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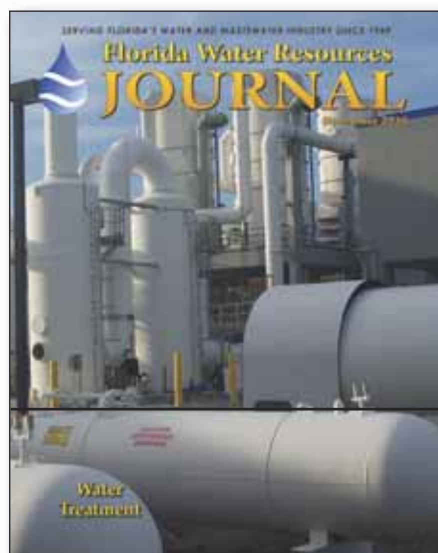

***ON THE COVER:** Collier County's lime softening plant uses a two-stage odor control system. Shown are its degas towers, bulk chemical storage, and odor control units. (photo: Randy Lewis)*

Volume 67 November 2016 Number 11

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First of Its Kind: City of Bunnell Utilizes Cutting-Edge Technology to Address Water Quality Consent Order Issues

Phil Locke and Nichole Smith

The City of Bunnell was issued a consent order from the Florida Department of Environmental Protection (FDEP) for exceeding maximum contaminant levels (MCLs) for disinfection byproducts (DBPs) at its water treatment plant. Additionally, hardness levels in the city's finished water often exceeded 300 mg/L, which resulted in scaling and damage to water transmission and distribution pipes and valves. Also, residential piping and water heaters were showing signs of scaling and deterioration.

Due to these issues, the city needed to implement a new treatment process that would remove total organic carbon (TOC) from the source groundwater supply to minimize the formation of DBPs that occur when free chlorine is added to water containing organic material. The general vicinity around the city has some high levels of TOC in the groundwater supplies, which can lead to DBP issues.

Pilot studies and evaluations were performed on the city's groundwater supply to evaluate and compare various treatment processes that can reduce DBPs and hardness. Alternatives evaluated for treatment included ion exchange, lime softening, and membrane treatment, along with a combination of these processes.

The studies and evaluations resulted in the recommendation for the city to implement a first-of-its-kind, single-vessel, "co-removal" ion exchange process, with a design capacity of 0.99 mil gal per day (mgd). A unique aspect of this project is the use of both anionic and cationic resins in a single, high-rate, fluidized bed contactor that simultaneously removes hardness and TOC from the city's groundwater supply. Resin regeneration is accomplished using a small amount of resin that is withdrawn from the base of the contactor reactor vessel and sent to a regeneration vessel. From there, the resin is accumulated, regenerated in a batch process, and returned to the contactor reactor vessel. This resin regeneration process enables the facility to maintain consistent ion exchange treatment capacity. The facility was constructed, start-up testing was completed with all goals being met, and the plant was placed into operation in October 2015.

Background

The City of Bunnell Water operates a 4-mgd water treatment plant (WTP) that treats groundwater and uses aeration to remove hydrogen sulfide, along with filtration and disinfection to achieve four-log virus inactivation. The plant had previously operated as a lime softening facility; however, the lime silo, its associated components, and the softeners were in inoperable condition and were offline for several years prior to the project's conception. Due to the inability to achieve the MCLs for total trihalomethanes (TTHMs), a consent order was issued to the city by FDEP in October 2011.

In addition to the consent order, the city's water customers experienced hardness levels exceeding 300 mg/L as calcium carbonate in their water. These levels were causing significant issues with water customers' appliances, and the city was receiving regular complaints about the hard water.

The main goal of the city's ion exchange WTP project is to remove natural organic matter (NOM) from the source groundwater supply to minimize the formation of DBPs that occur when free chlorine is added to water that contains organic material. By reducing the organics in the water, the DBPs will be reduced to levels that comply with drinking water regulations. A second goal is to reduce hardness to levels acceptable to the city and that meet secondary drinking water requirements for total hardness. Alternatives evaluated for treatment included ion exchange, lime softening, and reverse osmosis, along with a combination of these processes. A weighted treatment options decision matrix was developed for these potential alternatives and included:

- Capital and annual operation and maintenance (O&M) costs
- Technical feasibility
- Ability to meet DBP requirements
- Ability to meet city hardness goals and hardness requirements
- Proven implementation
- Consumptive use permit compatibility/water loss
- Minimization of treatment waste
- Footprint

Phil Locke, P.E., is senior project manager with McKim & Creed in Clearwater, and Nichole Smith, E.I., is an engineer intern with McKim & Creed in Tampa.

Based on the results from the evaluation, ion exchange was selected for implementation to remove organics and reduce DBP formation potential, as specified by the consent order. Two ion exchange systems were evaluated for their cost-effectiveness: the Tonka system uses a fixed-bed ion exchange system using a Pur-IX™ anion resin for TOC removal and a cation exchange system for softening; and the Orica MagnaPak™ fluidized bed co-removal system utilizes both anionic and cationic resins within the same reactor vessel. Results from the evaluation indicated that the Orica system had both lower capital and operational costs, and was selected for pilot testing. The results from the pilot test showed a 78 percent reduction in TOC, 46 percent reduction in hardness, 91 percent reduction in color units, and 98 percent reduction in hydrogen sulfide.

Based on the analyses and pilot testing, a new 0.999-mgd WTP using the first municipal application of an ion exchange process was designed, permitted, and constructed to provide for co-removal of organics and hardness, with cationic and anionic resins in a common reactor vessel. The process is being implemented within the existing water treatment plant. The overall project consists of:

- The addition of transfer pumps, which convey raw water from an existing tray aerator used for hydrogen sulfide removal to the ion exchange process.
- Ion exchange treatment, including regeneration of the resin.

Continued on page 6


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- A new process/operations building.
- Filtration of the ion exchange treated water.
- A new clearwell with transfer pumps to convey the water to the existing ground storage tanks.

The existing sodium hypochlorite and ammonium sulfate systems is used for disinfection. The project was online in October 2015.

How the Co-Removal System Works

The transfer pumps convey aerated water to the base of the high-rate contactor reactor vessel where the water is mixed with dissolved organic carbon (DOC) resin and other resin for organics and hardness removal. The raw water is fed into the contactor reactor vessel at an upflow rate of approximately 8 gal per minute per sq ft (gpm/ft2), and the contact time with the resin ranges from four to 12 minutes, based on the anticipated range of flows that will be treated by the new facility. The ion exchange process removes targeted ions in the contactor reactor vessel using selective ion exchange resins. Treatment in the ion exchange system is complete as the water flows from the contactor reactor vessel. A series of plates (or tube settlers) at the top of the contactor reactor vessel separates the resin from the water, and the treated and softened water overflows into collection launders. From the collection launders, the treated water flows by gravity to the filtration system, while the resin remains in the contactor reactor vessel.

Resin Regeneration

The unique aspect of this project is the use of both anionic and cationic resins in a fluidized bed co-removal system. Resin regeneration is accomplished using a small amount of resin, which is withdrawn from the base of the contactor reactor vessel and sent to a regeneration vessel. Resin sent to the regeneration vessel is accumulated and regenerated in a batch process and is returned to the contactor reactor vessel to maintain a consistent ion exchange capacity.

Regenerating the anionic and cationic resins involves contacting the resins with a brine solution in order to remove the DOC and hardness ions from the resin. The regeneration process starts by draining carrier water from the resin regeneration tank and adding a brine solution that consists of 12 percent sodium chloride solution. Brine is contacted with the resins to remove DOC and hardness, and then drained. Part of the drained brine is sent to waste, while the remainder is returned to the brine tank. Rinse water is added to the resin regeneration tank and then drained, and the resin is returned to the contactor reactor vessel.

Hydrochloric (HCL) acid is used to reduce iron scaling, and scaling is evaluated at regular intervals using resin activity and acid dissolution to determine the extent, if any, of iron fouling present. The acid dosage will be adjusted once a steady-state operation has been achieved and resin condition has been monitored for approximately six months.

In order to replace spent resin, or any resin lost due to carryover, virgin resin is periodically added to the regeneration system and then transferred to the contactor reactor vessel. Brine waste is conveyed to the existing onsite lined lagoon, and then transferred by an existing pump station to the wastewater collection system. The semicontinuous withdrawal of loaded resin and return of regenerated resin ensures a consistent treated water quality and prevents the chromatographic peaking that can occur with conventional ion exchange columns.

