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Water Conservation Techniques

For

Small and Medium Water Systems

Florida Rural Water Association

November 2007

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Introduction

Water Conservation in Florida

Small Florida water utilities are presented with unique challenges with expanding customers and with dry weather conditions that place stress on existing water supplies. Implementing water conservation measures can be extremely effective in assisting small communities in saving water and meeting these water shortage challenges.

The State of Florida's Water Conservation Initiative includes the following principals:

- Water conservation measures that result in permanent and cost-effective improvements in water use efficiency
- The focus of water conservation should be on the programs that lead to the largest conservation benefits in the shortest period of time
- Water conservation measures should be measured to ensure efficient use of resources.
- Water should be appropriately priced to provide conservation signals to consumers
- Expanded water conservation programs and cost sharing subsidies may be unrealistic in situations where there are budgetary constraints.
- Water conservation must be practices by all users, that is the supplier and the consumer of water

Implementing Water Conservation Measures in Conformance with Guiding Principals

Operational water conservation measures can be implemented quickly on the supply (utility) side and measurement systems that use water meters can easily be applied to ensure effectiveness. Likewise supply side improvements in billing practices and water accounting can be implemented quickly in administrative areas with proven results.

The development of pricing signals requires community involvement. Changes in the pricing of water can be a significant cost to the various users and can lead to complaints. When pricing signals are targeted at irrigation reductions, these can lead in significant decreases in planned revenue to the utility. These types of programs must be undertaken with community involvement and support of the various stakeholders.

Many demand side (customer) water conservation measures have extremely long time frames to be successfully implement and the pay-back periods can be marginal over the long-term. Demand side conservation measures must also be evaluated to ensure their effectiveness. Additionally, small communities typically do not have the financial resources or the customer base available to them that allows them to finance and implement comprehensive demand side water conservation programs such as toilet change-outs or subsidies for low volume appliances. Demand side conservation is typically most successful as part of a comprehensive conservation program where an assigned conservation coordinator can suggest and guide conservation programs. This being said, public water conservation education is inexpensive and results in conservation awareness and public goodwill. Providing water conservation information to water customers is a highly recommended practice which sets the stage for more comprehensive future water conservation programs.

The conservation approach suggested by Florida Rural Water Association take into account these issues and recommend planning and implementation of conservation strategies in a three tiered approach beginning with those that have been shown to be immediately effective for small communities. Additionally, Florida Rural Water Association can assist small communities operationally with the use of its specialized meter calibration and leak detection equipment that provides needed administrative information for conservation analysis and planning.

Florida Rural Water Association can also assist small utilities in the financial analysis portion of water conservation and assist the utility in identifying inefficient water practices and ineffective rate structures. Florida Rural Water Association assistance can lead to substantial water savings to the utility at no cost.

Benefits to Small Utilities Resulting from Effective Water Conservation Practices

Unaccounted for water loss can be very expensive to a small utility systems. Table 1 below, illustrates the monthly cost to a small water utility for water loss at an average cost of $2 per 1000 gallons, a fairly common charge for water use, over a range of observed unaccounted-for-water loss scenarios:

Table 1

Lost Revenue from Unaccounted-for-Water Loss
Typically Found in Florida Rural Water Association Surveys

	Monthly Water Production (gallons per day)		
Unaccounted For Water %	100,000	500,000	1 Million
10%	$600	$3,000	$6,000
15%	$900	$4,500	$9,000
20%	$1,200	$6,000	$12,000
25%	$1,500	$7,500	$15,000
30%	$1,800	$9,000	$18,000

Since many small water utilities also provide wastewater service, the revenue loss to a small utility can be significantly compounded by faulty water meters that are used to estimate wastewater charges. Table 2 below, illustrates the monthly cost to a small water utility for an unaccounted-for-water loss at an average meter charge of $2 per 1000 gallons for water use and $2.50 per 1,000 gallons for wastewater use, over a range of observed unaccounted-for-water loss scenarios:

Table 2

Lost Revenue from Unaccounted-for-Water Loss
For Faulty Meters where Utility also Provides Wastewater Service
Typically Found in Florida Rural Water Association Surveys

	Monthly Water Production (gallons per day)		
Unaccounted For Water %	100,000	500,000	1 Million
10%	$1,350	$6,750	$13,500
15%	$2,025	$10,125	$20,250
20%	$2,700	$13,500	$27,000
25%	$3,375	$16,875	$33,750
30%	$4,050	$20,250	$40,500

<u>Water conservation is not just a process targeted at reducing the amount of wasted water; it is also a program that can significantly affect a water system's physical capacity and financial health.</u> Water losses can be immediately converted into more revenue to the utility, but even more importantly, the cost in added water capacity necessary to obtain, treat, transport and distribute the water can dwarf the revenue losses that are illustrated above. For example, many Florida waters require expensive treatment processes for small systems that can easily cost up to $5 million just to dispose of the waste products produced in the treatment processes. These expenses can be deferred indefinitely with a good unaccounted-for-water management program.

Setting Water Conservation Goals

Florida Rural Water Association assistance to small water systems begins with the setting of basic water conservation goals. Goals are set in working with water systems in identifying the expected benefits that the water system can achieve.

Planning goals are designed by collaborative discussions with utility leaders and elected officials and are developed based on the administration, operation, maintenance and condition of the water system. Planning goals often include eliminating, downsizing, or postponing the need for capital projects; extending the life of existing facilities; avoiding new source water development costs; improving drought or emergency preparedness; and protecting and preserving environmental resources. These goals are achieved by an inspection of water system facilities and records and collection of information obtained from key utility staff. Information can be collected efficiently by using the FRWA Water Conservation checklists that can be completed by the utility's water system staff.

Metrics or measures are set in the planning process to judge success. Generally the metrics are targeted at improving unaccounted-for-water efficiencies and/or reducing average per capita water use.

Water Use Efficiency Measures for Utility Operation

The American Water Works Association (AWWA) has determined that unaccounted for water loss in water supply systems of 10–12 percent is acceptable. Unfortunately unaccounted for water of up to 30 percent in water systems lacking water loss programs to identify leaks, use inaccurate or broken meters, allow unmetered water use, have no tampering and theft detection or deterrent policies and/or use ineffective billing practices. In these water systems use of supply side water conservation measures are effective.

Per Capita Water Use in Florida

Water use by the public sector was described in a paper published in 1992 by Richard Marella of USGS for the Florida Department of Environmental Regulation, titled. "*Factors that Affect Public-Supply Water Use in Florida, with a Section on Projected Water Use to the Year 2020.*" The table below identifies the per capita public water use by county in Florida. The average water use was determined to be 178 gallons per capita per day and the average residential-only water use was determined to be 123 gallons per capita per day. It is generally accepted that a residential per capita water use of below 120 gallons per capita per day represents a water system where adequate water conservation practices are in place. Water systems with a per capita use of under 100 gallons per capita per day generally have mature and comprehensive conservation practices in place.

Comparison Between Supply-Side and Demand-Side Management Examples of Water Conservation Measures

Goal $\geq$ 90% Water Efficiency	Goal $\leq$ 120 gal./capita/day
Supply Side Management Metering Meter Efficiency Testing Leak Detection Water Auditing	Demand Side Management Low Volume Shower Heads Faucet Aerators Low Volume Toilets Irrigation Controls

The Table below shows the per capita use of water in all counties in Florida recorded in 1987 in the above-mentioned study. More current studies have shown per-capita-water-consumption to be steadily rising, residential dwellings becoming larger and irrigation becoming more prevalent.

Table 3

Public Water Use by Population
For 1987 Florida in gallons per capita per day

Alachua	161		Hamilton	155		Okaloosa	158
Baker	146		Hardee	151		Okeechobee	131
Bay	233		Hedry	176		Orange	198
Bradford	172		Hernando	135		Osceola	138
Bravard	149		Highlands	155		Palm Beach	222
Broward	180		Hillsborough	150		Pasco	109
Calhoun	149		Holmes	197		Pinellas	140
Charlotte	110		Inian River	243		Polk	192
Citrus	162		Jackson	157		Putnam	157
Clay	142		Jefferson	214		St. Johns	130
Collier	299		Lafayette	171		St. Lucie	151
Columbia	189		Lake	193		Santa Rosa	142
Dade	203		Lee	143		Sarasota	152
De Soto	102		Leon	167		Seminole	176
Dixie	154		Levy	170		Sumter	116
Duvall	168		Liberty	154		Suwanee	153
Escambia	158		Madison	213		Taylor	151
Flagler	146		Manatee	138		Union	153
Franklin	198		Marion	160		Volusia	138
Gadsen	146		Martin	195		Wakulla	110
Gilchrist	272		Monroe	179		Walton	127
Glades	115		Nassua	171		Washington	150
Gulf	160						

Per-Capita-Water-Consumption measures like these, are used to quantify the benefits of demand-side (customer use) water conservation improvements. When using these kinds of measures it is important to consider the climatic influences that modify customer water use behavior. For example, in wet years irrigation use will be lower than in drought years. Thus when using these types of measures, statistics can be misleading and climatic influences considered in making before and after comparison.

In general, newer homes tend to be larger, have more plumbing fixtures, irrigate landscape plants and turf areas, and often use automated in-ground irrigation systems that can create unusually high peak water demands. Larger homes are typically owned by customers with relatively higher disposable incomes than the average customer and thus larger newer units are inclined to show more water use. Conservation improvements are typically more effective when targeted at newer larger homes and leak detection improvements more effective when targeted at smaller older housing units.

Demand-side conservation measures are extremely effective when they are considered in the planning stages of a new residential development and are significantly less expensive than later retrofits.

Water Conservation for Small Utilities

The Four Categories of Water Conservation Measures

Florida Rural Water Association has organized some of the more common water conservation measures that have been demonstrated to be effective for small water system into three parts. These categories consist of: Basic Water Conservation, Intermediate Water Conservation, and Advanced Water Conservation measures, and General Water Conservation Procedures that can be implemented in phases by a small water utility as part of a long-term water conservation plan.

The **Basic Water Conservation Measures** are those measures that can be immediately implemented by small water systems and are most likely to result in immediate and measurable water conservation measures. These measures include basic water audits and leak detection analysis. Water audits and leak analysis are generally performed by Florida Rural Water Association by referral from the water management districts when small utility systems apply for additional source groundwater use. Identifying effective basic conservation measures is an area where Florida Rural Water Association can best assist the small utility in quickly achieving higher levels of water savings, efficiency and water conservation. These measures generally consist of implementing supply side improvements.

The **Intermediate Water Conservation Measures** are water conservation techniques that should be implemented over a longer period and can provide significant additional water savings. These measures require community support and evaluation of impacts that they may have on existing water system users by the modification of existing water rates. When water conservation measures are successful in this category, water revenue can drop leading to revenue shortfalls. Florida Rural Water Association can assist the utility in identifying water rates that meet revenue requirements but minimize the impacts of the potential for decreases in revenue. These issues should always be addressed in the planning stages. Intermediate conservation measures generally consist of changes in administrative practices and changes in rate structures that encourage customer behavior changes in how water is used.

