Kanapaha—Water Reuse Paradise

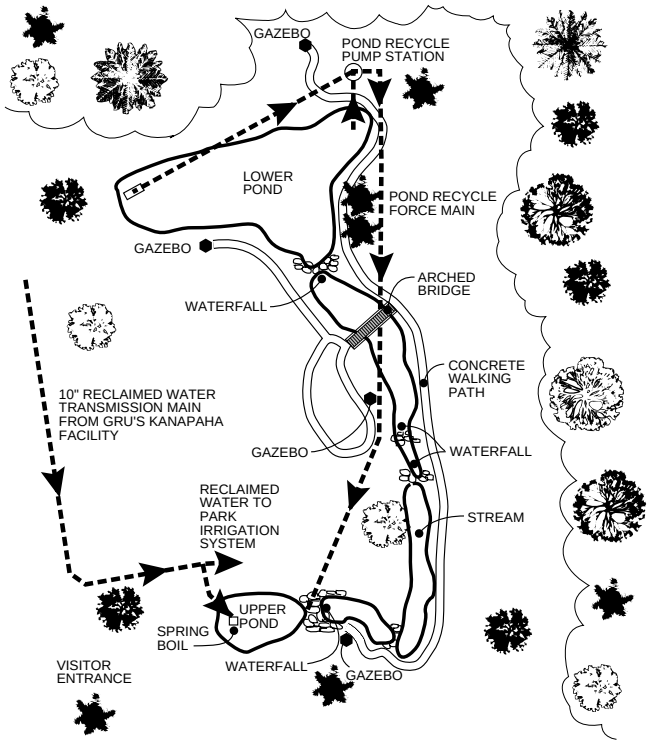
Steve Yeats, David Richardson, and Ed Regan

The Kanapaha Botanical Gardens, a 62-acre botanical park near Gainesville, features plants and trees native to north central Florida, as well as many rare and unusual plants and trees from around the world. The park is the second largest botanical gardens park in Florida and includes a butterfly garden, vinery, herb garden, bamboo garden, hummingbird garden, rock garden, bog garden, "sink hole garden," palm hammock, fern and wildflower gardens, and a carnivorous plant garden. It is also a wildlife sanctuary and a home to Florida bald eagles and alligators. The park site is owned by Alachua County and the gardens are maintained by the North Florida Botanical Society.

In 1992 less than one-half of the park was developed with display gardens and landscaped features. Further development of the park was limited by the existing irrigation water supply system. At about the same time, Gainesville Regional Utilities (GRU), a municipally owned electric, gas, water, and wastewater utility, was beginning to promote the concept of using reclaimed water for landscape irrigation as a means to expand the effluent disposal capacity for GRU's Kanapaha Water Reclamation Facility (KWRF). The KWRF site, about one-half mile to the north of the Kanapaha Botanical Gardens, presented a unique opportunity to provide a model for reclaimed water use in the community.

GRU approached the North Florida Botanical Society and proposed increased supply of landscape irrigation water with the construction of a reclaimed water transmission main to the park property. GRU also proposed to design and construct an aesthetic water feature that would use reclaimed water and be compatible with the botanical garden park. For GRU, construction and operation of the water garden and supply of reclaimed water to the park's landscape irrigation system would demonstrate to the local community the safe, aesthetic, and beneficial use of reclaimed water. For the North Florida Botanical Society, the reuse project would allow full development of park property for additional theme gardens, nursery facilities, picnic areas, and other irrigated landscape features.

Continues Page 37



Water Conservation Program Resource Guide

Rene Mathews and Norman Davis

o you feel at a loss in developing recommendations for water conservation programs?

Water conservation is a vital planning element for any water utility. The myriad of water conservation mechanisms includes both supply-side and demand-management options. General measures are mandated by regional water management districts as conditions of water use permits. The specific means to achieve these measures are the issue the utility must struggle with.

When it comes to implementing specific water conservation programs, decision makers often want to base decisions on past experience by other local or regional utilities. Also, the experience of others is invaluable in directing the implementation of programs. For those responsible for the management of water resources, contact points for successful programs are necessary. This was the impetus to the development of the "Conservation Resource Guide" by the Water Conservation Committee of FSAWWA. Printed by the South Florida Water Management District, it is available to interested persons.

The guide is intended to provide a quick reference of municipalities, utilities, and consultants who have experience in implementing specific conservation programs. It is divided into various categories of water conservation programs, as follows:

Economic Incentives
Utility Management
Regulatory Codes
Wastewater Reuse
Landscape and Irrigation Programs
Plumbing Retrofit Programs
Commercial/Industrial Programs
Educational Programs
Research

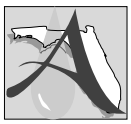
Contacts for each entry are provided so that information can be requested directly, encouraging dialogue to help ensure the success of upcoming water conservation programs, and the ultimate protection of Florida's water-related resources. This should help alleviate pitfalls experienced by others.

Copies of the "Conservation Resource Guide" are being mailed to FSAWWA members. Other interested parties may request a copy by sending a self addressed, stamped envelope to the attention of Rene Mathews, Hazen & Sawyer, P.C., 2101 Corporate Boulevard, Suite 301, Boca Raton, Florida 33431.

Rene Mathews is with Hazen & Sawyer, Boca Raton. Norman Davis is the Hillsborough County water conservation coordinator.

FSAWWA Water Conservation

Charles A. Lees



call for entries went out last December to all FSAWWA members to enter the annual water conservation awards competition. As always, many excellent entries were received and were judged in the areas of research, planning, execution, and evaluation, as well as how much effort was put into that program. The accompanying support material, binder and presentation, and creativity of the program were taken into consideration, and every part of a program in each category was given a numerical grade by each judge. The grades for each entry were then averaged and the high grade in each category was the winner. Happily, there was little variation in the marks from judge to judge, and each of the winners was unanimous. They were excellent entries of outstanding programs, and each of them received an award last April at the annual Florida Water Resources Conference.

Public Relations was won with "Do Your Part" by SWFWMD with an in-depth and far-reaching program prompted by the water shortage in the area. The concept was to initiate an aggressive awareness program in which "Do Your Part" would show the successes of individuals, businesses, agriculture, and industry in conserving water. Most awareness programs focus on the need to conserve and how but don't provide the success stories and models by which people can pattern their attempts. The program ran for almost two years with intensive media coverage and is now being expanded in conjunction with other water management districts. For more information contact Honey Rand, SWFWMD, 2379 Broad St., Brooksville, FL 34609.

Reclaimed Water Programs was won by an entry of the same name from the city of Largo. Through education and involvement, the "Sparkling Waters" program has progressed through several expansion phases and now conserves drinking water, decreases effluent discharge into Tampa Bay, and replenishes water being drawn from the aquifer. The project serves 1700 residential and 57 commercial/industrial customers with 6 MGD of reclaimed water. There are plans to double its capacity in the next four years. For more information contact Mike Sepessy, City of Largo, Reclaimed Water, 1000 2nd St., Largo, FL 43641.

Public Education Programs was won by Orange County Water Department with its entry, "Student Detectives." This was an extension of the yearly AWWA "Blue Thumb" program directed toward students during National Water Conservation Week. AWWA gives guidelines for programs, but OCWD went one step farther and created some serious student involvement by adding the "Student Detective" link to its program. Students were asked to search their homes and find the ways they might be wasting water, and then to write them up for discussion in class. Through student involvement, the program was a huge success. For more information contact Karen Snowman, Orange County Water Dept., 8100 Presidents Dr., Orlando, FL 32809.

Rebate Programs was won by Hillsborough County's "Irrigation Rain Sensing Shut Off Devise Rebate Program." After considerable research, the county commissioners adopted a new ordinance and amended the older, rather ineffective one requiring automatic rain sensor shut offs on all irrigation by October 1, 1996. Non-compliance will have fines and possible court appearances. To encourage the installation of sensors on all systems, HCPUD is offering up to $50 upon their installation. For more information contact Norm David, Hillsborough County Public Utilities Dept., 925 E. Twiggs St., Tampa, FL 33602.

Water Conservation Programs was won by Plant City with its entry, "Water Conservation Management." The program was initiated to elevate the importance of the water conservation and the need to focus attention on actively pursuing the same. A new position was created and through sufficient financing, well planned programs, public relations, leak detection, rigid conservation rate structures, and reclaimed water program. Tremendous gains were realized in conservation. In the past three years Plant City reduced the per capita water use rate from 171 to 148 GPD, with a projected reduction to 130 GPD by the year 2001. For more information contact Robert Bedell, City of Plant City, 1802 Spooner Dr., Plant City FL 33566.

Demonstrations and Exhibits was won by Pinellas County's entry of "Xeriscape

Demonstrations On The Pinellas Trail," which demonstrated how Xeriscape can save vast amounts of water yet offer an attractive landscape. Through cooperative effort, two Xeriscape displays were created at access points on the Pinellas Trail, which is a linear park spanning the length of Pinellas County. The public and others will be afforded the opportunity to participate in the expansion of the project and much understanding, good will, and knowledge of Xeriscape has been imparted to the public via this project and the media coverage of it. For more information contact Irma Reinpoldt, Pinellas County Utilities, 14 S. Ft. Harrison Ave., Clearwater, FL 34616.

Conservation Ordinances was won by Orange county's water department with its entry, "Water Restriction Enforcement Program." A water conservation ordinance was developed to effect strict time periods for watering lawns and gardens. Then an enforcement program was created to educate violators and document repeat violators for submittal to the Code Enforcement Board. The objective is to educate everyone about water conservation by handing out educational notices to violators. The notices have no fines associated with them to first-time offenders, but a mechanism is being planned to fine repeat offenders up to $250 a day per violation. Notice and explanation of such action is being done through training sessions for the one hundred employees within the water department with each vehicle having an education book for the driver. For more information contact Karen Snowman, Orange County Water Dept., 8100 Presidents Dr., Orlando, FL 32809.

