A Case of Illegal Discharge

Kent Kimes

On June 7, 2000, Southbay Utilities, Inc., and Southbay President Paul Paver pled guilty to criminal felony and misdemeanor charges, respectively, in U. S. District Court in Tampa. The charges were brought for violations of the Clean Water Act, specifically the unpermitted discharge of wastewater to Dryman Bay, a water of the United States. Formal sentencing in August or September in federal court is expected to follow the plea agreement between Southbay, Paver, and the Office of the U.S. Attorney, Middle District of Florida. The terms of that agreement call for the largest monetary penalty ever assessed in the Middle District of Florida for a violation of the Clean Water Act. Sarasota County's pollution control program staff discovered the illegal connections of the domestic wastewater subsurface effluent disposal system to surface water and led a subsequent investigation.

Suspicious Flow

In April 1998, members of the Sarasota County Environmental Services Pollution Control staff were investigating a report of cloudy water discharge in the yacht basin of the Southbay Yacht and Racquet Club development. The staff determined that the discharge was from a residential swimming pool renovation activity discharging to the county's stormwater system. After that violation was addressed with the property owner and contractor, the staff noticed another unusual flow in the subdivision's stormwater system. The flow was suspicious because it had not rained for quite some time and the stormwater system in other places was dry. A cursory inspection found that the flow originated in the vicinity of one of the drainfields used by Southbay for disposal of treated domestic wastewater effluent.

DEP staff joined the county staff to help identify the source of the unusual flow. Highly trained technicians relied on the "How-Cum-Hole" method to uncover the first evidence of the illicit connections. During inspection of the first drainfield, they asked themselves, "How come there's this hole in the surface of this drainfield?" Pulling back the turf of the depression revealed the end of a white 6-inch PVC pipe butted up against the typical black perforated pipe used in the drainfield. The drainfield pipe had been cut open to allow greater flow to enter the PVC pipe. The location and apparent direction of this PVC pipe indicated that it was carrying the drainfield flow to the storm sewer system, which was verified by dye tracing. Figure 1 shows dyed effluent entering the boat basin from the storm sewer.

Background

Paul Paver, as president of Strathmore Realty Corporation, had filed applications for construction of this wastewater treatment facility in 1973 to support the residential development of the Southbay Yacht and Racquet Club. The early application requested french drains to connect the drainfields to the storm sewers. That feature was specifically denied, and the construction and operating permits required that all effluent be retained on site. The Southbay facility began operation in 1976. At the time the illicit pipes to the stormwater system were discovered, the Southbay wastewater treatment facility served approximately 300 single-family residences and a small amount of commercial development.

The four drainfields were in two areas of the Southbay Yacht and Racquet Club development that resembled "open space" in the rear of and surrounded by single family residential lots.

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Each drainfield was about a half-acre and designed to receive approximately 62,500 gpd of effluent treated to secondary standards. The facility was permitted at 250,000 gpd.

Preliminary Investigations

Sarasota County Environmental Services Pollution Control obtained an inspection warrant from a local judge, and over the next seven days it and DEP conducted an intensive investigation of the Southbay wastewater treatment and disposal facilities. DEP staff conducted a thorough inspection of the treatment plant site and county staff focused on the four effluent disposal drainfields.

Early in the investigation, the operator was directed to switch effluent flow from one drainfield to another. Each time, flow appeared in the stormwater system adjacent to the loaded drainfield. When all the connections to the storm sewer were located, a contractor with sewer video and subsurface tracing equipment was hired to locate the source of the flow. One by one, the illicit pipes were uncovered near the storm sewer and the camera with subsurface transducer was inserted. Following the camera in the pipe, a connection with each of the four drainfields was located. One such illicit connection is shown in Figure 2.

The investigation at the wastewater treatment facility found no other illicit discharges; however, a number of deficiencies and excursions from the operating permit were identified. The alleged violations included, but were not limited to, inadequate records maintenance, sampling procedures, plant maintenance, operator staffing, and residuals monitoring.

Once the point of connection to each drainfield was located and documented, county staff disconnected the illicit pipes from the storm sewer. Southbay representatives were responsive and severed each connection within the drainfields. Within a week the drainfield receiving effluent failed, resulting in flooding conditions and surface discharges around the residential lots. Drainfield failure was repeated at each of the four drainfields. Southbay was then required to haul by tanker truck enough of the plant effluent to allow flow to the drain fields without causing flooded conditions.

Southbay attempted to increase drainfield capacities through a pneumatic injection process and the addition of gravel trenching. After all those efforts, it appeared that the drainfields only had a total capacity of 40,000 to 50,000 gpd. During the summer of 1998, off-season flow ranged from 71,000 to 91,000 gpd. During the March 1999 peak season, when the utility was purchased and connected to Sarasota County Utilities, the flow was 127,000 gpd.

Enforcement Actions

In the summer of 1998, county and DEP staff members presented their findings to the Tampa Bay Environmental Crimes Task Force, which took the reins of the criminal investigation. County staff and DEP staff were closely involved with the investigators from the Department of Justice, EPA, the FBI, the Internal Revenue Service, and the Florida Department of Law Enforcement.

DEP issued a five-page warning letter addressing the violations found during the facility inspection as well as the unpermitted drainfield connections. Sarasota County issued a warning letter addressing the illicit connections to the county's

Figure 1. Dyed effluent entering the boat basin from the storm sewer.

stormwater system. Following initial meetings in response to each letter, the administrative enforcement actions remained on hold pending the outcome of the U.S. Attorney's case.

The criminal investigation found that shortly after the plant began operation in 1976, one of the first two drainfields failed and overflowed. Southbay employees "corrected" the situation by connecting the drainfield to the storm sewer, which allowed the excess flow to be directed to "waters of the United States" without the requisite NPDES permit pursuant to the Clean Water Act. Each of the remaining drainfields had been connected to the storm sewer in a similar fashion. These underground connections were 100- to 400-foot lengths of 6-inch PVC that ran from the rear of residences, along the side property lines, and along the frontage rights-of-way to a convenient location to tap the storm sewer.

On May 15, 2000, the U.S Attorney for the Middle District of Florida filed charging instruments and Plea Agreements charging Southbay Utilities and its president, Paul Paver, with criminal violations of the Clean Water Act. In addition to pleading guilty, the Utility and Paver will pay $1.75 million in fines and place a full-page apology in the local paper. At final sentencing, the judge may also order a prison sentence of up to one year for Paver.

The $1.75 million in fines represents the largest fine ever imposed under the Clean Water Act in the Middle District of Florida, an area from Duval to Lee County. The fine will be divided among federal, state, and local agencies. Sarasota County will receive $400,000 for its Pollution Recovery Trust Fund, and DEP will receive $309,000 for its Ecosystem Management and Restoration Trust Fund. The remaining $1,041,000 will be evenly split between the Middle District of Florida Environmental Crimes Restitution Fund and fines to the federal government. Typically, these funds are used to provide environmental enhancement, restitution, and restoration in the areas impacted by the violation.

Figure 2. An illicit connection with a drainfield.

Epilogue

It seems that advances in technology and new environmental regulations can receive some credit for discovery of the violations. The camera and subsurface tracing technologies were not available in the late 1970s when the illegal pipes were installed. The EPA Stormwater NPDES Permit issued to Sarasota County also played a role in discovering the violation. Known as the Municipal Separate Storm Sewer System (MS4) permit, it placed new emphasis on preventing unauthorized discharges into the county's storm sewer system. It was while performing these permit-related duties that county staff became suspicious of the flow in the stormwater pipe.

