSU, 2012a).

Grass species	Adaptation					Appearance	
	Shade	Heat	Cold	Drought	Wear	Color	Texture
Bermudagrass	very poor	very good	very poor	excellent	excellent	medium	medium
Centipede	good	good	poor	good	poor	light	coarse
Tall Fescue	good	good	very good	very good	very good	medium	coarse
Kentucky Bluegrass/ Tall Fescue	good	good	very good	very good	very good	medium-dark	medium-coarse
Bahiagrass	good	good	poor	excellent	poor	medium-dark	coarse
St. Augustine grass	very good	very good	poor	good	poor	medium-dark	coarse
Zoysiagrass	good	very good	fair-good	excellent	good	medium-dark	fine-medium

North Carolina State University's Turffiles program has established an excellent online turf selection decision aid at http://turfselect.ncsu.edu/TurfSelection.aspx. This internet application only requires knowledge of the general use of the landscape, shadiness of area, and county. It will generate several appropriate choices, with a table of the positives and negatives for each turf type.

There are many factors that affect turfgrass survivability and water needs in drought conditions including species type, turf age, rooting depth, soil type, shade, maintenance, traffic and heat. Water efficiency should be a goal during all climate conditions; however, during drought conditions turf should be watered and irrigated only to keep the grasses alive. Due to the great deal of water needed to establish new turfgrasses, it is highly recommended that turf areas have at least minimum maintenance, as the water needed to maintain turf is less than the quantity needed to start again. A rule of thumb, when the watering regime goal is merely the survival of the turf, then irrigation of half an inch of water every two to four weeks is appropriate. This minimal water usage will keep the turf crowns hydrated, and allow the turfgrass to go semi-dormant to dormant. The color of the grasses may turn a dull brown. However, this may not occur in species such as tall fescue and bermudagrass. If the color changes do occur, the color and vigor will readily return once drought conditions have attenuated or reduced in severity. Keeping vehicle and foot traffic off the turf when it is under severe drought stress will further increase the survivability of the turf.

Use of herbicides and fertilizers are known to bind water molecules; therefore, avoid their usage when under drought conditions. However, under normal climate conditions, application herbicide treatments will serve to reduce competition for water resources by undesired/weed species. Similarly, the use of insecticides should

be restricted during drought conditions. However, their use under normal conditions will serve to control many insect, nematode or disease issues; thereby, avoiding the costly water use needed during reseeding. Keep in mind that judicious use is critical as some products can be toxic to certain turf species; therefore, it is critical to follow the manufacturer's suggested dosing.

During normal conditions in the summer months, turf generally needs approximately one-inch of water per week. This water can be provided from both irrigation and rainfall; therefore, it is important to install a rain gauge near the irrigated area and keep track of the amount of precipitation collected. Due to the somewhat spotty nature of rain events, this is likely to differ from the nearest reported/published rain gauge data. The Turf Irrigation Water Management Model, which can be found at http://turf-ims.ncsu.edu/, can be used to calculate and track irrigation use. It utilizes North Carolina State Climate Office weather data in concert with general soil type data, turfgrass type and irrigation discharge rate to provide monthly irrigation needs. The irrigation section of this BMP document provides detailed information about proper irrigation practices.

To further increase water efficiency of the turfgrass, the mowing height should be maintained at the higher end of the recommended scale for that specific turf species. Please visit, http://www.turffiles.ncsu.edu/Turfgrasses, for the recommended mowing heights of the specific species. Other mechanical maintenance practices, such as aeration, should be conducted at the appropriate times of the year for the specific turf type on the landscape. For cool-season grasses, these practices should occur in the fall when the ground is moist and the turf is typically subjected to little water stress. However, for warm-season grasses any mechanical activities should occur in the early summer to avoid turf damage.

Turfgrass that turns bluish-gray in the heat of the day may be in immediate need of water to prevent mortality. This situation may require exceeding the recommended watering regime, especially during an extremely hot and dry period. Be aware that the bluish-gray color may be a diurnal discoloration that will recover at night. Therefore, it is recommended that regular watering continue for at least one full day following observation of the discoloration before exceeding the normal watering regime. If the landscaped area is located in an area with local water restrictions, hand-watering of those areas that show visual signs of heat and moisture stress may be needed until the next allowable sprinkler irrigation opportunity (NCSU, 2012a).

Efficient Irrigation

Once the landscaped area has been properly planned and zoned and the locations of the large trees have been approximated, the type of irrigation system should be determined. There are two choices, below-ground permanent systems and above-ground temporary systems. For larger land areas with more extensive landscaping, the below-ground permanent systems are often preferred. However, many configurations are possible including maintaining both permanent and temporary

irrigation systems in the same planned landscape. This approach allows for more flexibility for landscape alterations and potentially greater water conservation and efficiency. For more information about conservation programs and efficiency ordinances local municipalities can initiate, please refer to the BMP entitled *Retrofitting Irrigation Systems*.

It should be noted that according to North Carolina general statute 89G-3, section 65.8.(a) and (b), no person shall engage in the practice of irrigation construction or contracting, use the designation 'irrigation contractor', or advertise using any title or description that implies licensure as an irrigation contractor unless the person is licensed as an irrigation contractor. All irrigation construction or contracting performed by an individual, partnership, association, corporation, firm, or other group shall be under the direct supervision of an individual licensed by the North Carolina Irrigation Contractors' Licensing Board.

For the below-ground permanent systems, pipe layout is vital. The piping should be laid out so that larger rooting trees are avoided and the nozzles are spaced such that there is little spray overlap. Irrigation water is not needed directly at the base of trees once they are established. Impermeable surfaces such as sidewalks, driveways and roads should never be irrigated. Use of water efficient nozzles, which are regularly maintained, is important to achieve water conservation goals. Leaks around the nozzles or within the below-ground piping can result in significant water loss, reduced water pressure through the system and mortality from oversaturation and erosion from a softening of the subsoil.

Permanent systems are typically constructed as automated systems. If the irrigation system is automated, rain and/or soil moisture sensors need to be installed and actively functioning. A well-functioning sensor will avoid both unnecessary water usage during times when no irrigation is needed and over-watering when some irrigation is needed. It is important to note that these devices must be accurately calibrated based upon the specific conditions at the landscaped area. Sensors should be calibrated at the initial installation and then periodically per manufacturers guidelines.

Temporary, above-ground irrigation systems include hand watering, manual irrigation and temporary sprinklers. These methods are thought to reduce water consumption. However, water reduction is on a case-by-case basis and hand watering does not always conserve water. Misuse of water can easily occur with a sprinkler attached to a hose by over-watering or watering surfaces with no plants. To avoid this situation, it is recommended to measure the irrigation radius of the sprinklers used and plan for where they will be placed.

A measure of the water volume discharged from sprinkler or nozzle heads should be conducted for permanent and temporary irrigation systems. To calculate the length of time required to irrigate one-inch of water on the landscape area, first distribute a few empty "catch" cans across the irrigated area. Note the exact time when irrigation

begins. Standard, small tuna cans are useful since they are typically one-inch tall. The irrigation cycle should end once the catch can is full. The ending time should be noted. This provides the user with an approximate length of time required to provide the turf with enough water to thrive for another week. It also serves as an assessment of the distribution evenness of the sprinkler heads.

Regardless of the irrigation system type, turf areas are generally wide and broad. Therefore, sprinkler irrigation is typically a better choice. However, drip irrigation is an appropriate alternative for shrubbery, gardens or during the grow-in period for trees. Drip irrigation uses less water than the traditional sprinkler because it places water directly into the soil and reduces the amount of water lost to runoff and evaporation.

In addition, manual hand-watering with a hose or bucket should be a tool everyone uses in landscaped areas. Some plants require more water than others and dry zones can be present, as rainfall is not equal everywhere even across a single lawn. If small areas of water stress are observed either in turf (i.e. blue-greenish blade color) or larger plants (i.e. brittle stems and early leaf drop), water should be provided directly to these plants to avoid loss, as establishing new plants will often require significantly more water than what's needed to save the existing plant. For more valuable landscaping vegetation, water injection and syringing is a tool that can be used to provide water directly to the roots. People should consult a landscape professional if they choose this method.

It is recommended that irrigation occur two to three times a week, keeping in mind that generally only one-inch of water total is needed for the entire week, including that received from precipitation. Irrigation frequency will often vary with climatic and environmental factors, such as seasonal shifts, temperature and rainfall. Significant alterations on water usage can be expected when any of these factors depart from normal conditions.

To avoid direct and immediate losses of irrigated water from evapotranspiration (ET), watering activities should be conducted between 10 p.m. and 8 a.m. Nighttime is generally less windy, cooler and more humid, resulting in less evaporation and more efficient application of water. It is advised that the watering be conducted late at night rather than early morning to avoid times of high water demand. Contrary to popular belief, studies have shown that irrigating during this period does not stimulate disease development. For more information, go to http://www.turffiles.ncsu.edu /PDFFiles/000851/ag661.pdf.

Measuring the depth of the root zone is important when determining the frequency and duration of irrigation. Landscapes with deep, well-established root zones may require less-frequent irrigation in the summer, even during peak ET demands. For younger landscapes, more frequent irrigation will likely be needed in the spring, when the roots are becoming established. Shallow rooting depth and warmer,

windier days result in higher ET rates. Understanding the changing needs of the landscaped area is important for water conservation and the health of the plants.

Irrigation frequency should also be adjusted depending on existing environmental factors such as compacted soils or soils with a shallow hardpan or clay lens. To avoid runoff on these soils, irrigate only a small portion of the needed water, wait until all the water has percolated into the soil, and continue to apply small portions of water. If kept near field capacity, and not allowed to dry, this process will assist in reducing the compaction of the soil. Field capacity is the amount of water remaining in a previously saturated soil after free drainage has ceased. On well-aerated soils with low to moderate traffic, minor water stress on the turf can serve to benefit the turfgrasses, as this will tend to increase the rooting depth. It is recommended that once wilting is observed on a few blades, wait another 24 hours, then water the area again to ensure water infiltrates deep into the soil column.

Table 2. Estimated monthly irrigation totals for turfgrasses in the Raleigh area (NCSU, 2012a).

Month	Mean Temperature(°F)	Average Rainfall	ETP [a]	Gross Irrigation Requirement [b]	Net Irrigation Requirement [c]
		(inches)			
Jan	40.2	3.63	0.59	-	-
Feb	42.9	3.44	0.77	-	-
March	49.9	3.79	1.68	-	-
April	59.3	2.88	3.27	1.83	2.29
May	67.2	3.64	5.20	3.38	4.23
June	74.6	3.54	6.88	5.11	6.39
July	78.4	4.51	7.60	5.35	6.68
Aug	77.1	4.33	6.73	4.57	5.71
Sept	70.8	3.70	4.86	3.01	3.76
Oct	60.0	2.94	2.85	1.38	1.73
Nov	50.6	2.90	1.29	-	-
Dec	42.4	3.01	0.65	-	-
Total	-	42.14	42.37	24.63	30.79

[a] ETP is potential evapotranspiration or the reference water use based on climatic information calculated using a modified Blaney-Criddle method.
[b] Gross irrigation requirement is determined by subtracting the effective rainfall from the ETP. Effective rainfall is assumed to be 50 percent of the average monthly rainfall.
[c] The net amount of water required by the turfgrasses is quantified by the following equation: Irrigation Requirement $= \frac{GIR}{DU}$
Where GIR is the gross irrigation requirement and DU is the uniformity of distribution of the irrigation system, which may be assumed to be 80 percent.