The Fountain of Youth—Education For Water Conservation

It's no secret that the fresh water resources of Florida are rapidly declining as our population soars. Our young people are already missing out on once-flowing springs, clean clear streams and lakes long gone. Their state is drying up, and we have left them with the responsibility of trying to turn the trend around. Our students see us squabbling daily over who has the right to water, those who have it or those who need it, and they wonder. They hear the arguments among counties, farmers, developers, and manufacturers over restrictions and need, and they wonder.

Although there is always more and more demand for less and less potable water, the people of Florida are one of the highest per capita water users in the world. They now use up to sixty percent of their potable water supply on their lawns and gardens. Such behavior can only be changed through youth education in water conservation and protection. If this not changed, our young will suffer uncompromising water ordinances, exorbitant water rates, heavy fines, severe shortages, unbelievable inconvenience, and moratoriums on new construction, just for openers.

School children are being taught the importance of our most valuable resource and how to conserve it. It is their water that needs to be conserved, and they must grasp the far reaching consequences of squandering an ever declining supply. They must learn early that the quantity and quality of the potable water supply determines the quality of life in their region. Every child, starting in kindergarten, must develop an unconscious habit of water conservation. Young minds are naturally open and can look on the importance of their involvement in water conservation and then practice it throughout their lives. Children, through education, are becoming unrelenting water conservationists as their parents well know, and happily this army is growing each year.

School conservation programs come in all sizes and shapes for each grade, and every one is better than none. The goal is always the same: save the future starting now! Live theater productions entertain and inform; publications teach and inspire; poster and slogan contests stimulate creativity; question and answer tests encourage competitiveness; videos show and explain; and plant tours help demonstrate—all so our children will understand why water conservation is so important now and in the future.

The earlier children are taught the ways of water conservation, the more valuable they will be as stewards of the resource of life. Only through continuing water conservation education in all our schools will Florida's embarrassing per capita water use be drastically reduced in the future.

Charles A. Lees III is with the Water Division of Jacksonville's Public Utilities Department.

The Central Florida Water Celebration

—A Model for Intergovernmental Cooperation

Bill Marcous and Doug Kutz

The Central Florida Water Celebration is one of the largest water related public awareness programs in Florida. Sponsored by the Mid-Florida Water Utility Council, the Water Celebration is a unique blend of information, ideas, and expertise from public and private water utilities, local government, and water management districts.

The Mid-Florida Water Utility Council represents most of the water-related utilities in Greater Orlando, which serve over 300,000 customers. It has met for several years as essentially an informal discussion group of utility managers.

Historically, to bring attention to water issues, utility managers would have open house events, poster contests, and exhibits. At the suggestion of a local television executive, the council agreed to pool its resources into one major event that would allow for broad-based marketing and media support.

A Water Celebration Committee was formed from differing ranks of the utilities to establish the event. Committee meetings began in August of 1991, with a presentation by Wendy Nero on Tampa's Water Fest, and ran steadily to the initial event day, which took place at Orlando's Lake Eola in May 1992. A few thousand people came to the park that day. Subsequent annual events have taken place at Orlando Fashion Square and Altamonte Malls, with several thousand people attending each event. The most remarkable fact about this award-winning educational event is that each utility on the council spent an average of $325 a year on display materials and event costs. This cost does not include man power due to the broad salary ranges of employees, and various amounts of employees representing each utility.

Collaborative Effects

The water celebration emphasizes water-related topics rather than specific utilities, with the positive effects of working together being an unexpected plus. Typically, employee interaction from neighboring utilities is done between management personnel. These exchanges usually take place at conferences and training workshops. Although, interaction is beneficial, the amount of networking and sharing of ideas is somewhat limited at the lower levels of the utility workforce.

The water celebration provides a means of multi-level interaction among utility employees in a way that promotes creativity and relationships. The Water Celebration Event has collaborative effects that help to break down the "we versus them" barriers between employees of neighboring utilities.

This fosters mutual respect and knowledge among employees who have basically the same goal—to serve the customers needs.

The Water Celebration Event is not just a recipe for good public information, it is a formula for developing interaction between individuals who will draw on the expertise of peers in the performance of their jobs.

Water Reuse in Orange County

Christopher J. Brooke and Victor J. Godlewski, Jr

range county has been and continues to be one of Florida's major suppliers of reclaimed water. It currently has three major urban service areas comprising approximately 188 square miles: the Eastern Service Area, the South Service Area, and the Northwest Service Area, which produce nearly 26 million gallons per day of reclaimed water. The methods of water reuse include groundwater recharge; irrigation of food crops, golf courses, roadway medians, and commercial areas; created and natural wetland systems; and cooling tower make-up water.

A regional wastewater treatment facility is located within each of the three wastewater service areas. During 1993 an average daily flow of 25.8 MGD was collected, treated, and reused by the county's regional facilities. DEP recognizes Orange County as the "Number One" wastewater reuser in the state. This distinction is shared by the cities in Orange County that have reuse programs, including Orlando, Winter Park, and Apopka.

Future Reuse in Orange County

A major urban reuse program is being implemented in the South Service Area. Planning is underway for a potential urban reuse program for the Eastern Service Area. The county will continue to focus on such large scale users of reclaimed water as industrial users and golf courses. However, the county also recognizes that reclaimed water use will ultimately trickle down to smaller size users, such as single family homes.

Eastern Service Area

The rapidly growing Eastern Service Area includes approximately 73.5 square miles. The Eastern Wastewater Reclamation Facility (EWRF) is designed for a capacity of 19.0 MGD. The average wastewater flow was approximately 7.2 MGD during calendar year 1993. The EWRF employs the Bardenpho biological nutrient removal (BNR) process. In addition to BNR, the liquid stream treatment processes at the EWRF include filtration and disinfection. The EWRF was designed to treat the reclaimed water to AWT Standards. Reclaimed water from the EWRF is distributed for reuse as follows: rapid infiltration/ groundwater recharge: 2.5 MGD, cooling tower water: 3.7 MGD, and wetlands enhancement: 5.0 MGD.

The EWRF's wetland system consists of 150 acres each of natural wetlands and created wetlands. all of which function as habitat for wildlife. The system is currently permitted to receive 5 MGD of flow but is designed to accept 6.2 MGD. Reclaimed water from the EWRF passes through the wetland system to a tributary of the Big Econlockhatchee River. A nearby power plant, called the Stanton Energy Center and owned and operated by the Orlando Utilities Commission, uses reclaimed water for cooling tower supply purposes.

The projected average daily flow for the EWRF in 2005 is 24.6 MGD. It is expected that additional disposal capacity for the EWRF will involve reuse. The cooling water demand from the SEC is expected to increase as the power plant expands. The demand for reclaimed water by the SEC could reach 8 MGD by 1997.

The county is currently in the process of evaluating the potential for additional reuse capacity within the Eastern Service Area.

South Service Area

The South Service Area covers approximately 66.5 square miles. The regional facility serving this area, the South Water Reclamation Facility (SWRF), is permitted for 30.5 MGD. The average flow during 1993 was 16.1 MGD. The SWRF currently provides secondary treatment plus filtration. High level disinfection is provided as required by the state for reuse on public access areas. A 7.5 MGD train of liquid stream treatment, expandable to 15 MGD, has been master planned for the Bardenpho BNR process. Additional BNR process tanks may be added as needed to meet more stringent reclaimed water quality standards.

Most of the reclaimed water currently produced by the SWRF (14 MGD) is pumped to the Water Conserv II/Southwest (SW) 201 system, which provides reclaimed water for irrigation of citrus trees and groundwater recharge via rapid infiltration basins (8 MGD).

In addition to the Water Conserv Il/SW 201 system, the SWRF has other options for water reuse. These include a 4.4 MGD RIB system, which is not affiliated with the Conserv Il/ SW 201 System, and 1.2 MGD for golf course irrigation. The South Service area is the county's only service area where urban reuse is currently practiced.

The projected wastewater flow in the South Service Area for 2005 is 30.6 MGD. Additional reuse capacity will be needed to meet future needs for effluent disposal capacity. The feasibility of reuse within the area was established in 1991[1]. The plans for the reclaimed water transmission system were updated by Boyle in l993[2]. The estimated potential demand for reclaimed water in the area is 20.3 MGD[3]. The future users of reclaimed water in the area include single and multifamily developments; industrial, commercial and office developments; golf courses; and other recreational users. The project has been divided into three phases.

The estimated capacities for Phases 1, 2, and 3 are 8.5, 6.1, and 5.7 MGD, respectively.[3] The current plans for the area include the construction of over 50 miles of pipeline, ranging from 8 to 42 inches in diameter. The estimated project cost for all three phases of development is $29 million, or $1.43 per gallon of estimated reclaimed water daily demand. To reduce the cost of the project, the county has been successful in converting abandoned force mains to reclaimed water transmission mains. The abandoned pipelines are cleaned, flushed and disinfected prior to being placed into service.

As part of the Phase I expansion, a reclaimed water pump station is being planned for construction at the SWRF. The station will be designed for a firm capacity of 43 MGD[4]. The peak hour to average day flow factor for this facility will be 2.15. Therefore, the pump station will have the capability of delivering the entire average daily volume of reclaimed water over an eleven hour period. The number of pumps in operation and the speed of operation will be controlled to maintain a constant

Cooperation of Exhibit Construction and Manning

Employees who develop the ideas, build the displays, and co-man the exhibits during the event number about 150 people. The information categories or themes, are divided amongst the groups of utilities participating. There are many themes presented in this event such as: water plants, wastewater treatment plants, distribution systems, indoor and outdoor conservation, stormwater, public information and so on.