Finishing

Following ion exchange treatment, the water is conveyed by gravity to a dual media filtration unit to remove particulates and any

Table 1. Raw Water Characteristics

Raw Water Characteristic	Raw Water Levels		
	Average	Minimum	Maximum
Dissolved Organics	6.92 mg/L	5.95 mg/L	6.52 mg/L
Hardness ($CaCO_3$)	333 mg/L	228 mg/L	382 mg/L
Conductivity	822 μS/cm	681 μS/cm	1048 μS/cm
Sodium	57 mg/L	23 mg/L	104 mg/L
Chloride	110 mg/L	36 mg/L	257 mg/L
TDS	284 mg/L	248 mg/L	371 mg/L
Iron	0.47 mg/L	0.17 mg/L	1.08 mg/L
Sulfate	4 mg/L	0 mg/L	12 mg/L

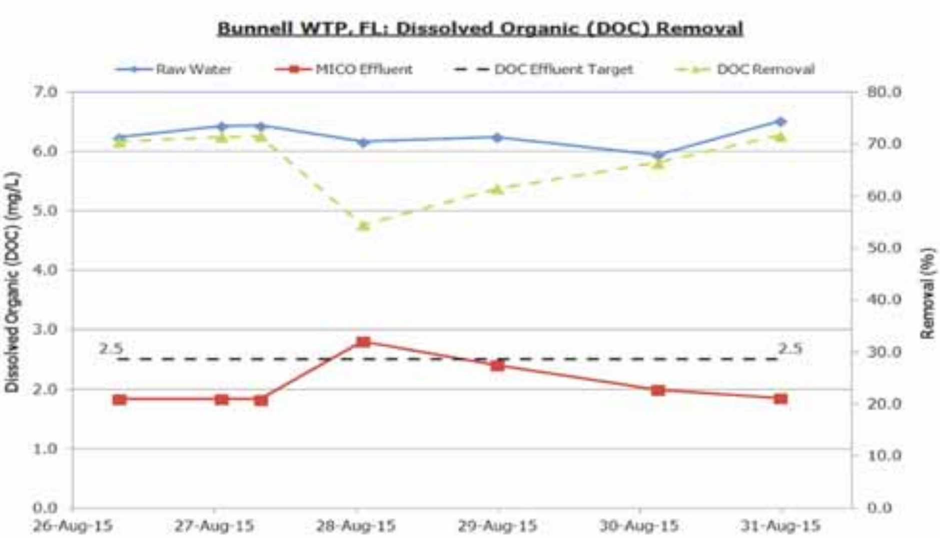

Figure 1. Dissolved Organic Carbon Levels and Removal

resin that may carry over from the ion exchange contactor. The filters include automated backwash and air scour systems, and effluent turbidity is measured on a continual basis.

The ion exchange and filtration systems are installed in a new prefabricated metal building that also contains a control/operations room, laboratory, supervisory control and data acquisition (SCADA) room, motor control centers, remaining chemical feed systems, and other process equipment. The ion exchange process, in and of itself, is a complex process that needs to be fully integrated with its respective components.

Additionally, the entire ion exchange process needs to be integrated into the entire WTP. The existing facility did not have a SCADA system, so a completely new instrumentation and SCADA system was provided to allow for seamless and automated operations, monitoring, and control.

Filtered effluent is conveyed by gravity to a clearwell and transfer pump station. Sodium hypochlorite is injected into a static mixer between the filters and the clearwell. New sodium hypochlorite and ammonium sulfate storage and feed systems provide disinfection of the water prior to conveyance from the clearwell transfer pumps to the existing storage tanks and high-service pump station that feeds the water distribution system. Based on the city's current population projections, the designed WTP capacity is projected to meet the finished water demands of the city through 2030.

The facility includes an HCL acid storage and feed system that will remove scaling within the ion exchange system on a periodic or as-needed basis. The HCL tank includes a simple scrubbing system to remove HCL vapors, which are both dangerous and corrosive. The scrubber operates using a 2-in. line that vents HCL vapor from the top of the 330-gal storage tank into a perforated PVC "tee" that is submerged approximately 5 in. in a 55-gal water-filled drum. Each time the storage tank is filled with HCL, the liquid will displace the vapors and the vapor will bubble into the water in the 55-gal tank. This reduces the pH and creates a slightly acid solution that will be drained after the storage tank is filled each time.

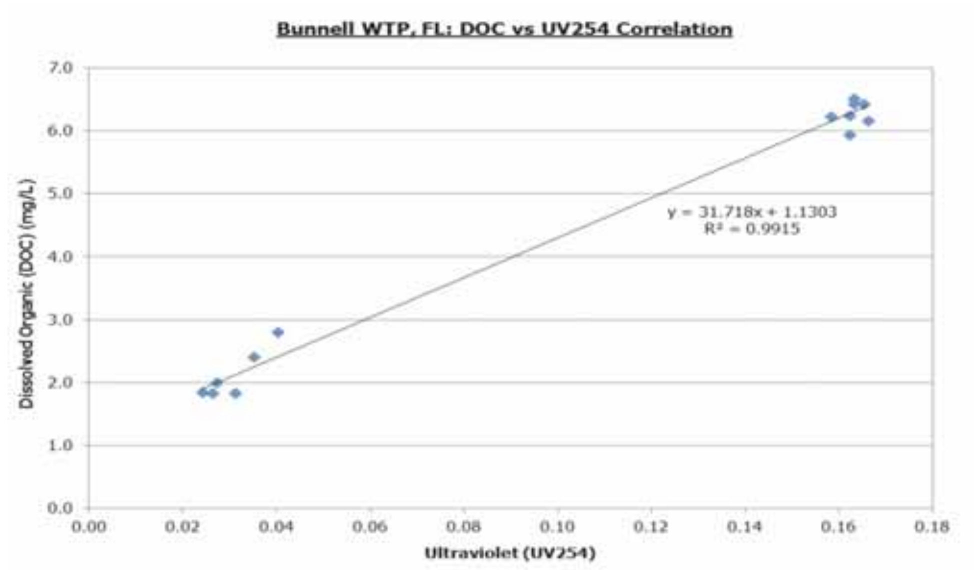

Figure 2. Ultraviolet 254 Removal

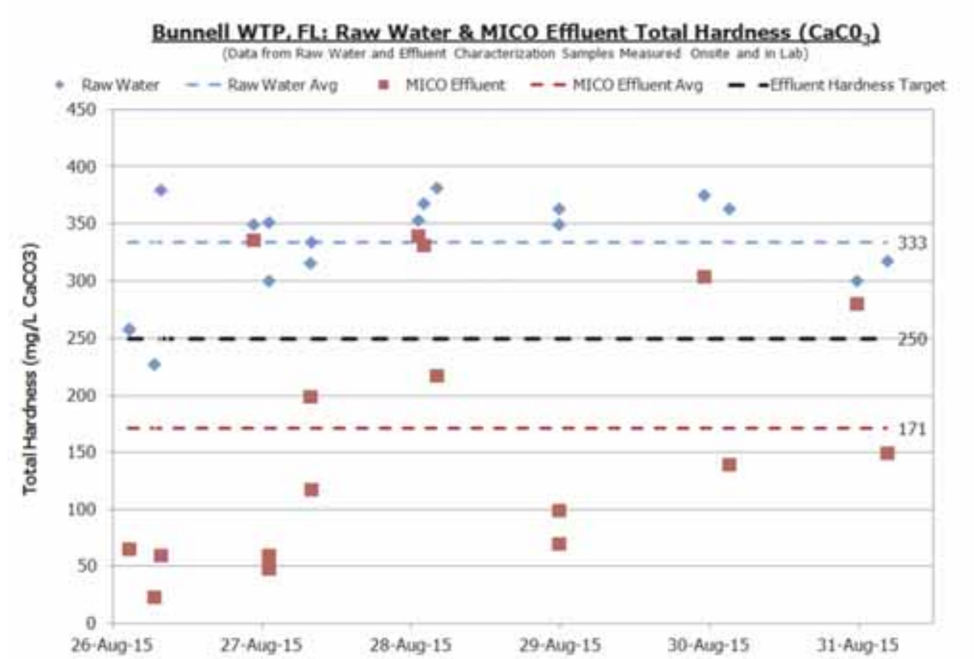

Figure 3: Dissolved Organic Carbon Versus Ultraviolet 254

System Performance Testing

Initial results of the performance of the ion exchange system were determined during the system start-up and acceptance test performed in September 2015. This testing was conducted over a six-day period and included various combinations of the facility's groundwater supply wells. The intent of the testing was to simulate the full range of anticipated flows and associated raw water quality that will be treated by the facility and to demonstrate that the effluent quality required for the project can be achieved. The system was operated using flows ranging from 250 gpm to 700 gpm, which approximate the lowest anticipated treatment flows and the WTP design capacity, respectively. Raw water characteristics measured during the testing period are summarized in Table 1. The range of the respective constituents shown is due mainly to the variation of the water quality in the city's groundwater supply wells.

Concurrent with raw water testing, the effluent water quality was measured for key con-

Continued on page 8

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stituents during the performance test. Figure 1 illustrates the DOC removal from the ion exchange process with measured average raw influent and the effluent at 6.29 mg/L and 2.08 mg/L, respectively. During the performance test, the TOC was removed at an average of 66.8 percent.

Another indicator for DOC removal is ultraviolet (UV) light removal. The UV254 (ultraviolet light absorption at a wavelength of 254 nm) is a surrogate means of measuring DOC, as they have a direct correlation. The UV254 removal during the performance test is shown in Figure 2. The DOC and UV254 levels are plotted together, as shown in Figure 3, to show the direct relationship between the two characteristics.