Soil Analysis and Amendments

In North Carolina, most soils are acidic and somewhat low in nutrients; therefore, optimal plant growth and yield often require the addition of amendments. Plants with nutrient deficiencies or ion toxicities will show symptoms of water stress. This is because essential nutrients such as Phosphorus (P), Potassium (K), and Nitrogen

(N) are necessary for the plant to transmit water from the soil into the roots and up into the above-ground portions of the plant. At the same time, ion toxicities, such as Aluminum (Al), Iron (Fe), or Sodium (Na) will restrict the uptake of water from the soil. Proper soil pH is also critical to avoid plant water uptake issues. In highly acidic soil conditions plant roots will be constrained in the uptake of water. For most areas throughout North Carolina, the recommended soil pH range is between 5.5 and 6.5.

Soil testing is the best way to determine the types and quantities of the soil amendments needed based on existing field conditions. Over-fertilization or over-liming should be avoided, as it could result in increased shoot growth at the expense of root development. A soil analysis should be completed prior to any planting. Ensuring the turf and larger plants have the proper amount of fertilizer applied early in the season will assist in making more efficient use of the available nutrients. This will result in increased efficiency of water uptake throughout the growing season. In North Carolina, the Department of Agriculture and Consumer Services (NCDA&CS) provides a free assessment of soil samples sent by North Carolina residents. This report details the existing levels of essential macronutrients, as well as important micronutrients present. The report also provides recommendations for quantities of soil amendments to be applied. These recommendations are based on the specific use of the landscaped area, which in this case would be a managed lawn.

It is important to follow the instructions provided by the State Department of Agriculture and Consumer Services for proper collection of samples, including sample depth and composite sampling. When, where and how the sample is taken all affect sample quality and the resulting nutrient/amendment recommendations. Each sample must accurately reflect the variability and conditions in the landscaped area, and typically soil from a single location cannot do this. Samples should be taken at the depths of the rooting zone for the plants planned for that location. Therefore, in planned turf areas the sample does not need to exceed 6 inches. However, in areas where larger plants are planned, the sample depths should be between 6 inches and 12 inches. The samples taken at different depths should not be combined together into a single composite sample. Rather, composite samples should be soil samples of the same depth at different locations. Each sample should be a composite of between 15 and 20 locations, thoroughly mixed, and the area represented by each sample should be relatively uniform. Avoid areas where soil conditions would be expected to be markedly different from those in the rest of the landscaped area (i.e. wet spots, severely eroded areas, old building sites, fence rows, spoil banks, burn row areas, old woodpiles or fire sites. These peculiar areas should have their own separate sample(s). The sample turn-around time varies throughout the year with the winter months generally taking longer than the summer months due to the increased agricultural needs (NCDA&CS, 2008). An example of a soil analysis report as well as an explanation of soil test results are included as Appendices 1 and 2 at the end of this BMP.

Mulching

Mulching around trees and shrubs in a landscaped area, excluding the lawn, provides temperature protection and moisture retention for the plants as well as creating an attractive landscape. Some of the primary water efficiency benefits mulches provide include:

- Soil moisture retention, which is then taken up by the plants.
- Reduction of moisture lost to the atmosphere from the soil by evaporation (i.e. 10 percent to 25 percent reduction in soil moisture loss from evaporation).
- Soil protection from compaction from traffic, as well as from precipitation striking the soil. Compaction reduces the total pore space in the soil available to hold water.
- Reduction of runoff, which results in holding more water on-site.
- Reduction of topsoil erosion. Topsoil often contains more water for plants and more nutrients than the deeper, underlying soil.
- Insulation of the soil below from heat loss in the winter and evenings. Resistance of rapid warming in the summer and mid-day. This consistent environment reduces the amount of water lost to evaporation.
- Impedes the growth of weeds and other undesirable plants, which compete for limited water resources. A 2-inch–to-4-inch layer (after settling) is adequate to prevent most weed seeds from germinating.

The mulched area should include as much of the root zone as possible. For plant beds, the entire area should be covered with mulch. For individual plants, such as trees, the mulched area should extend at least three feet from the base of the plant. It is advisable to pull the mulch between 1 inch and 2 inches from the base of plants to prevent bark decay. Mulch can be applied year-round. However, the best time to mulch is late spring after the soil has warmed. Early spring application will delay soil warming and possibly plant growth. It is not necessary to remove the mulch when you fertilize. Apply the fertilizer on the mulch. Nutrients will move with the water to the roots below.

Mulch depth depends on two factors: the moisture holding capacity of the underlying soil and the type of mulch material used. Sandy soils dry out quickly and often benefit from a slightly deeper mulch layer of between 3 inches and 4 inches. However, excessive application of mulch can result in a situation in which roots are growing in the mulch and not in the soil. Over-mulched plants are easily damaged when herbicides and fertilizers are applied and during periods of drought stress. Mulching an area that is poorly drained can further reduce the drainage resulting in an area permanently saturated, which the selected plants would not be able to tolerate (NCSU, 2012b).

Table 3. Mulching estimates to adequately cover a landscaped area with a loamy surface (top 6 inches) soil (NCSU, 2012b).

Inches of Material	Organic Material Needed to Cover 100 Square Feet
6	2 cubic yards
4	35 cubic feet
3	1 cubic yard
2	18 cubic feet
1	9 cubic feet
1/2	4 cubic feet

There are essentially two distinct categories of mulching products, organic mulches and inorganic mulches. Organic mulch lacks significant manufacturing in its production. As such, organic mulch contains only plant materials. Inorganic mulches often also contain plant material, but may also include many different types of materials integrated during the manufacturing process. Each has its own advantages and disadvantages, and its selection should be based upon landscape setting, anticipated use, maintenance requirements and budget.

Organic Mulch Materials

Many organic materials can be used as mulch. The material should be weed-free, non-matting, easy to apply, and readily available. Fine particle organic mulch will form a more complete soil cover than a coarse, loose material. Coarse mulch material will need to be applied in thicker layers in order to achieve the desired benefits. Organic mulches decompose with time, releasing small amounts of nutrients and organic matter to the soil. The layer of mulch should be renewed as needed to maintain a 2-inch-to-4-inch depth. On previously mulched areas, apply a 1-inch layer of new material every few years.

Some of the best organic materials include pine bark nuggets, shredded hardwood, pine straw and compost. Pine straw is aesthetically pleasing and will remain in place better than most other materials. However, pine straw can be a fire danger during drought conditions. Pine bark nuggets are longer lasting, but can be washed with a heavy rain. Note that pine bark mulch is primarily used as a soil conditioner and that pine bark nuggets are used as mulch. Bark used as mulch should contain less than 10 percent wood fiber. Reapplication time should be a consideration; pine straw will need to be reapplied each year while pine bark may not need to be reapplied for several years.

Other organic materials sometimes used for mulch include: wheat straw, shredded newspaper, peanut hulls, wood chips, sawdust and partially decomposed leaves. Most of these materials are less expensive than pine straw or pine bark but have some significant limitations. Any fresh, light-colored, unweathered organic mulch such as wheat straw, peanut hulls and wood chips will tie up nitrogen during the early stages of decomposition. Properly composted wood chips can be used as a long-lasting mulch that weathers to a silver-gray color. Unfortunately, most wood chip material is sold as a fresh material rather than as a composted or aged material. The chips decompose slowly, but as they decompose, microorganisms use nutrients from the soil that might otherwise be available for plant growth. If sawdust is used, it should be well-aged. Otherwise it will be difficult for water to move into the soil. Uncomposted sawdust is low in nitrogen and will rob nitrogen from the soil as it decomposes.

Yard waste, such as grass clippings, leaves and small twigs can be used as mulch in moderation. The back side of the shrub border or natural area is an ideal place to dispose of small pruning clippings. Ideally, these materials should be shredded or composted before applying; however, small amounts can be applied to existing mulch. Non-shredded leaves and grass clippings can form a thick mat that makes water penetration nearly impossible.

Organic material that has been stockpiled (in large piles) often goes through anaerobic (low oxygen, high moisture) decomposition and becomes acidic, with a pH of approximately 3. This can present a toxicity problem for the plants unless adequate liming material is provided. Properly composted organic material should have a pH of between 6.0 and 7.2. Anaerobic decomposition is often a problem with uncomposted materials such as leaves, grass clippings, wood chips or sawdust due to its toxic byproducts including methane and alcohol production. A good way of determining if the mulch underwent anaerobic decomposition is the strong smell of vinegar, ammonia or sulfur emanating from the mulch when turned. Damage usually occurs within 24 hours after application of the mulch and will manifest as marginal leaf chlorosis, leaf scorch, defoliation and/or plant death. Materials such as shredded newspaper, sawdust and yard waste may contain chemical contaminants that can harm plant growth.

Inorganic Mulch Materials

Though organic mulch provides good soil water benefits, geotextiles and landscape fabrics can be used to provide similar results. These materials are especially useful on areas with significant slopes and are used extensively on newly constructed road rights-of-way and other recent grading projects. They allow for normal water and oxygen exchange and prevent the growth of most weeds, while allowing desired grasses to grow through. The material should be applied on bare soil before or immediately after planting and held tightly in place by biodegradable staples or other similar devices. Good growth results have been shown when using a combination of landscape fabric covered with an organic material. However, a thin layer of soil can

develop atop the fabric, since these materials provide a semi-permeable covering. This thin layer of soil can be a haven for weeds, which can use the water before it is transmitted past the fabric and into the soil. In this situation, using a coarse-textured mulch, such as pine bark nuggets, will delay the development of this layer.

For comments or questions regarding the Regionally Appropriate Landscaping BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9005.

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- Dr. Charles Peacock, NCSU Turf Management Department and Dr. Anthony Lebude, NCSU Horticulture Department, Personal Communication.

Appendices

Appendix 1. Example of a NCDA&CS soil analysis report.