The **Advanced Conservation Measures** are those strategies that have been shown to be effective over the long-term and are part of a community-supported program that involves participation by customers at all levels. These types of water conservation measures do not show gains immediately and thus are typically not immediate focus in an effective conservation plan for a small utility. These measures are generally part of an overall long-term strategy that includes dedicated utility staff and measurement systems and subsidies that encourages direct customer assistance in demand side water reduction.

General Water Conservation Procedures consist of providing information to customers for the purpose of increasing conservation awareness. These are inexpensive techniques that are available to a small utility to increase customer support. They do not generally result in any significant or measurable water conservation gains. These procedures can be implemented at any stage in a conservation program.

Basic Water Conservation Measures

Basic water conservation measures are operational and result in immediate water conservation savings to smaller communities. Florida Rural Water Association recommends that all water systems, including those serving 10,000 or fewer people consider implementing the following basic guidelines:

- Universal Metering for all Customers
- Implementing a Meter Evaluation and Meter Replacement Program
- Performing a Water System Audit on Classes of Water Customers
- Initiating a Water Leak Detection Program
- Initiating a Water Loss Control and Meter Tampering Program

Intermediate Water Conservation Measures

Intermediate water conservation measures are administrative and are part of a longer-term strategy to reduce water use by implementation of both incentives and disincentives water pricing to affect change in customer water use behavior patterns. Florida Rural Water Association recommends that all water systems that have implemented basic water conservation measures or have mature, on-going water conservation programs in-place, consider implementing the following supplemental intermediate water conservation measures:

- Water Conservation Training and Planning for Administrators and City Officials
- Water Conservation Training for all Water Employees
- Performing a Simplified Comparative Costing and Pricing Analysis for Current and Future Customers
- Implementing an Irrigation Pricing Supplement to Current Rates as appropriate
- Instituting a Water Conservation Education Program for Customers
- Performing water-use audits on large water users
- Educating key staff in water conservation measures
- Educating Customers in retrofits such as toilets and shower heads
- Educating Customers in landscape efficiency, drip irrigation and xeriscaping

Advanced Water Conservation Measures

Advanced water conservation measures are typically part of a very mature water conservation program where dedicated staff is available to assist customers in making choices that aid water conservation programs. These programs are part of a longer-term strategy to reduce water use direct assistance to customers through education and training of vendors, development of water use regulations and financial incentives. Florida Rural Water Association recommends that type of programs have community support, are well staffed and funded and implemented as part of a mature, on-going and in-place water conservation program.

- Dedicated conservation staff person and written conservation program
- Financing of replacements of inefficient plumbing fixtures
- Adoption of the use of mandatory reclaimed water use for new developments
- Partnering with utilities that currently have reclaimed water programs
- Implementing permanent seasonal and time of use water regulations
- Licensing of landscape contractors to prohibit inefficient system designs and wasteful irrigation practices
- Integration of efficient construction practices into building codes and support of training in these areas for key staff
- Prohibiting Inefficient landscape or irrigation practices
- Integrated water resource management such as capture of surface water and use of surficial aquifers
- Management Auditing of Conservation Program on a Yearly Basis

General Water Conservation Procedures

General water conservation measures consist of providing information to customers through various media outlets in through partnerships with public and private concerns. T

These procedures can be used at any phase in the conservation process and generally are not accompanied by any type of measure to ensure effectiveness. They are generally used to increase conservation awareness within the entire community. These procedures consist of:

- Best Management Conservation Practices for Customers
- Public Education
- Programs to Increase Community Conservation Awareness
- Community Conservation Partnerships
- Permanent Water Use Restrictions

Basic Water Conservation Measures

Universal Metering for All Customers

Source and service metering are key to a successful water use efficiency program. Source and service meters provide the data necessary for determining leakage, assist in managing an important resource, and enhance planning activities. The installation of meters, coupled with other conservation measures, allow water systems to increase efficiency and/or expand connections without developing new sources or storage facilities.

- Meters are the foundation for a rate structure that can provide for funding of capital improvements, including the meters themselves.
- Metering helps systems identify high-use customers and take steps to lessen their impact on the system.
- The identification of unaccounted-for water losses is made easier with meters, and allows systems to recover capacity through leak identification and repair.

Checklist for Universal Metering:

- ❑ Source-water metering**.** All wells and water sources used by the utility are metered.

- ❑ Service-connection metering**.** All customer service-connections to the water supply system are metered. These include all utility facilities.

- ❑ Public-use and construction-use water metering. All water provided free of charge for public use such as for flushing, fire protection, street cleaning, construction, etc. is metered and read at regular intervals.

- ❑ Public-use and construction water use locations are identified. Water provided for these purposes if not metered should be identified and the water use estimated.

- ❑ Water meters are read at fixed intervals. This should be monthly for large commercial accounts and at least quarterly for residential accounts

- ❑ Water meter consumption for larger commercial customers is trended monthly.

- ❑ Water meter credits that are issued are approved by the operational supervisor responsible for meter reads.

Implementing a Meter Evaluation and Meter Replacement Program

Water meters can be damaged and deteriorate with age, thus producing inaccurate readings. Inaccurate readings will give misleading information regarding water usage, make leak detection difficult, and result in lost revenue for the system. All meters, especially older meters, should be tested for accuracy on a regular basis. Typically, water meter repair and replacement is the single most cost-effective action a utility can take to reduce the volume of unaccounted-for water.

> AWWA recommends that meters in service be tested or replaced, on average, as follows:
>
> Meter sizes 5/8 in. to 1 in = Every 10 years
> Meter sizes 1 in. to 4 in. = Every 5 years
> Meter sizes 4 in. and larger = Every year

Meters larger than two inches are usually tested in place using a calibrated field test meter. To be able to field-test a meter, there must be a tap and an isolation valve immediately downstream from the meter. This temporary connection can be made with a fire hose. These can also be tested with Ultrasonic strap on meters.

Even new meters should be tested. Master meters in water plants are, in some cases, difficult or impossible to test using a field test meter. In these situations, a drawdown test can be conducted, which involves comparing a known volume of water pumped out of a tank (clearwell) to the volume recorded on the meter being tested.

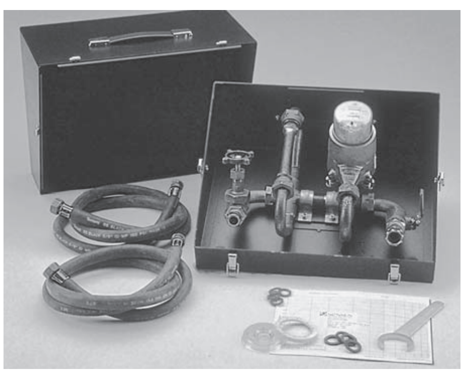
Although residential meters may be the final priority in the testing and maintenance program, in small systems, they are often times the largest single contributor of lost water. The residential meters can be broken down to the ones that have high usage and the ones that don't. A meter test program will be most effective when targeted on the residential meters that show the highest historical water usage.

The majority of residential meters are the positive displacement types, which almost always slow down when they are worn or encrusted by minerals or debris. Thus water systems with high hardness or high calcium content will have the larger problems with registration. The testing program for residential meters should either consist of periodic testing on a test bench or a complete change-out program based on a statistical analysis of meters with similar ages that show registration below a targeted limit of generally 95%.

Residential meters should be checked at least every seven to ten years. Testing and maintenance of the meters depends on the quality and quantity of the water. Water that has high levels of minerals will affect the operation of a meter over time. If adverse conditions, such as high minerals or large flows are encountered, meters will require more frequent attention. If your system does not have a certified meter test bench, a neighboring utility system may allow you to use its equipment. Testing can be performing by the meter vendor, or by a private company specializing in meter testing. FRWA also has small meter testers from companies like Mars, etc that can be used, borrowed, or purchased by the utility.

Residential Meter Test Bench used by Lakeland Utilities

Field-testing of residential meters can be performed in-place to determine a general range of accuracy. When properly used the field unit can measure within 0.5% of accuracy. These types of test units are most valuable for spot-checking meter accuracy where a problem is suspected. They are also valuable in performing statistical analysis to determine the overall expected residential water meter efficiency in a water system. These devices are generally limited to flow ranges between 0.5 and 20 gpm.



Field Meter Flow Test kits are available from a variety of manufactures and provide a means of spot-checking meter accuracy.

Field Meter Test Kit
Invensys LTD

The water system also should determine that meters are appropriately sized. Meters that are too large for a customer's level of use will tend to under-register water use the table below illustrates the type of meter, its proper application and the range of flows it will accurately record.

Table 5

Various Types of Water Meters for Water Measurement Applications and Flow Registration Accuracies

Type of Meter	Typical Application	Sizes	Flow Type	Flow Range GPM	Accuracy All ranges
Displacement Meters	Residential and Small Commercial	5/8" ¾ " 1" 1.5" 2"	Intermittent Flow	1 – 20 2 – 30 3 – 50 5 – 100 8 - 160	± 1.5% (Continuous flow at max. rate is 50% of rated value)
Multi Jet Meters	Residential and Commercial Irrigation	5/8" ¾ " 1" 1.5" 2"	Intermittent Flow	1 – 20 2 – 30 3 – 50 5 – 100 8 - 160	± 1.5% (Continuous flow at max. rate is 50% of rated value)
Propeller	Raw (dirty) Water Measurement	3" to 36"	10:1 Flow Range	Varies	± 2.0%
Turbine Meter	Commercial And Industrial	1.5" 2" 3"	100:1 Flow Range	4 - 120 4 -160 5 - 350	± 1.5% (Intermittent flows at 25% above max.)
Compound	Wholesale Customers	Varies	1000:1 Flow Range	Varies	± 1.5%

Meter accuracy is determined by flowing water through a calibrated meter or measuring the water flowing through the meter in a predetermined time and comparing the volume measured by the suspect meter. Source water meters should be calibrated yearly.

Meter Calibration using Ultrasonic Flow Meter

A well meter is tested using and ultrasonic clamp-on meter. Mastermeters can also be tested this way

FRWA assists utilities in calibrating well and master meters. Meters that measure less than 95% accuracy must be repaired or replaced per state requirements.

Florida Rural Water Association can assist utilities in checking the accuracy of flow meters.