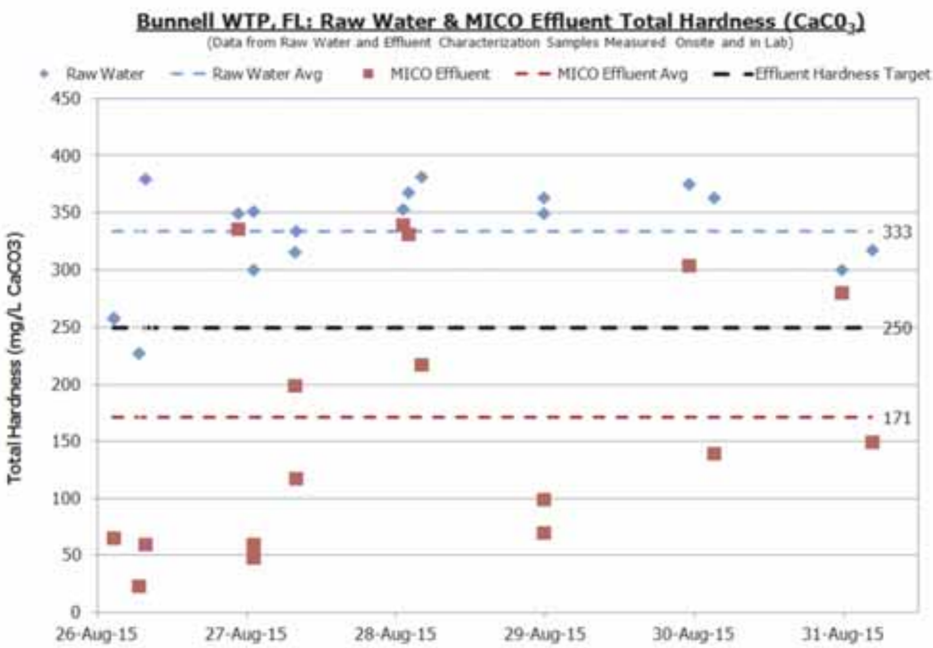

Figure 4. Hardness Comparison

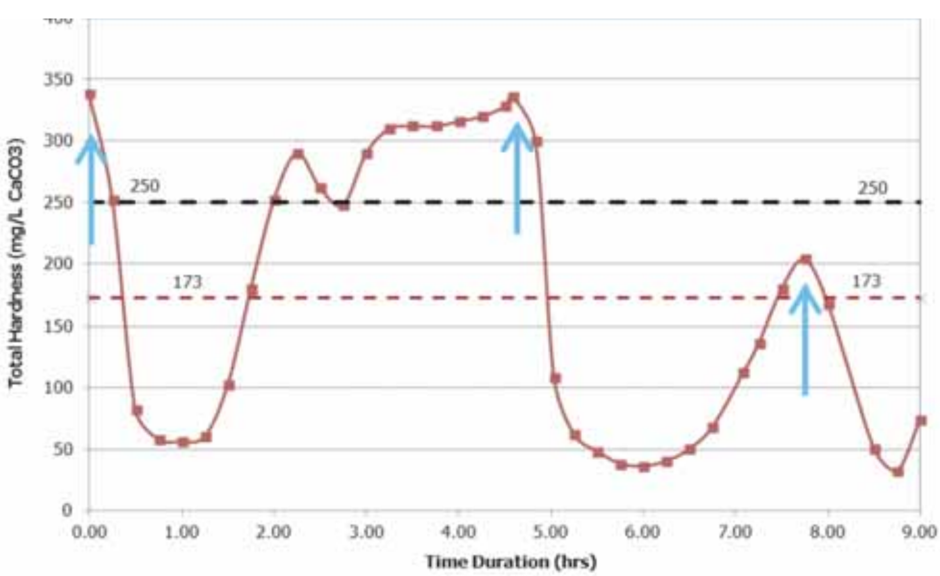

Figure 5. Cyclical Hardness Removal

Hardness Reduction

During the start-up demonstration testing, water quality samples were taken during the six-day period and tested for raw and effluent hardness levels.

As illustrated, the average effluent hardness of 171 mg/L during this period was below the target (and secondary limit) of 250 mg/L, with effluent hardness levels ranging from approximately 25 mg/L to 340 mg/L. Since this range showed a significant variation of effluent hardness levels, additional analysis was performed.

The softening process, in general, follows a cyclical hardness removal pattern. Once the resin is regenerated, softening will be very efficient. While hard water is treated by the softening process, the resin gradually loses the ability to reduce hardness, which results in higher effluent hardness levels until the resin is again regenerated. Similar to a conventional softening process, the effluent process achieves excellent (>80 percent) hardness reduction after the fresh resin is transferred into the contactor. As the process treats and removes hardness from the raw water, the hardness removal efficiency decreases until fresh cationic resin is again transferred into the contactor. This phenomenon is shown in Figure 5, which illustrates the cyclical nature of hardness removal over a nine-hour period, with sampling occurring at 15-minute intervals. The blue arrows show when fresh resin was transferred from the regeneration tanks to the contactor. It is important to note that the facility has a clearwell and two ground storage tanks, which provide good buffering for the cyclical hardness removal and will result in only minor variations in hardness levels entering into the city's distribution system.

Performance Test Summary Results

A summary of the key water quality parameters from the performance test is provided in Table 2, which shows that the effluent system achieved each of the two main water quality goals during the start-up demonstration testing. Although not identified as primary goals, the system also met other facility goals for conductivity, sodium, and chloride. Another important consideration for the facility was the requirement to limit the total volume of waste brine with its associated conductivity. This was important as the waste brine is being discharged for treatment in the city's WWTP, which was already challenged with high chloride levels.

Conclusion

The City of Bunnell had the clear need to implement a solution to address both TOC and hardness issues, which led to a consent order, customer complaints, and degradation of municipal water distribution infrastructure, as well as household piping and appliances. Subsequent to detailed pilot testing performed using two different manufacturers, the Orica system was recommended, and detailed design and construction for the new facility were performed. The result is a first-of-its-kind, single-vessel, "co-removal" ion exchange process with a design capacity of 0.99 mgd. The facility has been constructed, and the demonstration testing required for substantial completion shows that the new co-removal ion exchange system meets all TOC and hardness removal levels. Final clearance was obtained by the FDEP and the facility was placed into operation on Oct. 26, 2015. The facility has been in stable operations since that time and the city continues to meet all primary and secondary water regulations. In addition, many of the city's residents have indicated they noticed a significant improvement in the taste and clarity of the water produced by the new facility.

Table 2. Water Quality Results Summary

Water Quality Characteristic	MICo® Effluent Target Average	Treatment Effluent Levels		
		Average	Minimum	Maximum
MICO® Effluent DOC	< 2.5 mg/L	2.08 mg/L	1.83 mg/L	2.81 mg/L
MICO® Effluent Hardness ($CaCO_3$)	< 250 mg/L	171 mg/L	24 mg/L	340 mg/L
MICO® Effluent Conductivity	< 1000 µS/cm	645 µS/cm	332 µS/cm	1075 µS/cm
MICO® Effluent Sodium	< 160 mg/L	138 mg/L	39 mg/L	253 mg/L
MICO® Effluent Chloride	< 250 mg/L	135 mg/L	46 mg/L	292 mg/L
Total Dissolved Solids (TDS)	< 500 mg/L	303 mg/L	259 mg/L	412 mg/L
MICO® Effluent Sulfate	N/A	1.7 mg/L	<0.2 mg/L	5.0 mg/L
MICO® Waste Brine Conductivity	< 100 mS/cm	<90 mS/cm	N/A	N/A
MICO® Waste Brine Vol. (Daily)	< 2,667 gal/day	1,539 gal/day	1,204 gal/day	1,886 gal/day

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Calendar of Events

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November 27 to December 1, 2016 • Renaissance Orlando at SeaWorld

SUNDAY, November 27, 2016

10:00 am – 12:00 pm	FSAWWA Executive Committee Meeting	Atlantis
12:00 pm – 5:00 pm	Conference Registration	Oceans Ballroom Foyer
1:00 pm – 5:00 pm	FSAWWA Board of Governors Meeting	Atlantis

MONDAY, November 28, 2016

7:00 am – 6:00 pm	Conference Registration	Oceans Ballroom Foyer
7:00 am – 3:00 pm	Exhibit Set-up	Oceans Ballroom
8:30 am – 11:00 am	Workshop 1A: Engineering Laws, Rules and Ethics	Fantail
8:00 am – 11:00 am	Workshop 2A: Revised Total Coliform Rule Clarification & Hands on Level 1 & 2 Assessment Training	Walu
8:00 am – 11:00 am	Workshop 3A: Design Build – Roles in Design-Build Delivery	Nomeus
8:00 am – 5:00 pm	Workshop 4A: Utility Systems Symposium	Damselfish
9:00 am – 10:00 am	Administrative Council/Membership Committee Meeting	Zander
9:00 am – 10:00 pm	Public Affairs Council Meeting	Palani B
9:00 am – 10:30 am	Finance and Rates Committee Meeting	Palani A
10:00 am – 11:00 pm	Water For People Committee Meeting	Zander
11:30 am – 1:00 pm	Region and Council Chairs Lunch Meeting	Palani AB
11:30 am – 2:30 pm	Workshop 1B: Utility Financial Lessons Learned and Roundtable	Zander
11:30 am – 2:30 pm	Workshop 2B: An Overview of UCMR4 and what it Entails for Public Water Systems	Walu
11:30 am – 2:30 pm	Workshop 3B: Wetlands: Water Supply and Reuse, Quantity and Quality	Nomeus
2:30 pm – 4:00 pm	Opening General Session	Discovery Ballroom
4:00 pm – 5:00 pm	Technical and Education Council Meeting	Palani A
4:00 pm – 6:00 pm	Exhibit Hall Opens and Meet and Greet	Oceans Ballroom
6:30 pm – 9:00 pm	BBQ Challenge and Incoming Chair's Reception	Function Lawn
9:00 pm – 12:00 am	Poker Tournament	Discovery Ballroom