NCDA&CS Agronomic Division **Phone: (919)733-2655** **Web site: www.ncagr.gov/agronomi/** **Report No: 09536**

Grower: *Copies To:*

Soil Test Report

SERVING N.C. RESIDENTS FOR OVER 60 YEARS

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Agronomist Comments 4

Field Information		Applied Lime			Recommendations														
Sample No.	*Last Crop*	*Mo*	*Yr*	*T/A*	*Crop or Year*		*Lime*	*N*	*P_2O_5*	*K_2O*	*Mg*	*S*	*Cu*	*Zn*	*B*	*Mn*	*See Note*		
FRONT					1st Crop:	Lawn	0	(1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT)				0			.0		4		
					2nd Crop:	Lawn	0	(1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT)				0			.0		4		

Test Results

Soil Class	*HM%*	*W/V*	*CEC*	*BS%*	*Ac*	*pH*	*P-I*	*K-I*	*Ca%*	*Mg%*	*Mn-I*	*Mn-AI(1)*	*Mn-AI(2)*	*Zn-I*	*Zn-AI*	*Cu-I*	*S-I*	*SS-I*	*NO_3-N*	*NH_4-N*	*Na*
MIN	0.66	0.93	10.2	84.0	1.6	5.9	166	106	56.0	23.0	151			132	132	45	30				0.1

Field Information		Applied Lime			Recommendations														
Sample No.	*Last Crop*	*Mo*	*Yr*	*T/A*	*Crop or Year*		*Lime*	*N*	*P_2O_5*	*K_2O*	*Mg*	*S*	*Cu*	*Zn*	*B*	*Mn*	*See Note*		
BACk					1st Crop:	Lawn	30M	(1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT)				0			.0		4		
					2nd Crop:	Lawn	0	(1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT)				0			.0		4		

Test Results

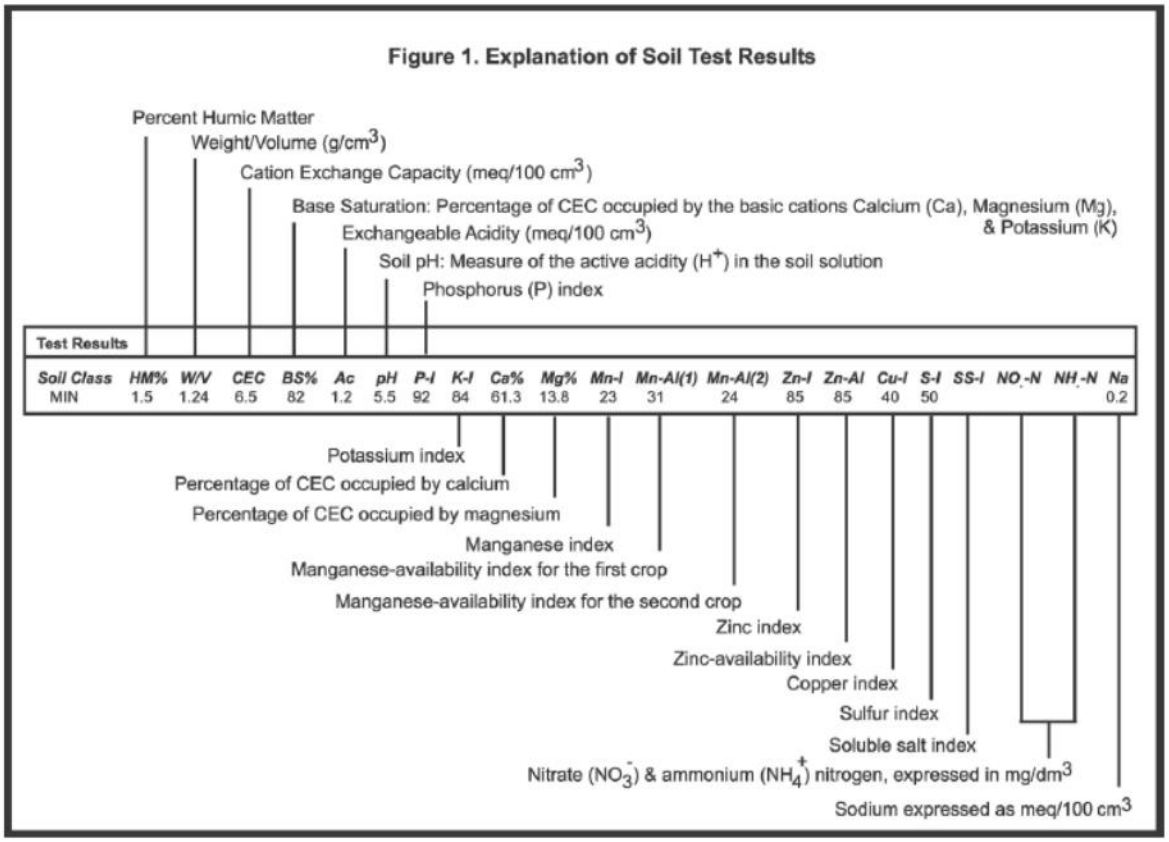
Soil Class	*HM%*	*W/V*	*CEC*	*BS%*	*Ac*	*pH*	*P-I*	*K-I*	*Ca%*	*Mg%*	*Mn-I*	*Mn-AI(1)*	*Mn-AI(2)*	*Zn-I*	*Zn-AI*	*Cu-I*	*S-I*	*SS-I*	*NO_3-N*	*NH_4-N*	*Na*
MIN	0.27	0.93	8.8	83.0	1.5	5.6	124	92	54.0	24.0	130			267	267	63	60				0.1

Field Information		Applied Lime			Recommendations														
Sample No.	*Last Crop*	*Mo*	*Yr*	*T/A*	*Crop or Year*		*Lime*	*N*	*P_2O_5*	*K_2O*	*Mg*	*S*	*Cu*	*Zn*	*B*	*Mn*	*See Note*		
HOSTA					1st Crop:	Garden,Flower	0	(7.0 lbs 15-0-14 or EQUIV PER 1000 SQ FT)				0			.0		4		
					2nd Crop:	Garden,Flower	0	(7.0 lbs 15-0-14 or EQUIV PER 1000 SQ FT)				0			.0		4		

Test Results

Soil Class	*HM%*	*W/V*	*CEC*	*BS%*	*Ac*	*pH*	*P-I*	*K-I*	*Ca%*	*Mg%*	*Mn-I*	*Mn-AI(1)*	*Mn-AI(2)*	*Zn-I*	*Zn-AI*	*Cu-I*	*S-I*	*SS-I*	*NO_3-N*	*NH_4-N*	*Na*
MIN	0.60	1.01	9.4	85.0	1.4	5.9	86	48	66.0	16.0	192			175	175	83	26				0.1

Appendix 2. Explanation of Soil Test Results.



Rainwater Harvesting, Condensate Reuse and Gray Water Use

Background

The purpose of this BMP is to highlight ways of creating water efficiency through the use of rainwater harvesting, condensate reuse and/or the use of recycled water for irrigation or other applicable purposes.

In addition to providing water use efficiency, use of rainwater harvesting methods, such as cisterns, can also count as stormwater treatment devices. Development projects that use rainwater harvesting methods for rooftop runoff can receive stormwater reduction credit. This credit can be used to reduce, or possibly eliminate, other types of stormwater treatment devices such as wet ponds. This document does not provide details on the design techniques to achieve stormwater credit but that information is available in the Stormwater BMP Manual provided by the N.C. Division of Water Quality. It can be found in Chapter 19, "Rooftop Runoff Management" and is available at http://portal.ncdenr.org/web/wq/ws/su/bmp-ch19.

Applicability

This BMP is intended for use by a water system ("utility") concerned with reducing outdoor irrigation demands on the potable water system.

Calculation of potential savings will depend on regional climate patterns. Rainwater harvesting and condensate reuse are applicable to industrial, commercial and institutional (ICI) buildings, while private homes can benefit from rainwater harvesting. Utilities may benefit by targeting this BMP to help shave peak demand through customer education. For maximum water-use efficiency benefit, the utility should adhere closely to the measures described below. Gray water use will not be discussed in this BMP until the N.C. Division of Water Quality has established an approved gray water use system as directed by the North Carolina General Assembly.

Description

Rainwater harvesting and condensate reuse ("RWH/CR") conservation programs are an effective method of reducing potable water usage while maintaining healthy landscapes and avoiding problems due to excessive run-off. Using this BMP, the utility provides customers with support, education, incentives and assistance in proper installation and use of RWH/CR systems. RWH/CR systems will be most effective if implemented in conjunction with other water efficiency measures including water-saving equipment and practices. Rainwater harvesting is based on ancient practices of collecting, usually from rooftops, and storing rainwater close to its source, in cisterns or surface impoundments, and using it for nearby needs. ICI users have found it to be cost-effective to collect the condensate from large cooling systems by returning it into their cisterns as well. Facilities with large cooling demands will be in the best position to take advantage of condensate reuse, which due to its quality can potentially be used in landscape

irrigation, as cooling tower makeup water, or in some industrial processes. The variability in rate and occurrence of rainfall requires that rainwater or condensate be used with maximum efficiency. Incentives may include rebates for purchase and installation of water-efficient equipment.

Several factors should be considered in the design of rainwater harvesting and condensate reuse systems. System components include the collection area, a first flush device, a roof washer, storage structure with the capacity to meet anticipated demand and a distribution system. For above ground structures, design consideration should be given to maintaining the highest elevation feasible for collection and storage systems for the benefit of gravity flow to distribution. When using drip irrigation systems, filters are necessary to prevent particulates from clogging drip nozzles. Regular maintenance of RWH/CR systems includes changing filter media on a regular basis and cleaning the first flush filter. The utility should consider providing participants with reminders of regular maintenance requirements for their RWH/CR systems. Maximum expected daily demand and knowledge of historical precipitation patterns, including amount, frequency and longest time between rainfall events, is important in designing the system. The Rainwater Harvesting: Guidance for Homeowners produced by North Carolina State University can be used as a resource, as well as technical assistance from professional installers of equipment for proper design and implementation of RWH systems. To see the guide, go to
http://www.bae.ncsu.edu/stormwater/PublicationFiles/WaterHarvestHome2008.pdf.

While residential cooling systems are unlikely to provide significant flows of condensate, ICI installations with large cooling demands can produce significant amounts of condensate and should be evaluated for the dual RWH/CR system. Large ICI installations can implement rainwater harvesting (from roofs), as well as capture of stormwater for irrigation or other non-potable uses. Large buildings that have or need French drain systems for foundation drain water should also evaluate the potential for recovery of this resource as well.

The utility should consider sponsoring one or more demonstration sites. Potential partners include customers with educational missions such as schools, universities, botanical gardens and museums with large public landscapes.

Although rainwater is recommended for all irrigation uses, it is most appropriate for use with drip or micro irrigation systems. Utilities implementing this BMP should consider offering a landscape water-use survey to help customers ensure that RWH/CR systems are properly designed and sized.

The water-use surveys, at a minimum, should include: measurement of the total irrigated area; irrigation system checks, review of irrigation schedules or development of schedules as appropriate; and provision of a customer survey report and information packet. The utility should provide information on climate-appropriate landscape design and efficient irrigation equipment and management for new customers and change-of-

service customer accounts. See the Residential and commercial Landscape Irrigation BMP for more detail.