Checklist for Water Sytstem Meter Sizing and Meter Testing Program:

- ❑ Water Meter Testing Program. The utility staff performs water meter testing.
- ❑ Water Meter Testing Program. Water meter testing is performed by contractor assistance or by outside agencies.
- ❑ Residential Water Meter Testing Program. The water system tests all residential meters at least every 7 to 10 years.
- ❑ Small Commercial and Industrial Water Meter Testing Program. The water system tests all water meters above 1 to 4 " in size at least every 5 to 7 years.
- ❑ Large Commercial and Industrial Water Meter Testing Program. The water system tests all water meters above 4" in size at least one time per year.
- ❑ Routine Water Meter Change Outs. Water meters are changed out based on no-read and <u>noticeable drops in average recorded historical monthly demand</u>.
- ❑ Exceptional Water Meter Change Program Out by Age: Water meters are changed out routinely after 7 to 10 years of use
- ❑ Acceptable Water Meter Change Out Program by Age: Water meters are changed out routinely after 10 to 15 years of use
- ❑ Below Average Water Meter Change Out Program by Age: Water meters are changed out after about 15 to 20 years of service
- ❑ Water Meter Standards: The utility requires that all meters used in its water system meet written standards
- ❑ Water Meter Installation Guidelines: The utility ensures that meters are installed horizontally and are level
- ❑ Water Meter Types: The utility requires that special use application meters such as for irrigation or high use be specified by a engineer or architect
- ❑ Water Meter Sizing Program: Meter sizing is performed by utility staff or reviewed by an engineering consultant for all new non-residential water service applications.
- ❑ Water Meter Sizing Follow-up: Actual water consumption is compared to calculated water consumption to ensure acceptable correlation.

Performing a Water System Audit

A water system audit can provide information needed to make a more accurate analysis of all types of water loss that might occur in a water system. It consists of systematically identifying the three types of water use: authorized unmetered water use, unauthorized unmetered water use and metered water use. Metered water use does not represent accurate water use unless programs are in place to ensure metered accuracy. Thus the water audit identifies deficiency that must be corrected to provide accurate water registration by the meters in use.

The summation of all forms of water consumption, including water consumption that is not registered because of inaccurate meter registration are then compared with the actual corrected metered amount of water to determine an efficiency for the water system. Water efficiency is generally calculated for a one-year period using data collected by the utility each month. The one-year period is used in a water audit to dampen the effect of the lag period between actual meter readings and water meter posting that may occur over different periods of time.

Generally an efficiency of 10% unaccounted-for-water is considered acceptable by AWWA. However, this statistic represents average contributions that includes utilities with older pipelines that have a much higher leakage factor than more currently installed pipelines that are constructed using modern standards. For this reason the utility should periodically perform a system audit to identify water loss that can be recovered reducing the utility’s overall operational costs, especially in new water systems using PVC pipe.

Checklist for Performing a Water System Audit

Defining Authorized Unmetered Water Use; The utility routinely identifies:

- ❑ Water Use for Firefighting and Firefighting Training
- ❑ Water Main Directional Flushing
- ❑ Storm Drain Flushing and Street Cleaning
- ❑ Landscaping Irrigation in Parks, Golf Courses, Cemeteries, Playgrounds, Median Strips, etc.
- ❑ Decorative Water Facilities
- ❑ Swimming Pools
- ❑ Construction Sites
- ❑ Water Quality, i.e. pressure and flow tests, flush valves or periodic flushing

- Process Water at Treatment or other Municipal facilities

- Potential Unmetered water loss are surveyed, i.e. wet areas in dry periods are investigated, water running into storm facilities, customer complaints of wet areas, etc.

- The Utility responds within 24 hours and repairs water leaks reported by customers.

Defining <u>Unauthorized</u> Unmetered Use; The utility has procedures in-place that routinely identifies

- Accounting Errors in Billing Procedures

- Illegal Connections

- Malfunctioning Controls Valves, i.e. faulty altitude valve, flush valve, pressure relief valves and check valves at well sites

- Water storage leakage from tanks

- Water Storage overflows

- Active Leak Identification Program for meter readers

- Meter Tampering and water theft program

<u>Defining Authorized Metered Efficiency; The utility has procedures in-place that routinely identifies water meter efficiency and water consumption for the various classes of customers.</u>

- The utility has identified all users of water by street address and has identified accounts with a specific meter number for each customer

- The water system has identified high water demand patterns from billing records and compared these with the type of meter used by the customer

- The utility has listed by meter size and meter number all active accounts for the various categories and has compiled total water use for a one year period

Initiating a Leak Detection Program

Leak detection is the logical and progressive follow-up step after conducting a water system audit, if water loss remains higher than 10-12% after water audit and proper water use accounting. The water system audit provides much of the information needed to make a more accurate analysis of all types of water loss that might occur in a water system. It helps focus the leak detection investigation to areas that have the highest likelihood of providing results.

Leak detection considers water losses slightly differently than in a water audit since it recognizes that some water loss will always occur even with the best water conservation programs. When conducting a leak detection program, AWWA suggests using three categories of water loss as shown below:

1) Real Losses

These are losses due to leakage and excess system pressure. Real losses can be reduced by more efficient leakage management, improved response time to repair leaks, improved pressure management and level control, and improved system maintenance, replacement, and rehabilitation. The variable cost of real losses may be estimated using the marginal production costs, such as energy and chemicals needed to treat and deliver the water. Although variable costs represent actual out-of–pocket expenses to the utility, <u>they significantly underestimate the capital cost necessary to treat and distribute the water to the customer.</u>

2) Apparent Losses

These are losses 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, unauthorized consumption including theft and improper billing credits issued by the utility. <u>Apparent losses are minimized by identification during the water audit and corrective action by the utility in the leak detection phase of the program</u>. The cost of apparent losses may be estimated using the retail commodity rates.

3) Unavoidable Annual Real Losses

These losses represent the theoretically low level of annual real losses in millions of gallons daily ("MGD") that could exist in a system if a leak detection program management were successfully implemented. These losses are calculated based on age, type of pipe and pressure maintained in the system and field data obtained from system inspection. Water loss is based on number of miles of water mains, number of service connections, average water pressure maintained in various areas, and length of service connections. Unavoidable annual real losses are allocated to service lines and water mains using methods suggested by the AWWA M36 Manual.

The table below shows a comparison of common types of pipe materials and acceptable water leakage allowances:

Pipe Material	Length	Test Pressure (psi)	Allowable Leakage GPD / mile-in
Asbestos Cement	13	150	30.00
Ductile Iron	18	150	23.30
PVC	20	150	1.88 (8” dia.)

Water losses can be targeted after compilation of the three categories of loss described above. Based on ideal conditions for the particular water system, a Water System Leakage Index is calculated. The index is the ratio of current leakage relative to the best level obtainable with current best management practices for leakage implemented. A ratio of 1.0 would indicate that the utility has reduced losses to the theoretically lowest level possible.

Causes of Pipeline Leaks in Water Distribution Systems

Identifying the area where pipeline leaks may be occurring is crucial in detecting the leaks. Leaks are caused by a variety of conditions that include the following:

- Drought conditions - as the ground dries out, the pipes can move and sometimes break
- Corrosion of the water main, due to some surrounding "aggressive" soils (mainly clays or loams) or stray cathodic protection systems
- Movement of above ground pipelines - which make the joints susceptible to leaks
- Improper bedding in trenches that contain rocks of voids that cause stress or shifting.
- Rapid changes in water pressure (water-hammer) caused by rapid closing of fire hydrants or valves can cause a pipe's weak point to start a horizontal crack
- Ground movement around the main caused by dry/wet/cold weather conditions can cause a "broken back" crack on the main
- Constant impact of road traffic or improper loading above the pipe can cause a pipe shift or to crack
- A poorly fitted main tap can cause metal corrosion and subsequent leaks
- Deterioration of aged fittings on a main (such as a hydrant or valve) can cause leaks
- Corrosion or damage to the house service line prior to the water meter
- Faulty or old meter or meter tap can cause leaks at the meter
- Older more brittle cast iron pipe is more subject to the effects of ground movements and will break more often than newer stress tolerant materials

Detecting actual leaks is the first step in eliminating pipeline leakage and follow up leak repair is always the more costly step in the process. In some cases where facilities are located in heavily congested and populated areas, repair costs can be exorbitant. On average, the savings in water no longer lost to leakage outweigh the cost of leak detection and repair. In most systems, assuming detection is followed by repair, it is typically cost effective to completely leak survey a water system every one to three years.

Effective leak detection and repair programs require the maintenance of accurate and sufficiently detailed records that document water system leaks consistently over time. Records concerning water production and sales, and leak costs and benefits generally become increasingly important over time as the system ages. Three sets of records should be kept: (1) monthly reports on unaccounted-for water comparing cumulative sales and production (for the last 12 months, to adjust discrepancies caused by the billing cycle); (2) leak-repair documentation reporting; and (3) updated maps of the distribution system showing the location, type, and class of each leak.

Leaks are not always associated with leaks from the causes listed above. For example, Fire hydrants, due to their construction, are the source of common leaks. Small outlets called weep holes located on the base of the hydrant allow the hydrant barrel to drain after use in climatic regions where freezing temperatures are common. Hydrants are often operated by inexperienced personnel who either do not shut the hydrant off completely, or damage the valve seat by using excessive force when closing it down. In either case, water continually flows into the hydrant body and escapes through the weep hole. Most often, a small amount of fire hydrants continuously leak and are not visible.

In a leak detection survey performed by the Southwest Florida Water Management District completed in 2005, with 72 utilities participating, 735 water leaks were identified with an estimated water loss of over 2 MGD. The leaks were quantified as follows:

Table 6

Results of Leak Survey on 72 Utilities
Leaks Detected by Access Point SWFWMD
Survey Conducted in 2005

Access Point	Water Valve	Fire Hyd	Service Conn.	Pipelines Leaks Joints/Other
No Inspected	32,779	20,776	4,917	1,606
Leaks Identified	293	233	76	133
% Per Inspection	1%	1%	1.5%	8.3%

The data suggests that there are a significant number of unaccounted for leaks in all systems and that many of the leaks are long-term and associated with water valves and fire hydrants. In areas where leaks are suspected they are found at much high frequencies.

Water Leak Detector

Leak Detection Equipment allows the operator to detect sound waves that emanate from the source of the leak.

Modern equipment isolates typical leak frequencies and filters background sounds that can allow an operator to more accurately locate the leak than the older style equipment.

Leak detection efforts are very effective when they are targeted on the portion of the distribution system with the greatest expected problems. These area generally include:

- areas with a history of excessive leak and break rates;
- areas in older areas of town or where cast iron pipe has been used;
- areas where system pressure is higher;
- areas exposed to stray electric current and traffic vibration;
- areas near stream crossings where erosion can occur; and
- areas where loads on pipe that exceed design loads.

Surface leaks are more easily to identify since wet areas will be visible especially in dry period. Larger leaks may be identified by very wet areas or sounds of running water. Subsurface leaks are more difficult to identify. The American Water Works Association (AWWA) estimates that, nationwide, only 30% of all underground leaks ever come to the surface. This statistic is compounded in Florida because of its unique subsurface conditions. These conditions produce paths of least resistance that may not allow the water to surface. Lateral movement through lime rock fissures can direct water away from the surface, as can leaks in sandy areas that flow away from the source. Leaks may also occur where the path of least resistance leads into a storm drain, sewer, or a nearby body of water. For this reason it is advisable to use personnel trained spotting these conditions and and experienced in the use of leak detection sounding equipment.

An added bonus of an effective leak detection program is that it allows the utility to prepare more effective accurate pipeline rehabilitation CIP budgets that use the information collected about system conditions to set priorities and allocate funds.