TUESDAY, November 29, 2016

7:00 am – 6:00 pm	Conference Registration	Oceans Ballroom Foyer
8:00 am – 6:00 pm	Exhibit Hall Open (closed 11:30 am - 1:30 pm)	Oceans Ballroom
8:15 am – 9:15 am	Continental Breakfast in Exhibit Hall	Oceans Ballroom
8:30 am – 11:30 am	Session 1A: Getting Ready for Potable Reuse as a Water Supply Option	Anemone
8:30 am – 11:30 am	Session 2A: Water Treatment	Grouper
8:30 am – 11:30 am	Session 3A: New View on Assessing Water Distribution Systems	Labrid
8:30 am – 11:30 am	Session 4A: Alternative Water Supply – Sustainability	Fantail
9:00 am – 12:00 pm	8th Annual Florida 2040 Water Summit	Coral Ballroom
10:00 am – 11:00 am	Young Professionals Committee Meeting	Zander
10:00 am – 11:00 am	Operators/Maintenance Council Meeting	Unicorn
10:00 am – 12:00 pm	Backhoe Rodeo	CC Parking
10:00 am – 2:00 pm	"Best of the Best" People's Choice Water Tasting	Oceans Ballroom
11:00 am – 12:00 pm	Top Ops Brainstorming	Unicorn
11:00 am – 12:00 pm	Ductile Iron Tap Competition	CC Parking
11:30 am – 1:00 pm	Students/Young Professionals Luncheon	Palani AB
1:00 pm – 2:00 pm	Water Quality and Resources Division Meeting	Zander
1:00 pm – 2:30 pm	Fun Tap Competition	CC Parking
1:30 pm – 4:30 pm	Session 1B: Asset Management	Coral A
1:30 pm – 4:30 pm	Session 2B: SEDA-AMTA Membrane Session	Coral B
1:30 pm – 4:30 pm	Session 3B: Water Distribution System Quality	Coral C
1:30 pm – 4:30 pm	Session 4B: Alternative Water Supplies Part 2	Fantail
2:00 pm – 3:00 pm	Students Water Bowl	Oceans Ballroom
2:00 pm – 4:00 pm	FSAWWA Utility Council Meeting	Damselfish
2:30 pm – 4:00 pm	FWRJ Ad Hoc Committee Meeting	Zander
3:00 pm – 6:00 pm	Students/Young Professionals Poster Session	Oceans Ballroom Foyer
4:00 pm – 5:00 pm	Meter Madness	Oceans Ballroom
4:00 pm – 6:00 pm	Meet and Greet	Oceans Ballroom
6:30 pm – 10:00 pm	90th Gala Celebration	Hard Rock Hotel

WEDNESDAY, November 30, 2016

7:00 am – 12:00 pm	Conference Registration	Oceans Ballroom Foyer
8:00 am – 12:00 pm	Exhibit Hall Open	Oceans Ballroom
8:15 am – 9:15 am	Continental Breakfast in Exhibit Hall	Oceans Ballroom
8:30 am – 11:30 am	Session 1C: Asset Management Modeling Challenges	Coral A
8:30 am – 11:30 am	Session 2C: Water Treatment Solutions Using Ion Exchange	Coral B
8:30 am – 11:30 am	Session 3C: Water Conservation Symposium	Zander
8:30 am – 11:30 am	Session 4C: Cybersecurity Workshop	Coral C
12:00 pm – 2:00 pm	FSAWWA Annual Business Luncheon and Awards Ceremony	Crystal Ballroom
2:00 pm – 4:00 pm	Water Use Efficiency Division Meeting	Zander

THURSDAY, December 1, 2016

8:00 am – 1:00 pm	Golf Tournament	Falcon's Fire Club
1:00 pm – 2:00 pm	Lunch and Awards	Falcon's Fire Club

American Water Works Association
Florida Section

FSAWWA 90th ANNIVERSARY 2016 FALL CONFERENCE
The Value of Water

First Name: ______________________ Last Name: ______________________

Name to Appear on Badge: ______________________

Organization: ______________________ Position/Title: ______________________

Address: ______________________

City: ______________________ State: ______________________ Zip: ______________________

Phone: ______________________ Fax: ______________________

E-mail: ______________________ AWWA Member No.: ______________________

CEU/PDH REGISTRATION: We offer 0.1 CEU and 1 PDH per hour of participation in Technical Sessions, Symposiums, and Workshops. Fall Conference Course #05100542.

☐ I am a Florida Professional Engineer, No.: ____________

☐ I am a Florida Licensed Operator: No.: ____________

Please Select One: ☐ Plant ☐ Distribution ☐ Collection

	Member After Nov. 1	Non-Member After Nov. 1
FULL REGISTRATION (3 days): Includes: one 90th Gala Celebration ticket, Monday Workshops, Monday Opening General Session, Monday BBQ, Technical Sessions, Water Summit, Exhibits and Meet & Greet ***(Does not include Laws and Rules, Utility Systems Symposium and Business & Awards Luncheon)***	$325	$495
DAILY REGISTRATION: Workshops, Technical Sessions and Exhibits		
Please select a day: ☐ Monday (Includes all Monday events, except Laws/Rules & Symposium)	$110	$140
☐ Tuesday (90th Gala Celebration not included)	$185	$240
☐ Wednesday (Business & Awards Luncheon not included)	$110	$140

SYMPOSIUM REGISTRATION/LAWS & RULES WORKSHOP (Not included with any registration)

				Member	Non-Member
☐	Utility Systems Symposium (Includes lunch)	0.8 CEU/8.0 PDH	Mon (8 to 5)	$120	$190
☐	Engineering Laws, Rules and Ethics	2.0 PDH	Mon AM	$65	$65

SPECIAL REGISTRATION: (Must register)

			Member	Non-Member
☐	Speaker (One-day only)* *Free with full or one-day registration	Select Day ☐ Mon ☐ Tue ☐ Wed	$30	$30
☐	Retired AWWA member	Select Day ☐ Tue ☐ Wed	$50	$50
	☐ Spouse (lunch not included)	☐ Tue ☐ Wed	$50	$50
☐	Operator Competitions	☐ Tue	$35	$35
☐	Water Conservation Symposium* *Free with full registration	☐ Wed	$50	$50
☐	Students - Free *(registration required if attending)*		$0	$0

ADDITIONAL EVENTS (Not included with any registration)

			Member	Non-Member
☐	Membership/Young Professionals Luncheon	Tuesday PM	$25	$25
☐	90th Gala Celebration Ticket (included in Full Registration)	Tuesday PM	$50	$50
☐	FSAWWA Business & Awards Luncheon	Wednesday PM	$50	$50
☐	Opening General Session *(registration required if attending)*	Monday PM	$0	$0
☐	BBQ after Meet & Greet *(registration required if attending)*	Monday PM	$0	$0
☐	8th Annual Florida 2040 Water Summit *(registration required if attending)*	Tuesday AM	$0	$0

TOTAL __________

REGISTER ONLINE AT http://fsawwa.org/2016fallconference
Or Mail Completed Registration Form (use same link to download form) and Check To:

FSAWWA Conference c/o Stacey A. Smith, Register With Ease℠, 473 Las Cruces, Winter Haven, FL 33884. Make checks payable to: FSAWWA Conference. Please submit one form per registrant. A 30% service fee will be retained on any cancellation by Nov. 1. No refunds after Nov. 1, 2016.

HOTEL:
For reservations, call the Renaissance Orlando at SeaWorld 407.248.7438 by November 8th to receive the conference rate of $149 per night.

Questions? Call (863) 325-0077. Completed forms can also be faxed to Stacey A. Smith, Register With Ease℠ at (863) 325-0051.

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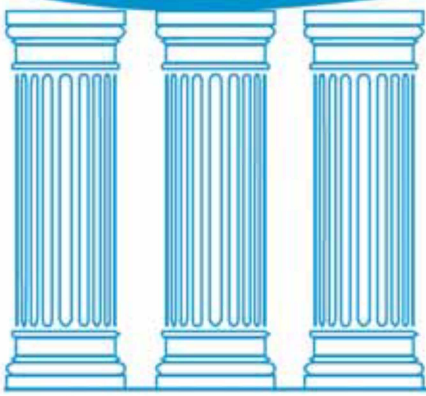
FSAWWA 90th ANNIVERSARY 2016 FALL CONFERENCE

The Value of Water

American Water Works Association
Florida Section



FLORIDA 2040 Water Summit

PLANNING, IMPLEMENTATION and FUNDING

*The **three pillars** to Florida's Water Future and a Sustainable Water Infrastructure.*

Tuesday, November 29, 2016 | 9am - 12pm

Summit Location: Discovery Ballroom

How do we continue to meet the water demands of the citizens, visitors, and industries of the state of Florida? How do we maintain a holistic balance with the natural environment to meet those needs? Are the current regulatory and legislative mechanisms in place enough to achieve these goals?

Discussions take place all year long to determine the best available practices to achieve the goals set forth by policy and regulatory agendas. Do we have the right tools in place to fully implement and fund the programs necessary to achieve Florida's future water demands? Are we giving equal consideration to the needs of our natural systems in conjunction with the needs of industry and Florida's residents?