Implementation

Programs should consider the following elements:

Retrofit or Rain Barrel Program

- Marketing the program to the customer via bill inserts will allow the utility to target the largest summer peak users first. The utility should consider also approaching local weather announcers, radio gardening show hosts, and newspaper columnists for assistance in notifying the public about the program. The program can be marketed using public/private partnerships with non-profits such as gardening clubs, neighborhood associations, cooperative extension offices or with green industry businesses such as rainwater harvesting companies and local sustainable building groups. Using these partnerships can also be an effective way to leverage available resources.
- Incentives can include rebates for RWH/CR systems, recognition for RWH/CR systems through signage, award programs, and certification of trained landscape company employees and volunteer representatives to promote the program.
- The initial step in assisting customers with landscape irrigation systems is a thorough evaluation of the potential water captured by a RWH/CR system.
- The water customers who participate in this program will need to maintain and operate their irrigation systems efficiently. The utility should consider implementing a notification program to remind customers of the need for maintenance and adjustments in irrigation schedules and to system filters as the seasons change.
- The utility needs to ensure that RWH/CR system specifications are coordinated with local building and plumbing codes.
- The American Rainwater Catchment Systems Association lists evaluation training for RWH/CR programs. ICI customers may want to consider performance contracting as an option for financing retrofitted RWH/CR systems.

New Construction: In addition to retrofitting existing homes and buildings with RWH/CR systems, a utility may also choose to support new construction. Using this approach, the utility could:

- Adopt ordinances requiring all new ICI properties to install a RWH/CR system that collects and stores rainwater and condensate from all eligible sources and distributes it to irrigation and/or a cooling tower make-up system.
- Implement an incentive program to encourage builders and owners of new ICI properties to install a RWH/CR system that collects and stores rainwater and condensate from all eligible sources and distributes it to irrigation and/or a cooling tower make-up system. In large ICI buildings requiring cooling towers, design consideration should be given to returning condensate flows from air

conditioning coils to cooling tower make-up. It may be effective for this BMP to be part of a Green Builder-type rating system that also includes WaterWise landscaping and adequate soil depth.

- Implement an incentive program to encourage homebuilders and homeowners to install a RWH system for landscape use to reduce potable water consumption from the utility in the summer season.
- Adopt ordinances requiring that new homes or multi-unit properties install plumbing that separately collects and stores rainwater from eligible sources and distributes the rainwater through a subsurface irrigation system. The rainwater could be distributed around the foundation of the residence or building or for other landscape use.

Such programs would need to be carefully coordinated with stormwater collection programs and meet all applicable regulations for stormwater collection and reuse.

Schedule

Depending on the option(s) selected, the corresponding schedule should be followed.

Incentive Approach**:** In the first six months, plan the program including stakeholder meetings as needed. Develop a plan for educating potential homebuyers, developers, plumbers, green industry trade groups, landscape architects and realtors about this program. After six months, implement the program.

Ordinance Approach: In the first six months, hold stakeholder meetings to develop the ordinance. Consider offering incentives for the first year of implementation. Propose the ordinance or rules to the local city council for approval. Develop a plan for educating potential homebuyers, developers, plumbers and realtors about this program. After six months, implement the program.

Scope

To accomplish the goals of this BMP, the utility should do one or more of the following:

- Develop and implement an incentive program to encourage RWH/CR in new multi-unit properties and certain new commercial developments such as office parks.
- Develop and implement an incentive program to encourage RWH/CR in existing multi-unit properties and certain existing commercial developments such as office parks.
- Develop and implement an incentive program to encourage residential customers to install rainwater harvesting systems.
- Develop and implement an ordinance requiring condensate recovery in new non-residential construction as applicable.

Documentation

To track this BMP, the utility should gather and have available the following documentation for each year of operation:

- The number of new RWH/CR developments for which design planning started after adoption of this BMP.
- The number and type of RWH/CR installations completed each year.
- The estimated rainwater and condensate use in each RWH/CR installation.
- Aggregate water capacity of RWH/CR sites.
- The number, type and dollar value of incentives, rebates or loans offered to and accepted by customers.
- Estimated water savings achieved through customer surveys.

Determination of Water Savings

Water savings from a RWH/CR program is determined by water volume harvested and used to replace other potable water sources. In programs which target new construction, the water savings should be estimated based upon known water consumptions for the proposed end use. A number of sources, including other BMPs, can be helpful in estimating potential water savings. A method for estimating potential water catchment and a monthly water balance equation for estimating water storage capacity are:

Catchment Potential (gals) = Area x 0.62 x 0.8 x [Rainfall]

Where Area = total area of catchment surface in square feet.
0.62 = coefficient for converting inches per square feet to gallons
(unit conversion from 7.48 gallons per cubic feet).
0.8 = collection efficiency factor.
0.9 Rainfall = average rainfall in inches.

Note: Median and lowest recorded rainfall can also be calculated in order to develop a range of expected values.

Storage Capacity: A simple assumption is that up to three weeks may lapse without significant rainfall. As such, it's recommended that storage structures are sized to maintain three weeks' worth of water use.

- More precise methods of estimating needed storage capacity or additional information for estimating water balance of RWH/CR systems and of accounting for the variability in seasonal rainfall pattern is available at the Rainwater Harvesting website of NCSU at http://www.bae.ncsu.edu/topic/waterharvesting/model.html.

- For condensate recovery, storage should be based on the anticipated maximum holding time before the condensate is reused for irrigation or other purposes.

Cost-Effectiveness

The costs of this BMP to the utility will include administrative program management costs and incentives to customers for implementing rainwater harvesting or condensate reuse projects. Depending on program design and whether project inspections are required, staff labor costs should range from $50-to-$100 per project. Marketing and outreach costs range from between $20 and $50 per project. Administrative and overhead costs range from 10-to-20 percent of labor costs. For rain barrel installations, labor costs range from $8 to $12 per project and warehouse storage costs may be an additional consideration.

For comments or questions on the Rainwater Harvesting and Condensate Reuse BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9021.

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Case Studies for Rainwater Harvesting and Water Reuse

North Guilford Middle and High School Greensboro, North Carolina

Background

Greensboro is in Guilford County in north central North Carolina and has a population of 263,000 people. North Guildford Middle and High School have a total student population of 2,344. The schools were constructed in 2007. The design of the rainwater harvesting infrastructure for the school took place at the time of the school design.

The goal for the project was to collect enough water to flush the toilets in the facility and also to irrigate the school grounds. This goal was met on completion of the project.

Cistern size – 360,000 gallons
Water saved per year – 4 million gallons
Cost – $500,000 or $1.39/gallon
Cost Savings – 4 million gallons at a cost of $1.50/gallon which = $6,000/year

The project's design was driven by location, number of students and faculty, weekly and seasonal schedule of the schools, available collection area, plumbing fixture efficiency, rain water supply and other factors.

The rainwater harvesting project has also been used as an educational resource for the school. Other system benefits include the elimination of stormwater runoff from the site and the reduction of utility bills.

For more details on this project, go to
http://innovativedesign.net/files/Download/NMS%2085x11.pdf.

University of North Carolina at Chapel Hill Chapel Hill, North Carolina

Background

Chapel Hill is in Orange County, where water is provided by Orange Water and Sewer Authority. The University of North Carolina at Chapel Hill has a population of more than 28,000 students.

The facilities service division of the University of North Carolina noted the limited local water supplies and recent droughts. This highlighted the need to reduce water consumption across the UNC campus. Planning and construction of cisterns and the use of reclaimed water have reduced the overall need for potable water. In 2009, operations started on a reclaimed water system that further reduced potable water consumption by more than 200 million gallons per year.

The first project the university undertook was using reclaimed water to irrigate some athletic fields and to help cool the chilled water plants. In 2009, all five chilled water plants, which use 200 million gallons of water per year, were using reclaimed water as their water source.

In 2012, a 350,000-gallon cistern is being constructed in the former UNC Bell Tower parking lot. Water from the roof of the new Genome Sciences building will be stored here and then used to irrigate Kenan Stadium and flush the stadium's toilets. Other cisterns installed in front of Hanes Hall and beneath the parking structure at Boshamer Stadium collect water from the roofs of these structures and this water is then used to irrigate the baseball field at Boshamer Stadium. Overflow irrigation is collected and recycled into the cistern.

UNC has worked closely with OWASA on this process. The reclaimed water used on the campus is highly treated wastewater that is pumped to the university after being treated at Mason Farm Sewage Treatment Plant.

UNC continues to look for opportunities to use reclaimed water and harvested rainwater. The expansion of the campus to the north will be designed using the information gained from these existing projects.

For information on home rainwater harvesting, please see the following links:

http://sustainability.unc.edu/Initiatives/WaterManagement.aspx
http://www.bae.ncsu.edu/topic/waterharvesting/

For more information at UNC's reclaimed water use, please see the following links:

http://www.owasa.org/whatwedo/reclaimed-water.aspx
http://sustainability.unc.edu/Initiatives/WaterManagement.aspx

Case Study for Rainwater Harvesting

North Carolina Aquarium at Pine Knoll Shores, NC

Background

The design and construction of this rainwater harvesting cistern took place after the aquarium was built.

The goal for the project was to prevent stormwater runoff from the site. The collected water is used to irrigate the greenhouse and plant nursery and for maintenance purposes such as deck and vehicle washing. This goal was met on completion of the project.

Cistern size – 18,000 gallons held in six tanks
Water saved per year – 4 million gallons
Purpose – stormwater runoff abatement and conservation of municipal water

The rainwater harvesting project has also been used as an education resource for the aquarium. A major benefit of the system is that stormwater runoff on the site has been reduced and utility bills have been lowered.

For more details on this project, go to http://www.nccoastaltraining.net/uploads/Rainwater%20-%20KATHY%20DeBUSK.pdf.

Water Conservation Pricing

Background

Water conservation pricing is the use of rate structures to encourage efficient use and discourage the waste of water. Water conservation pricing provides economic incentives to customers to use water efficiently. It is possible to achieve full-cost pricing of water while using water conservation pricing principles.

Appropriately designed and implemented water conservation pricing can:

- Reduce water consumption while limiting negative impacts on utility revenues.
- Reward customers for making cost-effective changes in water appliances and water use behavior through greater savings.
- Target inefficiency in discretionary water uses such as landscape irrigation.
- Delay costly and perhaps unnecessary water supply expansion projects.
- Avoid financial hardships on low-income customers.

Applicability

This BMP is intended for all water systems ("utility") wishing to send price signals to customers that will encourage water conservation. A water system may have already accomplished this BMP if it currently has a conservation price structure that has resulted in water conservation at the desired rate. The objective of the desired rate should be to show both a declining usage measured on a per customer or per capital basis, and to achieve a lower seasonal peaking factor.