Estimating Water Loss Caused by Leaks in Pipelines and Service Laterals Leads

Water loss can be reasonably estimated by identifying the various types of leaks that occur in a water system. A table that may be used for this purpose is provided below:

Table 7

Estimating Water Loss from Small Pin-Hole Type Leaks
Water Loss in Gallons per Minute (gpm)

	Pressure (psi)				
Diameter of Hole (in)	20	40	60	80	100
0.1	1.1	1.5	1.9	2.1	2.4
0.2	4.3	6.0	7.4	8.5	9.5
0.3	9.6	13.6	16.6	19.2	21.5
0.4	17.1	24.2	29.6	34.1	38.2
0.5	26.7	37.8	46.2	53.4	59.7
0.6	38.5	54.4	66.6	76.9	86.0
0.7	52.3	74.0	90.6	104.7	117.0
0.8	68.4	96.7	118.4	136.7	152.8
0.9	86.5	122.3	149.8	173.0	193.4
1.0	106.8	151.0	184.0	213.6	238.8
1.5	240.3	339.8	416.2	480.6	537.3
2.0	427.2	604.1	739.7	854.4	955.2

Leaks that occur from horizontal cracks in pipelines can be estimated using the following table. For larger length horizontal cracks multiply column one by the length in inches.

Table 8

Estimating Water Loss from Pipeline Cracks
Water Loss in Gallons per Minute (gpm)

Area (in)		Pressure (psi)				
Length	Width	20	40	60	80	100
1.0	1/32	3.2	4.5	5.5	6.4	7.1
1.0	1/16	6.4	9.0	11.0	12.7	14.2
1.0	1/8	12.7	18.0	22.1	25.5	28.5
1.0	1/4	25.5	36.0	44.1	51.0	57.0

Leaks may be reduced by reducing pressure in instances where system pressures exceed 80 psi. Reducing pressure in other situations must be considered carefully with hydraulic analysis to ensure the minimum DEP pressure requirements are not violated, fire protection is not compromised and electric motors are not caused to run excessively. In selected cases, installation of pressure-reducing valves in street mains, as well as individual buildings may be considered.

Table 9

Estimating Water Loss from Drips and Very Small Flows
Water Loss in Gallons per Minute (gpm)

Counted Drips			8 oz. Cup	
Drips per Second	Loss (gpm)		Cups per minute	Loss (gpm)
1	0.006		0.25	0.016
2	0.012		0.50	0.031
3	0.018		0.75	0.047
4	0.024		1.00	0.062
5	0.030		1.50	0.094
6	0.036		2.00	0.125
7	0.042		3.00	0.188
8	0.048		4.00	0.250

The effective use of Leak detection equipment in a leak detection program follows a series of progressive steps as listed below:

Leak Detection Procedures

Step 1: The first step in a leak detection program is a preliminary survey to determine obvious leaks and water losses through malfunctioning pumps and excessive seal water use, valves, meters and other appurtenances.

Step 2: The next step is to measure water flow by isolating each distribution zone, then listening to water movement, testing pressures, and watching tank levels and meters to determine leakage.

Step 3: The third step is to pinpoint leaks with listening devices. These can range from using a screwdriver to listen for vibrations, to using advanced leak correlators that use a tranducer and pipe characteristics for accurate estimating.

Step 4: The fourth step is to record the size (using the FRWA tables provided) and documenting the location of the leaks.

Step 5: The final step is to repair the found leaks. Depending upon the extent of the leaks, repairs or replacement may need to be scheduled into a capital improvement program. Unless the leaks that are discovered are repaired as part of a leak reduction strategy, the program will be ineffective.

Leak detection can be conducted either by a utility crew or by a contracted firm.

Checklist for a Comprehensive Water Sytstem Leak Detection Program:

- ❑ The water systems routinely inspects hydrants and valves in a distribution system as part of a leak detection program
- ❑ The water system updates water distribution system maps within one year after as-built drawings are obtained
- ❑ The water system has inspected water pipelines for the purpose of cleaning, pigging, lining, or has other on-going water system maintenance efforts in-place to improve the distribution system reliability and to prevent leaks and ruptures from occurring
- ❑ The utility estimates total leakage from each leak based on the leakage flow rate and length of leakage from time reported to repair the leak
- ❑ Customers are encouraged to report leaks
- ❑ The water system tracks the location of leaks and has a method to calculate when it is cost-effective to replace mains and service lines
- ❑ Meter readers are trained to look for and report leaks
- ❑ Water Consumption records are adjusted when billed consumption is modified

Water Theft Control and Meter Tampering Program

Water theft and meter tampering occurs in almost every water system and can be a significant loss of revenue to the utility if there is no program in place to prevent it. Water theft can be identified using billing records, with field inspection or a combination of both. Non-paying customers hurt the utility's bottom line and other customers in the long run. Some utility workers suspect tampering is going on but will likely not pursue resolution unless supported by an on-going anti-theft program. Others may suspect tampering, but know the burden of proof is too difficult to overcome to accuse someone.

The older type meters allowed the register to be removed and thus water could pass through it without being recorded. Newer type meters are sealed and do not allow this to occur.

Most water theft occurs when the utility has turned the water off for non-payment and the resident turns it back on. Water can be stolen by replacing the meter with a fabricated spacer pipe or can be directly taken from a fire hydrant.

Florida Rural Water Association works with Utilities in Identifying Water Theft and in setting up Effective programs for for training utility employees in detection.

Common Straight Pipe Connection used to obtain free water.

From the billing side the best way to determine water theft is by maintaining customer usage trends. When water use drops dramatically in a hot dry period it is likely that meter tampering or meter malfunction is a problem. The two most likely tampering indicators are:

- Meter readings that are lower than the history for previous readings
- Low consumption based on knowledge of average water consumption

Meters can be attached to the shut off valve using a safety wire. This is typically done when the tampering is suspected. Utilities are encouraged to train meter readers in identifying the unusual conditions where water theft is likely. For example, very green lawns in dry periods are an indication of irrigation. Irrigation theft typically occurs in relatively high socioeconomic areas.

Theft of water for construction purposes including irrigation of newly installed sod is perhaps the most common type of water theft. This type of theft occurs when the utility does not have provisions for the permitted use of temporary construction water.

Other theft and tampering indicators are when the customer refuses to allow meter readers to access a property to obtain an actual reading. Meter readers should always be on the lookout for unusual conditions that lead to suspected tampering and these observations should be recorded for future reference.

There are many instances of residences that receive water service but are not recorded as a customer in the billing records. In new subdivisions mistakes can occur and so can illegal taps. It is a good policy to reconcile street addresses with billing records.

Checklist for a Water Theft Control and Meter Tampering Program:

- ❑ The utility has an on-going water theft control and meter tampering program
- ❑ The utility trains meter readers in identifying suspected water theft
- ❑ The utility instructs meter readers to record comments on observation of unusual conditions that may indicate water theft
- ❑ The utility regularly inspects service connections (meter installations) for evidence of theft
- ❑ The utility maintains a permit system for the use of construction water
- ❑ The utility has in-place a penalty mechanism that includes discontinuation of service for water theft
- ❑ The utility flags water usage using billing records that is significantly below average especially in dry periods

Intermediate Water Conservation Measures

Water Conservation Training and Planning for Administrators and City Officials

Utility management and governing board training are available from Florida Rural Water Association professionals. Management sessions may be formal classroom type training or training for individuals. Florida Rural Water Association is available to help utilities operate more efficiently using best management practice water conservation techniques.

Conservation Planning goals typically include eliminating, downsizing, or postponing the need for capital projects; extending the life of existing facilities; avoiding new source water development costs; improving drought or emergency preparedness; educating customers about the value of water; or protecting and preserving environmental resources.

Conservation planning begins by the setting of water conservation goals. Each water system begins its conservation plan by stating its goals in terms of the desired and expected benefits to be achieved for the water system and for its customers. Once the goals are set, the Conservation Planning Process proceeds systematically as a series of steps are completed. The steps are tasks that begin using the work accomplished in completing Basic Conservation Measures for water auditing, metering and leak detection.

The Florida Rural Water Association Conservation Planning Process

Step 1. Specify Conservation Planning Goals

- List conservation planning goals and their relationship to supply-side planning
- Describe community involvement in the goals-development process

Step 2: Develop a Water System Profile

- Inventory existing facilities, production characteristics, and water use
- Review conditions that might affect the water system and conservation planning

Step 3. Prepare a Demand Forecast

- Anticipate water demand for future time period’s
- Adjust demand based on known and measurable factors
- Discuss uncertainties and “what if” scenarios (sensitivity analysis)

Step 4. Describe Planned Facilities

- Plan improvements for the water system over a reasonable time period
- Estimate the total, annualized, and unit cost (per gallon) of planned supply-side improvements and additions
- Anticipate total installed water capacity over the planning period based on potential improvements and additions

Step 5. Identify Water Conservation Measures

- Review conservation measures that have been implemented or that are planned for implementation
- Discuss legal or other barriers to implementing recommended measures
- Identify measures for further analysis

Step 6. Analyze Benefits and Costs

- Estimate total implementation costs and anticipated water savings
- Assess cost effectiveness for recommended conservation measures
- Compare implementation costs to avoided supply-side costs

7. Select Conservation Measures

- Select criteria for choosing conservation measures
- Identify selected measures
- Explain why recommended measures will not be implemented
- Provide strategy and timetable for implementing conservation measures

8. Integrate Resources and Modify Forecasts

- Modify water demand and supply capacity forecasts to reflect anticipated effects of conservation
- Discuss the effects of conservation on planned water purchases, improvements, and additions
- Discuss the effects of planned conservation measures on water utility revenues

9. Present Implementation and Evaluation Strategy

- Explain approaches for implementing and evaluating the conservation plan
- Ascertain support of the conservation plan by the system's governing body

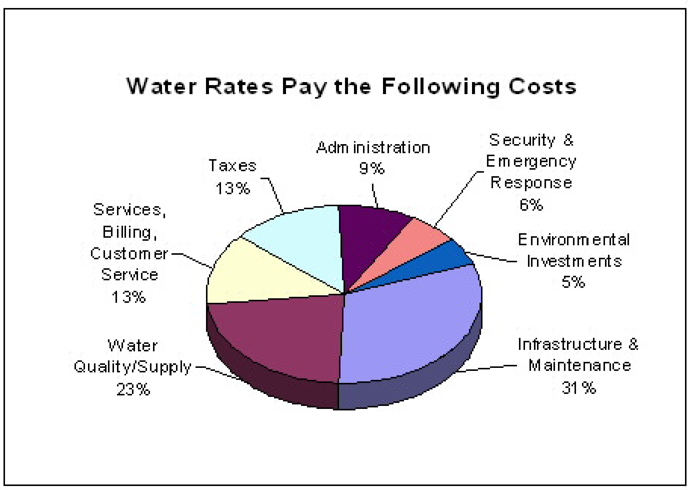
Florida Rural Water Association can assist small utilities in preparing Water Conservation Plans.