Construction of the display board's topics were tackled by pairs of utilities who had expertise available in a particular topic area. They developed display boards by drafting illustrations, using photographs, and/or developing models, and conducted "work days" to construct the pictorial display boards.

At show time these groups worked together to erect, and man the displays at a local mall or a popular park. Table top displays show the actual field materials such as pipes and meters and tools used to do utility jobs. This gave the exhibitors a chance to explain their roles and the exhibitees a chance to handle the wares.

Event teamwork also carries over to the most entertaining aspect of the water celebration—the childrens activities. Throughout the day children participate in coloring and fire hydrant painting contests, while kids of all ages are invited to try their hand at the water graffiti paper scroll, on which free style water conservation pictures and slogans are drawn. Entertainment is provided by local attractions, such as Sea World and Wet 'N Wild and radio station Mix 105.1 FM. Like the exhibits, the fun activities are coordinated by a team of volunteers from a variety of utilities.

Joint Activities Create New Initiatives

The Mid-Florida Water Utility Council developed into a unit with more clout than a single user. For example, it sponsored a video about proper lead and copper hometap sampling techniques in conjunction with a local public broadcasting station program. In return for airing the training video in primetime, the utility council produced a billing message to customers endorsing both programs. The moral of the story: a single utility has the potential to reach perhaps 100,000 viewers, but the council had the ability to reach over 300,000. All the utilities benefited from the programming at basically no cost, since the bills go out either way. Another example of joint activity is the exchange of emergency response equipment listing among council members, which will help expedite mutual aid assistance.

In order to avoid a large competition for media coverage of many open house events, combine your people and resources under the umbrella of a group of utilities and government agencies. This will allow the group to educate a larger number of people about the water message for a nominal amount of money. The collective clout of the group and the collaborative effects among utility employees will become an added plus. Setting up a similar water celebration event can create positive effects for other utility groups. For more information about the water celebration, please contact Bill Marcous at 407-330-5649 or Doug Kutz at 407-836-6861.

Bill Marcous is with the city of Sanford. Doug Kutz is with Orange County Public Utilities, Water Department.

downstream pressure. The pump station will initially withdraw reclaimed water from two 5-million gallon covered storage tanks.[4]

A major Phase I reclaimed water transmission pipeline project is also in the final design stages for the South Service Area. Over seven miles of pipeline will be constructed ranging from 16 to 36 inches in diameter. The project will supply reclaimed water to two golf courses, including the Bay Hill Club, which is the site of the Nestle Invitational Professional Golf Tournament. The two golf courses have requested a total daily demand of 1.3 MGD.

The SWRF will also be in position to take advantage of new reuse opportunities associated with the Conserv Il/SW 201 System. The design of the latest expansion of the system's reclaimed water distribution network has been completed and will soon be under construction. This most recent expansion will provide reclaimed water to customers with an estimated 5.0 MGD of irrigation demand to be shared equally by Orange County and the city of Orlando.

An innovative project that will also involve the SWRF is the Orange County National Golf Course, which has been launched by Orange County and the city of Orlando. It includes a partnership between government and private enterprise. The county advertised for private firms to provide proposals for converting 590 acres of county and city owned property into use as a golf course. Additionally, the design of the 45 hole golf course and other proposed improvements would have to maximize the use of reclaimed water through high rate and irrigation systems.

Orange County and the Orlando have entered into a long-term lease with a private firm to permit, design, construct, and operate the project. Investment by the private firm will be recovered through the fees charged at the golf course.

The proposed project will handle up to an estimated 5.0 MGD of reclaimed water. In addition to irrigation of turf and landscaping, reclaimed water may also be directed to sand traps waste bunkers which are also rapid infiltration basins. Certain areas of the project site will contain subsurface irrigation in order to maximize reclaimed water application and at the same time keep the turf surfaces playable.

Northwest Service Area

The Northwest Service Area is approximately 47.5 square miles in size. The regional facility that serves this area, the Northwest Water Reclamation Facility (NWRF), is permitted for 3.5 MGD. The average flow for the NWRF during 1993 was 2.5 MGD. The NWRF has been master planned for the Bardenpho BNR process. It is currently operated in a nitrogen removal mode using a preanoxic zone in accordance with the Modified Ludzack Ettinger process. Additional BNR process tanks may be added in the future to meet more stringent reclaimed water quality standards. The liquid stream process train does not currently include filtration.

All the reclaimed water currently processed at the NWRF is used for groundwater recharge via rapid infiltration basins. The RIB facilities are located within the 700 acres which make up the site for the NWRF.

The projected wastewater flow for the NWRF in 2005 is 6.2 MGD. It is anticipated that additional effluent disposal capacity will be developed through the use of rapid infiltration basin and irrigation of some of the neighboring agricultural areas. The NWRF is located near Apopka, known as the "Indoor Foliage Capital of the World." There are hundreds of acres of indoor nursery operations in the vicinity of the NWRF.

Stressing conservation measures too strongly during the dry season may modify use patterns during the wet season...

A plan is underway to expand the capacity of the NWRF from 3 .5 to 7.0 MGD. It is anticipated that filtration will be added to the liquid process train. With the addition of the filtration process, the reclaimed water produced at the NWRF will be suitable for use on public access areas.

Future Challenges

Generally reclaimed water is not needed for irrigation use when it is raining. Excess reclaimed water can be stored for later use; however, in most cases, the large storage volumes required are difficult to accommodate. Many reclaimed water suppliers are asking regulators to take a practical look at limited wet weather surface discharge for reclaimed water systems. Without the option of wet weather disposal, many utility systems, including Orange County, have had to construct expensive alternative disposal systems to handle wet weather conditions.

On the flip side are conditions that promote high demands for reclaimed water, which generally occur during the springtime dry season. There is no question that reclaimed water should be used wisely and the customers should be advised to prudently use the resource, but at the same time a reclaimed water system does function as an effluent disposal system. Stressing conservation measures too strongly during the dry season may modify use patterns during the wet season as well.

When reclaimed water flows are insufficient, supplemental sources of water can be used to meet the demand. Supplemental water supplies can play a vital role in maximizing the use of reclaimed water throughout the remaining parts of the year[5]. However, regulators in Florida are often leery of allocating other water sources for use in a reclaimed water system.

References

1. Camp, Dresser & McKee, South Service Area Reuse Feasibility Study, October 1991 .
2. Boyle Engineering Corporation, South Service Area Reuse System Implementation Report, June 1993.
3. Boyle Engineering Corporation, Preliminary Design of Improvement to the Hunter's Creek Reclaimed Water System, December, 1993.
4. Boyle Engineering Corporation, South Water Reclamation Facility Reclaimed Water Pumping and Storage Facilities Preliminary Design Report, November 1993.
5. Godlewski, Jr., Victor J., Planning for the Drought: Supplemental Supply Considerations for Reclaimed Water Systems, Proceedings 68th Florida Water Resources Conference, November 1993.

Christopher J. Brooke, P.E., is a staff engineer with Orange County Public Utilities. Victor J. Godlewski, Jr., P.E., is a senior engineer with Boyle Engineering Corporation.

Integrated Resource Planning

Meeting Multiple Objectives of Managing Florida's Water Resources

Wendy Nero

The events of the past year suggest that there's considerable focus on Florida's water resources and how they should be managed. We saw the creation of two groups, the House Select Committee on Water Policy and the Governor's Water Management District Review Commission, both charged with improving the fundamental way in which water is presently managed. During the legislative session, bills mandating the use of reclaimed water and a move to limit the use of underground injection wells were introduced. Another proposed bill would have allowed water suppliers to mitigate wellfield impacts on wetlands. The high profile and varied nature of the draft legislation indicates that developing acceptable water supplies and effectively managing Florida's water recourses will become increasingly complex and challenging. Many factors contribute to this challenge:

- Scarcity of acceptable water resources
- Numerous and often competing demands for water supplies
- Need for environmental preservation and/or restoration
- A more knowledgeable and participatory public
- The high cost of water supply development
- The future uncertainty of all these factors

Because of the number, magnitude, and interrelated nature of these issues, "business as usual" in water resource management will no longer be sufficient. We must use an integrated resource management approach to meet the objectives of regulatory agencies, provide water at a reasonable cost, satisfy the needs of the environment, and maintain quality of life.

Integrated Resource Planning Defined

Integrated Resource Planning (IRP) differs from traditional water supply planning because it serves multiple objectives and considers a wide range of conventional and innovative water supply strategies for evaluation. IRP incorporates least-cost planning, but also considers the optimal mix of alternative water supplies, which may or may not result in selection of the least-cost plan. Alternative supplies which might be evaluated in the resource plan include but are not limited to:

- Water reuse (indirect potable, urban, recreational and agricultural irrigation, cooling tower make-up water, environmental restoration, etc.)
- Aquifer Storage and Recovery (ASR)
- Development of lower quality sources using advanced treatment technologies (i.e., reverse osmosis)
- Surface water storage and recovery
- Conservation technologies

These options are compared on a "level playing field" with factors such as reliability, uncertainty, and externalities weighed during the evaluation. The IRP approach is based on clearly stated policy objectives and allows for meaningful public involvement throughout the process.

Elements of an IRP

A number of common elements are found in different IRP applications, but there is no single right way to carry out the process. In fact, the most effective IRPs are developed by customizing the approach to better meet the needs of the study area. Certain elements, however, are common to all IRPs. These include: (1) clearly-defined policy objectives; (2) an open and participatory process; (3) evaluation of supply and demand options; (4) economic analysis which incorporates externalities; and (5) the calculation of risks and reliability.