Description

Water conservation pricing is the use of rate structures to provide for the financial security of a water system and encourage efficient use and discourage the waste of water. Conservation pricing structures often increase unit prices with increased consumption (increasing block rates), charge higher rates during high-use seasons (seasonal rates), and/or impose water shortage response plan-linked temporary surcharges during water shortage periods. The goal of conservation pricing is to use price signals, based on the extra costs necessary to meet peak demands caused by elective usage, to encourage more efficient long-term usage patterns by customers. For example, high water use imposes greater costs to the utility in terms of capacity and should be charged higher rates. Using this BMP, water systems should consider establishing rates based on long-run marginal costs, or the cost of adding the next unit of capacity to the system. An established cost of service methodology should be followed whenever rates are developed or proposed for change. For a typical system, where elective usage is not a significant portion of total usage, or total usage for a given customer class (i.e. residential), less drastic pricing signals or price differentials, combined with appropriate tier cut-offs, can be highly effective.

This BMP addresses conservation pricing structures for retail customers. For water systems supplying water and sewer service, the principles contained in this BMP can be applied to the pricing of both services. The way to support tiered rates for residential customers is to avoid having the sewer rates based on a capped level of water flows, so the sewer rate continues to reinforce the higher water rates as customers reach higher usage levels. A capped sewer rate structure for residential customers does serve to undermine some tiered structures. Water systems that supply water but not sewer service should make good faith efforts to work with sewer agencies so that these sewer agencies do not provide sewer services using a pricing structure that conflicts with the objectives of the water pricing structure.

For conservation pricing structures to be effective, customers should be educated on the type of rate structure the water system uses and be provided feedback through the water bill on their water use. Most customers do not track water use during the month because of the difficulty and inconvenience of reading the meter. When customers read their bills, they often just look at the total amount billed. Conservation pricing has the advantage of providing stronger feedback to the customers. Customers will see a larger percentage increase in their water bill that will appear disproportionate to their increase in water use. Water systems should move toward using billing software that allows customers to compare water use on their bill with average water use for their customer class, as well as the household's water use for the last 12 months. The rate structure should be clearly explained on the water bill, including information about the block sizes and rates if applicable.

It is not recommended that a minimum monthly water allotment be included in the minimum bill. The American Water Works Association's (AWWA) M1 Manual notes that minimum charges are often considered to work counter to conservation goals and are unfair to those who use less than the monthly minimum. A customer in a small house with all efficient fixtures and appliances may be able to consume less than 1,000 gallons per month and may be inclined to increase their water use if a minimum bill includes charges for at least 1,000 gallons.

Implementation

Conservation pricing is best if introduced over time and in multiple steps. Some of these steps include:

- Implementing reporting procedures.
- Monitoring and documenting usage patterns for various sectors of users.
- Educating consumers on the value that the utility provides.

Successful adoption of a new rate structure may necessitate developing and implementing a public involvement process in order to educate the community about the new rate structure. The new rate structure should adhere to all applicable regulatory procedures and constraints. If the conservation pricing structure to be implemented is substantially different from current practices, then a phased-in approach may be

appropriate.

Public involvement in the development and implementation of conservation rates can help assure that the goals of the conservation pricing initiatives will be met and accepted by local constituents. Public meetings, advisory groups and public announcements are among ways to generate public involvement.

Development of conservation-based rate structures is more than just a selection of arbitrary usage breaks for increasing block rates. The process requires consideration of the effect on water demand and water system finances.

Basic rate structure considerations should include rates designed to recover the cost of providing service and billing for water and sewer service based on actual metered water use. Conservation pricing should provide incentives to customers to reduce average and peak use. The conservation rate structure can be designed to bring in the same amount of revenue, often termed revenue neutral, as the previous rate structure.

Only one form of conservation pricing is required for this BMP. Conservation pricing is characterized by one or more of the following components:

- Rates in which the unit price ($/1,000 gallons) increases as the quantity of water used increases are called *increasing block rates*. A water system should analyze historical records for consumption patterns of its customers. The first block should typically cover the amount of water for normal household health and sanitary needs. Rates for single family residential and other customer classes may be set differently to reflect the different demand patterns of the classes. To increase the effectiveness of this rate structure type, the additional revenue from the higher blocks should be associated with discretionary and seasonal outdoor water use.

    - The price difference between blocks is important in influencing the customer's usage behavior. Price increases between blocks should be no less than 25 percent of the previous block. For maximum effectiveness, the price difference going from one block to the next highest block is recommended to be at least 50 percent of the lower block. For example if the third block of a four block rate structure is $4 per 1,000 gallons, the fourth and final block should have a rate of at least $6 (50 percent higher) per 1,000 gallons. Any surcharge based on water usage should be included when calculating these percentages.

- Rates based on individual customer water budgets, in which each customer is charged according to an increasing block rate structure in which each block size is determined by that individual customer's water needs, often called *budget-based rates*. Water budget rate structures are based on the philosophy that each customer has a unique amount of water that is needed for public health and is adequate for all necessary uses (drinking, cooking, washing, etc.), and uses

above that amount are considered discretionary and charged as excessive (irrigating lawns, washing cars, etc.). Typically, there should be an indoor and an outdoor component to a water budget.

- For residential rates, the indoor component should be based upon estimates of the household's average wintertime use. The outdoor component is based upon landscape area. For business customers, water budgets will often be based on historical average for indoor water use, and the outdoor component based on landscape area.

- To qualify as a conservation rate, water systems that implement water budget based rate structures typically begin excess rate charges for landscaped areas at no more than 80 percent of average annual reference evapotranspiration replacement rates.

- Rates based upon the long-run marginal cost, or the full-cost of providing water.

  - Conservation pricing should use a consumption charge based upon actual gallons metered. The base charge ("minimum bill") for service should be based on the fixed costs of providing that service which generally includes administrative and meter-reading and billing charges, plus a portion of debt service and other capacity costs. Including an allotment for water consumption in the minimum bill does not promote conservation. It is recommended that if an allotment is included, it should not exceed 2,000 gallons per month. Water systems including a water allotment in the minimum bill should consider eliminating that allotment within five years of implementing this BMP.

  - Adoption of lifeline rates neither qualifies nor disqualifies a rate structure as meeting the requirements of this BMP except that the minimum bill guidelines should be followed. Lifeline rates are intended to make a minimum level of water service affordable to all customers. Lifeline rates should not be applicable past the first 2,000 gallons of use.

  - The water system should educate customers about the rate structure and use billing software that allows the customer to compare water use on his or her bill with average water use for his or her customer class, as well as his or her household water use for the last 12 months. The rate structure should be clearly explained on the water bill. The water system may want to consider implementing the Public Information BMP in conjunction with this BMP in order to provide customers information on how to reduce their water bill under a conservation rate structure.

  - In order to set up an effective irrigation rate, all water used through irrigation meters should be charged at least at the highest block rate, if

applicable. If you charge for water and sewer, keep in mind that by installing an irrigation meter, the customer will no longer be paying wastewater rates for that volume of water, and the total price for high units of water will decrease. Charging irrigation rates at or above the highest block rate for indoor water allows you to specifically target this type of discretionary water use. The water system must adopt rules or ordinances requiring customers serviced after July 1, 2009, with in-ground irrigation systems to install separate irrigation meters, as required by G.S. 143-355.4, and should consider retrofitting customers serviced prior to July 1, 2009, with separate irrigation meters. It is important for these customers to have a separate irrigation meter, so it is more apparent how much water they are using for irrigation.

Schedule

Water systems pursuing this BMP should begin implementing it according to the following schedule:

- The water system should follow applicable regulatory procedures and adopt a conservation-oriented rate structure within the first 12 months. The conservation rate structure should be designed to promote the efficient use of water by customer classes. Additional suggestions and guidance on setting up conservation-oriented rate structures are provided in *SWIC-Recommended Guidance for North Carolina Utilities Attempting to Support Water Conservation in the Long-Term through Rate Structure Design and Billing Practices* available at http://www.ncwater.org/Water_Supply_Planning/Water_Conservation/SWIC_11-22-10.pdf.

- At least annually, a water system should review the consumption patterns (including seasonal use) and revenue and expense levels to determine if the conservation rates are effective. The system should make appropriate, regular rate structure adjustments as needed.

- At least annually, the water system should provide information to all customers on the conservation rate structure.

- If not already in place, within five years or when the water system changes billing software (whichever is sooner), the water system bill should provide customers with their historical water use for the last 12 months and a comparison of water use with the other customers in their customer class. The rate structure should be clearly indicated on the water bill.

Scope

To accomplish this BMP, the water system should implement a conservation-oriented rate structure and maintain its rate structure consistently with this BMP's definition of

conservation pricing and implement the other items listed in the section above.

Documentation

To track this BMP, the water system should maintain the following documentation:

- A copy of its legally adopted rate ordinance or rate tariff that follows the guidelines of this BMP.
- Billing and customer records which include annual revenues by customer class and revenue derived from commodity charges and fixed charges by customer class for the reporting period.
- Customer numbers and water consumption by customer class at the beginning and end of the reporting period.
- If a water allotment is included in the minimum bill, a cumulative bill usage analysis similar to Figure 1 (C-3) in the AWWA M1 Manual. (See below.)[3]
- A copy of the educational materials on the conservation rate sent to customers for each calendar year this BMP is in effect.
- An account of all system costs as identified in the Implementation Section.
- A water system bill meeting the parameters and schedule in the Schedule Section.
- Optional provisions:
    - A copy of the rule or ordinance requiring all customers after July 1, 2009, to install separate irrigation meters for in-ground irrigation systems.

    - Implementation and schedule for an irrigation meter retrofit program for in-ground irrigation customers prior to July 1, 2009, or a feasibility analysis for such a program.

[3] *Principles of Water Rates, Fees, and Charges (M1 Manual)*, AWWA, 2000.

(1) Usage Block *Ccf*	(2) Number of Bills in Block	(3) Cumulative Bills Through Block	(4) Total Use of Bills Stopping in Block *Ccf*	(5) Cumulative Use of Bills Stopping in Block *Ccf*	(6) Total Use to This Block of All Bills Passing Through Block *Ccf*	(7) Cumulative Billed Usage *Ccf*	(8) Cumulative Billed Usage %
0	4,134	187,836	0	0	0	0	0
1	11,531	183,702	11,531	11,531	172,171	183,702	14.6
2	18,013	172,171	36,026	47,557	308,316	355,873	28.4
3	24,317	154,158	72,951	120,508	389,523	510,031	40.7
4	20,089	129,841	80,356	200,864	439,008	639,872	51.0
5	20,065	109,752	100,325	301,189	448,435	749,624	59.8
6	17,141	89,687	102,846	404,035	435,276	839,311	66.9
7	13,807	72,546	96,649	500,684	411,173	911,857	72.7
8	11,468	58,739	91,744	592,428	378,168	970,596	77.4
9	14,909	47,271	134,181	726,609	291,258	1,017,867	81.1
10	7,943	32,362	79,430	806,039	244,190	1,050,229	83.7
11–15	13,149	24,419	167,764	973,803	169,050	1,142,853	91.1
16–20	5,635	11,270	92,309	1,066,112	112,700	1,178,812	94.0
21–25	2,817	5,635	60,576	1,126,688	70,450	1,197,138	95.4
26–30	784	2,818	22,823	1,149,511	61,020	1,210,531	96.5
31–50	1,389	2,034	49,027	1,198,538	32,250	1,230,788	98.1
51–100	564	645	39,569	1,238,107	8,100	1,246,207	99.4
101–250	72	81	11,617	1,249,724	2,250	1,251,974	99.8
251 and over	9	9	4,584	1,254,308	0	1,254,308	100.0

Figure 1. Development of cumulative billed usage residential class-annual number of bills and usage – 5/8-in. meters.