The initial investigation required many county and DEP personnel, who deserve the credit for the successful action. The investigation and subsequent enforcement actions exemplify the effectiveness of the Tampa Bay Environmental Crimes Task Force and shows how multiple agencies can work together and remove "turf battles" that often occur in federal, state, and local jurisdictions. It is estimated that this illicit discharge put 1.5 tons of nitrogen into the Sarasota Bay system each year. The elimination of that nitrogen source will certainly serve to improve the quality of Sarasota Bay, and thereby the quality of life of residents and visitors of Sarasota County. ■

Notices, Announcements, Events

FWPCOA Short School

The fall FWPCOA short school is scheduled for **August 7 - 11** at Brevard Community College in Titusville. The cost is $175 for FWPCOA members and $195 for non-members. For further information see the FWPCOA training calendar in this issue or contact Rosemary Tilley at 407-267-5452. Registration forms were published in the June issue of the journal.

Summer Seminar

The FS/AWWA – FWEA Summer Seminar, "Construction Concerns — Trenchless Solutions," will be held **August 23-24**, at the Orange County Eastern Regional Water Treatment Plant, Orlando. The one-day seminar will be capped by a golf tournament to raise funds for the creation of AWWA university student chapters throughout the state. Registration fee of $30 includes the seminar, lunch, and demonstrations. Other registrations available are: golf $75, sponsorship $250, exhibitor $100, exhibitor demonstration $200, hole sponsorship (includes 4-some) $350. For further information contact Rob Teegarden at 321-728-2255 or email Robert.teegarden@co.orange.fl.us.

Call for Papers

WEF is accepting abstracts of papers to be considered for the specialty conferance "2001 A Collection Systems Odyssey: Integrating O&M and Wet Weather Solutions" to be held July 8-11, 2001, in Bellevue, WA. Abstracts must be received by **August 18, 2000**. For complere abstract instructions, contact Edward Gonzalez at 703-684-2400 x7401 or email egonzalez@wef.org.

Call for Papers

The South Carolina Environmental Conference Program Committee is soliciting presentations for the 2001 South Carolina Environmental Conference (March 18-21, 2001, Myrtle Beach, SC). Interested presenters should submit a one-page typed abstract (200 words) to include their name, address, phone, fax, title of the presentation, and a brief description of its subject. Abstract submittals are **due by October 2, 2000**. Individuals whose papers are selected for the 2001 program will be notified in December, 2000. Papers are due by February 2, 2001 and will be published in the conference proceedings, which will be made available to all fully registered conference attendees. All submittals should be addressed to: Furman Buchanan, P. O. Box 50627, Columbia, South Carolina 29250 803-540-1888 Fax: 803-771-7442.

FSAWWA 2000 Conference

FSAWWA Annual Conference, Hyatt Orlando. **November 5-8.** Also see www.fsawwa.org. For further information contact Don Cochran 561-835-7036 .

The 2000 Reuse Round Table

Looking To the Future of Water Reuse in Florida

Edited by David York for the FWEA Water Reuse Committee

FWEA's Water Reuse Committee sponsors the annual Reuse Round Table at the Florida Water Resources Conference. At the 2000 conference in Tampa, the Reuse Round Table was structured as an interactive session designed to obtain feedback from the reuse professionals in the audience on their view of future needs and priorities for Florida's water reuse program. DEP's Reuse Coordinator David York moderated the session with assistance from Committee Chairperson Christianne Ferraro (DEP/Orlando), and fellow committee members Phil Cross (Woodward & Curran), Tom Cummings (Black & Veatch), Glenn Forrest (URS), Vic Godlewski (Boyle Engineering), and Mark McNeal (CH2M Hill).

The Process

Initially, potential reuse program needs were solicited from the audience, who were encouraged to offer verbal suggestions for improving Florida's reuse program. These were arranged according to the six categories of funding/financing, legislative, public education/outreach, regulations/rules, research, and miscellaneous.

The audience next ranked the program needs. Within each category, the audience was asked to vote (by show of hands) for the highest priority suggestion. In categories having a relatively lengthy list of suggestions, each member of the audience was allowed two votes.

Finally, the top two priority items within each category (a total of 13 as a result of a tie within one category) were selected and the audience assigned overall priorities to the 13 top-ranked needs (drawn from all six categories). Each individual was allowed two votes.

Ranked by priority, the following sections list the needs within each of the six categories:

Funding/Financing

1. Maintain and strengthen funding programs in the water management districts that can be used to fund reuse projects. The remarkably successful program in SWFWMD is regarded as the model that other districts should strive to replicate.
2. Establish a federal funding program that will be active in the eastern states for water reuse projects.
3. Create a database for economic data related to construction of reuse facilities.

Legislative

1. Better integrate water reuse options (including ground water recharge and indirect potable reuse concepts) in regional water supply planning.
2. Mandate that the water management districts require use of reclaimed water, when it is available, in lieu of issuing consumptive use permits for other conventional water sources.
3. Consider providing some form of relief for trihalomethanes (THMs) in reclaimed water for ground water recharge projects.

Public Education/Outreach

1. Increase public education programs related to water reuse.
2. Educate the news media about water reuse.

Regulations/Rules

1. Transition to a regulatory approach that treats reclaimed water as a valuable water resource.
2. Revise Rule 62-610.475, FAC., to allow direct contact application methods on all types of edible crops. This was the subject of a paper presented at the 2000 Florida Water Resources Conference [1].
3 Update and refine the operator staffing and certification rules to better address reuse issues, including possible use of "trainees" to perform some functions and to address satellite treatment facilities that only provide high-level disinfection.
4. Strengthen requirements for reliability at water reclamation facilities.
5. Refine rules governing sales of reclaimed water to other utilities.
6. Increase the maximum allowable hydraulic loading rates for rapid infiltration basins.
7 Refine required procedures for notifying the regulatory agencies and the public in the event of problems within a reuse system.
8. Clarify minimum system size requirements in Rule 62-610.452, F.A.C.

Research

1. Develop methods to facilitate dissemination of research data.
2. (Tie) Develop a means for obtaining "credit" from the water management districts for reuse activities that result in ground water recharge.
2. (Tie) Investigate changes in the quality of injected fluids associated with injection and aquifer storage and recover (ASR) activities.
4. Evaluate the effectiveness of projects that blend stormwater with reclaimed water.
5. Study the fate and transport of endocrine disrupters and pharmaceuticals in water reclamation facilities and in the environment.

Miscellaneous

1. Develop guidance for the design of reclaimed water transmission and distribution systems.
2. Develop a guidance document for monitoring and reporting.
3. (Tie) Plan for 75 percent utilization of reclaimed water.
3. (Tie) Establish a goal of 75 percent efficiency for water reuse systems [i.e., use of 100 gallons of reclaimed water for landscape irrigation should reduce potable water consumption by at least 75 gallons].

Overall Priorities

The audience then evaluated the 13 top-ranked needs (drawn from all six categories) in an effort to identify the highest overall priorities. The following are the five highest ranked needs:

1. Transition to a regulatory approach that treats reclaimed water as a valuable water resource.
2. Maintain and strengthen funding programs in the water management districts that can be used to fund reuse projects.
3. Better integrate water reuse options (including ground water recharge and indirect potable reuse concepts) in regional water supply planning.
4. Increase public education programs related to water reuse.
5. Revise Rule 62-610.475, F.A.C., to allow direct contact application methods on all types of edible crops.