Florida's public and private water suppliers, legislators, regulators and local governments have been discussing these issues for several decades. With the implementation of the Central Florida Water Initiative (CFWI) we now have a model with tools and ideas in place to help meet the water demands of Central Florida. This model may be expanded to other areas of the state. Now is the time to look at funding those plans and set the stage for other projects across the state.

THIS YEAR'S WATER SUMMIT WILL INCLUDE:

- Updates on national funding initiatives
- A statewide regulatory briefing to include CFWI
- FDEP Emergency rule on public notification
- A summary of the recently passed water policy bill
- Current legislative efforts including:
  - FDOT Coordination
  - Amendment 1 implementation
  - Reclaimed Water
- A Panel Discussion with our distinguished guests on Water Project Funding

8TH ANNUAL
American Water Works Association
FLORIDA 2040
A Vision for Sustainable Water Infrastructure
www.florida2040.com

WATER SUMMIT

It is currently the policy of the State to ensure that new supplies of water will be developed so that all users in all parts of the State will have adequate supplies of water to meet all their needs now and into the future, including sufficient water to meet the needs of natural systems.

By the year 2040, the water supply Vision of Florida is one in which statewide water demands are sustained through a combination of alternative water supplies, water use efficiency, and collaborative multi-jurisdictional water supply efforts.

For more information:
www.fsawwa.org

November 27 to December 1, 2016 • Renaissance Orlando at SeaWorld

FSAWWA 90th ANNIVERSARY 2016 FALL CONFERENCE
The Value of Water

American Water Works Association Florida Section

STUDENT & YOUNG PROFESSIONAL
Conference Activities

Tuesday, November 29, 2016

Please submit Registration form to Jordan Walker by e-mail at *Jordan.Walker@kimley-horn.com* by ***November 8, 2016.***

AT A GLANCE...

EVENT	TIME	LOCATION
YP Committee Meeting	10:00am - 11:00am	Zander
Students/Young Professionals Lunch	11:30am - 1:00pm	Palani AB
Water Bowl Competition	2:00pm - 3:00pm	Oceans Ballroom
Fresh Ideas Poster Session	3:00pm - 6:00pm	Oceans Ballroom

FREE Student Registration | Lunch is **$25**

WATER BOWL TEAM REGISTRATION

Water Bowl is a jeopardy-like competition for students from Florida universities. Teams compete against each other to see who can answer the most questions correctly in the least amount of time. All questions are related to the drinking water industry. Universities can have more than one team.

Sign up your team today!

Team University|College ______________________

Team Member #1 ______________________

Team Member #2 ______________________

Team Member #3 ______________________

FRESH IDEAS POSTER COMPETITION

The "Fresh Ideas" Poster Session is an effort of the Young Professionals Committee to encourage YP participation in the technical program at the conference through presentation of a poster. Posters will be judged and the winner will receive airfare, hotel, and conference registration to attend the Annual AWWA Conference in June 2017, in Philadelphia, PA to compete against other "Fresh Ideas" AWWA Section winners. Competition is open to any student or YP with less than three years of work experience. Any poster topic related to the water industry is encouraged.

Poster Presenter ______________________

Poster Title ______________________

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American Water Works Association
FloridaSection

FSAWWA 90th ANNIVERSARY 2016 FALL CONFERENCE
The Value of Water

POKER NIGHT & HAPPY HOUR

Monday, November 28, 2016

Time: 9:00 pm to midnight
Renaissance Orlando at SeaWorld

Join us for a good cause and a lot of fun at the Florida Section AWWA Poker Tournament. There will be a cash bar and hors d'oeuvres will be served.

Buy-In entry fee: Spade: $20 for 2,000 chips or Heart: $40 for 5,000 chips

Games: Texas Hold'Em for Grand Prize and Blackjack

Grand Prize: 42 inch HDTV!

Any contribution of prizes is greatly appreciated for this worthwhile cause. Pre-purchase Buy-In and Table Sponsorships through Conference Registration. Buy–Ins may be purchased at the door during first hour of play with credit card, personal check, or cash. Space is limited so pre-purchase to ensure that you have a chance to win. Entry tickets and chips have no cash value. Once they are purchased no refunds will be given. Only paid entries and sponsors will be allowed access to the hall.

Payment:
Register online at **http://fsawwa.org/2016fallconference**
or mail payment to:
Stacey A. Smith, Register With Ease™
473 Las Cruces, Winter Haven, FL 33884
Fax: (863) 325-0051 • Email: stacey@registerwithease.com

GOLF TOURNAMENT

Thursday, December 1, 2016

Falcon's Fire Golf Club
3200 Seralago Blvd., Kissimmee, Florida

Individual Player: $125 **Foursome: $500**
Individual Utility Operator Player: $50

Entry Fee includes: Buffet Lunch, Gift Bag, Door Prizes, Green Fees, and Range Balls

Prepay for a Mulligan Package: $25/person
Onsite: $35/person

Player Gift Bag or Raffle Donations

We are requesting firms or individuals to donate items such as golf balls, tee packs, drink coolies, hats, shirts, towels, umbrellas, clubs, your logo items, etc. These items will be used in each golfer's gift bag or be raffled off to help with our purpose of raising money for the Roy Likins Scholarship Fund. Your generosity and support are appreciated.

Questions:
John Edwards, Golf Tournament Chair
T: (352)789-2539 • E: John.Edwards@krauszusa.com

Payment:
Register online at **http://fsawwa.org/2016fallconference**
or mail payment to:
Stacey A. Smith, Register With Ease™
473 Las Cruces, Winter Haven, FL 33884
Fax: (863) 325-0051 • Email: stacey@registerwithease.com

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Planning and Investing Result in Infrastructure Reliability

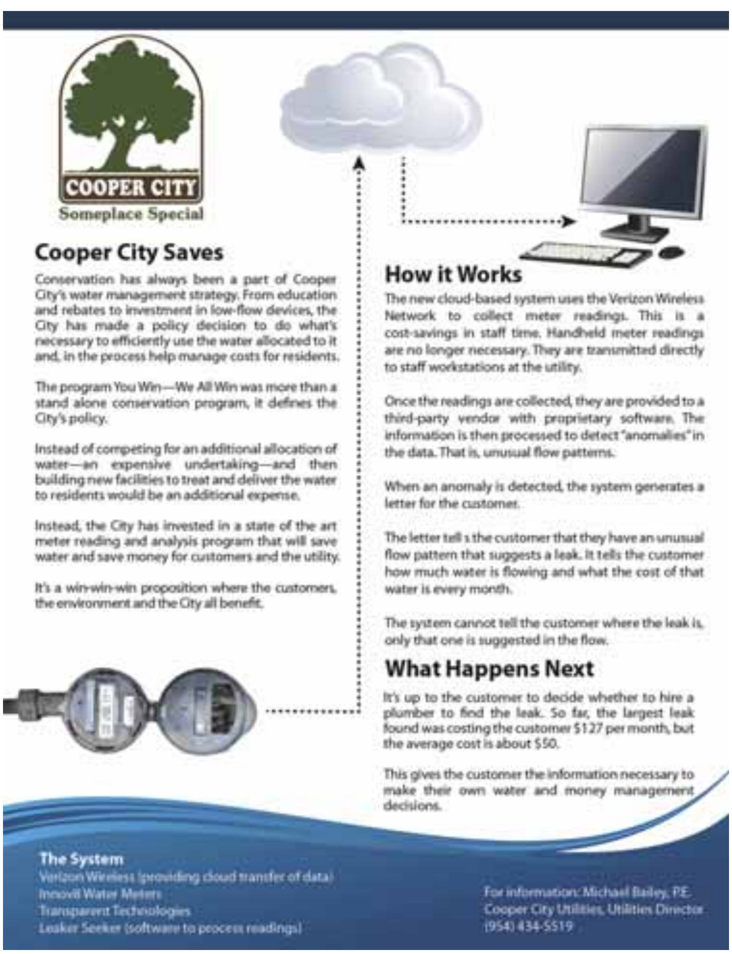
Michael Bailey

Because of *what* it is and *where* it is, no one thinks about infrastructure—until it fails. And when it does fail, it doesn't matter whether it's the water or wastewater system; people are rightfully and laser-beam focused on it. Systems fail, and sometimes the fault doesn't lie anywhere—it's just a system failure. But, too often, systems falter because communities don't plan for basic infrastructure maintenance and replacement, and failures are caused by aging infrastructure. Many communities, however, are doing what's necessary to plan for incremental improvements before their systems fail.

Sometimes communities look to larger entities, like the state or federal government, to help them fund their infrastructure replacement programs. Others plan ahead, building infrastructure and technology maintenance into their capital improvement plans. Doing so keeps ratepayers from "rate shock" when a sudden, catastrophic event forces a major, unplanned investment.

The American Water Works Association estimates that the cost of repairing and expanding drinking water infrastructure in the United States will top $1 trillion in the next 25 years. Higher water bills and fees will pay for much of it, but likely, the federal government will have to invest as well.

Cooper City is a moderately-sized community of around 30,000, located in Broward County along Florida's lower east coast. It has planned ahead, not just for infrastructure, but to ensure that it could continue to deliver all the high-quality water needed—despite climate change—well into the future.