Performing a Comparative Costing and Pricing Analysis

Florida Rural Water Association assists small systems in performing cost of service analysis for their water system. The study evaluates the true and proposed costs associated with providing water to their customers. Cost based rates are identified by a systematic analysis of the current and future costs for providing the water service. The analysis takes into consideration the impact of using remaining treatment capacity, the timing of future expansions, maintaining regulatory compliance, funding operating requirements and the costs of, engineering design, and permitting. A typical cost of service study methodology used by Florida Rural Water Association is illustrated below:

Fundamentals of a Cost of Service Study

- Determine current expenses for residential, commercial and industrial classes of customers.
- Estimate short and long-term facility needs based on identified development, historical trends and economic indicators.
- Establish Construction Schedules, Capital Needs (cash flows), cash, interest payments and interest ratios to be maintained required by Bond Resolutions.
- Estimate operating revenue and non-operating expenses
- Rates are allocated to individual classes of customers that fairly allocates charges to those using the service



Florida Rural Water Association assists small utilities in collecting and allocating water revenues to ensure a strong financial position for meeting future obligations.

Typical Breakdown of Water Rate Revenue

Water utilities must cover a variety of costs that are listed below. Many utilities underestimate the water capacity cost required to meet peak demands on the water system by irrigation. These high demands may be significantly influenced by new construction and can best be addressed by good conservation planning.

Operating Costs for a Small Water System

- Supply and Transmission Costs – average cost of supply and transmission to customer, i.e. electricity, chemicals & labor
- Commodity Cost - Costs that vary proportionately with the amount of water provided under average consumption; typically based on size of meter (proportioned by meter size)
- Capacity Cost - Costs that are incurred to meet the maximum demand (Peak demands have much higher costs)
- Customer Related Cost - The costs that are associated with serving customers independent of the amount of water they use
- Public Fire Protection. The cost of hydrants and the over-sizing of water mains and reservoirs to provide fire flow.
- Taxes, Surcharges and General Fund Transfers. Costs include state & city utility taxes, customer billing audits utility maintenance.

Implementing an Irrigation Pricing Supplement to Current Rates

The cost and price of water constitute conservation strategies because they involve understanding and pricing the true value of water and conveying information about that value, through prices, to water customers. Evaluating and modifying current user charges to address true cost, is considered a necessary part of a water conservation strategy.

Conservation pricing includes consideration of a number of variables shown below.

Definition of Variables Used in Water Conservation Rate Making

- Cost-of-service accounting**.** Water systems must use cost-of-service accounting, consistent with generally accepted practices. Understanding and tracking system costs provides not only operating cost information but can provide information for developing the utility's long-term capacity-development strategy.

- User charges. These costs generally cover the administration and billing costs for operating the utility. User charges that are developed as part of a water rate structure do not send conservation signals but can be used to buffer the effects of lost revenue due to effective conservation practices resulting in permanent decreases in the average amount of water used by the customer.

- Metered rates**.** Metered rates must be used so that the customer's water bill corresponds to their water usage. For most systems changes in water rates must be approved by regulators and oversight bodies. It is important for water systems to communicate with regulators about costs and the need for cost-based pricing that recognizes the costs that it places on operating the system.

- Cost analysis. Systems should conduct a cost-of-service analysis that includes the considerations above and identifies the types of water usage that drive system costs. For optimizing water conservation, systems should include the patterns of usage by season and user category receiving water service.

- Nonpromotional rates**.** Utilities should consider whether their current rate structure promotes or discourages excessive water usage. Nonpromotional conservation rates are water rates that are intended to change customer behavior by sending signals to conserve water. Systems seeking to encourage conservation through their rates should consider issues such as: the allocation between fixed and variable charges, usage blocks and breakpoints, the minimum bills and how much water is provided, seasonal pricing, and pricing by customer category.

- Inverted block rates: Inverted block rates are the opposite of a declining block rate structure. Under this alternative, rates increase for progressively larger volumes of water use. As a result, larger volume customers pay a progressively higher average rate for increased water use. The concept of an increasing price per unit frequently arises from the desire for water reductions for higher patterns of total water use. Increased concern for conservation of resources has led to acceptance of inverted rates in many Florida water utilities, particularly those facing immediate and recognizable water supply problems.

  A note of caution is that it is possible to impose an inverted block rate structure that is applicable to all customers; however, this practice has many drawbacks from an equity standpoint due to the diverse water usage characteristics of various customer categories. Thus, most utilities adopt a separate inverted block rate structure primarily for residential customers. Under an inverted structure, the residential class may be charged a higher unit rate for increased water use in excess of an established amount per billing period. Typically, the higher priced blocks are established at amounts that would typically include non-sanitary uses such as irrigation or filling swimming pools. Under this alternative, these uses are charged at a higher rate that send signals that encourage water conservation.

- Seasonal rates. Seasonal rates establish a higher rate for water use during the utility's peak season. These reflect the higher cost of providing water during those periods for energy, chemicals and increased pressure. Seasonal rate structures send the signal to the consumer for more efficient use of water.

In most water systems, the peak demand for water service occurs in the summertime, when lawn irrigation and other outdoor uses are more prevalent. This fact has given rise to consideration of seasonal rates, whereby higher rates are charged for water used in the summer or peak season than for the non-peaking portion of the year. Seasonal rates have received greater attention in more recent years due in part to droughts and water shortages. In addition, the recognition of peaking requirements that require a utility to install larger pipelines, storage and pumping facilities and the operating costs to support it.

There are several types of seasonal water rates. The simplest type is merely to charge a higher unit price for water used in the summer than for water used the rest of the year. The more complicated rates use customized algorithms.

- <u>Excess-Use charges</u>. Excess-use charges are characterized by having one schedule of charges for winter season level-of-use, with an additional charge for use in excess of the base amount during a peak water-using period. Excess-use is usually determined from the average usage patterns of the individual customer. The added charge is developed from an analysis of costs during peak and off-peak seasonal periods. For example, if a customer's average monthly usage during the winter period is 10,000 gallons (gal) and its usage during a given month during the summer period is 25,000 gal, then the excess above-average winter period monthly use of 15,000 gal would be charged at a higher rate than the rate for the first 10,000 gal, which would be at the lower winter rate.

One consideration in developing excess-use charges is the determination of a suitable definition for excess use. Excess use is the volume of water used over a given period of time that exceeds an established base figure. To be a practical indicator, excess use must be measured within a set period of time and be above some reasonable average measured for similar customer categories over the same period. The definition of excess use selected must be defensible since it can significantly affect the magnitude of the cost of water for the excess-use and the base rate of charge (that is, the charge for off-peak usage). Before adopting any one definition of excess use, historic records should be analyzed to determine the quantitative and political impacts that are bound to occur. Some water systems have went so far as to publish exorbitant water use as “water hogs” in local media. <u>Making water-hog examples, although eliciting attention to exorbitant water use, can be detrimental in building overall support in the community and it is more effective to target exorbitant excess-use customers with personal attention and education than create animosity and distrust with public embarrassment.</u> In all cases of discouraging excess-use, particular emphasis should be placed on practicality of application, customer understanding, and potential/administrative constraints such as added costs related to metering, billing, and data processing.

> One beneficial aspect of an excess-use charge, even though it is a more sophisticated form of charge, is that it does tend to result in a more equitable bearing of costs by individual customers of the system. The costs incurred in meeting peaking requirements can be derived from among those customers using the extra capacity, while customers exerting relatively uniform requirements on the system bear only the costs related to such service.

When any conservation signals or advanced pricing methods are added to encourage conservation, the utility must consider the effect of the new rate structure on utility revenues. Conservation-oriented pricing, requires planners to make certain assumptions about the elasticity or the responsiveness of water use to a change in price of water demand. Elasticity is measured by the ratio of a percentage change in quantity demanded to a percentage change in price. Generally, residential water elasticity ranges from –0.2 to -0.4 for residential water use and –0.5 to –0.8 (Stallworth, USEPA) for commercial water use, (for example, for each 10% increase in price, water demand drops by 2 to 4% for residential and 5 to 8% for commercial and industrial water customers.) <u>When utilities incorporate any type of conservation measure, the impact of the measure to potentially result in revenue shortfalls must be carefully considered.</u>

The Disadvantages of Conservation Rate Structures

Conservation rate structures can have some significant disadvantages that are best considered in the development process. These are identified below:

Disadvantages of Advanced Conservation Rates

- <u>Unstable Revenues</u> – A high level of community awareness can lead to extensive conservation. This reduced use can cause revenue shortfalls. External factors, such as wet years or mandatory reductions can also cause severe revenue problems. Higher levels of operating reserves are appropriate.

- <u>Adverse Public Response</u> – Since seasonal rates target high use periods, they result in increased customer bills during the summer months when bills are already higher. While this is an intended outcome, it results in an increase in complaints and in customer ill will.

- <u>Impact on Large Families</u> – Larger households naturally use more water. Conservation rates must be carefully structured to avoid penalizing such customers.

- <u>Timing</u> – In many systems, residences are billed bimonthly. Thus, the first price signal may arrive after the heavy irrigation season is over, resulting in a greater effect only in the second year of a conservation rate. This occurs because the signal was too late to affect usage in the first year. The phased public relations (PR) program should be implemented before this peak period occurs.

Rate issues can be very complicated to a small utility. Florida Rural Water Association can assist the utility in designing a custom conservation rates that are easy to understand, effective and protective of anticipated revenue.

Advanced Conservation Measures

Developing Advanced Conservation Measures

Efficient water use can have major environmental, public health, and economic benefits by helping to improve water quality, maintain aquatic ecosystems, and protect drinking water resources. In an effort to identify and prioritize the most effective water conservation techniques, the Florida Department of Environmental Protection, using a series of six public workshops across the state, developed a document in 2002, titled, “The Florida Water Conservation Initiative.” This document identifies water conservation measures by priority, amount of water saved, cost effectiveness and ease of implementation. This comprehensive list includes recommendations for agricultural irrigation, landscape irrigation, water pricing, industrial, commercial and institutional water saving methods, indoor water use and water reuse. The 51 water conservation or best management practices (BMPs) are included in the Appendix.

Using Water Conservation BMPs in Developing a Water Conservation Program

A Water Conservation Program is a comprehensive community supported commitment to achieving maximum value from collaboratively developed water conservation goals and implementation of specific water conservation Best Management Practices. Use of BMPs are most effective when they are part of an overall integrated strategy that includes all stakeholders.