Observations and Conclusions

Interest in treating reclaimed water as a valuable water resource received significant attention at the Reuse Round Table. Overall, it was established as the top ranked need. There is also growing interest in the regulatory community in this concept. The two needs dealing with reclaimed water utilization and efficiency in the miscellaneous category also relate to this concept. It is interesting to note that the needs dealing with reclaimed water utilization and efficiency are beginning to be included as grant conditions for reuse projects funded by the Southwest Florida Water Management District. As Florida's reuse program has matured and as the track record has been established, the challenge now will shift to ensuring that reclaimed water is used wisely and is recognized as a valuable water resource.

Several of the potential needs discussed at the 2000 Reuse Round Table are related to research needs identified by the National Water Research Institute (NWRI) in 1999 [2]. In addition, several of the identified needs are being addressed by ongoing or anticipated activities. For example, the Water Environment Research Foundation (WERF) will sponsor a project related to public acceptance and participation [3]. A workshop planned by the NWRI will look at concepts related to the dissemination and communication of research data. Ongoing research, including a NWRI-funded study by the University of California at Berkeley, is investigating endocrine disrupters, pharmaceuticals, and other chemicals in reclaimed water and in the environment. In addition, the DEP currently is developing guidance for reporting of monitoring data. This probably will result in development of refined instructions for completing discharge monitoring reports (DMRs).

Reuse has rapidly become an integral part of water resource and wastewater management in Florida. In 1999, Florida's reuse capacity exceeded one billion gallons per day [4]. Florida has comprehensive rules [5], which address a wide range of reuse activities. The extensive reuse experience base has demonstrated the safety of reuse practice.

Program needs and priorities identified at the 2000 Reuse Round Table should provide useful information to DEP, the water management districts, and Florida's reuse community as we collectively strive to refine Florida's reuse program and to encourage and promote water reuse.

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2. National Water Research Institute. Non-Potable Water Recycling. Workshop Report. NWRI. Pomona, CA. May 23-25, 1999.
3. Crook, J. "Issues Affecting Development of Rational Nonpotable Reuse Criteria are Identified." Proceedings of Water Reuse 2000. AWWA. San Antonio, TX. Jan. 30 – Feb. 2, 2000.
4. DEP. 1999 Reuse Inventory. Tallahassee: DEP. May 2000.
5. DEP. Reuse of Reclaimed Water and Land Application. Chapter 62-610, Florida Administrative Code. August 8, 1999.

Glossary of Common Terms Used in this Publication

ASR	aquifer storage and recovery	MLSS	mixed liquer suspended solids
AWT	advanced water treatment	MLTSS	mixed liquer total suspended solids
AWWT	advanced wastewater treatment	NPDES	Nat. Pollutant Discharge Elimination System
AWWA	American Water Works Association	NTU	nephelometric turbidity units
BOD	5-day biochemical oxygen demand	ORP	oxidation reduction potential
BOD_x	BOD test based on other than 5 days	POTW	public-owned treatment works
CBOD	5-day carbonaeous BOD	ppm	parts per million
COD	chemical oxygen demand	ppb	parts per billion
CWA	Clean Water Act	psi	pounds per square inch
DEP	Florida Dept. of Environmental Protection	PVC	polyvinyl chloride
EIS	Environmental Impact Statement	RO	reverse osmosis
EPA	U.S. Environmental Protection Agency	SCADA	supervisory control and data acquisition
FAC	Florida Administrative Code	SJRWMD	St. Johns River Water Mangement District
fps	feet per second	SFWMD	South Florida Water Management District
FSAWWA	Florida Section of AWWA	SRWMD	Suwannee River Water Management District
FWEA	Florida Water Environment Association	SWFWMD	Southwest Florida Water Management District
FWPCOA	Fla. Water & Pollution Control Operators Assoc.	TDS	total dissolved solids
GIS	Geographic Information System	TOC	total organic carbon
gpcd	gallons per capita per day	TSS	total suspended solids
gpd	gallons per day	USGS	United States Geological Survey
gpm	gallons per minute	WEF	Water Environment Federation
hp	horsepower	WRF	water reclamation facility
MGD	million gallons per day	WTP	water treatment plant
mg/L	milligrams per liter	WWTP	wastewater treatment plant

Water Conservation in Florida

FSAWWA Water Conservation Committee

Water Conservation as Growth Management Policy

Ronnie Duncan and Kathy Foley

Ronnie Duncan is treasurer of SWFWMD's governing board and is president of The Duncan Companies, a commercial real estate consulting and development enterprise. Kathy Foley is manager of the Conservation Projects Section for SWFWMD.

Responsible growth management. Sustainable development. These have been the catch phrases of the planning community for the past ten years, particularly in the area of resource planning. Traditionally, the need for continued water conservation has been identified and stated as a goal or objective in planning documents, but the specific policies necessary to achieve those goals have been lacking.

Southwest Florida is right now experiencing record-low surface and ground water levels, with little relief in sight. The April governing board meeting of SWFWMD included the ratification of four emergency board orders necessary to ensure that safe and adequate water supplies will remain available in the Tampa Bay Area during the current extreme conditions. Meanwhile, economic growth is critical, and residential and commercial building development continues at a steady pace.

New developments likely do not carry the same inefficient designs as older developments; however, efficiency can and should be increased. Responsibility lies not with the developers, although a few have taken the initiative to require efficiency through deed restrictions, and other creative development practices. The lack of consistent growth management efficiency requirements for development on local and state levels is the issue.

When conservation requirements are suggested, the interpretation is often that a sacrifice must be made. On the contrary, well-planned concepts promote the same or better quality of life, but with more efficiency and less waste. An argument for a better quality of life can be made if the health and beauty of the Florida environment can be sustained. After all, the environment is often what brings new people to the state and generates the need for such development.

Responsible growth management cannot succeed without local and regional coordination. The SWFWMD governing board has made a commitment to strengthen the link between water conservation and growth management. Not only will governments and utilities call for local cooperationm, but so will all water users and stakeholders. An interagency task force will be assembled during the next several months, local and district conservation efforts will be inventoried, strengths and weaknesses will be identified, and coordination among all stakeholders will be sought.

Four of five water management districts in Florida have indicated that there are regions within their boundaries where demand will exceed the available traditional supplies within the next 20 years. Supplies that must be developed have been identified to meet the demand, but none is more cost-effective in reducing future demand than responsible growth. Although one among many options, a building moratorium is not in the best interest of Florida. An abundance of opportunities for responsible growth remains with the reinforcement of water conservation requirements and the enhancement of existing conservation efforts.

Conservation of Reclaimed Water

Anthony Andrade and Jo Ann Jackson

Anthony Andrade is a staff water conservation analyst with SWFWMD and project manager for numerous water conservation and reclaimed water projects. Jo Ann Jackson, P.E., is a senior project manager with PBS&J, Winter Park and the firm's reuse technology leader specializing in water conservation and reuse.

The days of using reclaimed water as little more than a solution to an effluent disposal requirement are fast disappearing. Reclaimed water is now being viewed as a resource by many utilities, and it is increasingly relied upon as one way to meet community water demands. In order to meet those demands, utilities must manage and conserve their reclaimed water resources. The responsible management of reclaimed water has two major components: efficiency (offset) and utilization.