Investment

Year after year, the city's commission has collectively decided to make water a priority. Its members have made the hard choices for rate increases for infrastructure and for water conservation education.

The choices have not been easy or cheap, and they came at a time when many communities adopted the "no new taxes" posture, in some cases ignoring the ever-increasing demand for more water and for system replacement. No one wants to raise water rates, but to upgrade systems, sometimes there is no choice.

There were people who came to commission meetings to support infrastructure recapitalization. They understood that it's better to plan for these upgrades than to deal with huge emergency replacements. Every time a nearby community has a pipe collapse, city residents are reminded that their leaders made choices to bite the bullet and invest before the system failed.

The goal is to look 20 years down the road to anticipate levels of service, then plan to meet them. This avoids "sticker shock" to ratepayers for massive failures or replacements, while ensuring that necessary upgrades and expansions are made.

Again, no one wants to raise rates, but no one wants sewage backing up because of system overload during flooding, and absolutely no one wants to go without water because aging pipes have failed. It helps to have political leaders who make water and wastewater a priority.

Construction Considerations

When it's time to make changes, the city does its best to minimize disruptions. In the last 12 months, it has rehabilitated seven of 81 sewer pump stations and replaced 15 miles of water mains (out of about 140 miles total). Lift stations are particularly unsexy, but they have a specific limited lifespan and must be replaced.

To reduce neighborhood inconvenience and annoyance during any needed construction, the city's engineers used pipe-bursting technology, while the staff visited neighborhoods to talk to residents about the project, including enhancing landscaping and repairing any impacted private property.

A Twitter site was established to keep people posted on a specific project, and scheduling took into consideration neighborhood activities, including when people might not be working. The work process was changed to ensure project activities wouldn't block traffic in one neighborhood, and in another, the screening and landscaping for the lift stations were improved.

In the end, it's a lift station, so there's only so much to be done. Still, the city continues to show residents that their utility is working hard every day to ensure that their water and wastewater services are excellent, and whatever improvements need to be made, inconvenience will be minimized to the largest extent possible.

Up next for the city is replacing computer control hardware and software at the water treatment plant. Again, this is not very sexy, but it is absolutely essential to ensuring that customers never have to think about the quality or availability of water.

Water Conservation

Planning ahead and managing costs have been a cornerstone of the city's water policy. About seven years ago, the city was faced with the choice of reducing demand or trying to get an additional water allocation from the regulators in an already stressed water supply system.

More than trying to get an additional allocation, the city would have to build an additional treatment plant, and all the infrastructure to get the water to the plant, then out into the existing system. Looking at the numbers, it became clear that if the community could be convinced to reduce water use by 5 percent, the city could avoid the costs of new infrastructure.

The difference in cost between a new plant and pipes, and conserving water, was huge. The comprehensive conservation program, including rebates and contests for ratepayers and changes for city irrigation and low-flow toilets, was planned to approach $900,000. New infrastructure costs, however, would be more than $15 million.

There was really no choice. The commission elected to engage in a comprehensive education, outreach, and rebate program—one that resulted in a 12 percent reduction, which continues today.

Technology

A few years following its award-winning conservation program, the city invested in technology that allows the remote collection of water-use data for billing. This cloud-based technology was a significant investment, but the city was looking ahead when it was recommended to the commission, including staff time and costs and the ability to easily tell if water use had unusual trends.

Once again, the commission voted for the investment.

One of the best things about this technology is that the utility can tell if specific users have an anomaly in their usage. If they do, they get a letter pointing out the water use and how much more they are paying for water because of it. People seem to appreciate it and understand that the utility is managing their water resource and trying to help them manage costs.

Taking Care of Business

This year, the city is making another investment—this time, paying for multi-unit and commercial backflow inspections. The state of Florida requires these checks annually and the city has to ensure compliance.

By offering this service for commercial and multi-user customers, the city relieves them of the responsibility and ensures compliance with the state. If there's a small problem, city inspectors will fix it on the spot. If there's a bigger issue, the owner or property manager is notified and the city follows up to ensure the issue is dealt with.

Most of the city's customers are residential, but whether customers are residential or commercial, or whether the system is large, medium, or small, the only way to ensure that it is sustainable is to plan for infrastructure repair, maintenance, and replacement. Investment, conservation, customer consideration, and technology help the city manage limited resources for itself and for the ratepayers.

Cooper City has tried to find the balance when bonds are paid and future investments planned (along with rate increases), and customer care is always a top priority. Its commission had determined that the only way to ensure infrastructure integrity is to plan for it—then invest in it. That's good leadership.

Michael Bailey, P.E., is utilities director and city engineer with Cooper City.

Changing Priorities and Perspectives

Kim Kunihiro
Chair, FSAWWA

It has been a challenging month for water and wastewater utilities. A couple of noteworthy incidents come to mind, namely the Mosaic sinkhole and the St. Petersburg flooding and sewer system overflows, which began the process that resulted in the Florida Department of Environmental Protection (FDEP) Emergency Rule 62ER 16-01. The confusion for water and wastewater facilities, as well as all other regulated entities on what to do to comply and when we are expected to act to inform the public, caused a flurry of communications between and among utilities through our utility councils. Just as we were starting to get some more information and direction from FDEP through its website and follow-up workshops for future rulemaking were scheduled, our focus shifted to the Atlantic and Hurricane Matthew.

Our perspective quickly changed to preparing our families, our homes, and our facilities for a very powerful storm. As I write this column, our friends in the eastern portions of the state are still suffering from power outages and the destruction of roads and infrastructure, which their communities need to function. Power outages continue and the death toll continues to increase. The FDEP emergency rule is still in place, but the immediate priorities changed to protection of infrastructure and being able to pump and treat water and wastewater if we lost power. Fuel, chemical, and other supply items that we take for granted were delayed because roads were unsafe and the winds unpredictable, and the ports were closed due to weather.

The common factor with these recent events is that the utility and water community pulls together to keep each other informed, prepare for the worst, and prepare for recovery as soon as possible. After the three hurricanes that central Florida received in 2004 we learned a lot about how to prepare, what was expected through the event, and what to expect afterwards. Preparation helps, but we all have to deal with the reality when it happens—and the devastation, rebuilding, and paperwork afterwards. We probably didn't learn enough about how to properly fill out the reports to facilitate repayment from the Federal Emergency Management Agency, but after Matthew, I am sure we will learn more and be better prepared the next time.

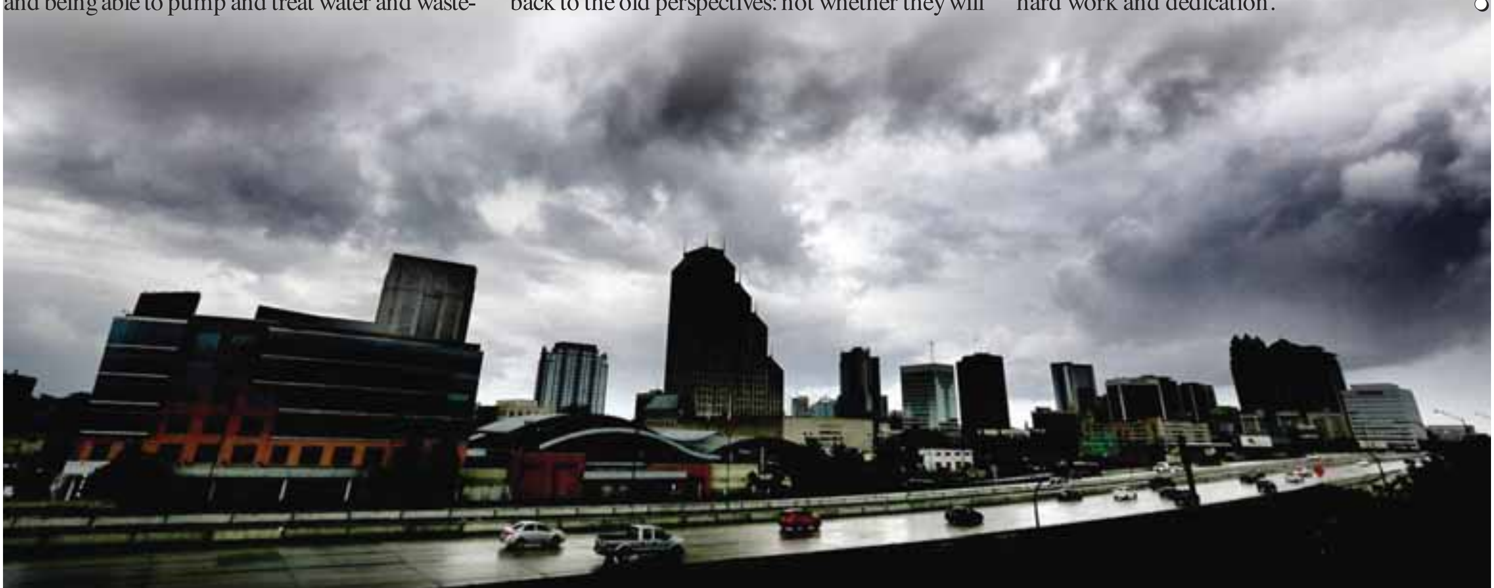
I am sure many of you watched as the store shelves emptied and the gas stations closed shortly after that. We stock up, we hunker down, and many of our customers still worry that they will not have safe drinking water or the ability to flush their toilets, as we at the utilities strive to keep them in water and wastewater coverage through the storm and after the storm. But, our preparations pay off and we get back to normal as soon as we can, many times with help from our friends in the industry through FlaWARN, the Florida Water/Wastewater Agency Response Network, which is the formalized system of "utilities helping utilities" to address mutual aid during emergency situations.