Developing a Water Conservation Program

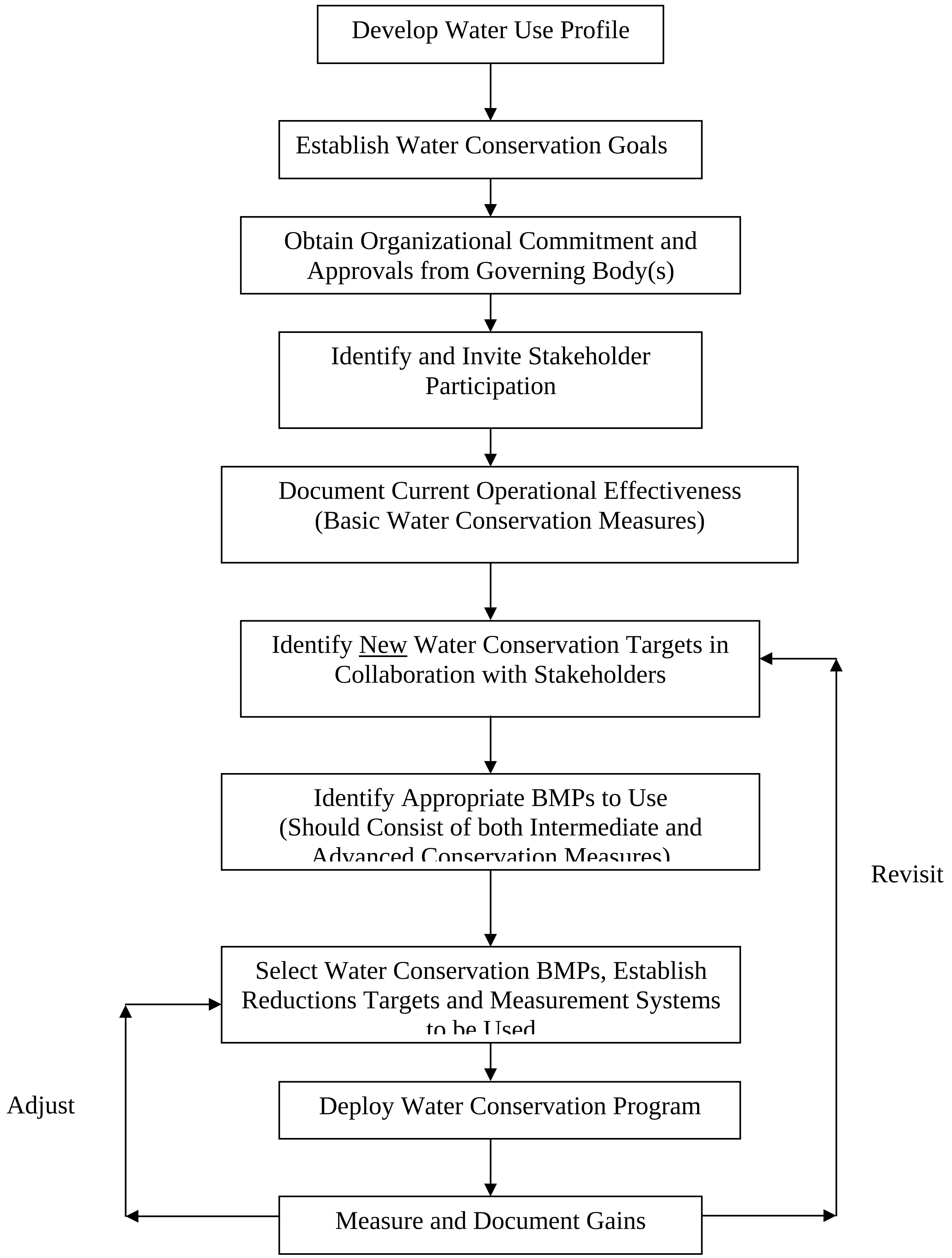
A Water Conservation Program is a structured systematic and on-going goal oriented program to improve overall water savings through the implementation of custom best management practices. In developing such a program community input is solicited to ensure support for the many conservation measures that may adversely affect the current prices paid for water.

The basic tenant of a water conservation program is to ensure that water is priced fairly. This means that all users pay their appropriate share of the true cost to the utility for providing water service. Thus water conservation measures that are contemplated must be evaluated for their cost effectiveness in contributing to the overall system water reductions.

An effective water conservation program is never static. Water conservation program goals and strategies must be continuously evaluated and adjusted to provide for maximum cost benefit.

A Flow chart that identifies the development of a Water Conservation Program is provided below. Florida Rural Water Association can assist in the development of such a program.

Flow Chart for a Comprehensive Water Conservation Program



Setting Effective Water Conservation Performance Measures

It is important for utilities to understand the difference between activity measures and result measures used in water conservation reporting. These are shown in the following table.

Table 11

Comparison Between Activity and Result Measures

Performance Measure	Definition	Examples
Activity Measure	Measures Desirable Behavior	1. Number of Brochures distributed 2. Number of Schools visited 3. Number of Customers contacted
Results Measure	Measures Effectiveness of a Strategy	1. Reduction in Water Use per average customer in gallons per capita per day 2. Decreases in Unaccounted for water in gallons per month

The importance of setting results measures for water conservation improvements can not be overestimated. Emphasis on activity measures can lead to expensive and ineffective water conservation programs. Thus activity measures must always be expressed in both a time frame and a target that is tied to a result measure that has a quantifiable goal. Use of a "value mapping" process can improve the effectiveness of using both measures.

Development of quantifiable results measures must always include considerations of the affects of climatic conditions such as droughts and wet periods. Florida Rural Water Association can assist a utility in factoring out these influences.

Benefits of a Designated Water Conservation Program Coordinator

A Water Conservation Program can be optimized when dedicated staff works with stakeholders to develop, monitor and adjust the effectiveness of a written goal-based Water Conservation Program. Some utilities that have designated water conservation program coordinators, have found success in implementing a modified form of a full-scale water conservation program that uses a combination of proven highly effective water conservation measures that are systematically implemented under the direction of a dedicated water conservation staff person.

However the utility chooses to use the staff person, the duties of a water conservation coordinator typically will include:

- Develop a water efficiency plan for the utility
- Educate key staff in water conservation measures
- Provide water conservation training for all water and billing employees
- Educate residents and school children in water efficiency efforts
- Institute a Water Conservation Education Program for Customers
- Administer water audits directed at demand side water uses
- Educate customers in easy retrofits such as low-flow toilets and shower heads
- Educate Customers in landscape efficiency, drip irrigation and xeriscaping
- Partner with irrigation contractors to achieve improved irrigation use
- Statistically track water conservation effectiveness and make adjustment to continually improve water conservation programs

Modified Short-Track Water Conservation Plan

Many utilities chose to use a modified form of the full-scale water conservation plan to expedite the benefits of proven measures without the time constraints imposed by full-scale program. Like other conservation initiatives, implementing these types of conservation strategies should proceed systematically in completing a series of progressive steps that start at the supply side, move to easily implemented effective supply side measures, progressing to rate programs that send signals and incentive programs that change customer use and customer behavior.

Step 1: Administration and Planning

- Designate a water efficiency coordinator.
- Identify water efficiency improvement plan that includes the basic and or intermediate water conservation measures.
- Educate employees, customers, schools, etc. to create conservation awareness.

Step 2: Document Basic Supply Side Water Conservation Measures

- Implement all basic water-loss management program (i.e. water audit, leak detection, meter efficiency programs) to target water industry conservation goals for unaccounted-for-water of below 10 percent and/or residential water use of below 120 gallons per capita per day.
- Implementation of universal metering for water uses if not already in-place.
- Use reclaimed wastewater distribution system for non-potable uses as possible.
- Ensuring anti-theft and tampering programs are in-place including fire hydrant metering

Step 3: Implement the Use of Water Saving Fixtures in <u>Utility</u> Applications (Become a Leader in Captive Utility Markets)

- Replace toilets with high-efficiency models and retrofit existing water wasting plumbing devices with water-saving units
- Replace faucet aerators and low flow shower heads in municipal buildings
- Develop utility policies to replace fixtures with water-saving models as they age.
- Eliminate “once-through” cooling of equipment with municipal water by recycling water

flow to cooling tower or replacing with air-cooled equipment.
- Minimize the water used in space cooling equipment in accordance with manufacturer's recommendations. Shut off cooling units when not needed.
- Install water-saving pool filters in municipal applications.

Step 4: Encourage and Demand Side (Intermediate and Advanced) Water Conservation Measures:

- Remove barriers that discourage water conservation in the rate structure and ensure the utility rate structure encourages water efficiency
- Educate customers and make retrofit kits for residences and businesses available free or at cost. Kits may contain low flow faucet aerators, high efficiency showerheads, leak detection tablets, and replacement valves.
- Promote water-efficient landscape practices for homeowners and businesses, especially those with large, irrigated properties, i.e. use of native plants, landscape renovation to reduce water use, and more efficient irrigation.
- Offer incentive programs (rebates/tax credits) to homeowners and businesses to encourage replacement of plumbing fixtures and appliances with water-efficient models.
- Conduct water-use audits of homes, businesses and industries. Audits provide users with invaluable information about how water is used and how usage might be reduced by specific measures.

However, the utility chooses to proceed is of course dependant on the utility's need to show immediate progress. The benefit of the modified plan is that it can be modified to dove-tail into the full-scale conservation plan as the program matures. Florida Rural Water Association can assist the utility with development of a custom short-track plan.

Suggestion for Performing a Residential or Commercial Water Audit

The performance of residential and commercial water audits are generally used in combination with an advanced community supported conservation program where dedicated and trained utility staff are available to perform the audit.

The audit should begin with a meter check to determine water registration accuracy. Today's meters make the job easy by use of the sweep dial that indicates leaks in customer pipelines and plumbing fixtures.

The "sweep indicator" is located to the left of the meter dial and will move when any water passes through the meter.

Checklist for a Water Theft Control and Meter Tampering Program:

Water Meter

- ❑ Perform meter calibration/flow test
- ❑ Perform a customer side leak analysis

Kitchen

- ❑ Check faucet flow rate and install aerator if needed
- ❑ Check for drips and leaks

Bathroom

- ❑ Check shower flow rate and install aerator if needed
- ❑ Check for drips and leaks
- ❑ Check sink flow rates and install aerators if needed
- ❑ Check for drips and leaks
- ❑ Check Toilet for leaks using dye
- ❑ Clean and replace flapper if need
- ❑ Make manual adjustment to float arm
- ❑ Provide information on toilet rebates

Outside Irrigation

- ❑ Measure the flow rate of sprinkler
- ❑ Check for leaks in pipes/hoses and the irrigation systems
- ❑ Check the position of sprinkler heads
- ❑ Check and adjust the irrigation timer for proper water application
- ❑ Provide the customer with information on drip irrigation
- ❑ Provide the customer with information on native plants and xeriscaping

General Conservation Procedures for Utilities

Encouraging Customer Conservation Awareness

Water customers can make just a few small changes to their daily routine and save a significant amount of water. This water savings helps the utility by deferring capacity improvements.

Water-efficient plumbing fixtures and irrigation systems provide the same performance and quality as wasteful products, but with the added benefit of water savings. The table below illustrates some water savings advantages that can generally be achieved by the use of water saving fixtures.