Efficiency

Reclaimed water efficiency represents the amount of traditional water sources (groundwater, surface water) which is replaced. The amount of reclaimed water used by reclaimed water customers is usually more than the amount of traditional sources used for the same purposes since reclaimed water is typically provided to customers at a significantly lower cost and the enforcement of water restrictions is no longer an issue. For example, a single-family residence using 300 gpd of drinking water for irrigation will tend to limit irrigation because of the expense associated with metered drinking water supplies. Experience has demonstrated that the same single family residence using a non-metered or flat rate reclaimed water irrigation supply will tend to increase irrigation by as much as four times (1,200 gpd) the previous amount used. In this example, the offset rate would be 25%. A power plant or other industry using 1 MGD of surface or ground water for cooling or process water that converts to reclaimed water will normally use the same amount (1 MGD) of reclaimed water as they did when supplied by their previous source. In this example, the offset rate would be 100%. For this reason, industrial uses are considered to be among the most efficient.

When many of the existing reclaimed water systems were developed, the primary focus was on maximizing effluent disposal, and water savings associated with those reuse systems were just ancillary benefits. Incentives were offered in order to encourage customer connection to the reclaimed water systems, such as free use of the water or a nominal flat monthly charge and no restrictions on irrigation frequency. Today these incentives continue to promote an inefficient overuse of the reclaimed water supply.

Because of the historical and continued overuse of reclaimed water, many utilities are limited in their ability to serve the

demands for reclaimed water in their service areas. By promoting and implementing methods for more efficient use of reclaimed water, utilities could serve more customers and increase the offset of traditional supplies. In implementing such methods an evaluation of existing reclaimed water systems is advisable, including review of seasonal storage, current reclaimed water rate structures, and other aspects of the reuse programs that might encourage non-efficient use of the resource.

Some efficiency measures that could be examined include:

- Customer type (provide reclaimed water primarily to customers with high efficiency rates)
- Reclaimed water Conservation Rate Structures (apply traditional inverted rate structures to reclaimed water)
- Metering (without metering, reclaimed water use and overuse are difficult to control)
- Reclaimed water use restrictions (time of day, and day of week restrictions have proven to be effective)
- Telemetry control of reclaimed water availability (automatic/remote control of customers= reclaimed water supply, duration, and pressure)
- Increased customer inspections (timers, application rates, etc.)
- Customer education programs (educating the customer that more is not always better)

SWFWMD's Regional Water Supply Plan has revealed that these measures could result in a potential increase from the current 60% average to 75% efficiency. In addition to efficiency efforts, the more traditional conservation measures such as leak detection should also be used for reclaimed water systems.

Utilization

Utilization is the actual percentage of WWTP flows sent to customers. In 1995 wastewater treatment plants within Florida were providing customers with 361 MGD of reclaimed water (DEP, 1996), which represented only 25% of the wastewater effluent available. The remaining effluent was primarily disposed of into surface waters or injected into deep wells.

It is recognized that utilization varies by area and utility and is limited by seasonal supply and storage. The daily and seasonal supply of reclaimed water from a WWTP is normally fairly constant; however, the daily and seasonal demand from customers for that supply is usually highly variable. A utility cannot reliably serve customers if it expands its system beyond peak flow demand. A key to increasing utilization is developing seasonal storage to capture and store the reclaimed water that is unused for most of the year. This stored reclaimed water can then be used to augment the daily reclaimed water flows to meet peak demand to store the large volumes associated with seasonal storage, either surface reservoirs or ASR wells may be necessary. By developing seasonal storage, SWFWMD has estimated utilities can increase utilization to 75% of WWTP flows.

Potential Benefits for Florida

The conservation of reclaimed water is linked to both utilization and efficiency rates. The current average reclaimed water utilization rate limit is approximately 50%; current efficiency rates are an average of approximately 60% offset (SWFWMD 2000). Using 1999 DEP WWTP effluent data, the total estimated potential benefit from reclaimed water in Florida would be only 377 MGD from the 1,258 MGD effluent available. However, by using a target utilization rate of 75% and a target efficiency rate of 75%, the total estimated reclaimed water benefit would increase to approximately 707 MGD. By implementing responsible reclaimed water management it may be possible to nearly double the benefit that reclaimed water provides to Florida.

The degree to which regional water supply planning has been accelerated indicates that the water demand in much of Florida, particularly urban areas, is expected to exceed traditional sources of supply. Alternative sources must be focused on to help meet those demands and conserve traditional supplies. The SWFWMD plans to implement a project which will examine the specific measures utilities can take to increase utilization and efficiency and conserve their reclaimed water resources, in order to have the largest beneficial impact on the traditional water resources within the District.

The message is clear: Florida's reclaimed water supply is not unlimited, and should be treated accordingly. Increased utilization of WWTP flows, coupled with increased efficiency, can enable utilities to maximize the responsible use of reclaimed water supplies and conserve Florida's water resources.

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One-Day/Week Water Restrictions

Norman Davis

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When adopting emergency watering restrictions, it is of paramount importance that a balance is struck with the operational capabilities of water utilities, the requirement to reduce water use, and the necessity to not unfairly impact certain industries such as plant growers, irrigation contractors, and developers.

The drought of 2000 brought the driest winter and spring on record to the Tampa Bay region. The Hillsborough River, Tampa's primary water source, hit record low levels, causing the city to augment the in-stream reservoir on a daily basis, to the tune of some 40 million gallons. On March 16 the city declared mandatory one-day/week outdoor watering restrictions and stepped up enforcement with a no first-time warning policy. Odd-numbered addresses were allowed to water on Sundays only, even-numbered on Tuesdays only. All exemptions to the rules, as promulgated by SWFWMD in Chapter 40D-21, FAC, were removed, except through special variances. As of May 14 over 2,000 citations had been issued.

Also on March 16, in the neighboring political jurisdiction of Hillsborough County, the board of county commissioners received a report of low well levels and a forecast of continuing La Niña weather patterns through August. The board immediately took similar action as the city of Tampa had, mirroring the days and hours for allowable watering of established lawns and landscaping. The major difference between the communities is that in the county, all exemptions to the rules remained in effect,

and the county board provided a 30-day advisory period prior to the issuance of citations for watering on a previously allowable day. The board also requested the other members of Tampa Bay Water, and the other local communities of Temple Terrace and Plant City, to adopt similar rules. Over the course of the next couple of weeks, most communities did so.

In April SWFWMD adopted Executive Director Emergency Order No. 00-18, restricting water use district-wide to the two days already utilized in Hillsborough, Pasco, and Pinellas counties and their respective incorporated communities. This was in contrast to the specific pre-adopted plan in Chapter 40D-21.641 FAC, which provides for a single day per week, with approximately 20% of locations allowed each day, according to the last digit of a location's address, Monday through Friday. The district's reasoning in adopting the Sunday/Tuesday scenario was that much of the population had already been placed on those days. At that time, delivery system problems had not yet surfaced in response to increasing irrigation demand.

As the spring advanced with substantially less than normal rainfall and with watering demands increasing concomitantly, the customers of the Hillsborough County Water Department exhibited great compliance with the new single day per week watering schedule. In April the demand on allowable watering days continued to grow on a weekly basis, to the point that extremely low pressures in the system were experienced. Precautionary Boil Water Notices were provided to specific neighborhoods, as required when pressures drop below 20 psi. Had there been other localized events such as a dwelling fire, line break, or pump failure, the public's welfare may well have been jeopardized. Should negative pressures have occurred, the potential of siphoning contaminants into the potable water system would have become a reality. Immediate action was necessary to prevent this situation from occurring.