Clearly-Defined Policy Objectives

To successfully develop an IRP, policy objectives that reach well beyond traditional planning goals, must be clearly defined. Traditionally, water supply objectives centered on the ability to develop water supplies at the lowest possible cost with a prescribed level of risk and reliability. With IRP, a water supplier will likely try to achieve multiple and often competing policy objectives, such as minimizing the risk of water shortage, preserving wetland habitat, or using the highest quality water for the greatest public need, maximizing water use efficiency, to name a few. Nonetheless, each must be explicitly stated so that alternatives can be weighed against the established, guiding objectives. In defining the policy objectives, consideration must be given to regulatory, organizational, and political and cultural opportunities and constraints.

Open and Participatory Process

Involving interested and potentially affected stakeholders differentiates IRP from traditional planning approaches. Even though the mere thought of opening up the decision process for public involvement strikes fear in the heart of most public officials, it is a critical and valuable undertaking. There are a number of reasons. First, the public is far more interested, knowledgeable, and active than ever before. The water industry has enjoyed a fair amount of anonymity and autonomy in the past; a scenario which is gone forever. This is especially true when environmental impacts or health effects are concerned. Secondly, a wide range of "publics" automatically will be affected because a variety of alternatives are being considered. These diverse stakeholders will have a number of valid, previously overlooked ideas worthy of consideration.

Public involvement provides an opportunity to hear from these stakeholders—elected officials, ratepayers, environmental groups, and concerned citizens—early in the process, which minimizes the risk of being "blind-sided" later in the process. With early, meaningful input, the resulting project will have public "buy-in," be more comprehensive, have a greater chance of being permitted, and be more likely to remain on schedule.

Evaluation of Supply and Demand Options

IRP is similar to traditional planning in that a number of supply alternatives are identified for consideration. IRP differs, though, in that demand-side (conservation) alternatives are included and evaluated with the same rigor as conventional or innovative supply options. The important features of this element of an IRP is the identification of as many alternatives as possible and screening of the options according to carefully selected criteria. The evaluation criteria should reflect the policy objectives and result in the selection of options

which best achieve the stated objectives. Evaluation criteria will likely vary depending on the type of measure being considered, but might include:

- Water quality and treatment requirements
- Expected life of the option
- Waver availability
- Ability to obtain permits
- Public acceptance
- Water savings
- Demonstrated feasibility

It is important to begin the process with a wide range of alternatives, and conclude with a manageable number of realistic water supply solutions.

Economic Analysis Which Incorporates Externalities

The level of analysis with an IRP is consistent with traditional supply planning. It includes information regarding cost (expressed as the present value of capital and operating costs), unit cost of the alternative (e.g., $/1000 gallons of water provided) and availability. Two analyses make IRP different from traditional planning: the inclusion of externalities in economic evaluation and the evaluation of conservation measures. To arrive at the true cost of any water supply development option, externalities must be identified and quantified. For example, if an identified groundwater source pumped to capacity will result in damage to adjacent wetlands, at least three scenarios impacting water supply costs must be assessed: (1) incorporating the cost of mitigating the impacts; (2) reducing pumpage and adding an additional water supply alternative to the resource mix; and (3) transferring the cost stemming from lost or damaged wetlands to society.

IRP also includes and requires the same rigorous consideration of conservation alternatives. For each conservation measure considered, water savings and total program costs (expressed in present worth) must be determined. This level of analysis allows supply and demand-side alternatives to be compared fairly in terms of cost and return on investment.

Calculation of Risks and Reliability

An essential element of IRP is the calculation of risks and reliability. This is central to the integration process and allows for accurate assessment of trade-offs among supply scenarios. Because any planning for the future is dependent upon a variety of forecasts, uncertainty is inherent in any plans based upon those original projections. Four methods are commonly used for assessing the risk associated with differing resource scenarios: sensitivity analysis, scenario analysis, probability analysis, and decision analysis.

Sensitivity analysis assesses the impact that individual variables will have on the resource plan. If the resource mix is highly sensitive to any of the variables, it may be beneficial to collect more data and improve forecasting methods of the highly sensitive variable. For example, if a water supply is highly sensitive to water quality issues, more research may be necessary to further define water quality trends, factors affecting water quality, and treatment enhancements to limit the amount of risk associated with that variable.

Scenario analysis is similar to sensitivity analysis in that the stability of the resource mix is measured against changing variables. With scenario analysis, however, many assumptions are changed simultaneously.

Probability analysis takes the above approaches one step further and assigns a probability of occurrence of any of the forecast variables. For example, it is known that water demand forecasts are variable and largely influence water supply planning initiatives. In this example, a probability of demand forecast being low is 20 percent, high 20 percent, and medium 60 percent. These probabilities are adjusted and the effect on the optimal resource mix is observed

Decision analysis is the most complex means of assessing uncertainty, and may include aspects of all three of the previously discussed approaches. Decision analysis requires that all variables be quantified to some degree and results in a "decision tree," or suggested resource investment path, which displays potential outcomes of the plan based on the input values of multiple decision variables.

Benefits of IRP as a Water Resource Planning Tool

IRP possesses numerous advantages compared to traditional planning. By its very nature, IRP increases the likelihood of successfully planning, permitting and developing water supplies. Why? Because policy objectives are clearly identified and crafted with considerable input by affected stakeholders. Because the public is involved, the process is automatically broadened and results in a wider, more creative range of alternatives. Public and political support for the plan is enhanced because environmental interests are included in the analysis in the form of efficiency (conservation), wetland preservation or mitigation, and regulatory issues. From a risk of investment standpoint, IRP is advantageous because it often, but not always, results in a series of incremental supply additions with corresponding incremental investments. The financial risk associated with this approach is less than with conventional supply investments, which tend to be singular, large investments in one major water source. If planning assumptions supporting such a large investment are wrong, the cost of the error is much higher.

Another benefit of IRP is the ability to make comparisons of alternatives based upon tradeoffs associated with each option. For example, least-cost planning would select the measure that results in the lowest cost, and traditional planning would select the option with the least risk of supply shortfall. With an IRP approach, a combination of both or possibly neither alternative might be chosen. Although least-cost planning is used to establish a list of alternatives, the combination of measures, weighed against the policy objectives, might result in a resource mix which includes a higher total cost but also minimizes environmental damage. The optimal mix of water resource alternatives will vary from place to place depending on the options available and the stated policy objectives.

Finally, IRP results in a series of unique combinations of water resource alternatives (i.e., ASR, reuse, and conservation) with distinct and measurable characteristics. Consideration of these discrete options inherently leads to better decision making. When policy makers are faced with clearly differentiated choices where the benefits, costs, risks and societal values are incorporated, the outcome can only result in the greatest good for the community.

Wendy Nero is with CH2M HILL's Tampa office.

Orlando Easterly Wetlands

Success in the Use of Reclaimed Water for Environmental Enhancement

Jo Ann Jackson, Thomas L. Lothrop, and Mark D. Sees

In mid-1987, the Orlando Easterly Wetlands began receiving reclaimed water from the city's Iron Bridge Regional Water Pollution Control Facility. The wetlands were constructed to provide additional treatment for a design annual average daily flow of 20 MGD prior to discharge to the St. Johns River. Designed primarily to reduce nitrogen and phosphorus concentrations in the Iron Bridge effluent, the wetlands have continued to perform better than initial expectations.

The wetlands include three vegetative communities: a 410-acre deep marsh composed primarily of cattail and bulrush and designed to accomplish nutrient removal, a 380-acre mixed marsh composed of over 60 submergent and emergent herbaceous species and designed to provide wildlife habitat and additional nutrient removal, and a 400-acre hardwood swamp originating from the planting of over 100,000 tree seedlings with a herbaceous understory. The hardwood swamp was designed with the primary function of wildlife habitat. An approximately 90-acre lake is located within the hardwood swamp. The lake was constructed to enhance wildlife habitat and to provide fill material for berm construction.

The wetlands are divided into 17 cells as shown in Figure

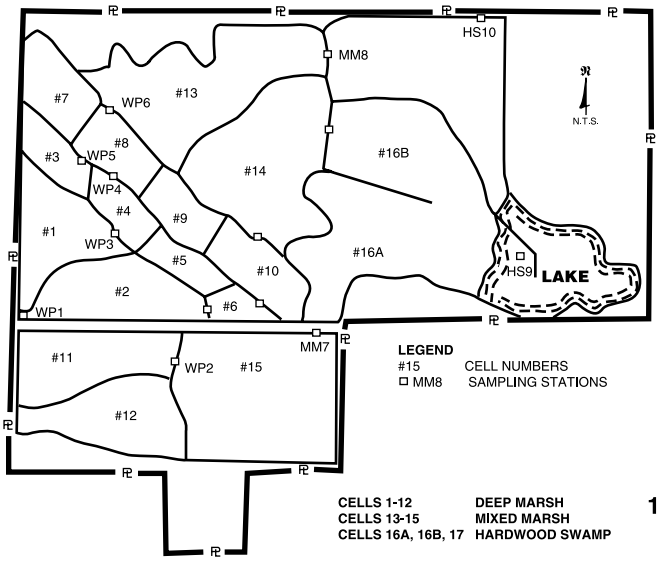


Figure 1. Wetlands layout

1. Samples are collected from a total of 10 stations. Station WP1 represents the influent and HS10 the effluent. These stations are monitored with composite samples collected and analyzed daily. The remaining stations are monitored monthly over a three-consecutive-day period.

The influent flow is split into thirds and travels through three separate flow pathways. The northern pathway has been used to represent overall system performance. This pathway is monitored at stations WP3, WP4 and 5, WP6, and MM8.

Water leaving the wetlands is conveyed in a ditch along the north property boundary to adjacent natural marshes bordering the St. Johns River. Control structures allow the water to flow directly through the ditch to the St. Johns River or across the natural marshes.