As soon as the storm passes, the same day-to-day customer complaints come in and we are back to the old perspectives: not whether they will have water and wastewater, but is it pristine enough and reliable enough. And then we at the utilities are once again taken for granted.

I guess we don't work in this industry to expect pats on the back and appreciation from others; we do it because we find some satisfaction in doing a good job to provide what our customers take for granted. During Matthew, as I worked at our operations center through the night, I was impressed by the professionals that I am fortunate to work with every day—the staff that volunteered to work through the storm and could hardly wait to come in the next day to do the damage assessments, and their families that let them go and understand why they need to go. Each time, we have to hold them back and wait until it is safe to get back on the roads. They want to start again and bring us back to some sort of normalcy.

So with that in mind, let's change perspectives and priorities once again. Please go on the FDEP website (www.dep.state.fl.us/pollution-notice/Emergency-Rule-FAQs.pdf) and get more information on the emergency rule and the newest information as rulemaking continues. Stay connected via FSAWWA's website under the utility council tab at www.fsawwa.org. Stay connected with other operators and maintenance personnel through the Operators and Maintenance Council. And come to the FSAWWA Fall Conference on November 28 through December 1 and get the most current information about emergency planning and operations, and so much more; you can register at http://www.fsawwa.org/page/2016Homepage.

And thank your colleagues who work in this industry—in good weather and in bad—for their hard work and dedication.



Awardees Honored at Fall State Short School

The Florida Water and Pollution Control Operators Association recognized several outstanding water/wastewater professionals, utilities, and facilities during its Fall State Short School for operational excellence, service to the Association, and outstanding safety records. The school was held in August at the Indian River State College in Fort Pierce.

Dr. A.P. Black Award—
Water Plant Operator Award of Excellence
Jack Green,
City of Marco Island

Dr. A.P. Black Award—
Water Plant Operator Award of Excellence
Steve Saffels,
City of Plant City

Dr. A.P. Black Award—
Wastewater Plant Operator Award of Excellence
Zoe Chaiser,
City of Plant City

Dr. A.P. Black Award—
Wastewater Plant Operator Award of Excellence
Manolito Sewel,
Severn Trent

Robert E. Heilman Award—
Industrial Pretreatment Award of Excellence
Joe Squitieri,
Hillsborough County Utilities

Theodore Kamien Award
Glenn Cockrell,
Port St. Lucie

Nathan Pope Award
Bradley Hayes,
City of Tavares

Emory Dawkins Award—
Regional Newsletter Award of Excellence
Region X
Accepted by Charles E. Nichols.

Safety Awards

Chairman's Award
Richard A. Heyman Wastewater Treatment Facility, Key West
Accepted by Jimmy Green.

Water Plant A
Corkscrew Water Treatment Plant, Ft. Myers
Accepted by Daniel Chapman, Scott Bonetz, and Ron Dewitt

Water Plant A
Murphee Water Treatment Plant, Gainesville
Accepted by Tom Mikell. (no photo)

Water Plant B
Marco Island Reverse Osmosis Treatment Plant
Accepted by Scott Edson and Oscar Castellanos.

Water Plant C
City of Quincy Water Treatment Plant
(no photo)

Wastewater Plant A
Plant City Water Reclamation Facility
Accepted by Pat Murphy.

Wastewater Plant B
Golden Gate Wastewater Treatment Plant, Naples
Accepted by Nathaniel Mastroeni.

Wastewater Plant C
Burnt Store Ware Reclamation Facility, Punta Gorda
Accepted by Paul Sugg.

Combined Distribution/Collection
City of Stuart Distribution and Collection
Accepted by Janine Wilde, Corky Kossen, and Mike Ledoux.

Reuse Plant A
Woodard & Curran – Water Conserv II
Accepted by John Sowka.

Reuse Plant B
City of Stuart Water Reclamation Facility
Accepted by Paul Hitchcock and Janine Wilde.

Reuse Plant C
Woodard & Curran – Inverness Wastewater Treatment Facility
Accepted by Glenn Burden.

Stormwater
City of Oakland Park
Accepted by Arthur Saey.

Collection System
Seacoast Utility Authority, Palm Beach Gardens
Accepted by Sam Faust.

Distribution System
Gainesville Regional Authority
(no photo)

Multiple Water Plants
Lake Park Water Treatment Plants, Lutz
(no photo)

Water and Wastewater Operators Respond to Hurricane Matthew and the After Effects

Scott Anaheim
President, FWPCOA

Hurricane Matthew will have passed through Florida and we'll still be in the process of cleaning up the damage when this column is published. Municipalities and utilities prepared and reviewed their disaster plans and it looks like, for most of us on the east coast of Florida that is, that we're not going to be as lucky as we have been over the last decade.

It's always great when we prepare and have crews on standby to respond, only to watch as the approaching storm moves out in the open water away from us. Water and wastewater operators, along with distribution and collection crews, will again ride out the storm so they can start restoration efforts as soon as it passes.

While everyone else was evacuating, or at home with loved ones when the storm hit, these operators were there, or ready to return as soon as possible to maintain their systems. In 2005, when Hurricane Katrina hit, I was a director of the collection and distribution group at my utility. We sent crews to Mississippi to assist with restoration efforts, and the devastation they saw was overwhelming. Luckily, our crews took enough supplies of food and water for the first few days because the staging areas can be located many miles away from where the crews are performing their work, or the local systems are not ready for the influx of multiple operators from other utilities converging all at once.

I like to say that we do as great a job in Florida of responding and restoring operations as any state in the nation—probably because we deal with these storms on a more frequent basis; plus, our mutual aid system (FlaWarn) is such a strong network of utilities and municipalities willing to assist each other.

The weather experts determined that Hurricane Matthew was a Category 4 storm when it passed over the east coast of Florida, and with the strong winds and tidal surges, it caused severe damage. The restoration efforts will be long and customer's patience will be tested, because with the all the damage to the power grid, there will be delays in getting the water or sewer service restored to many areas.

There's nothing like being in Florida (even in October) without any power or water for days, and the cleanup crews will have to deal with these customers, which is not always an easy thing to do. As if it wasn't already bad enough to work in an area that has been destroyed by a storm, add to it the angry and frustrated customers wanting you to get their service restored *now*. The longer the system is down, the higher the frustration level builds, which can make working conditions very hazardous.

Another issue for the responders is that many of them may not have been able to take care of their own issues from the storm or able to help their families, so this can lead to many needing to resolve those issues. People forget that just because you work for a utility that you should be willing to drop everything to assist with restoration, but we're human and want to ensure that our own family is safe first. That's why all employees should have a good family disaster plan in place and make arrangements to have their family review it every year. I always review mine in May so that we're all on the same page, and it's good to check your generator and chain saws on a regular basis at the same time.

The weather got uglier and as we got closer to the weekend here in north Florida, and with the arrival of the worst storm to hit our area since Hurricane Dora, our crews were doing their duty. They will be fueling equipment, checking inventory, staging, and prepping pumps and generators. Management will be holding meetings and reviewing plans, plus working on storm assignments and staffing. There's so much that goes into preparing for a storm and you can't prepare for everything, but one thing I am sure of—we here in this state have the best operators and employees to handle any disaster that comes our way to keep the water and sewer flowing. I just want to thank all of you for the hard work that is ahead of you.

Bylaws Update

Directors: please remember to send Ken Enlow any changes to your region bylaws so we can complete all the updates for approval. Ken has done a great job of bringing them to the board for approval and staying on top of me to get my regions approved. Our last board of directors meeting was October 16 and we had a couple to approve, which did help to catch us up on this item.

Online Institute Update

The Online Institute presently has 84 active courses and 334 registered students. For the 2017 license renewal cycle, FWPCOA has sold an average of 49 online courses per month, which is greater than the monthly average of 36 courses sold during the 2015 cycle. There was a decline in revenue for September this year when compared with September 2014; however, the average monthly revenue for the 2017 renewal cycle remains above that of the 2015 cycle: $2,795 per month versus $2,331 per month, respectively.

Please continue to advise your members of the availability of the FWPCOA Online Institute in your newsletters and at your membership meetings. Also, continue to encourage operators to complete their CEU courses for the 2017 renewal cycle.

Help Publicize These Online Courses!

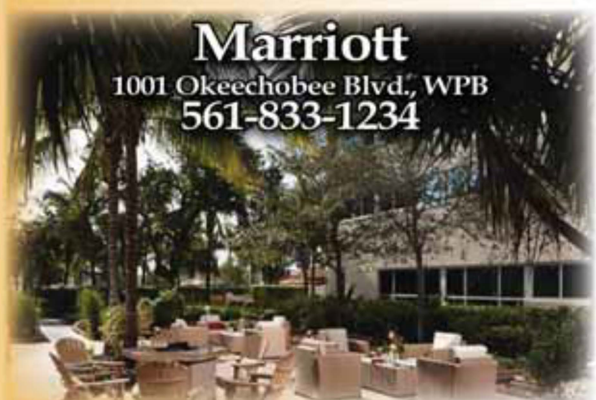
Please publicize the availability of the following online short courses:

- Stormwater C
- Utility Customer Relations I
- Wastewater Collection C
- Water Distribution Levels 2 and 3

Don't forget to mention the Class C treatment plant operator courses!