On May 8, during the public meeting of Hillsborough County's Water Conservation Technical Committee, operations and planning staff of the water department presented the above evidence to the committee. In response, the committee recommended that the board of county commissioners take immediate action in changing the allowable days for irrigation to level off demand throughout the week. On May 10, the board adopted an emergency ordinance amending Ordinance 91-27 and providing for single-day-per-week watering, with Mondays through Fridays being specified for watering, according to a location's address. The penalty for violations was also increased from $35 to $70, plus $5 in administrative fees.

For an emergency ordinance to pass, it requires 80% of the full membership of the governing body. Therefore, since Hillsborough County is governed by a board of seven members, we needed six affirmative votes. The item needed to be placed on the agenda, and the emergency ordinance needed to be drafted. In addition, ancillary public awareness materials needed to be prepared, because the changes in the rules would have to be communicated to the public immediately upon adoption by the board to realize the positive impact we were hoping for, through a reduction in demand on the following Sunday.

As the county attorney's office drafted the necessary legal documents, the communication department prepared display advertisements for the local newspapers. The water conservation team, in the meantime, prepared a series of news releases and planned for the anticipated public response on the pre-established conservation hotline and at the utility's customer telephone response center. Direct visitations with the commissioners and their aides enabled their concerns to be addressed and incorporated into the ordinance. Specifically, and of considerable importance in Florida, we included provisions for seasonal residents, who were out of the state at the time of adoption, to be exempt from the change in allowable day, as long as they were still watering on a previously allowable day.

The strategy was successful. Significantly less demand on Sundays and Tuesdays occurred immediately.

At the same time recommendations for increasing the aggressiveness and effectiveness of the conservation program were being forwarded by the Technical Committee to the county commissioners. Because of that, presentations were made before the Citizens Advisory Committee to the board and the Citizens Environmental Advisory Committee to the Environmental Protection Commission. Also, the local media were hungry for sound bites. We were featured on a prominent local television station for a thirty-minute program that aired twice on the first weekend of implementation. The low delivery pressure situation had been avoided, even as total weekly demands continued to climb through the remainder of spring. All said, the Drought of 2000 underscored the need for continued aggressive water conservation measures in Hillsborough County.

Time to Get "Xerious" About Landscape Codes

Albert Bond

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Large areas within SWFWMD, including the Intrerstate-4 corridor, Hillsborough County, and Pasco County, are currently experiencing vigorous economic and population growth and associated large-scale residential development. One of the most immediately discernable environmental impacts inherent to large-scale residential land development is water supply. Simply speaking, as population increases, water demand increases.

Water used for landscape irrigation generally comprises more than one quarter of total residential water demand. Incorporating Xeriscape principles into landscape codes governing new residential developments results in significant water savings.

Within a typical landscape, turf, usually St. Augustine grass, is predominant, covering up to 80% or more of the land surface and requiring up to a 1-inch depth of water per week. Concrete driveways or sidewalks cover most of the remaining area. Ornamental flowerbeds, trees, and rock gardens may be present to a limited extent. Underlying the landscape may be fill material, which may or may not be conducive to healthy plant growth. An in-ground irrigation system may be operated long enough to provide sufficient water to the driest areas of the landscape, thereby over watering the remaining areas. Significant non-irrigable areas (i.e., streets, driveways, and sidewalks) may be receiving water.

Alternately, a Xeriscape landscape exhibits a culmination of principles that result in efficient water use. The landscape is segregated based on water need into natural, drought tolerant, and oasis zones, allowing for precision irrigation. Mulch deters weed growth, prevents soil erosion, reduces evaporation, and preserves organic matter in soil. The irrigation system is designed and maintained for maximum application efficiency. Finally, a Xeriscape landscape exhibits practicality. Plants are appropriate for the conditions where they are planted. Conditions to consider include irrigation and precipitation, soil pH and moisture holding capacity, shade, adjacent plants, pests, and other factors that affect plant growth. This minimizes the need to amend the soil and provide supplemental irrigation.

The water use associated with residential landscape irrigation is significant. Public supply water use in Hillsborough County in 1998 was an estimated 157 MGD (*1998 Estimated Water Use in the Southwest Florida Water Management District*, SWFWMD, 1999). Applying the general guideline that at least 25% of public supply

water is used for landscape irrigation, as much as 39 MGD or more was directed toward landscape irrigation in the county in 1998.

Potential water savings associated with Xeriscape are also significant. Assuming a 2,500-square-foot home on a quarter-acre lot with typical landscaping where 80% of the outside area is irrigable, 1 inch of water applied weekly to the entire irrigable area equals 4,184 gallons per week. Assuming the same dimensions where Xeriscape principles are integrated into the landscape design, 1 inch of water applied weekly to 50% of the area (oasis zones), less water applied weekly to 25% of the area (drought tolerant zones), and no water applied to 25% of the area (natural zones), the requirement is 2,615 gallons per week. In this scenario, the landscape designed using Xeriscape principles requires 38% less water. This is a conservative estimate because the scenario does not account for the improved irrigation system design and maintenance of the Xeriscape landscape or the over watering inherent in typical landscape design. Applying results from the above scenario, landscapes designed and installed using Xeriscape principles versus typical landscapes in new residential communities would save 224,000 gpd for every 1000 new homes built.

Local codes are the mechanism by which Xeriscape principles should be incorporated into new residential community landscaping. While local communities generally support water-efficient landscaping by encouraging Xeriscape landscaping, this has not been effective in curbing inefficient landscaping and irrigation practices.

Although landscape characteristics within a residential community are generally specified by deed restrictions, such specifications cannot conflict with local codes. However, most local codes governing residential development are not consistent with sound water management policy. Therefore, many deed restrictions promote intensive water use by including stipulations that require large portions of the landscape be covered by turf grass and a minimum amount of irrigation based on turf grass appearance. Considering the costs associated with "new water" projects and the conservation efforts undertaken by residents, public agencies, and private entities within SWFWMD, requiring water intensive landscaping seems contrary to sound water management policy.

Integrating Xeriscape principles into local codes would save several million gallons of water per day over the next few years. It would be far better to look back in the future at the water that was saved and is then available for a more beneficial use than to look back at continued inefficient water use. Integrating Xeriscape principles into local codes governing residential landscape planning is an extremely inexpensive way to achieve substantial water savings and should be pursued by local governments.

Rain Barrels as an Educational Tool

Billie Lofland

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Over the past year 220 people in Hillsborough County have converted 250 food-grade drums into rain barrels. The "How to Make a Rain Barrel" workshops, conducted by the Florida Yards and Neighborhoods Program of the Environmental Horticulture Department of the Hillsborough County Cooperative Extension Service and co-sponsored by the water departments of Hillsborough County and the City of Tampa, are a useful tool in educating residents about the important issues of water conservation and reducing stormwater runoff pollution.

Before the workshop begins, each household is requested to complete a one-page (front and back) questionnaire that's divided into eight sections covering landscape design and maintenance practices — general information (size of property maintained and percent of yard in turf); site analysis, planting and landscape design; stormwater runoff; irrigation; fertilization; pest management; mow, mulching and recycling; wildlife; and waterfront. The Extension Service sends a follow-up questionnaire six months to a year later. Each participant also receives a workshop evaluation sheet.