The wetlands began receiving 8 MGD of reclaimed water in July, 1987. In 1988, flows were increased to approximately 13 MGD because of excellent performance and because 8 MGD was not sufficient to maintain wetland vegetation. Annual average flows have remained slightly under 13 MGD through 1994. Performance has continued to be excellent and flow was increased to approximately 16 MGD in January 1995. The present schedule is for the flow to be increased to 18 MGD in 1995 and to the 20 MGD design flow in 1996.

Wetland Performance

Figures 2 and 3 illustrate the seven-year average and 1994 average concentrations of total nitrogen (TN) and total phos-

Continues Page 36

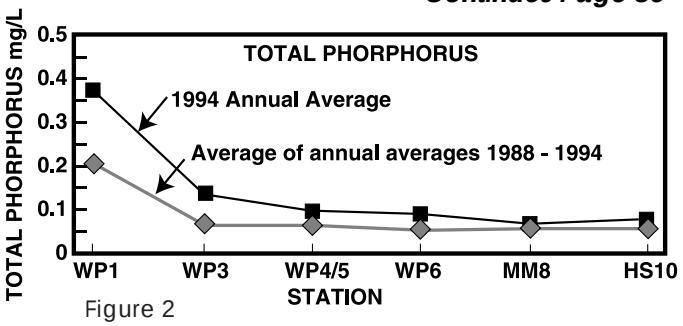


Figure 2

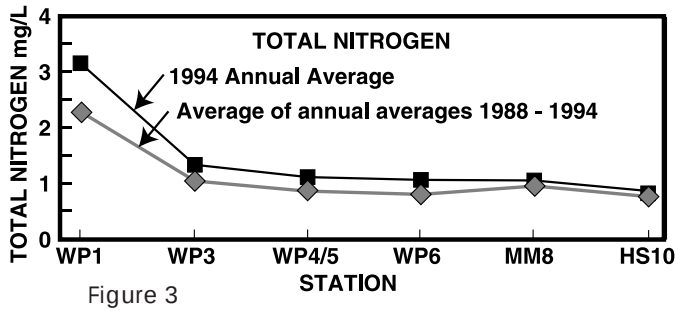


Figure 3

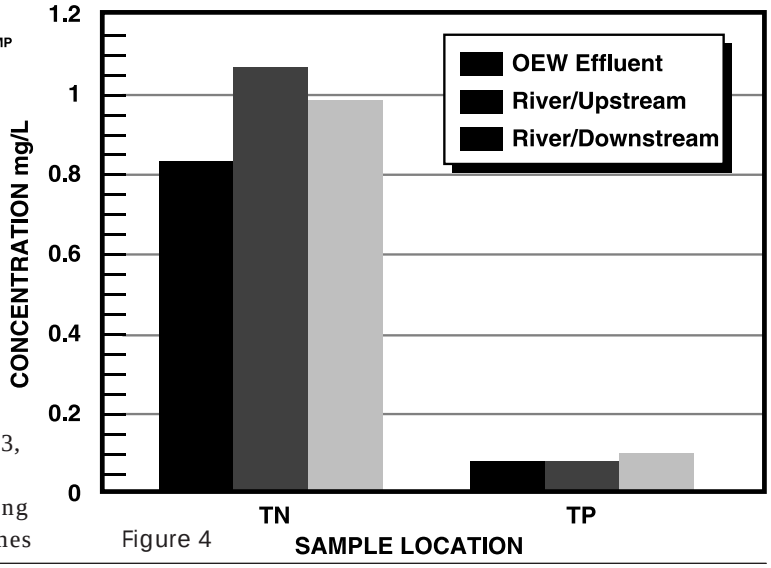


Figure 4

Automatic Rain Sensing Shut-Off Devices

Norman Davis

How many times have you been driving during a rain and noticed irrigation occurring at various properties? It's ridiculous to waste such a valuable natural resource as water during an event that provides precipitation naturally. Most individuals likely do not knowingly allow it to happen, yet in today's myriad of on-ramps and cloverleafs in the Information Superhighway, who has the time to check the irrigation controller? Not to worry, full automation has arrived for irrigation systems.

Automatic rain sensing shut-off devices are a low-cost addition to an irrigation system. When properly installed, they keep tabs on local rainfall conditions and prevent unnecessary sprinkling by temporarily interrupting the pre-set schedule. In Florida, at least for new lawn irrigation installations, the devices are mandatory.

Florida gets its share of rain, a lot of rain— 50-54 inches annually in most areas of the peninsula, much more in the panhandle. Most of it falls in a season that spans only a few months, from June through November. And if more than a few days pass without precipitation, ornamental plant materials may suffer heat stress. The Sunshine State has recurring water crises, which of late have been more of the nature of shortages rather than deluges.

Florida is a second home to many *snowbirds* who escape the frigid cold of the north during the winter. Those who own a second home expect to arrive each year to lush, tropical lawns. Meanwhile, they leave their northern homesteads with the grass going into dormancy. For the part time resident, an automatic rain sensing shut-off device makes sense from the standpoint that the device automatically checks local rainfall. This allows the irrigation system to dispense water if natural rainfall has been inadequate during periods of vacancy.

Our temporary residents are not the only ones who have reason enough to use automatic shut-off devices. Rainfall in Florida usually occurs in deluges, with minimal if any rain down the block or a few miles away. If a homeowner is away from home while the rain event occurs, unless they monitor it with a rain gauge, they have no absolute knowledge whether their home received rain.

New lawn irrigation systems in Florida must have automatic shut-off devices installed

Since mid-l991, new lawn irrigation systems in Florida must have automatic shut-off devices installed. The specific state statute reads as follows:

"373.62 Water Conservation; automatic sprinkler systems. Any person who purchases and installs an automatic lawn sprinkler system after May 1, 1991, shall install a rain sensor device or switch which will override the irrigation cycle of the sprinkler system when adequate rainfall has occurred."

The interpretation of this language is loose. Often local governments accepted integral switches on the controller as a way to satisfy the requirement. Recently there has been a shift in the interpretation. Increasing numbers of local governments are inspecting for the proper installation for issuance of a certificate of occupancy.

The Florida Water Wise Council offers an attractively priced tri-fold informational brochure, Sensible Sprinkling, which explains rain shut-off switches in layman terms. The brochure is available in quantities by contacting the council at 813-366-7277, or in writing at The Florida Water Wise Council, Post Office Box 617365, Orlando, FL 32861-7365.

At least one local government, Hillsborough County, requires automatic shut-off devices on all irrigation systems by a specific date. The county has paired the requirement with an attractive rebate program as an incentive to those who may be on the fence about installing a rain switch. For information on this local ordinance, the rebate program, and enforcement of the ordinance, contact the author at the Hillsborough County Public Utilities Department, 925 East Twiggs Street, Tampa, Florida 33602.

So how do these devices work? And what is the proper way to install one? Most operate on the principle of interrupting the irrigation cycle when a predetermined amount of rain has fallen. The controller maintains its preset scheduling, but the valves will not open until the rain switch deactivates through evaporation. An important aspect of the installation is to be sure that the device is clear of any overhangs. If not, rainfall may be blocked or runoff concentrated, either of which will adversely affect the accuracy of the device. Some individuals prefer to wire the switch into the common line for the valves, rather than directly to the controller. Either manner works well, but the former can lessen the need to route wire through tricky areas. If a bypass switch is included, then the irrigation manager can easily conduct routine maintenance.

What about the water-saving capabilities of these devices? The jury is still out. Water savings is directly proportional to the amount of landscaped area served by the irrigation system. A simple six-zone irrigation system operated at 30 minutes per zone and using water at 15 gallons per minute might consume 2,700 gallons during one irrigation cycle. Presuming the device will prevent eight irrigation events annually, this one location can save 21,600 gallons in one year. A larger system can potentially save much more. In a community-wide program, these demand-management tools can be a part of a comprehensive water conservation program.

Norman Davis is the Hillsborough County water conservation coordinator and chairperson of the FSAWWA Water Conservation Committee and the Florida Water Wise Commercial/Industrial/ Manufacturing Council.

Innovative Water Conservation Ratemaking

Robert J. Ori and E. Scott Barrington

Water conservation and water conservation ratemaking have become critical issues for utilities throughout Florida and South Florida in particular. Increasing pressures from regulatory agencies to reduce per capital consumption levels while also providing water for a rapidly expanding customer base and meeting increased revenue demands from management and elected officials have made these tasks onerous indeed.

To date, a typical response has been to institute an "inverted or including-block" structure on the single family customer class. The high irrigation usage demands of this class relative to other classes in the community and the class's apparent homogeneity have made it an obvious first target for the introduction of these rate structures. However, in communities where there are great differences between single family customers, particularly in irrigation usage, these rate structures can result in great inequities in customer charges.

The town of Gulf Stream, located between Fort Lauderdale and West Palm Beach, is one such community with great differences in water consumption between single family customers. The wide variety of lot sizes and customer needs presented great challenges to the development and implementation of a fair and equitable conservation rate structure. While Gulf Stream's single family customer base is far from typical in many respects (e.g., household income and property size), the ratemaking approach used here undoubtedly can be applied to other communities, particularly those with high irrigation use.

Water Use in Gulf Stream

Gulf Stream, incorporated in 1925, has areas on both sides of the Intracoastal Waterway and comprises about 0.8 square miles, with about 75% of the area located on the beach side of the waterway. Land uses in the town are almost entirely residential, with two private golf clubs, a private tennis club, and a private day school. The 300 single family homes and 200 multi-family units support a permanent population of 700 and a seasonal high population of about 1000. There are no commercial or industrial uses.

The town's water system is classified as a "consecutive" system as it buys treated water from the neighboring City of Delray Beach and resells the water to its residents. Gulf Stream maintains its own distribution system and meters but has no treatment facilities and no fulltime staff. Because the water supply agreement between Gulf Stream and Delray Beach provides the community with essentially all the water it can use, water conservation has been more of policy or regulatory issue than a supply issue.