Determination of Water Savings

The effect of conservation pricing implementation is specific to each water system. Elasticity studies have shown an average reduction in water use of between 1 percent and 3 percent for every 10 percent increase in the average monthly water and sewer bill. When implementing a conservation pricing structure, consideration should be given to the following factors:

- Average price is better than marginal price in explaining the quantity of water demanded by customers.
- Customers are typically unaware of their block rates.
- The water savings that accompanies a switch to a block rate may be lost in subsequent years if water rates are not increased to keep up with rising costs.
- Customers do not understand the link between water use and sewer billing. As such, customers do not tend to factor sewer prices into their water use decisions.
- Many studies and reports indicate price elasticities for the Southeastern United States of approximately -0.30, which translates into a reduction of 3 percent in water use for a 10 percent increase in price.

The water system should focus on a rate design that sends the appropriate price signal to customers to reduce discretionary water use. To remain effective, the rates need to be analyzed annually and adjusted periodically to account for rising costs and changes to the system's capital plan and operations.

Cost Effectiveness

The effectiveness of a water-conserving rate structure depends on how well it is designed and implemented. Each utility has a unique mix of single-family residential profiles and other customers and circumstances to consider. A cost effectiveness analysis can be done by comparing the cost of implementing this BMP to the anticipated water savings from adopting the conservation rate structure. The costs for implementing a rate structure change are associated with managing a stakeholder involvement process and costs for consultant services, if needed, and there may be one-time costs associated with developing and adopting ordinances and enforcement procedures. There may be significant costs associated with reprogramming the billing system if this step is necessary.

Other Considerations

While conservation pricing is a valuable tool to ensure the utility has adequate water for its customers, the utility must also ensure that the rates are adequate to provide for the day-to-day operations of the water system and the funds necessary for long-term system repairs and replacement.

The June 2012 Journal of AWWA, contained an article by H. Edwin Overcast entitled "*Is it time for water utilities to rethink pricing?*" In the article, Mr. Overcast discussed how utilities face declining per capita consumption as a result of conservation measures, unpredictable weather patterns, and implementation of increasing-block rate structures. Faced with generally declining use per customer, water utilities are confronted with the unfortunate fact that revenues may not be sufficient to cover the cost of operation, maintenance, and debt service needed to keep the system of reservoirs, treatment plants, pumps, pipes, valves, fire hydrants and meters running.

One solution that Mr. Overcast discusses is recovering fixed capital cost associated with local infrastructure (distribution system-related fixed cost) through fixed monthly charges and recovering traditional volumetric-related cost through volumetric charges. This option, called straight fixed-variable rate design has been adopted by other types of utility providers. Shifting customer cost from volumetric charge to fixed charge would likely require a phase-in period of a few years in order to mitigate the impact of such changes on the bills of the smaller-volume users.

For comments or questions regarding the Water Conservation Pricing BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9021.

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Case Study for Water Conservation Pricing

Orange Water and Sewer Authority (OWASA) Carrboro, North Carolina

Background

OWASA was established in 1977 to consolidate the water and sewer facilities and operations previously owned and operated by the University of North Carolina at Chapel Hill, and Carrboro in southeastern Orange County. OWASA is governed by a nine-member board of directors appointed by the two towns and Orange County. It now serves about 80,050 people through nearly 21,000 customer accounts.

OWASA is financially self-sustaining and funded primarily by customer revenues from monthly water and sewer charges and from one-time service availability fees (system buy-in charges) paid by new customers when they connect to the water, sewer and/or reclaimed water system. Revenues remaining after the payment of current operating expenses and debt service are used to pay for rehabilitation, replacement, improvement, and expansion of the utility systems. Unlike other local government utilities, OWASA's revenues cannot be used for non-utility related purposes.

OWASA does not receive any tax revenues, but it has received some limited state and federal grant funds to offset certain capital expenditures.

In 2001, OWASA completed a comprehensive water and sewer master plan which identified the need for water and wastewater system infrastructure capacity expansions to meet projected increases in local water and sewer service demands. At that time, the peak-day water demand ratio was about 165 percent, and the ratio of wastewater flow during the maximum month to the flow during the average month was about 140 percent.

In May 2002, OWASA implemented a seasonal water rate structure to replace the previous year-round uniform block rate structure. The utility put the seasonal water rate structure in place to reduce peak-day demands, defer the need for future capacity expansions, and promote greater conservation of the community's essential water resources. Coincidentally, the new seasonal rate structure was followed by the drought of record, which reduced the remaining supply in OWASA's Cane Creek Reservoir and University Lake to an all-time low of less than 32 percent of total storage.

The seasonal rate structure remained in place for all OWASA customers until May 2007, when OWASA implemented a five-tiered increasing block rate structure for individually-metered residential customers. Seasonal rates remained in place for all other customer classes. OWASA also adopted a new system of water rate surcharges under which water rates would increase as the severity of a declared drought increases. As occurred in 2002, implementation of these new conservation pricing policies was followed by an extreme drought.

As other utilities have experienced, OWASA's usage charge revenues declined as water sales dropped. OWASA offset a portion of the revenue reductions by deferring or eliminating certain operating, maintenance and capital expenditures. However, rate increases were required to pay for increasing expenses while ensuring financial stability in the face of reduced water sales. The increased rates sent an even stronger pricing signal to OWASA customers, and have likely further contributed to the substantial demand reductions across all customer classes. For a typical residential customer billed for 4,000 gallons of water and sewer service each month, OWASA's combined charges have increased from $34.12 a month in 2001 to $70.66 a month in 2012. That is a compounded rate of increase of about 6.25 percent a year.

OWASA's conservation rates, together with education and outreach efforts, implementation of a new reclaimed water system, and installation of water efficient fixtures by many OWASA customers, have resulted in a dramatic reduction in raw water pumping requirements and average-day use by OWASA's customers.

Since 2002, OWASA's customer base has increased by about 11 percent. However, average-day water sales declined by more than 25 percent during that same period, while the accounted for water ratio has remained constant. The average billed water use per metered connection (including both drinking water sales and reclaimed water sales) has declined from about 470 gallons per day in 2002 to about 350 gallons per day in 2011.

There have been similar reductions in the peak demands on OWASA's water and wastewater infrastructure. During the past five years, the average peaking ratios for the water plant and wastewater plant have declined to less than 145 percent and 120 percent, respectively.

This has enabled OWASA to revise its capital improvements plan to defer plans for expansions of its water and wastewater treatment plants. It has also reduced the amount of energy and chemicals needed to meet the community's water needs. The reductions in drinking water demands have helped reduce the community's risk to extended droughts.

All these benefits will be important as OWASA strives to meet local water and sewer service demands in a more sustainable manner.

For more details about OWASA's water conservation pricing, go to
http://www.owasa.org/client_resources/customerservice/owasa%20is%20well%20positioned%20for%20the%20future--%202011%20owasa%20customer%20letter.pdf.

Full-Cost Water Pricing

Background

Historically, many utilities have based their water rates on the operation and maintenance costs of water treatment only and have not been able or willing to include the cost of the replacement of the water treatment, storage and distribution systems. Those replacements will come in future years. While this method has resulted in lower water rates for the system's customers, historically, water rates have not acknowledged the full-cost of providing water service. Water systems, like all other man-made systems, have a useful life expectancy. Water system management must incorporate the cost of upgrading, maintaining and replacing this infrastructure into their water pricing.

Full-cost pricing is when the water system ("utility") charges customers for the actual cost of water service, including explicit recognition of the level of reinvestment needed on an on-going basis to refurbish, replace or upgrade existing assets. This will guarantee the utility the revenue needed to cover at a minimum the costs of operation, treatment, storage, distribution and for past and future investments. Full-cost pricing is a pricing structure for drinking water and wastewater service, which fully recovers the cost of providing that service. Full-cost pricing should be implemented in an economically efficient, environmentally sound and socially acceptable manner. Full-cost pricing should also promote efficient water use by customers.

Water systems must base their rates on the true costs of providing water in order to have the resources available for proper system maintenance and to pay for current capacity as well as future upgrades and replacements. Availability of state and federal funds to assist with this work are limited, therefore utilities must be prepared to fund these upgrades and replacements using their own resources. The sooner a system's water rates are based on full-cost pricing, the sooner the needed upgrades and replacements can be completed. With proper planning, the work can be completed prior to any major system failures. This planning should not only prevent system failure, but also prevents sudden, major rate increases in the future that would be needed to repair the failing systems.

Full-cost pricing:

- Is essential for sustainability and economic efficiency; accurate pricing encourages efficient production and use.
- Ensures rates are sufficient and that there is a stable source of funds and reserves.
- Ensures a water system's financial health, enabling the utility to provide safe water now and in the future.
- Provides better information to customers on the total costs of water service, and the true value of the product they are purchasing.
- Helps customers recognize the value of the service and be more aware of

their water use.

According to North Carolina's 2008 Drought Bill (Session Law 2008-143), Section 9-G.S.143-355.4(b)(1), water rate structures should be adequate to pay the cost of maintaining, repairing and operating the system. That includes reserves for payment of principal and interest on indebtedness incurred for maintenance or improvement of the water system during periods of normal use and periods of reduced water use due to water conservation measures. In addition, water rates should be sufficient to pay for future capital costs, whether up-front or through debt service of future loans.

Once the full-cost (the true cost of providing water) has been established, the next step must be to determine how this cost will be distributed to the system's customers. Often the cost of water has not been established at a level that encourages the efficient use of available water. In fact, in some cases the use of decreasing block rates have actually resulted in less incentives for water conservation.

Applicability

This BMP is intended for all water systems wishing to recover the full-cost of supplying water to their customers and to send price signals to customers that will encourage water conservation. A water system may have already accomplished this BMP if it currently has a price structure that recovers the true cost of supplying water.

Description

Full-cost pricing is the use of rate structures to provide for the financial security of a water system. Using this BMP, water systems should consider establishing rates based on the revenue requirements of the system based on specific consideration of the level of investment needed to maintain, refurbish, replace and upgrade the existing assets to preserve the long-term capacity and efficiency of those assets or the cost of adding the next unit of capacity to the system. An established cost of service methodology should be followed whenever rates are developed or proposed for change.

This BMP addresses pricing structures for retail customers. For water systems supplying water and sewer services, the principles contained in this BMP can be applied to the pricing of both services. Water systems that supply water, but not sewer service should make good faith efforts to work with sewer agencies so that sewer services are not provided using a pricing structure that conflicts with the objectives of the water pricing structure.