The workshop begins with a 30-minute presentation that explains that rain barrels are being promoted because they can help conserve water and reduce stormwater runoff pollution. It is noted, however, that since each barrel holds only 55 gallons of water there are other important actions people need to take, including following water restrictions, requesting a sprinkler system evaluation, and applying fertilizers and pesticides properly.

A master gardener then demonstrates how to make a rain barrel. The Cooperative Extension Service recommends using open top, wide-mouthed barrels and avoiding white barrels because they are reported to disintegrate more quickly in the sun. Also covered are ways to connect the barrel to a downspout, or, if there are no downspouts, how to use screening over the top to safely collect and store water running off the roof. Other topics include connecting more than one rain barrel together, keeping leaves out of the barrels, and taking care of overflow. People are told to rinse out the barrels once they get home, because the barrels often have remnants of their original contents, including olives, spices, wine vinegar, or fruit juice concentrate.

After a question and answer session, people make their own barrels. For a $15 donation to the Master Gardener Program, people receive a rain barrel kit, which includes the used 55-gallon food-grade drum and a boiler drain faucet. The contribution basically covers the cost of the materials. Drills and glue are provided. Staff and master gardeners help those who are uncomfortable using a drill or have problems putting faucets in place. Most make their own drums and enjoy the process.

People with very small cars or who have ordered more than one rain barrel kit can run into problems getting their barrels home. While a barrel fits easily in the back seats of most sedans, it can be difficult to get a barrel into a car trunk.

The "How to Make a Rain Barrel" workshops compliment the Hillsborough County Water Department's efforts in encouraging the use of cisterns. During the workshops people have expressed an interest in having a more extensive water-retention system to use for their landscapes and/or toilets.

Florida Yards and Neighborhoods also promotes rain barrels through its Florida Yard Certification process. A homeowner, business, or community completes the Florida Yard Certification Checklist and, if they have 36 points or more (some are mandatory), they can request that a landscape be certified as a Florida Yard — an attractive, healthy landscape that also protects Florida's environment. One of the actions under the Stormwater Runoff category is "Collect and store rain runoff from your roof in a rain barrel or cistern."

Florida Yards and Neighborhoods is a state-wide program of the University of Florida Cooperative Extension Service. However, so that the program can accommodate the needs of any given county, programs do differ from county to county. Because water conservation is a critical issue in Hillsborough County, many departments within the Hillsborough County Extension Service are working with their communities on increasing water-use efficiency.

The region's water supplier, Tampa Bay Water, a partnership of member governments, provides funding for Florida Yards and Neighborhoods programs in Pinellas, Pasco, and Hillsborough Counties. Fiscal Year 2000 marks the sixth year of funding support for Florida Yards and Neighborhoods by Tampa Bay Water.

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Irrigating Edible Crops with Reclaimed Water

David York, Lawrence Parsons, and Lauren Walker-Coleman

Reuse has become very popular in Florida. In 1998, 451 domestic wastewater treatment facilities provided 490 MGD of reclaimed water for reuse[1]. The combined capacity of these systems totaled 1,009 MGD, 45% of the total permitted domestic wastewater treatment plant capacity in Florida.

In 1998, 88 MGD of reclaimed water was used to irrigate about 33,500 acres of agricultural land[1]. Although most of the reclaimed water was used to irrigate feed and fodder crops, 20 MGD was used to irrigate over 15,200 acres of edible crops. The permitted reuse capacity of all edible crop systems was 41 MGD. While citrus represents the primary edible crop irrigated with reclaimed water, a wide range of other edible crops (tomatoes, cabbage, peppers, watermelon, corn, eggplant, strawberries, peas, beans, herbs, squash, and cucumbers) also are irrigated with reclaimed water.

Florida's regulations governing water reuse[2] are contained in Chapter 62-610, FAC.. The use of reclaimed water to irrigate edible crops is addressed in Rule 62-610.475 in Part III of this chapter, which requires that the reclaimed water receive secondary treatment, filtration, and high-level disinfection. This rule, established in 1989, specifically allows for the irrigation of edible crops with reclaimed water. The only limitation is that direct contact application methods (spray irrigation) are not allowed, if reclaimed water is to be used to irrigate crops that will not be peeled, skinned, cooked, or thermally processed before human consumption (the "salad crops"). Indirect contact methods (drip, subsurface, and ridge and furrow irrigation) may be used to irrigate the salad crops. Any type of irrigation system may be used to irrigate tobacco, citrus, and any crop that will be peeled, skinned, cooked, or thermally processed before human consumption.

When Chapter 62-610, FAC., was originally adopted in April 1989, the edible crop rule allowed any type of application system for use with the salad crops. This was based on review of reuse experience and studies conducted elsewhere in the U.S. and world and a unanimous recommendation from the Reuse Technical Advisory Committee (TAC) – a panel of reuse and public health experts that provided technical input into the rulemaking activity. Adoption of this rule (specifically the fact that direct contact methods were allowed for the salad crops) was immediately greeted with negative press coverage. In an effort to maximize public acceptance of water reuse and to

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Code of Good Practices for Water Reuse in Florida

David W. York and Christianne Ferraro

Christianne Ferraro, P.E., water facilities administrator, DEP, Orlando, chairs the FWEA Water Reuse Committee.

The *Code of Good Practices for Water Reuse in Florida.* was developed by DEP and FWEA's Water Reuse Committee to aid reuse utilities as they implement quality water reuse programs. The focus is on reuse systems that provide reclaimed water for irrigation of public access areas (golf courses, parks, and other landscaped areas), residential lawns, and edible food crops. These types of reuse activities are regulated under Part III of Chapter 62-610, FAC. The full text of the code follows:

Protection of Public Health and Environmental Quality

Public Health Significance – To recognize that distribution of reclaimed water for non-potable purposes offers potential for public contact and that such contact has significance related to the public health.

Compliance – To comply with all applicable state, federal, and local requirements for water reclamation, storage, transmission, distribution, and reuse of reclaimed water.

Product – To provide reclaimed water that meets state treatment and disinfection requirements and that is safe and acceptable for the intended uses when delivered to the end users.

Quality Monitoring and Process Control – To continuously monitor the reclaimed water being produced and rigorously enforce the approved operating protocol such that only high-quality reclaimed water is delivered to the end users.

Effective Filtration – To optimize performance of the filtration process in order to maximize the effectiveness of the disinfection process in the inactivation of viruses and to effectively remove protozoan pathogens.

Cross-Connection Control – To ensure that effective cross-connection control programs are rigorously enforced in areas served with reclaimed water.

Inspections – To provide thorough, routine inspections of reclaimed water facilities, including facilities located on the property of end users, to ensure that reclaimed water is used in accordance with state and local requirements and that cross-connections do not occur.

Reuse System Management

Water Supply Philosophy – To adopt a "water supply" philosophy oriented towards reliable delivery of a high-quality reclaimed water product to the end users.

Conservation – To recognize that reclaimed water is a valuable water resource, which should be used efficiently and effectively to promote conservation of the resource.

Partnerships – To enter into partnerships with the Department of Environmental Protection, the end users, the public, the drinking water utility, other local and regional agencies, the water management district, and the county health department to follow and promote these practices.

Communications – To provide effective and open communication with the public, end users, the drinking water utility, other local and regional agencies, the Department of Environmental Protection, the water management district, and the county health department.

Contingency Plans – To develop response plans for unanticipated events, such as inclement weather, hurricanes, tornadoes, floods, drought, supply shortfalls, equipment failure, and power disruptions.