Water conservation has always been a difficult issue for Gulf Stream given the vast amount of water used for irrigation, despite the fact that both golf clubs use private wells. Home lots in Gulf Stream range from a third of an acre to over four acres, with most in the halfacre or larger category. All the lots are extensively landscaped with vast areas of sod and water dependent exotics and ornamentals and very little xeriscaping. Although Gulf Stream does not have a sewer system to help differentiate domestic use from irrigation use, irrigation is thought to comprise about 90% of all water used in the community.

Beginning in 1989, Gulf Stream began to seriously track water use and promote conservation. While Gulf Stream had always been aware of its higher per capita use, the issue came to a head when the state rejected the town's comprehensive plan for failure to adequately address conservation issues. Due to the extremely high level of service (expressed on a gallons per capita per day basis) reported in the plan that was nearly ten times higher than statewide averages, the state refused to accept Gulf Stream's plan until it contained drastic per capita reduction goals and the programs necessary to achieve them.

Immediately after the state's rejection of the comprehensive plan, Gulf Stream began a public awareness and education campaign, which consisted mainly of sending letters to all customers requesting they reduce their use. Gulf Stream also began to closely review customer bills and would contact the ten highest users by phone or in person with a similar plea. In addition, Gulf Stream passed an ordinance limiting irrigation to a maximum of three days per week during non-daylight hours only.

While these programs had some success in reducing usage, thanks in large part to increased rainfall ending a two year drought, Gulf Stream believed a more comprehensive approach was needed to affect significant and lasting reductions. Because Gulf Stream is builtout, any reductions in the per capita use would have to come from existing users. Unlike most South Florida communities, there was no opportunity to "grow" out of a high per capita use by mandating water conservation measures on new homes.

In 1992, town staff prepared a report that detailed water use patterns in the community and recommended Gulf Stream adopt a variety of conservation programs. Not surprisingly, the report reaffirmed that over 80% of all water used in the community went to single family homes and, of this, nearly 90% was used for irrigation. The report concluded that significant water savings could be achieved only by programs aimed at reducing single family irrigation. Unfortunately, the relatively large number of customers in this class and the great diversity in property sizes between them made this an extremely difficult task. Because of the broad range in lot sizes, it was determined that high usage did not necessarily correlate with wasted usage. It was concluded that an effective method to promote conservation was by extreme price incentives targeted towards wasted water use.

Parcel Size Based Rate Structure

As a result of Gulf Stream's unique usage characteristics, a water conservation rate that would not penalize wise water users, yet set a proper price signal to those customers who had excessive water use habits, was required. The water rate had to be designed that tended to be more customer specific and met the diverse demographics of Gulf Stream's single family residential customer base.

Water utility systems have been implementing water conservation-oriented rate structures for many years with the

most common rate structure utilized today in Florida being the "inverted or inclining-block" rate structure. This rate structure is characterized by predetermined levels of usage, or consumption blocks, which recognize that as usage increases, the per unit cost (generally expressed in thousands of gallons) increases. Simply put, the more a customer chooses to use, the more the customer will pay proportionately. This type of rate structure has been recognized by the Water Management Districts as a potentially effective method in the conserving of water resources.

There are several issues involved relative to the design of water conservation based rates. These issues deal with price, customer usage characteristics, metering and billing relationships, and income. Generally, rates have been targeted primarily to the single family residential class for several reasons including utility rate administration and billing, relative size of the single family residential class to the total utility customer base, the homogeneity of the customers among this class, and the ease of applying conservation-oriented rates to irrigation demands that are readily identifiable for this class. Due to the unique demographics of the Gulf Stream's water customer base, the implementation of the generally accepted water conservation promoting rates were not quite applicable to Gulf Stream. This was due primarily to the size of the single family residential parcels and the associated irrigation needs of Gulf Stream's customer base, coupled with the income levels of the towns's population.

As a result of Gulf Stream's unique situation, a modified inverted or inclining block rate structure was implemented that recognized the land use relationships of its single family customers. As previously mentioned, the predominance of the water is used for irrigation and the emphasis of the conservation rate was to avoid excessive irrigation. Therefore, it was determined that the single family class should be characterized by lot size and general surface pervious characteristics such that a reasonable and equitable consumption block rate structure could be developed for Gulf Stream's single family residential customers. Based on detailed billing information and land use data regarding Gulf Stream's single family customers, the single family residential class was stratified into ten (10) categories as shown on Table l. These categories were selected based on the review of the number of parcels reflected in each category as well as to reduce the diversity of potential water use between the high and low lot sizes for each category. With respect to the last category (i.e., lots greater than 70,000 square feet), an individual analysis of each lot was conducted since the diversity in lot size in this category is material.

Table 1. Single-Family Billing Categories

Category	*Lot Size Parameters*
1	0 - 16,000 sq. ft.
2	16,001 - 19,000 sq. ft
3	19,001 - 23,000 sq. ft.
4	23,001 - 28,000 sq. ft
5	28,001 - 34,000 sq. ft.
6	34,001 - 40,000 sq. ft.
7	40,001 - 50,000 sq ft.
8	50,001 - 60,000 sq ft.
9	60,001 - 70,000 sq. ft.
10	Above 70,000 sq. ft

Water Conservation Rates and Blocks

Once the residential land use categories were identified, the inverted or inclining block rate structure was then developed. Based on the review of other conservation rates throughout the state of Florida, the average number of consumption blocks for the inclining block rate structure range between three and four consumption blocks. These consumption blocks generally are targeted to essential, discretionary, and excessive use characteristics of each utility's water customer base. It was decided that the number of usage blocks for Gulf Stream's proposed water conservation rates should reflect the norms of other utilities in the state of Florida. As a result, the proposed water rate for Gulf Stream reflected a four block rate structure.

Various published studies discuss the effects of price on the use of water. Although water is an essential need to maintain standards of living, a negative price elasticity relationship between water use and the charge for service has been well documented. As the price of the commodity increases, the use of the commodity typically decreases. This is the main reason why the use of conservation-oriented rate structures is receiving acceptance in Florida and is targeted primarily to "excessive use" type customers. It is noted, however, that the income level of the customer base is an important variable related to the potential effects of the water conservation-oriented rates. To the extent that the cost of water use is a small component of the disposable income of a residence, the likelihood that a residence will conserve is obviously dampened. This was a major concern of Gulf Stream for the establishment of the conservation based rates where the 1990 census found a median annual household income of $93,232 and a median home value of $487,000.

Based on the lot size requirements and household incomes, the following blocks and rates were established:

l. The first rate block includes the first 10,000 gallons of use on a monthly basis (20,000 gallons per bi-monthly billing period) and is applicable to all single residential categories. The 10,000 gallon monthly threshold was assumed for this block since it provides for the essential water use of a residence and also allows for some use of diversity within the class due to differences in family size and other demographic factors that would probably be applicable to Gulf Stream's water customer base. Based on the detailed review of historical customer usage patterns, this consumption block included approximately 18.7% of total single family residential water consumption. A detailed analysis of the operating costs of the water system revealed Gulf Stream's break-even rate per 1,000 gallons was about $1.87. However, in order to promote conservation and give incentives to essential water use customers while recognizing revenue stability, a rate for the first consumption block was set at $1.70 per 1,000 gallons (see Table 3).

2. The second rate block for the single family residential class was designed to allow for effective irrigation of the pervious area of each customer's parcel. Based on the residential classifications described on Table 1, an analysis of the impervious surface per lot size, and an allowance of one-inch per week from Gulf Stream's potable water resources, the consumption blocks for single family residential classification were then developed. In determining the amount of water consumption to be reflected in this second block, discussions were held with the University of Florida Institute of Food and Agricultural Science, representatives of the South and South-

Table 2. Monthly Water Use for Irrigation Allowance

Category	Maximum Lot Size per Category sq. ft.	Average Lot Size sq. ft.	Estimated Average Amount of Pervious Surface	Average Percent Pervious Surface	Water Use Gallons* Monthly Water Use	Rounded
1	16,000	13,673	9,175	66.98	29,170	30,000
2	19,000	17,188	12,479	72.60	37,568	38,000
3	23,000	21,362	15,694	73.47	46,022	46,000
4	28,000	25,051	19,446	77.63	59,200	60,000
5	34,000	30,370	23,528	77.47	71,737	72,000
6	40,000	36,969	30,148	81.55	88,842	89,000
7	50,000	44,460	36,584	82.29%	112,060	112,000
8	60,000	56,921	48,609	85.40%	139,555	140,000
9	70,000	65,394	56,470	86.35	164,625	165,000
10	Above 70,000	113,752	N/A	N/A	N/A	N/A

N/A = Not Applicable, determined separately for customers in this category.
*Determined assuming l-inch per week of irrigation based on the maximum lot size and pervious surface.

west Florida Water Management Districts, and water utilities to determine the amount of irrigation that would normally be required to maintain south Florida green space areas. As a result of these discussions, a normal irrigation rate for Gulf Stream's customers of 1.0 inches per week was assumed. Table 2 provides a summary of the consumption blocks for each category. Based on detailed historical billing information of the town's single family residential class, the second block included approximately 62.4% of the total single family residential use. As discussed, Gulf Stream's break-even rate was determined to be about $1.87 per 1,000 gallons. Because most use fell into this block, and Gulf Stream hoped to direct users in the third and fourth blocks into this block, a rate of $1.90 per 1,000 gallons was established for the second block (see Table 3).