Table 10

Conservation Benefits Achieved by the Use of Water Saving Fixtures

Targeted Water Use	Years Manufact.•	Application ‡	Use/ Unit◊	Avg. Use/ Unit	Frequency of use		Service or Device	Use/ unit◊	Savings GPD*
Toilet	1980-94	Residential	GPF	3.5	5.1	Flushes per person per day	ULFT	1.6	9.7[1]
	1980-98		GPF	3.5	5.1		HET	1.28	11[1]
	1980-94	Commercial	NA	NA	NA		ULFT	1.6	16 – 5.7[2]
Urinal	1980-94	Commercial	GPF	3.0	2.0	Flushes per person per day	ULFU	1.0	4.0[3]
	1980-94		GPF	3.0	2.0		Waterless Urinal	0.0	6.0[3]
Showerhead	1980-94	Residential	GPM	4.0	5.3	Min./person per day	Low-vol Shwrhd	2.5	5.3[1]
Faucets	1980-94	Residential - Kitchen	GPM	3.0	8.1	Min./person per day	Low-vol Faucet	2.5	2.7[1]
	1980-94	Residential - Bathroom	GPM	3.0	8.1		Low-vol Faucet	1.5	8.1[1]
Clothes Washer	1990-98	Residential	GPL	43.0	0.4	Loads/day per person	Efficient machines	27.0	5.9[1]
Dishwasher	1990-95	Residential	GPL	12.0	0.1	Loads/day per person	Efficient machines	7.0	0.5[1]
Rain Sensor Device ▼	NA	Residential	GPD	300	1.0	Irrigation Cycles/Day	Automatic Sensor	200	100
Pre-Rinse Spray Valves	1980-2000	Commercial	GPM	3.0	NA	Gallons/min/ day	Low-volume spray valve	1.6	100-300[4]

Courtesy SWFWMD

The EPA Water Sense program label helps customers to identify high-efficiency products and programs that feature certified irrigation professionals.

Along with using EPA designated Water Sense products, the following water-efficient practices have been found effective for all utilities and can be used for immediate benefit:

Best Management Conservation Practices for Residential Water Customers

- **Fix Leaky Faucets:** Leaky faucets that drip at the rate of one drip per second can waste more than 3,000 gallons of water each year.
  Solution: If unsure whether there is a leak, read the water meter before and after a two-hour period when no water is being used. If the meter does not read exactly the same, you probably have a leak. Many meters have a sweep dial to show small water movement or leaks.

- **Fix Leaky Toilets** A leaky toilet can waste about 200 gallons of water every day.
  Solution: To tell if a toilet has a leak, place a drop of food coloring in the tank; if the color shows in the bowl without flushing, there is a leak.

- **Take Shower vs. Bath:** A full bath tub requires about 70 gallons of water, while taking a five-minute shower uses 10 to 25 gallons.
  Solution: If you take a bath, stopper the drain immediately and adjust the temperature as you fill the tub.

- **Turn off the Tap when Brushing:** The average bathroom faucet flows at a rate of two gallons per minute.
  Solution: Turning off the tap while brushing your teeth in the morning and at bedtime can save up to 8 gallons of water per day, which equals 240 gallons a month!

- **Use Drip Irrigation:** The typical single-family suburban household uses at least 30 percent of their water outdoors for irrigation. Some experts estimate that more than 50 percent of landscape water use goes to waste due to evaporation or runoff caused by over watering!
  Solution: Drip irrigation systems use between 20 to 50 percent less water than conventional in-ground sprinkler systems. They are also much more efficient than conventional sprinklers because no water is lost to wind, runoff, and evaporation. If your in-ground system uses 100,000 gallons annually, you could potentially save more than 200,000 gallons over its lifetime.

- **Use Full Laundry Loads:** The average washing machine about 41 gallons of water per load.
  Solution: High-efficiency washing machines use less than 28 gallons of water per load. To achieve even greater savings, wash only full loads of laundry or use the

appropriate load size selection on the washing machine.

- **Use Water Saving Toilet:** If your toilet is from 1992 or earlier, you probably have an inefficient model that uses between 3.5 to 7 gallons per flush. **Solution:** New and improved high-efficiency models use less than 1.3 gallons per flush—that's at least 60 percent less than their older, less efficient counterparts. Retrofitting your house with high-efficiency toilets can save a family of four roughly $1,000 over the next 10 years without compromising performance.

Community Conservation Education

Information and education are critical to the success of any conservation program. Information and education measures can directly produce water savings by encouraging customers to change wasteful water-use habits.

Public education alone may not produce the same amount of sustained water savings as other, more direct approaches such as leak repairs and retrofits but educational measures create awareness that support the effectiveness of other conservation measures. For example, it is widely believed that information plays a role in how water consumers respond to changes in price. More generally, customers that are informed and involved are more likely to support the water system’s conservation planning goals with modified water use.

Providing information to the customer on their water bill in how their water is priced is an important water conservation technique that can result in reductions in water use by the customer. Customers should be able to read and understand their water bills. An understandable water bill identifies the volume of water used, the various rates and charges, and other relevant information that leads to the final price for the water.

Providing pamphlets and bill inserts is another method of communicating water conservation information. Public information and education are important components of every water conservation plan. Consumers are often willing to participate in sound water management practices if provided with accurate information. An information and education program should explain to water users all of the costs involved in supplying drinking water and demonstrate how water conservation practices will provide water users with long-term savings.

Partnering in the Community

Partnering with schools can be effective in promoting conservation since the information provided to children is often transmitted to the parents. Contacts through schools can help socialize young people about the value of water and conservation techniques. Utilities can use a variety of methods to disseminate information and educate the public on water conservation. Outreach methods include speakers' bureaus, operating booths at public events, printed and video materials, and coordination with civic organizations.

Targeted public workshops are another avenue for gaining support for conservation efforts. Large commercial concerns and industries are often aware of the public relations values gained in supporting water conservation and will participate. Trade groups such as plumbers, plumbing fixture suppliers, builders and landscape and irrigation service providers are other groups that will participate.

Water conservation advisory committee can involve the public in the conservation process; potential committee members include elected officials, local business people, interested citizens, agency representatives, and representatives of concerned local groups. The committee can provide feedback to the utility concerning its conservation plan and develop new material and ideas about public information and support for conservation in the community. To be meaningful, the utility must be receptive to ideas offered by the committee and thus up-front commitment and a true desire by the utility
.

Implementing Permanent Water Use Regulations

Water use regulation limiting irrigation are often invoked by water management districts to ensure water conservation during droughts or other water-supply emergencies. In some cases, utilities may find it desirable to extend water-use regulations to promote conservation during non-emergency situations.

Another type of regulation is to impose standards on new developments with regard to landscaping, drainage, and irrigation practices. Larger homes frequently use in-ground irrigation systems that significantly add to a utility's peak demand.

Restrictions on water use should be justified by the system's circumstances and should not unduly compromise the customer's rights or quality of service.

Implementing Water Saving Construction Regulations for New Homes

The three factors of higher income, larger homes and numbers of people moving to Florida have placed stress on small utilities in providing water demand. Higher income increases one's ability to purchase and use water-intensive appliances and facilities; for example, higher income households are more apt to have additional bathrooms, larger yards, swimming pools, outdoor landscaping, and lawn irrigation systems (Linaweaver and others, 1967; Lewis and others, 1981). Second, higher income households are less likely to be concerned about the cost of water or the amount paid for water services.

Florida water management districts encourage the adoption of water savings programs that can reduce the demand for water from new development. Florida Water StarSM is a service mark of the St. Johns River Water Management District (SJRWMD) of Florida. This program for new residential construction is intended to provide water-efficient options for homes and landscapes, and help prevent water leaks. The program gives points where minimum Florida Water StarSM water saving criteria have been met or exceeded. Additional information on water savings in new development is available from the water management districts.

References:

Information from a variety of sources was used in preparing this document. Much of the information came from USEPA Water Conservation Programs. The USEPA water conservation classification guidelines were modified slightly to better accommodate typical utility business practices that would allow conservation measures and planning to be more efficiently integrated into normal utility operations. The *Florida Water Conservation Initiative* was used as a guide for identification of water conservation best practices. Information and methodologies that is included in the Appendix was obtained from Florida Rural Water Association's documents and working experiences in assisting utilities in water conservation planning as part of the Florida State Revolving Fund program.

This document is intended as a guideline to be used in assisting small water utilities in developing more efficient water conservation practices and can be obtained free of charge from the Florida Rural Water Association Web Site at: http://www.frwa.net.

Appendix

1. **FRWA Water Leak Repair Report Form**
2. **FRWA Meter Inspection and Calibration Form**
3. **FRWA Comprehensive Water Efficiency Report Form**
4. **FRWA Conservation Equipment Inventory**
5. **Water Conservation Initiative – Water Conservation Best Management Practices**

WATER LEAK REPAIR REPORT

Agency ______________________________ Date of Repair ______________________

Map Reference ______________________________ Page and Coordinates ______________________

Leak Identification (Refer to Daily Log):

Leak Number ______________________

Discovery Date______________________

Leak Location ____

____

Was a leak actually found? (Y or N) If yes:

Size of Leak ______________________

Measured (GPM) ______________________

Estimated (GPM) ____

How determined? ____

____

Total volume of water lost (GPD) ______________

Estimated Age of the leak ______________

Is there evidence of previous leak or repairs in general area? Number of previous leak repair clamps present?

____

Last repair date ______________________

Cause of leak ____

Type of Leak (circle appropriate response)

Meter leak | Main line leak | Joint leak | Meter spud leak | Service lateral leak

Meter yoke leak | Fire hydrant leak | Curb stop leak | Valve leak | Other (describe)

Does leak require excavation (Y or N) ? If yes, indicate ground conditions:

Soil: Rocky | Sandy | Clay | Hard Pan | Adobe | Loam | Other

Type of surfacing: Concrete | Asphalt | Soil | Other

What is the depth to the leak? ______________

Description of Repair:

If Repaired, what repairs were made (circle appropriate response):

Leak Clamp | Welded | Repacked valve | Recaulked joint | Other

If Replaced, what material was used? ______________________________________

Repair time (hours) ______________

Crew Size ______________

Equipment used ____

METER CALIBRATION INSPECTION REPORT

CALIBRATED METER FLOW TEST

Client ______________________ Page _____ of ______

Subject ______________________ Date ______________

Detail ______________________ By ______________

METER TEST __________

Location ____

Size ______ Manufacture __________ Type of meter ____________

Serial#__________ Register-Cubic Ft __________ Gallons ________

Reads - 10s ______ 100s ______ 1000s ______

LOW FLOW TEST:

Reading: Start ______ End ________ Start ______ End ______
Gallons Flowed __________________ Gallons Flowed ____________
Gallons Flowed Test Meter __________ Gallons Flowed TM ________
% of Accuracy Test Meter __________ % of Accuracy TM ________

MEDIUM FLOW TEST:

Reading: Start ______ End ________ Start ______ End ______
Gallons Flowed __________________ Gallons Flowed ____________
Gallons Flowed Test Meter __________ Gallons Flowed TM ________
% of Accuracy Test Meter __________ % of Accuracy TM ________

HIGH FLOW TEST:

Reading: Start ______ End ________ Start ______ End ______
Gallons Flowed __________________ Gallons Flowed ____________
Gallons Flowed Test Meter __________ Gallons Flowed TM ________
% of Accuracy Test Meter __________ % of Accuracy TM ________