For full cost pricing structures to be effective, customers must be educated on the reasons for the system's rate structure. An explanation of the rate structure should be included with each customer's water bill.

Determining Full-Cost Pricing

Full-cost pricing for water utilities is based on the cost of maintaining, repairing and operating the system. This pricing includes reserves for payment of principal and interest on indebtedness for the maintenance or improvements, and future capital expenses such as expected debt service. Essentially, full-cost pricing is an effective way to achieve long-term sustainability, and if done correctly, can address equity concerns, provide increased financial flexibility and stability, can be more cost effective over the long term, and can provide better cost justification for tiered rate structures.

There are many ways to account for your system's costs. You should pick one that works well with your current accounting system and that supports the rates you plan to use. Any approach must fully account for all costs related to the provision of water. To estimate these costs, review records of the last year's expenditures and account for changes to operating costs and capital projects expected to be completed during the next five years to twenty years. All utilities should create a capital improvement plan that estimates future capital costs in each year for the next five years to twenty years, and incorporate it into full-cost pricing. A ten to twenty year capital planning horizon is good, but financial planning should take into account, but be limited to a five year forecast. Beyond five years, any rate or financial forecast is typically unreliable, at best.

Cost components are calculated annually, and can be categorized into three different areas: personnel costs, non-personnel costs, and capital reserves (debt service set-aside and reserves for future capital costs).

Personnel Costs:

- Salaries and wages for administrative and operations and maintenance personnel.
- Labor costs for services required in the operations of the system including:
    - Treatment
    - Monitoring
    - Maintenance
    - Testing
    - Meter reading and billing operations
    - Customer Service
    - Legal and Accounting
    - Engineering, if applicable
    - Management
    - Benefits for personnel including:
        - Medical Insurance
        - Retirement
        - Vacation
        - Bonuses

Non-personnel Costs:

- Cost for office operations including:
    - Space rentals
    - Mortgages
    - Office supplies
    - Computer and lab equipment
    - Contracts
    - Cost for utilities including:
        - Electricity
        - Natural Gas
        - Communications
        - Water purchased from other systems

When estimating future utility costs and revenues, you will likely need to forecast the total annual water use. Examine your billing data to determine the total annual sales as well as your records for water withdrawals each year to predict future demand.

- Other direct costs to operate the system including:
    - Chemicals
    - Leased equipment
    - Routine maintenance and repair costs at facility sites, and for equipment and vehicles
    - Insurance costs covering buildings, vehicles, and personnel.
    - Costs for professional services such as accounting, legal and engineering if not done in-house
    - Permitting costs
    - Costs for career development and certification renewals for personnel.
    - Costs for residuals disposal
    - Costs for security and surveillance

- Indirect costs to operate the system including:
    - Transfers to the City or County for financial, personnel or other services provided

Capital Reserves and Debt Service Payments:

Sufficient revenue must be allocated to make principal and interest payments on current and future indebtedness, and for capital expenses that will be paid in cash. Debt service excludes mortgages, but covers investments for capital projects needed to maintain the safe operation of your system. The timing of investing in system assets is an integral component to determining sufficient reserves, and should be addressed in your Capital Improvement Plan. Projects for which capital reserves and debt service set-asides should be allocated can include:

- Rehabilitation and replacement of existing assets, including pipes, pumps, control systems, tanks, etc.
- Expansions and upgrades of the treatment and distribution systems.
- Interconnections to other systems.
- Source water development and protection.
- Any other interest owed by the system.

Managing system assets should be addressed in your Asset Management Plan. Asset management can be a lengthy process. It involves following five steps that will help you determine how much money should be placed in a reserve fund each year. Asset management is a part of your Capital Improvement Plan. The five steps are to:

- Develop an inventory of all of your assets by listing them and collecting information on the condition, age, service history and useful life of each one.
- Prioritize your assets to help you decide how best to allocate your limited resources. Priority should be based on the asset's importance ("criticality") to the operation of your system and the protection of public health. Other factors to consider include how soon you will have to replace the asset and whether other pieces of equipment can perform the same function (redundancy).
- Determine the costs of asset rehabilitation and replacement, which should include an analysis of both capital cost and life cycle cost.
- Decide what percentage of these costs you will cover with cash (i.e., money you set aside in the reserve account), and how much you will cover through debt. In some cases, it may make more financial sense to borrow money to cover the initial cost of the project and pay those costs over a longer period of time, even with interest payments.
- Review and revise your plan. Your Asset Management Plan should be used to help you shape your Capital Improvement Plan. It should evolve as you gain more information and as your system's assets and utility's priorities change.

Following this process will help you determine how much money must be generated through water rates to fulfill your capital improvement plan.

Determine the costs associated with operating, maintaining, rehabilitating, replacement, upgrading, expanding and repairing your system. Then, tally those costs to determine the full-cost pricing of water. These full cost data should be reviewed annually and adjustments made to future budgets as appropriate.

<u>Determining Revenue Requirements</u>:

After determining your costs, you will need to calculate how much revenue you collect each year to offset these costs. Revenue sources can include:

- Water sales
- Fees and service charges
- Tap or connection charges

- Interest
- Grants
- Transfer payments from other funds (this practice is not recommended for any public enterprise fund)
- Private investments
- Other sources

Now that you have a better sense of your costs, revenues and reserves, you are ready to determine how much revenue will be needed from customers each year to cover any shortfalls. To cover the full cost of doing business (i.e., to meet the goals of full-cost pricing), the amount of revenue that you receive from your customers should equal your total annual costs including your annual debt service payments minus any subsidies or transfer payments you receive.

Required Customer Revenue = (Total Annual Costs) – (Subsidies) – (Transfer Payments) – (Other Revenues)

You will need to calculate your required revenue annually, taking into account your budget for the upcoming year. In addition, you will need to think beyond your needs for the next year. Variable costs, changes in subsidies, debt service costs, and other factors can affect your required revenue from year to year. Estimating costs for the next several years based on your fixed costs, operating expenses, asset rehabilitation and repair needs, and existing debt service can help avoid a significant gap between future revenue and costs. Once you have a better idea of actual costs, you can revise your estimates accordingly.

Now that you know your costs and the amount of money you need to collect from your customers to fully cover those costs, you are ready to start thinking about how you are going to collect this money. One way is through setting appropriate rates for water used by your customers that will account for your full cost.

Implementation

Full-cost pricing is best introduced over time and in multiple steps. Some of these steps include:

- Evaluating all the costs associated with the utility and incorporating adequate accounting programs.
- Implementing reporting procedures.
- Monitoring and documenting usage patterns for various sectors of users.
- Educating consumers on the value the utility provides.
- Planning for reserves necessary to fund the maintenance and upgrades required.
- Planning for the future and forecasting revenue requirements.
- Determining the actual cost of service.

- Implementing an Asset Management Plan.
- Evaluating and optimizing all aspects of the system (treatment, operations, metering, billing, distribution, debt instruments, etc.).

A rate structure that allows the utility to be self-sustaining is a balanced approach to utility management. Given the constraints discussed above, the structure of cost-based rates will vary by community. In the long run, full-cost pricing is imperative for every utility.

Successful adoption of a new rate structure may necessitate developing and implementing a public involvement process in order to educate the community about the new rate structure. The new rate structure should adhere to all applicable regulatory procedures and constraints. If the conservation pricing structure to be implemented is substantially different from current practices, then a phased-in approach may be appropriate.

Public involvement in the development and implementation of rates can help assure that the goals of the full-cost pricing initiatives will be met and accepted by local constituents. Public meetings, advisory groups and public announcements are among ways to generate public involvement.

Schedule

Water systems pursuing this BMP should begin implementing it at the earliest possible date. Although the implementation of full-cost pricing will likely have a significant impact on a system's water rates, phasing in this change can avoid more severe impacts on the system's customers. Improper planning will result in system failures and the inability to provide an adequate and safe water supply. When this happens, utilities may be forced to implement water rates that far exceed those that could have been implemented earlier with sufficient planning.

The implementation of full-cost pricing will take a major commitment by the system's management and its customers. The easy path is to continue to ignore the problem and leave the pending system failures and resulting major rate increases for others.

The key to full-cost pricing is to explain the need for the proposed rate structure and the consequences of inaction. The educational process starts with the system's management and staff and then quickly moves on to the system's customers.

Scope

To accomplish this BMP, the water system must determine the full cost for the operation of the system and set water rates at a level to help meet these current and future needs. Management must also maintain these funds for their intended purposes and not divert them for other needs.

Documentation

To track this BMP, the water system should maintain the following documentation:

- A copy of its legally adopted rate ordinance or rate tariff that follows the guidelines of this BMP.
- Billing and customer records that include annual revenues by customer class and revenue derived from commodity charges and fixed charges by customer class for the reporting period.
- A copy of the education materials on full-cost pricing sent to customers for each calendar year this BMP is in effect.
- An account of all system costs.
- An Asset Management Plan, last updated within the past two or three years.
- A Capital Improvement Plan, last updated within the past two or three years.
- A water system bill meeting the parameters and schedule in the Schedule Section.

Other Considerations

While Full-Cost Water Pricing is a valuable tool to help ensure that the utility will have adequate water available for all its customers, the utility must also ensure the rates are adequate to cover the day-to-day operation of the water system and the system's long-term system repairs or replacement.

The June 2012 Journal of the AWWA, contained an article by H. Edwin Overcast titled "Is it time for water utilities to rethink pricing?" In the article, Overcast discussed how utilities face declining per capita consumption as a result of conservation measures, unpredictable weather patterns, and implementation of increasing-block rate structures. Faced with generally declining use per customer, water utilities are confronted with the unfortunate fact that revenues may not be sufficient to cover the costs of operation, maintenance and debt service needed to keep the system of reservoirs, treatment plants, pumps, pipes, valves, fire hydrants and meters running.

One solution Overcast discusses is recovering fixed capital cost associated with local infrastructure (distribution system-related fixed cost) through fixed monthly charges and recovering traditional volumetric-related costs through volumetric charges. This option, called straight fixed-variable rate design has been adopted by other types of utility providers. Shifting customer costs from volumetric charges to fixed charges would likely need to be phased in over several years in order to mitigate the impact of such changes on the bills of the smaller-volume users.

For comments or questions regarding the full-cost pricing BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9021.

References

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- Setting Small Drinking Water Systems Rates for a Sustainable Future, EPA Office of Water, January 2006. http://www.epa.gov/ogwdw/smallsystems/pdfs/guide_smallsystems_final_ratesetting_guide.pdf.
- Water Price Elasticities for Single-Family Homes in Texas, Texas Water Development Board, August 1999. http://www.twdb.state.tx.us/rwpg/rpgm_rpts/96483189.pdf
- Designing, Evaluating, and Implementing Conservation Rate Structures, California Urban Water Conservation Council, July 1997.
- Effectiveness of Residential Water Price and Nonprice Programs, AWWARF, 1998. http://www.waterrf.org/ProjectsReports/ExecutiveSummaryLibrary/90747_737A_profile.pdf
- Is it time for water utilities to rethink pricing?, Journal AWWA, June 2012

- SWIC-Recommended Guidance for North Carolina Utilities Attempting to Support Water Conservation in the Long-Term through Rate Structure Design and Billing Practices, http://www.ncwater.org/Water_Supply_Planning/Water_Conservation/SWIC_11-22-10.pdf, November 2010.
- Town of Cary Elasticity Analysis, prepared by Keith Bishton and Dave Green- ftp://199.72.17.76/Engineering/IntWatResMP/Appendices/Appendix_C_Price%20Elasticity%20TM_05042007.pdf.