Table 3. Bi-monthly Residential Rates

Essential Use	
Block I - 0 to 20,000 gallons	$1.70 per 1,000 gallons
Discretionary Use	
Block 2 - approx. 1" of irrigation	$1.90 per 1,000 gallons
Excessive Use	
Block 3 - 0.25" of irrigation	$2.65 per 1,000 gallons
Block 4 - remaining use	$4.65 per 1,000 gallons

3. The third rate block represents an additional irrigation allowance equal to 0.25 inches per week or approximately 25% above the optimal irrigation levels as reflected in the second block. Although providing diversity in usage, this rate block also initiates the beginning of a strong conservation message through price incentives for these users. At a rate of $2.65 per 1,000 gallons, which represents a 40% increase over the second block rate, customers should see a significant increase in their bill and an incentive to reduce use. However, the price increase is also low enough so that those requiring additional irrigation during periods of low rainfall will not find the cost prohibitive. Based on detailed billing information, the third block included approximately 7.3% of the total single family residential water use.

4. The fourth, and final, rate block for the single family class represented all usages above the first three consumption blocks. This rate block was designated as an excessive use block and was priced substantially, nearly 145%, higher than the second block in order to send a strong conservation message to reduce excessive water use consumption (see Table 3). This rate block accounted for 11.76% of the total of single family residential water sales.

Customer Information Program and Response

Gulf Stream's new water rates became effective October 1, 1994. The town had began a customer education program on the new rates in August 1994, informing customers through its quarterly newsletter that the new structure would be based on parcel size and an allocation of one inch of irrigation per week. This announcement was followed by a more complete description of the rate structure sent out with the September water bills, the last bills sent under the old rates.

The notice sent with the water bills explained the program fully but invited questions and comments. Anticipating a large number of inquiries, the town manager met with all town phone staff, explained the program, and distributed detailed information sheets, including the size of every single property in the community. As expected, most residents did not know the exact size of their lots and flooded the town with calls seeking the information.

Once the residents were aware of their lot size, many took the opportunity to review previous bills to determine which block they would fall in under the new rates. This prompted a second set of calls, although far fewer in number, requesting information and assistance on how to reduce consumption. These calls also were prompted by the letter sent with bills advising customers that Gulf Stream would perform free water "audits" for those whose use was deemed excessive.

The water use audits were conducted by Gulf Stream's contracted utility maintenance company, who sent a representative to each home to meet directly with the customer. During the visit, the irrigation clock was the first thing checked. Not surprisingly, in the vast majority of cases, the system settings were well above one inch per week and far exceeded the amount of water necessary to adequately maintain the landscaping. Although the irrigation system settings alone were usually the cause of excessive water use, other checks also were made in an attempt to find leaks, running toilets, and malfunctioning water softeners.

Although the new water rates contain strong price signals of excessive use, the town still wanted to ensure that high users were fully aware of their consumption rates. Accordingly, the first bills sent under the new rate system were previewed and a special notice included with those whose use extended into the third and fourth blocks. Again, the notice advised customers to make use of the town's free audits. Of the 60 notices mailed, approximately half contacted the town. Since then, Gulf Stream continues to review bills and specifically identifies those in the third and fourth blocks. When time is available, the town manager attempts to reach these users by phone and encourage them to seek assistance from the town, an irrigation contractor, or a plumber. Incredibly, despite penalty charges as high as $200 to $300 per billing period, some users still do not view their bills as excessive, and several of those of which the town is aware have yet to take any concrete actions to reduce use. However, thanks in large part to greater than

Continues Page 37

Boca Raton's Project IRIS

Accelerated Schedule Report

James M. Chansler and Cindy L. Martin

Boca Raton's Project IRIS (In-city Reclamation Irrigation System) began in 1990 with a "pay-as-you-go" philosophy, which meant the reclaimed water program would be phased-in as funds became available rather than as one large project (estimated at $40 million at the time).

Even prior to the formal IRIS program, some form of water recycling was anticipated in Boca Raton due to the city's intense irrigation needs. Capital Improvement Project (CIP) funding began available in fiscal year 1987-1988, and a reclaimed water master plan was adopted in September 1990.

The schedule in the master plan called for an annual CIP budget of $2.5 million whenever revenues in the utility services department permitted. This has occurred in some years, but not in others due to budget constraints.

In 1988 a small water reclamation facility (3 MGD capacity) was constructed. The utility services complex uses over 800,000 GPD itself, and Florida Atlantic University began using 20,000 GPD of reclaimed water for irrigation in 1992.

Annual CIP funding of Project IRIS made possible Phase I of the treatment and distribution system which came on-line in August 1994 with a total capacity of 9 MGD. Customers currently receiving service include approximately 100 single family homes and 75 commercial establishments. In addition, the city irrigates some medians and parks with reclaimed water. These Phase I users use another 400,000 GPD.

The master plan originally envisioned Phase II to occur when a second $10 million was accumulated in the IRIS CIP account. With annual funding restored to the $2.5 million level, this would occur in fiscal year 1998-1999. The proposed accelerated schedule calls for not waiting for large accumulations, but rather consistently funding the program at the $2.5 million annual level proceeding with small projects in areas with intense irrigation needs.

The areas selected were chosen for their irrigation intensity and periodic low potable water pressures, and because construction disruption could be minimized through coordination with the city's street paving program.

While there are numerous benefits to an accelerated IRIS schedule, there are some negative fiscal impacts.

The utility services department has not been funding IRIS at the $2.5 million level because the city's traditionally low potable water rates (which fund the capital portion of IRIS) have left the department budget in a $1 million to $2 million deficit for the past three years. The budget has been balanced using funds accumulated during the booming growth of the 1980s. These retained earnings—due to be exhausted in the near future—will expire that much sooner.

In addition, when irrigation is converted from potable water to Project IRIS, customers pay $0.55 per 1000 gallons as opposed to $0.85 or $1.10 per 1000 gallons (depending on volume). The accelerated schedule described here will result in approximately $285,000 in annual commodity revenues from Project IRIS; potable water commodity revenue will drop by approximately $510,000 per year. The $225,000 decrease in revenues is not considered significant and should be substantially offset as area golf courses complete their internal construction and replace (free) well water with reclaimed water.

The city is currently experiencing water pressure problems caused by high irrigation demands. An accelerated Project IRIS schedule will provide improved irrigation and potable water pressures and flows years earlier than originally proposed and with modest fiscal impacts.

After fiscal year 1996-1997, two Project IRIS schedule alternatives will be investigated. The original Master Plan Phase II can be implemented, or a second accelerated plan can be developed based on the needs of the city at that time.

James M. Chansler, P.E., is director of utility services and Cindy L. Martin is special projects coordinator for the city of Boca Raton.

Orlando from Page 31

phorus (TP) as reclaimed water passes through the wetlands. The quality of reclaimed water leaving the wetlands has consistently been well below permit limits of 2.31 mg/L TN and 0.20 mg/L TP. As shown in Figure 4, effluent concentrations have also been below the TN and TP concentrations measured in the receiving water body, the St. Johns River.

More than 75 percent of the TN and TP removal appears to be occurring within 10 to 20 percent of the wetlands area. Studies conducted within Cell 1 in 1994 indicated that most TN removal occurred within 2,000 feet of the influent structure, or 900 feet from monitoring station WP1. Very little of the wetland area appeared to be used for TN removal. Most of the TP removal occurred by sampling station WP1 during the 1994 study, or within 2,900 feet of the influent structure.

After sample station WP3, TN and TP concentrations approach background concentrations. The remaining TN and TP are primarily in organic forms so significant additional removal does not occur. Also, in the organic form, TN and TP would not be expected to contribute to eutrophication in the receiving waters.

The better than expected performance of the wetlands can be partly attributed to the system being under loaded based on design conditions. Design was based on an annual average flow of 20 MGD and influent TN concentration of 6 mg/L and influent TP concentration of 0.75 mg/L. Operations of the Iron Bridge facility have resulted in a much better quality reclaimed water being produced for delivery to the wetlands than originally anticipated. In 1994, the wetlands received an average monthly flow of 12.42 MGD with an influent TN concentration of 2.29 mg/l and influent TP concentration of 0.20 mg/L. Loadings will be increasing as the influent flows are increased to the 20-MGD design flow over the next year.

The wetlands have historically shown a slight increase in TN concentration at monitoring station MM8, which is located

at the outfall of Cell 13. This cell is noted for its large open water areas which serve as an attractant to migratory water fowl. Under further examination, it was realized that the increase in TN concentration in this cell was largely due to an increase in ammonia-nitrogen concentration in the winter months when water fowl are most predominant. It is now thought that the water fowl are the primary contributor to this small increase in TN concentration.

Other Benefits

The wetlands were designed to serve multiple purposes. A portion open to the public as the Orlando Wetlands Park is designed for bicycling, hiking, and jogging on berm roads and nature trails. Park facilities include covered picnic areas and an observation deck. It is estimated by park staff that nearly 10,000 persons visit there annually. The park is open to the public from late January through late September each year.

Nearly two-thirds of the area was designed to encourage and maximize wildlife usage. Twenty animal species that are listed by the state or federal government as threatened, endangered, or of special concern have been observed at the site. Recent vegetation management activities have provided more open water habitat and have resulted in an increase in wildlife utilization. The Everglades snail kite, an endangered species, was observed shortly after start-up, but disappeared as open water areas filled with vegetation. They have recently been observed on site again. Other listed species observed include bald eagles, limpkins, roseate spoonbills, snowy egrets, woodstorks, American alligators, eastern indigo snakes, and Florida black bears.

The project has demonstrated that reclaimed water can be used to restore wetlands and recreate wildlife habitat. It is for this reason that the Orlando Easternly Wetlands, like Lakeland's constructed wetland system, is one of two wetland treatment systems in the state that are considered to be beneficial reuse systems in the DEP's 1992 Reuse Inventory.

Acknowledgements

Thanks to William P. Allman, Iron Bridge Regional WPCF plant manager; McCoy Hill, Iron Bridge Regional WPCF laboratory manager, and other city wastewater bureau staff for their continued personal dedication to the successful operation of the Orlando Easternly Wetlands.