Preventative Maintenance – To prepare and implement a plan for preventative maintenance for equipment and facilities to treat wastewater and to store, convey, and distribute reclaimed water.

Continual Improvement – To continually improve all aspects of water reclamation and reuse.

Public Awareness

Public Notification – To provide effective signage advising the public about the use of reclaimed water and to provide effective written notification to end users of reclaimed water about the origin of, the nature of, and proper use of reclaimed water.

Education – To educate the public, children, and other agencies about the need for water conservation and reuse, reuse activities in the state and local area, and environmentally sound wastewater management and water reuse practices.

forge a strong partnership with the Florida Department of Health, DEP immediately moved to revise the rule dealing with edible crops. As a result, Chapter 62-610, FAC, was amended later in 1989, and the current prohibition on direct contact methods for irrigation of the salad crops was added.

The rule governing irrigation of edible crops (Rule 62-610.475, FAC.) also includes provisions allowing for demonstration studies of direct contact methods for irrigation of edible crops that are not peeled, skinned, cooked, or thermally processed before human consumption[2]. These provisions were added to the rule in 1989, when the prohibition on direct contact methods was adopted. At that time, it was hoped that someone would conduct a study in Florida documenting the viability of direct contact methods. To date, no one has undertaken such a study, and state funding has not been secured to fund a study.

Florida Agriculture

Florida is a major agricultural state, leading the U.S. in the production of oranges, grapefruit, limes, tangelos, corn (fresh market), green peppers, tomatoes (fresh market), and watermelons[3]. Florida also ranks in the top three states in the production of strawberries and head lettuce. In 1996, cash receipts for farm production in Florida totaled about $6.1 billion, which ranked ninth among the states in the U.S.[4].

Florida's agriculture lands totaled about 3.70 million acres in 1995, of which 1.97 million acres (53%) were irrigated[5]. Of the 925,000 acres devoted to fruit crops, 894,000 acres (97%) are irrigated. Citrus accounts for 92% of the area planted in fruit crops. Of the state's 851,000 acres of citrus, over 97% is irrigated. Irrigation is used on 68% of the 798,000 acres of field crops (including sugarcane, cotton, and others) and on 93% of the 297,000 acres planted in vegetables.

Flood, ridge and furrow, and subsurface irrigation methods are used on 51% of lands being irrigated in Florida[5]. Micro-irrigation methods are used on 31% and sprinkler irrigation methods are used on the remaining 18% of irrigated lands. Virtually all of the state's 417,000 acres of sugarcane is irrigated using seepage methods. Micro-irrigation methods are used on over 67% of the 830,000 acres of irrigated citrus groves.

In 1995, about 3,240 MGD of fresh water was used for irrigation in Florida[5]. Of this total, 53% was surface water and 47% was groundwater. Irrigation accounted for 45% of the total fresh water used in Florida. Citrus accounted for about 44% of the total irrigation water. Florida's irrigation water use ranked 13th among the states in the U.S.[6]. All 13 states using more irrigation water are located west of the Mississippi River.

Agriculture in Florida uses over 750 MGD of surface water to irrigate vegetables and fruit crops[5]. The surface waters used are Class III (recreation and fish and wildlife) or Class IV (agricultural water supplies) waters[7]. Class III waters are held to a microbiological standard of 200 fecal coliforms per 100 mL (average), while there are no microbiological standards for Class IV agricultural waters. These surface water quality standards are significantly less restrictive than the no detectable fecal coliform standard imposed on reclaimed water used to irrigate edible crops in Florida[8].

Research, Studies, And Guidelines

EPA's Reuse Guidelines: In developing *Guidelines for Water Reuse*[9], EPA's Technical Advisory Committee took into account available research, studies, and practices when considering irrigation of edible crops. For irrigation (including spray irrigation) of food crops that are not commercially processed before human consumption, it was recommended that the reclaimed water have BOD less than 10 mg/L, average turbidity less than 2 NTU, and fecal coliforms less than detection (median value). If TSS are used in lieu of turbidity, the guidelines recommended that average TSS be less than 5 mg/L.

The National Research Council conducted a comprehensive evaluation of the use of reclaimed water and residuals in food crop production[10]. It concluded that "Current technology to remove pollutants from wastewater, coupled with existing regulations and guidelines governing the use of reclaimed water in crop production, are adequate to protect human health and the environment." It also noted that "food crops thus produced do not present a greater risk to the consumer than do crops irrigated from conventional sources."

The World Health Organization developed guidelines for the use of reclaimed water to irrigate edible crops[11] based on major epidemiological investigations and on input from internationally acclaimed health experts. For irrigation of edible crops likely to be eaten uncooked, it was recommended that fecal coliforms be less than 1,000 per 100 mL (geometric mean) and that helminths be less than 1 egg per liter (mean).

A landmark, five-year study[12] in Monterey County, California, investigated the use of reclaimed water to irrigate artichokes, broccoli, cauliflower, celery, and lettuce. Groundwater served as the control. The reclaimed water used met treatment and disinfection requirements similar to that of Florida. Health studies concluded that irrigation with reclaimed water posed no increased health risks to workers. Irrigation with reclaimed water was found to produce excellent yields of high-quality produce. No differences in plant vigor or appearance, shelf life or quality, or in spoilage rates were observed. Marketability studies concluded that labeling of crops would not be needed and that business risks to growers were extremely low. Heavy metals did not accumulate in crops or soils. Chlorine residuals had no effect on crops. Salinity and sodicity in the reclaimed water fell in the favorable range and no significant reductions in soil permeability were noted. No virus, *Salmonellae*, *Shigellae*, *Ascaris lumbricoides*, *Entamoeba histolytica*, or other parasites were found in the soils or crops. The study found no aerosol transmission of pathogens.

In a follow-up study in Monterey County, Sheikh and Cooper[13] evaluated several protozoan (*Giardia*, *Cryptosporidium*, and *Cyclospora*) and other pathogens (*Escherichia coli* 0157:H7, *Legionella*, and *Salmonella*). The only pathogen found in the reclaimed water was *Giardia*, which was detected in 80% of the samples at concentrations ranging from 3 to 9 cysts per 100 L. However, all *Giardia* cysts were devoid of internal structure and were considered to be non-viable.

A three-year study[14] in Melbourne, Australia, investigated the use of reclaimed water and groundwater to irrigate cabbage, carrots, celery, lettuce, spinach, and tomatoes. The reclaimed water received a lower level of treatment (secondary and disinfection) than what is required in Florida. The investigation, including sampling for viruses, *Salmonella*, and several indicator organisms, concluded that irrigating with reclaimed water posed no risk of viral infection and no health risk related to heavy metals. Yields were highest with the use of reclaimed water and balanced fertilization. It was concluded that use of reclaimed water could save 75% of the cost of chemical fertilizers. Use of reclaimed water resulted in the production of high-quality crops. While the reclaimed water delivered to the storage pond contained an average of 210 PFU/100 L, viruses were not detected on crops irrigated with reclaimed water. *Salmonella* was not detected in the reclaimed water or on the crops. Concentrations of indicator organisms on crops irrigated with reclaimed water did not differ significantly from concentrations found on produce in local markets.