REMARKS: ____

System: ____________________

Background Information

Month											
System Delivery:											
Gallons Pumped MG (finished)											
Gallons Pumped MG (raw)											
Gallons Used Filter Wash											
Gallons Plant Use MG											
Municipal Use MG											
Gallons Sold MG											
Unaccounted for MG (finished)											
Percent Unaccounted for (finish)											
Unaccounted for MG (raw)											
Percent Unaccounted for (raw)											
Expenses:											
Employee Cost											
Production Cost											
Power Cost											
Chemical Cost											
Waste Disposal											
Cost of Purchased Water											
Accounting Cost											
Management Cost											
Maintenance Cost											
Office Expense Cost											
Misc. Expense Cost											
Other O & M Cost											
Captial Expense											
Total Expense											
Expense MG											
Expense Cost 1,000 gal											

System: ______________________________

Background Information

Month											
Unmetered Water Uses:											
Firefighting & Training											
Main Flushing											
Store Drain Flushing											
Sewer Cleaning											
Street Cleaning											
Water Company Use (domestic)											
Bulk Water Sales											
Tank Drainage											
Schools											
Landscaping in Large Public Areas											
Parks											
Golf Courses											
Cemeteries											
Playgrounds											
Highway Median Strips											
Other Landscaping											
Decorative Water Facilities											
Swimming Pools											
Construction Sites											
Water Quality & Other Testing											
Plant Uses:											
Chemical Mix & Application											
Filter Wash Water											
Filter Surface Wash											
Deicers											
Pump Price											
Pump Bearing Lubrication											
Laboratory Use											
Other Misc. Plant Use											
Other Unmetered Uses											
Repaired System Leaks											

System: ______________________________

Background Information

Month											
Water Sold:											
Gallons Sold Metered/Use											
Gallons Sold Estimated/Use											
Total Gallons Sold MG											
Revenue Metered/Use											
Revenue Estimated/Use											
Total Revenue											
Revenue per MG Sold											
Revenue per 1,000 gal Sold											
Revenue/Total Pumpage MG											
Revenue/Total Pumpage 1,000 gal											

Page 3 of 3

Florida Rural Water Association's
Water Efficiency Testing and Monitoring Equipment

Florida Rural Water Association maintains and inventory of water efficiency testing and monitoring equipment and provides it on loan to utilities for direct use or with the use of skilled Florida Rural Water Association operators. The equipment is used to reduce lost water and improve overall water system efficiency.

Activity Chart Recorders
Fire Hydrant Gauges
Flow meters
Global Positioning System
Ground Penetrating Radar Units
Hydrant Flow meters
Hydrant Pressure and Flow Kits
Leak Detectors
Line Tracers
Magnetic Locator
Meter Testers
Large Meter Testers
Leak Correlators Optical Range Finders
Pressure Recorders
Small Meter Analyzer
Small Meter Tester
Valve Locators
Water Level Indicators
Weather-Proof Recorders

Recommended Water Conservation Alternatives[1]

Water Conservation Alternative	Priority	Total Score	Amount of Water Saved (1 to 5)[2]	Cost-Effec-tiveness (1 to 3)[3]	Ease of Imple-menting (1 to 3)[4]
Agricultural Irrigation					
AI-1: Cost share and other incentives	High	10	♦ ♦ ♦ ♦ ♦	$ $ $	ō ō
AI-2: More mobile irrigation labs to achieve water conservation BMPs	High	10	♦ ♦ ♦ ♦ ♦	$ $ $	ō ō
AI-3: Increase rainfall harvesting and recycling of irrigation water	High	9	♦ ♦ ♦ ♦ ♦	$ $ $	ō
AI-4: Increase the reuse of reclaimed water	High	9	♦ ♦ ♦ ♦ ♦	$ $ $	ō
AI-5: Improve methods for measuring water use and estimating agricultural water needs	Medium	8	♦ ♦ ♦ ♦	$ $	ō ō
AI-6: Conduct additional research to improve agricultural water use efficiency	Medium	8	♦ ♦ ♦ ♦	$ $	ō ō
AI-7: Increase education and information dissemination	Medium	8	♦ ♦ ♦	$ $	ō ō ō
AI-8: Amend WMD rules to create incentives for water conservation	Medium	8	♦ ♦ ♦ ♦	$ $	ō ō

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1 The "scores" assigned to each alternative have been made by the Department of Environmental Protection, with the benefit of the recommendations of participants in the Water Conservation Initiative.

2 A score of 1 indicates the least water saved, 5 the most.

3 A score of 1 indicates the least cost-effective, 3 the most cost-effective.

4 A score of 1 indicates relatively difficult to implement, 3 relatively easy.

Water Conservation Alternative	Priority	Total Score	Amount of Water Saved (1 to 5)[2]	Cost-Effectiveness (1 to 3)[3]	Ease of Implementing (1 to 3)[4]
Landscape Irrigation					
LI-1: Develop and adopt state irrigation design & installation standards and require inspection.	High	10	♦ ♦ ♦ ♦ ♦	$ $ $	ō ō
LI-2: Expand and coordinate educational/outreach programs on water-efficient landscaping.	High	9	♦ ♦ ♦ ♦	$ $ $	ō ō
LI-3: Establish a statewide training and certification program for irrigation design and installation professionals.	High	9	♦ ♦ ♦ ♦	$ $ $	ō ō
LI-4: Develop environmentally sound guidelines for the review of site plans	Medium	8	♦ ♦ ♦ ♦	$ $ $	ō
LI-5: Conduct applied research to improve turf and landscape water conservation	Medium	8	♦ ♦ ♦ ♦	$ $	ō ō
LI-6: Establish a training and certification program for landscape maintenance workers.	Medium	7	♦ ♦ ♦ ♦	$ $	ō
LI-7: Evaluate the use of water budgeting as an effective water conservation practice	Low	6	♦ ♦ ♦ ♦	$	ō
LI-8: Evaluate the need to establish consistent statewide watering restrictions for landscape irrigation	Low	6	♦ ♦ ♦	$ $	ō

Water Conservation Alternative	Priority	Total Score	Amount of Water Saved (1 to 5)[2]	Cost-Effec-tiveness (1 to 3)[3]	Ease of Imple-menting (1 to 3)[4]
Water Pricing					
WP-1: Phase in conservation rate structures	High	10	💧 💧 💧 💧 💧	$ $ $	ŏ ŏ
WP-2: Require drought rates as part of utility conservation rate structures	Medium	8	💧 💧 💧	$ $ $	ŏ ŏ
WP-3: Consider using market principles in the allocation of water, while still protecting the fundamental principles of Florida water law	Medium	7	💧 💧 💧	$ $ $	ŏ
WP-4: Improve cost-effectiveness in the next cycle of regional water supply plans	Medium	7	💧 💧	$ $ $	ŏ ŏ
WP-5: Phase in informative billing	Medium	7	💧 💧	$ $ $	ŏ ŏ
WP-6: Require more measurement of water use, including metering and sub-metering					
a) Sub-metering of new multi-family residences	Medium	7	💧 💧 💧	$ $	ŏ ŏ
b) Sub-metering retrofit of existing multi-family residences	Low	6	💧 💧 💧 💧	$	ŏ
WP-7: Adopt additional state guidance on water supply development subsidies	Low	6	💧 💧	$ $	ŏ ŏ

Water Conservation Alternative	Priority	Total Score	Amount of Water Saved (1 to 5)[2]	Cost-Effec-tiveness (1 to 3)[3]	Ease of Imple-menting (1 to 3)[4]
Industrial/Commercial/Institutional					
ICI-1: Consider establishing a "Conservation Certification" program	High	10	♦ ♦ ♦ ♦	$ $ $	ŏ ŏ ŏ
ICI-2: Consider a range of financial incentives and alternative water supply credits	High	10	♦ ♦ ♦ ♦	$ $ $	ŏ ŏ ŏ
ICI-3: Consider cooperative funding for the use of alternative technologies to conserve water	High	9	♦ ♦ ♦ ♦	$ $ $	ŏ ŏ
ICI-4: Implement additional water auditing programs	Medium	8	♦ ♦ ♦ ♦	$ $	ŏ ŏ
ICI-5: Promote utilization of reclaimed water	Medium	8	♦ ♦ ♦ ♦	$ $	ŏ ŏ
ICI-6: Investigate methods of assuring that large users from public suppliers have the same conservation requirements as users with individual permits	Low	6	♦ ♦ ♦	$ $	ŏ
Indoor Water Use					
IWU-1: Expand programs to replace inefficient toilets	High	10	♦ ♦ ♦ ♦ ♦	$ $ $	ŏ ŏ
IWU-2: Require that inefficient plumbing fixtures be retrofitted at time of home sale	High	9	♦ ♦ ♦ ♦	$ $ $	ŏ ŏ
IWU-3: Provide incentives to retrofit inefficient home plumbing fixtures	High	9	♦ ♦ ♦ ♦	$ $ $	ŏ ŏ
IWU-4: Support national dishwasher and clothes washer standards; offer incentives for purchasing efficient washers	High	9	♦ ♦ ♦ ♦	$ $ $	ŏ ŏ
IWU-5: Create a water auditor inspection program for the sale of new and existing homes, supported by a refundable utility service fee	Medium	8	♦ ♦ ♦ ♦	$ $ $	ŏ
IWU-6: Coordinate and expand the statewide water conservation campaigns	Medium	8	♦ ♦ ♦ ♦	$ $	ŏ ŏ

Water Conservation Alternative	Priority	Total Score	Amount of Water Saved (1 to 5)[2]	Cost-Effec-tiveness (1 to 3)[3]	Ease of Imple-menting (1 to 3)[4]
RW-1: Encourage metering and volume-based rate structures for reclaimed water service	High	10	● ● ● ● ●	$ $ $	ŏ ŏ
RW-2: Education and Outreach	High	9	● ● ● ●	$ $	ŏ ŏ ŏ
RW-3: Facilitate seasonal reclaimed water storage (including ASR)	High	9	● ● ● ●	$ $ $	ŏ ŏ
RW-4: Link reuse to regional water supply planning	High	9	● ● ● ●	$ $ $	ŏ ŏ
RW-5: Implement viable funding programs	High	9	● ● ● ● ●	$ $	ŏ ŏ
RW-6: Promote agency support of groundwater recharge and indirect potable reuse	High	9	● ● ● ● ●	$ $	ŏ ŏ
RW-7: Encourage reuse in Southeast Florida	High	9	● ● ● ● ●	$ $	ŏ ŏ
RW-8: CUP incentives for utilities that implement reuse programs	Medium	8	● ● ● ●	$ $	ŏ ŏ
RW-9: Encourage use of supple-mental water supplies	Medium	7	● ● ●	$ $	ŏ ŏ
RW-10: Assist in ensuring economic feasibility for reuse utilities and end users	Medium	7	● ● ●	$ $	ŏ ŏ
RW-11: Encourage reuse system interconnects	Medium	7	● ● ●	$ $	ŏ ŏ
RW-12: Enable redirection of existing reuse systems to more desirable reuse options	Low	6	● ● ●	$ $	ŏ
RW-13: Facilitate permitting of backup discharges	Low	6	● ●	$ $	ŏ ŏ