Jo Ann Jackson, P.E., is with Post, Buckley, Schuh & Jernigan, Inc. in Winter Park and is project manager for operation and monitoring of the Orlando Eastern Wetlands. Thomas L. Lothrop, P.E., is director of environmental services for Orlando. Mark D. Sees, with PBS&J, serves as lead field biologist for the operation and monitoring of the wetlands.

Innovative Ratemaking from Page 35

normal rainfall during the winter, the vast majority of customers are well within the first or second blocks, and most of those who have crept into the third and fourth blocks have taken appropriate action to cut back their use.

Conclusion

Establishing water conservation oriented rates is a very challenging issue facing water utilities today. The rates must not only satisfy the revenue requirements of the utility, but must be publicly and politically acceptable to its users and regulators. We believe the Gulf Stream's water conservation rates meet these challenges. Specifically, the rates were designed to recognize the demographics of Gulf Stream's water customer base, recognize a significant price for excessive outdoor irrigation use, and meet the revenue requirement needs of the utility system. Because of this, the town's rates were accepted favorably and implemented without challenge.

Robert J. Ori is a certified public accountant and the managing partner of Public Resources Management Group, Inc., a firm specializing in utility rate, finance, and management issues. E. Scott Harrington is Gulf Stream's town manager and a member of the American Institute of Certified Planners.

Kanapaha from Page 4

Project Development

In 1992 GRU hired a local engineering consultant to assist in the preparation of construction plans for the proposed water garden. The construction of the proposed landscape irrigation and water garden was permitted by the Florida Department of Environmental Protection under Florida's Administration Code Chapter 62-610. The theme of the water garden was to simulate a "spring to sink" Florida ecosystem. The final design consisted of an upper pond, a 600-foot long meandering stream, four waterfalls, and a lower pond.

Sitework, earthwork, piping, and the pump station construction work was performed by GRU. The waterfalls were constructed by a private contractor specializing in waterfall design and construction. The upper pond is designed to simulate a shallow "spring boil" containing clear reclaimed water emerging to the land surface. The upper pond spills over an extensive waterfall structure constructed from native limestone boulders, concrete, reinforcing steel, and a high density polyethylene liner material. The design and appearance of the waterfall portrays a natural surface water flow that has eroded an underlying limestone bedding plane. The meandering stream is segmented by three smaller limestone boulder waterfalls and flows to the lower pond. The lower pond is the largest water feature and is designed to resemble a "slow sink." The upper and lower ponds and stream provide approximately one acre of water surface area.

Reclaimed water is provided by a 10-inch diameter reclaimed water transmission main constructed between the KWRF site and the park. Approximately 50 gpm of reclaimed water (70,000 gallons per day) is introduced to the upper pond from the transmission main. An additional 450 gpm is recirculated from the lower pond to the first large waterfall by a recirculation pump station adjacent to the lower pond. The recirculated flow improves the aesthetics of the waterfalls and stream, and improves dissolved oxygen levels in the stream by aerating the stream flow over the successive waterfalls.

The reclaimed water received from GRU's KWRF is a high quality effluent. Reclaimed water suspended solids are typically 1 mg/l or less, and turbidities are consistently below 0.3 NTU. An average of 6 to 7 mg/l total nitrogen as N and 1 to 2 mg/l total phosphorous as P is available in the reclaimed water. Some denitrification occurs within the stream and lower pond, however, the lower pond typically contains 5 mg/l total nitrogen as N. This nutrient content is beneficial for landscape irrigation, however, the nutrients do encourage algae growth in the water garden system.

Planning, design, and operation of the water garden recognizes the high nutrient content of the reclaimed water and subsequent growth of algae. A natural biofiltration effect in the stream and lower pond is used to control algae. Biofiltration occurs through the action of emergent macrophytes and numerous organisms that consume or prey upon algae. Emergent macrophytes such as hyacinths, pickerel weed, penny wort, and other floating vegetation reduce the amount of light available for algae production. Furthermore, the fibrous root systems of these plants harbor algae grazing organisms such as slimes, zooplankton, rotifers, aquatic worms, snails, and insect larvae. Other organisms within the pond and stream that consume algae are copepoda, seed shrimps, and tadpoles. Ninety percent of suspended solids can be removed through this biofiltration effect when the system detention time reaches five days (Reference 2). The stream and lower pond design provides more than five days detention time and the filtering provided by the natural ecosystem established in the water garden has resulted in a water feature relatively free from floating scum and filamentous algae.

The water garden vegetation root systems deeply penetrate the pond bottom and maintain sufficient soil porosity for infiltration of reclaimed water to underlying soils and aquifer. The water garden vegetation is periodically harvested and composted on-site for use as a soil amendment.

Chlorine residuals of 0.05 to 0.08 mg/l as chlorine have been measured in the lower pond (Reference 3). Sensitive ornamental fish such as Koi have been successfully established in the lower portions of the stream and lower pond and Gambusia, a minnow size fish that consumes mosquito larvae, have also been introduced to control mosquito propagation. Wading birds, turtles, frogs, snakes, insects, and alligators have also made their homes at the water garden.

A Community Effort

The conceptualization, planning, and implementation of the Kanapaha Botanical Gardens reuse project has been a significant work effort for both GRU and the North Florida Botanical Society. This project was also a significant financial investment donated by GRU to the communities of Gainesville and Alachua County. Numerous private individuals and community groups have responded to this project with donated labor, materials, and monies. Shortly after the major construction work was completed by GRU in 1993, a local Boy Scout troop began the landscaping and planting work. Three of the Boy Scouts conducted community service projects required to attain the rank of Eagle Scout.

The University of Florida provided geotechnical investigations prior to construction and studied ecosystem development and ground water response after construction (Reference 3). A local Rotary Club and individual citizens donated time and materials for the construction of four gazebos adjacent to the water garden. An elaborate arched wooden walkover bridge was designed and constructed by an individual in memory of the late young movie industry actor River Phoenix, a former Gainesville resident. Plants, trees, mulch, and wood chips were donated by local nurseries, the Florida Nurserymen and Growers Association, and a wood processing/recycling company. Numerous park benches have been donated by local citizens, and construction funds, labor, and materials have been contributed to the project by the city of Gainesville and Alachua County governments.

Dr. Don Goodman, park director, has stated, "It would be difficult to overstate the impact of this project on Kanapaha Botanical Gardens. Where we once had a pasture-turned-meadow, we now have a spring of pristine appearance, waterfalls, streams, and ponds. A barrenness of prickly pear cacti, broomsedge, and bahia has been replaced by the green lushness of irises, rushes, river birches, red buckeyes, water lilies, and other wetland species. This project has also provided a great enhancement to our park's irrigation system, a feature that has enabled us to continue expanding our cultivated areas while better meeting the irrigation needs of our older gardens. Particularly during drought periods, we wonder how we ever survived without access to the abundance of reclaimed water that makes it all possible."

Those who attend the Kanapaha Botanical Gardens, and particularly the water gardens, have a better understanding

In 1765 a Philadelphia botanist named John Bartham was trekking along the Alatamaha River in the wilderness of the Georgia colony when he came across a plant he had never before encountered. He determined the plant was new to science and named it Franklinia Alatamaha in honor of the friend Benjamin Franklin and the river where it grew. Fifteen years later Bartham returned to Georgia and brought the Ben Franklin tree back to Philadelphia, where it was propagated. Apparently the tree was on the brink of extinction, because a search for it in Georgia in 1790 located only a single tree, and none has since been found in the wild. All Ben Franklin trees are descendants of those Bartham took to Philadelphia in 1778.

The tree has never been grown successfully in Florida. Because it is extinct in the wild, it was impossible to determine from its natural habitat why it would begin to die immediately upon being placed in Florida soil.

Last winter Don Goodman and his staff consulted the journal of William Bartham, the famous son of John who accompanied his father on both of the Georgia trips and left what is probably the only information about Franklinia Alatamaha recorded at that time. William listed the fever tree among the associates of the Franklin tree. This small tree is found only in acid seepage bogs.

Assuming the Franklin tree prefers a similar environment, Goodman established a "peat wick" bed in the Kanapaha Water Gardens. It was placed along side a stream where capillarity could keep it moist.

The Franklin tree planted in the peat bed is thriving and is now blanketed with flower buds. Three fever trees, also planted in the bog, are also flourishing.

Thus, between-the-lines reading of the two-century old notes of William Bartham has led to what appears to be the first successful planting of a Ben Franklin tree in Florida. And application of the encoded secret was made possible by the creation of the Kanapaha Water Gardens.

of reclaimed water and the potential beneficial use of this resource. The water garden has even gained acceptance as a site to conduct outdoor marriage ceremonies. To those who are familiar with the wastewater treatment industry, the Kanapaha park and water garden is a unique and aesthetic means for effluent disposal. But for most of the people who visit the Kanapaha Botanical Gardens, the park is a peaceful and beautiful place to visit and enjoy.

References

1. Richardson, David M. and Ed Regan, 1994. "Kanapaha Gardens Reuse Project." Paper presented at the Florida Water Resources Conference, Tampa, Florida, August 1994.

2. Dinges, Ray, 1978. "Upgrading Stabilization Pond Effluent by Water Hyacinth Culture." Journal WPCF, May 1978.

3. Owen, Paul K. and Mark T. Brown, "Evaluation of Ecological Self-Organization and Hydrology of the Constructed Aquatic System at the Kanapaha Botanical Gardens." Center for Wetlands and Water Resources, University of Florida, Gainesville, Florida.

Steven A. Yeats, P.E. and David M. Richardson, P.E. are water/wastewater engineers in GRU's Strategic Planning Department. Ed Regan, P.E., is director of strategic planning for GRU.