Water Conserv II[15], a joint venture between Orange County and the city of Orlando, is one of the world's largest reuse projects featuring agricultural irrigation and groundwater recharge. Reclaimed water from two water reclamation facilities

is conveyed to a distribution center west of Orlando and is used by 60 growers to irrigate about 4000 acres of citrus. Reclaimed water also is used for irrigation of nine landscape and foliage nurseries, three tree farms, two landfills, and the Orange County National Golf Center. An extensive network of rapid infiltration basins is used for ground water recharge. This award-winning project has been operating for 13 years and currently uses about 30 MGD of reclaimed water.

Facing "no discharge" limits, the city and county proposed Water Conserv II in the early 1980s. Citrus grove owners initially were skeptical of the plan because of their concerns about possible heavy metal contamination, possible public health issues, flooding, and lack of flexibility in water application during periods of high rainfall. Growers also raised concerns over psychological aspects and felt consumers might consider that fruit from trees irrigated with reclaimed water would be of poorer quality. Ultimately, Orlando, Orange County, and the growers developed a plan that provided for the establishment of reclaimed water standards, regular monitoring of the water, greater grower flexibility on timing of use, use of reclaimed water and ground water for freeze protection, and research on the effects of the reclaimed water on citrus tree performance[15,16].

To promote grower acceptance of the plan, rigorous water quality guidelines for citrus trees were developed by the University of Florida[17,18]. The maximum average concentration limits for sodium, chloride, barium, chromium, copper, selenium, silver, sulfate, and zinc are more stringent than Florida's drinking water standards.

To promote research on agricultural reuse, the city and county established the Mid-Florida Citrus Foundation (a nonprofit research foundation), dedicated over 100 acres for research, and established a relationship with the University of Florida to conduct research in support of the project[15].

Studies were conducted to determine if citrus could tolerate high application rates of reclaimed water. In research plantings, very high rates of up to 100 inches/year were applied to two citrus varieties, Hamlin orange and Orlando tangelo, on four rootstocks. Application of 100 inches of reclaimed water significantly increased canopy volume and fruit yield compared to 16-inch applications of ground water and reclaimed water[19]. This excessive irrigation diluted the soluble solids somewhat, but because of the greater total fruit production, total soluble solids per acre were increased by the high irrigation rate. Growers of fruit for juice processing are paid on the basis of total mass of soluble solids, so the greater total soluble solids production at high irrigation rates was beneficial to them.

Weed growth was greater where high rates of reclaimed water were used[19]. Weed growth can be controlled with proper herbicide use and mowing and is not as great a problem in mature groves. Irrigation with reclaimed water increased soil and leaf phosphorus, calcium, and sodium. Leaf levels of sodium, chloride, and boron were elevated but remained below toxic levels[20]. Annual energy savings from eliminating irrigation pumping costs can be as much as $128/acre[15].

In an evaluation of the nutritional value of the reclaimed water, trees that were given no fertilizer and irrigated only with reclaimed water took two to five years to show deficiency symptoms and yield declines. In experimental plots, high application rates of reclaimed water maintained yields for one year, but yields declined in the second year without additional fertilizer application[21]. Although reclaimed water provides all the phosphorus, calcium, and boron required by trees in central Florida, it cannot supply sufficient nitrogen, even if it is applied at high [100 inches/year] rates[22].

The 13 years of successful operation of Water Conserv II and data generated from the ongoing research program have demonstrated the acceptability of using reclaimed water for irrigation of citrus. Research and experience have shown that the growers' initial fears were unjustified, and grower acceptance of reclaimed water has increased significantly. Cross, et al.[15] noted that "citrus trees irrigated with reclaimed water are in better condition, produce larger crops, and have better soil and leaf mineral profiles than those irrigated with well water." Significant problems have not resulted from irrigating with reclaimed water.

In other Florida Research, studies with reclaimed water were carried out on mature grapefruit trees in poorly drained soils near Vero Beach. In one study[23], canal water was compared with reclaimed water applied at low, moderate, and high rates. Grapefruit yield and canopy growth were greater at the low and moderate reclaimed water irrigation treatments. It was suggested that for this flatwoods soil with a hardpan, irrigation rates should be less than 1.2 inch/week. When drainage was reduced because of weed buildup or drainage pipe blockage, trees became unproductive and stunted. It was concluded that fertilizer rates could be lowered without reducing yield when using reclaimed water.

Another study [24] showed that young grapefruit trees were not adversely affected by simulated reclaimed water irrigation if sufficient fertilizer was applied. Reclaimed water alone did not provide adequate nutrition for the trees. Irrigation rates of 0.75 or 1.0 inch/week did not affect young tree growth differentially.

Future Direction

As noted previously, DEP had hoped to conduct a study of edible crop irrigation using reclaimed water in Florida. The possibility of such a study was introduced as a possible research need at a 1999 workshop[25] sponsored by the National Water Research Institute. This concept received virtually no support from the other delegates (experts in water reuse, health, and environmental engineering and science) to the workshop, primarily because of the delegates' belief that previous research (as discussed above) had conclusively demonstrated the acceptability of the practice.

The available literature and extensive agricultural reuse practice in California have demonstrated the acceptability of using reclaimed water to irrigate edible food crops – including the use of spray irrigation on crops that will be consumed raw.

Chapter 62-610, FAC[2], currently prohibits the use of direct contact irrigation methods (spray irrigation) using reclaimed water for irrigation of edible crops that will not be peeled, skinned, cooked, or thermally processed before human consumption. Based on the literature cited in this paper and the experience in California, Florida's prohibition on direct contact application methods may not be justified. As a result, when Chapter 62-610, FAC., is next opened for revision, it is suggested that DEP revisit the issue of allowing direct contact methods for the irrigation of all types of edible crops.

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Showerhead Exchange — An Innovative Way to Get Low-Volume Showerheads

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Last November, wishing to educate the public about improvements in current showerheads as well as to conserve water, Sarasota County Environmental Services/Utilities invited customers to bring in old, water-wasting showerheads and exchange them for deluxe water-efficient massage models. The purpose of conducting an exchange rather than a "give away" was to ensure that the water conserving showerheads, delivering 2.5 gpm, would actually get installed. To make it convenient for customers, two different county sites were used.

With only the minimum promotion of a bill insert in the utilities bill, people were lined up before lobby doors opened at 8 a.m. In less than two days, 2,000 showerheads were exchanged.

Feedback has been positive. Customers were pleasantly surprised that current models delivered such forceful streams of water.

No special training was required for front counter staff during the event. All that was required was to accept the old showerhead.

Old showerheads were disposed of promptly in order to get them out of service. The quality of the old showerheads varied from cheap plastic to solid brass, but all were water-wasters. The media, hearing of the event, sent a reporter, and it was covered on local news.

Some liked the showerhead so much they quickly brought in one from a second bathroom to exchange. Several customers, while paying bills weeks later, commented on how much they liked the showerhead and shared how pleased they were with the new showerhead with friends and relatives.

Assuming that 1,000 households installed two showerheads each, thereby each saving 30,000 gallons per year per household, 30 million gallons of water will be saved every year for an investment of $5320.

By investing a minimal amount of funds and staff time, such a showerhead retrofit program can easily be duplicated. Water will be saved as long as the showerhead remains in use. No change in habits or constant reinforcement is required. Even if the house is sold, the showerhead remains and continues to conserve water.

The beauty of this innovative program, which we believe was conducted for the first time in Florida, is that it simplifies earlier retrofit programs that expended large sums of money and staff time delivering kits to neighborhoods. It also improves on just handing out showerheads as requested because by bringing in the old one, the customer has invested some effort and will need to install the new one promptly and not just leave it on a shelf as a "to do later" project.