Water Purchasing Contracts

Applicability

This BMP is intended for all water systems ("utility") that purchase or sell water. A utility may have already accomplished this BMP if it has a written contract to purchase or sell water.

Description

In order for many water systems ("utilities") to meet the water supply needs of their customers, they must contract with other utilities to supply the needed water. When these contracts are developed and formalized, it is important that the seller and the buyer have a complete understanding of the requirements and expectations of the contract.

Some of the obvious contract requirements that should be documented are the volume of water committed for sale or purchase, how the cost of the water will be determined, the length of the contract, if the contract is renewable and if the water will be used on a regular or emergency basis. The contract should also indicate if the buying system is required to comply with all of the selling system's water use restrictions when implemented. Open contracts in which a utility verbally agrees to sell water to another utility should be avoided. It is important for both utilities to maintain contractually agreed upon water volumes to facilitate good planning practices. Utilities that list contract water volumes on their local water supply plans will also facilitate a quicker review and approval of their plan.

Another important part of the contract is the conditions that will be placed on the buyer concerning efforts to implement BMPs for water conservation.

In accordance with Session Law 2011-374, all local water supply plans must include a plan for the reduction of long-term per capita demand on potable water. Since the utility selling the water must implement BMPs to meet this requirement, it would be appropriate for the sales contract to require the buying utility to also implement BMPs to reduce potable water demand. The implementation of BMPs will help reduce the amount of water used and reduce the cost of the water to the utility.

Some of the BMPs that should be considered for inclusion in the contract are requirements for:

- Water Audits
- Water Loss Abatement
- Metering
- Retrofitting of Residential Fixtures
- Public Information Program
- School Education and Outreach
- Retrofitting Irrigation Systems

- Regionally Approved Landscaping
- Rainwater Harvesting, Condensate Reuse and Gray Water Use

Implementation

Utilities pursuing this BMP should begin implementing it according to the following procedure:

- Review all the wholesale water purchases and sales contracts.
- Use the sample contract enclosed (sample contracts may also be obtained from North Carolina League of Municipality) to negotiate with the purchaser or seller on price and volume.
- Decide which water efficiency practices will be asked of the purchasing entity.

Schedule

To accomplish this BMP, the utility should do the following:

- The utility should develop procedures for implementation of this BMP in the first six months. The procedures should include an annual, or at least a five year review, of all information related to the established contract.
- The contract participants should develop procedures for making changes to and maintain a proactive review of the contract.

Scope

To accomplish this BMP, the utility should adopt a contract within six months after implementation, and maintain a copy of the contract at the town or city hall and water treatment plant. The town or city manager, as well as the water system manager/Operator in Responsible Charge (ORC) should be well-versed with the terms of the contract.

Documentation

To track this BMP, the utility should maintain the following documentation:

- A copy of its legally adopted contract should be held at town or city hall, as well as at the water treatment plant.
- A review should be made at regular intervals (annually, or at least every five years) of the contract and its applicability.
- A copy of any changes or modification to the contract should be officially amended by adoption.

Determination of Water Savings

Water savings can be tracked through performance of annual water audits and implementation of other BMPs to conserve water. Water savings for the selling and buying utility should be realized as a result of contract conditions requiring the implementation of BMPs.

Cost Effectiveness

The cost effectiveness of implementing this BMP can in part be determined based on the effectiveness of BMPs enacted by the buying utility. Although a true cost-effectiveness analysis cannot be determined without a measure of water savings prior to establishing a contract, the point at which this BMP is implemented can serve as the benchmark year, and successive years that reveal a reduction in water used can be used to calculate cost savings by the selling and buying utility. This BMP is an integral part of a best management practice program, and should be considered fundamental to a successful water efficiency program. In addition, by implementing this BMP, the selling utility can assure the needed water supply to the buying utility.

For comments or questions regarding the Water Purchasing Contracts BMP, please contact the water resources specialist of the Water Supply Planning Branch at 919-707-9035.

Additional Inter-local Water Agreement Tips

The UNC Environmental Finance Center has developed guidelines for the crafting of inter-local agreements. These guidelines provide extensive information on items to consider when drafting water supply contracts. Those items can include service area and annexation, which party is responsible for maintaining the meter, water quality issues, water pressure requirements, how and when water rates will change, re-selling water to other systems, nonrevenue water, and inflow & infiltration (I&I). These guidelines can be found at:
http://www.efc.unc.edu/publications/2009/water_partnership_tips.pdf.

Purchase Water Contract Sample

State of North Carolina
County of _____

WATER SERVICE UTILITY AGREEMENT

THIS AGREEMENT, made and entered into this ____ day of _____, 20__ by and between the _____, a North Carolina (Authority, City, County, Private Entity, Sanitary Districts, Town, etc.), hereinafter referred to as "PROVIDER and the _____, a (Authority, City, County, Private Entity, Sanitary Districts, Town, etc.), hereinafter referred to as "CUSTOMER";

WHEREAS, the CUSTOMER wishes to procure a source of treated drinking water suitable for re-sale to it citizens, residents and industries; and

WHEREAS, the PROVIDER has treated drinking water available for sale to CUSTOMER; now, therefore;

WITNESSETH:

That in consideration of, and subject to, the terms and conditions hereinafter set forth, the parties covenant and agree as follows:

1. Purpose. The purpose of this Agreement is to set forth the terms and conditions by which CUSTOMER shall purchase, and PROVIDER shall sell, treated drinking water for re-sale by CUSTOMER to its constituent citizens, residents and industries.

2. Purchase and Sale. CUSTOMER agrees to buy from PROVIDER and PROVIDER agrees to sell and deliver to CUSTOMER water on the terms and conditions hereinafter set forth. The water being sold by PROVIDER shall at all times meet the standards for safe drinking water as promulgated at 40 CFR, sections 140 through 143, pursuant to the terms of the Safe Drinking Water Act at 42 USCA, all as amended from time to time, which standards have been adopted by the State of North Carolina Department of Environment and Natural Resources, under which standards PROVIDER produces water at its water treatment plant.

3. Term. This Agreement shall be effective from and after, _____ and shall continue and remain in full force and effect until and including _____ (__ years). Either party hereto may, at any time prior to the beginning of the year before the expiration of this Agreement, give notice to the other of its desire to renew this Agreement and upon the giving of such notice, the parties hereto shall negotiate in good faith with reference to a renewal of this Agreement.

4. Construction of Water Line Appurtenances. Following permit approval by the Public Water Supply Section of the North Carolina Division of Water Resources; the CUSTOMER at its own expense shall connect its water system to that of the PROVIDER in accordance with permitting and sound engineering practices as mutually agreed upon by both parties regarding pumping capacity, size and type of materials, workmanship and location. The water line, pumps (if required) and connections shall be referred to hereinafter as "The Pipeline". The metering point(s) shall be mutually agreed upon by both parties and installed by CUSTOMER at its own expense per PROVIDER specifications and permit approval.
5. Ownership and Maintenance. The CUSTOMER will own and maintain the Pipeline up to the metering point(s). The metering point(s) will be owned and maintained by the PROVIDER. The CUSTOMER will be responsible for the cost of meter replacement when necessary.

6. Maximum Usage Limit. The CUSTOMER shall have the privilege to receive water from the PROVIDER water system with a maximum daily consumption not to exceed _____ gallons per day.

7. Treated Water Charge. The purchase rate for treated water from PROVIDER to CUSTOMER will be $_____ per thousand gallons.

8. Invoicing. Bills for water supplied hereunder shall be rendered and paid monthly.

9. Water Related Restrictions. CUSTOMER shall be subject to PROVIDER's water conservation/restrictions policies in effect at the time of execution of this Agreement and as they may be amended. Accordingly, CUSTOMER's water supply may be preempted in the same manner and fashion as all other water users of PROVIDER.

10. Long-term Per Capita Reduction.
In accordance with Session Law 2011-374, all local water supply plans must include a plan for the reduction of long-term per capita demand on potable water. Since the PROVIDER must implement Best Management Practices (BMPs) to meet this requirement, it is required for the CUSTOMER to also implement BMPs to reduce potable water demand. The PROVIDER will supply a list of BMPs they have implemented to the CUSTOMER as measures to implement or the Customer must demonstrate to the Provider that comparable BMPs have been previously implemented or will be implemented on an established schedule.

11. Interruption of Service. Whenever practicable, PROVIDER will notify CUSTOMER with at least twenty-four (24) hours notice prior to any interruption of service necessary due to planned maintenance, repairs or other foreseeable extent of interruption. When interruptions of service are due to emergency situations, which cannot be foreseen, the affected party will be notified as soon as possible as to the estimated duration and extent of the interruption.

12. Amendment or Termination. This Agreement may be amended or terminated only by an instrument in writing executed by both parties hereto.

IN WITNESS WHEREOF, the undersigned municipal corporations have caused this Agreement to be executed on their behalf by individuals duly authorized, all as of the day and year first above written.

PROVIDER_____

_____
Mayor or Manager of PROVIDER

ATTEST:

_____
PROVIDER Clerk

PROVIDER_____

_____
Mayor or Manager PROVIDER

ATTEST:

_____
PROVIDER Clerk
STATE OF NORTH CAROLINA
COUNTY OF _____

I, _____, a Notary Public of the aforesaid County and State, so hereby certify that _____, personally appeared before me this day and acknowledged that (s)he is the (Deputy) PROVIDER Clerk of the PROVIDER of _____ and that by authority duly given and as the act of the PROVIDER, the foregoing instrument was signed in its name by its _____, sealed with its corporate seal and attested by (him or her) as its (Deputy) PROVIDER Clerk.

WITNESS my hand and Notarial Seal, this the ____ day of _____ 20__.

_____
Notary Public

My Commission Expires: _____

STATE OF NORTH CAROLINA
COUTNY OF _____

I, _____, a Notary Public of the aforesaid County and State, so hereby certify that _____, personally appeared before me this day and acknowledged that (s)he is the (Deputy) PROVIDER Clerk of the PROVIDER_____ and that by authority duly given and as the act of the municipal corporation, the foregoing instrument was signed in its name by its _____, sealed with its corporate seal and attested by (him or her) as its (Deputy) PROVIDER Clerk.

WITNESS my hand and Notarial Seal, this the ____ day of _____ 20__.

_____
Notary Public

My Commission Expires: _____