HOTELS

Easy to book hotel on-line or when calling, identify yourself as a Florida Water Resources Conference Attendee and obtain the discounted room rate, available until April 1, 2017. Reservations received after that date will be accepted on a space-available basis only, and the group rate may not apply. Both hotels within walking distance of convention center.



Daily Parking

Convention Center: $5 • Hilton: $10 • Marriott $5

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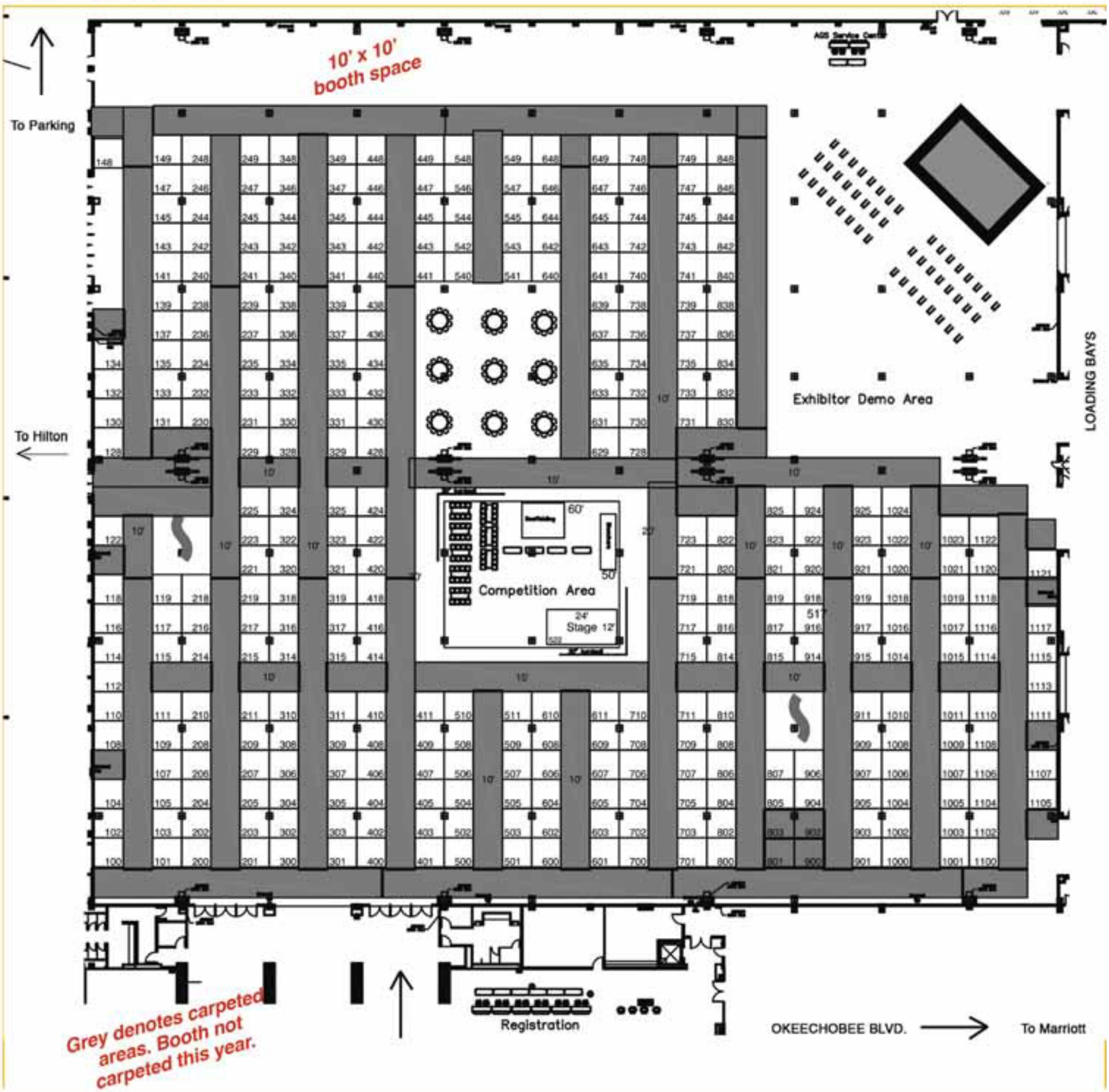

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Anion Exchange Treatment for Color Removal: The Story of a Utility That Experienced Finished Water Foul Odor and Eliminated It

Renuka Mohammed-Bajnath, Jeffrey Pinter, GJ Schers, and André McBarnette

The Town of Davie (town) operates a water treatment plant (WTP) with a rated capacity of 4 mil gal per day (mgd), but operates generally between 2 and 3 mgd. This facility is commonly referred to as System 3. Using the Biscayne Aquifer as the raw water source, the treatment process includes lime softening, media filtration, and chlorine disinfection. Hydrated lime and polymer (Praestol 2530 TR) are dosed to the softener influent to remove hardness and alkalinity, and to improve the softened water turbidity. The town also adds phosphoric acid (Carus Aquadene SK-7641) for corrosion control in the distribution system and hydrofluosilicic acid (Dumont HFS 2300) for dental hygiene. A simplified flow diagram is included in Figure 1.

The raw water contains naturally occurring elevated levels of free ammonia and color that have been reported to be as high as 2.5 mg/L and 50 platinum-cobalt units (PCUs), respectively. There is some variation in levels of hardness, alkalinity, color, and ammonia among the production wells, and the limits listed are considered worst-case. Some free ammonia combines with chlorine to form chloramines downstream of the softener, and some free ammonia remains in the water. The main water quality data from the WTP are summarized in Table 1.

Renuka Mohammed-Bajnath is assistant utilities director and Jeffrey Pinter is lead operator with the Town of Davie. GJ Schers is senior water treatment technologist with CH2M in Fort Lauderdale. André McBarnette is a professional environmental/civil engineer with MWH in West Palm Beach.

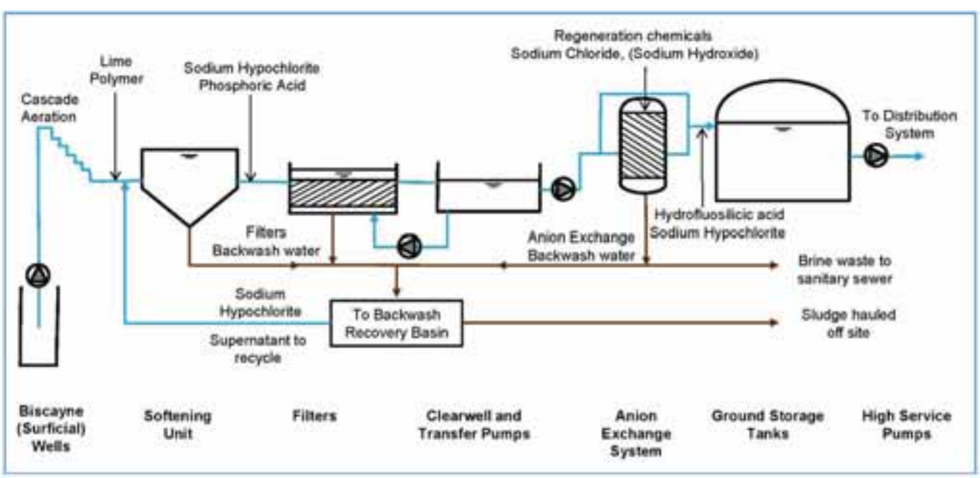


Figure 1. Schematic Diagram of Town of Davie System 3 Water Treatment Plant

Table 1. Main Water Quality Data at Town of Davie System 3 Water Treatment Plant (average values, year 2015)

Parameters	Raw Water	Settled Water	Finished Water
pH, s.u.	7.5	9.6	9.4
Hardness, mg/L as $CaCO_3$	320	90	90
Alkalinity, mg/L as $CaCO_3$	260	70	70
Color, p.c.u.	50	25	<5
Ammonia, mg/L as NH_3	2.5	1.5	1.0
Total Organic Carbon, mg/L	14.0	11.0	2.5 (10-11 when IEX is not operational)

In 2008, an anion exchange (IEX) treatment system was installed at the WTP, downstream of the filters, to remove objectionable color from the filtered water. The system consists of pressurized vessels filled with macroporous Type-1 strong-base anion resin for color removal and ancillary facilities for resin regeneration.

Ancillary facilities include brine storage tanks, recirculation piping and pumps, brine dissolution system, waste tanks, and supporting electrical and instrumentation systems. Since installation in 2008, the system has been operating successfully; however, since 2014, objectionable foul odors have been detected in the finished water, evident by customer complaints. Initial investigations by the town's staff revealed that the odor was of a "musty and fishy" nature and originated from the IEX system.

Several changes were implemented at the WTP in 2014, including replacement of IEX resin, start of phosphate-based corrosion inhibitor dosing, and conversion of onsite hypochlorite generation to bulk sodium hypochlorite. Furthermore, in mid-2014, considerable biological growth was observed in

IEX vessels and subsequently analyzed. The analysis revealed the presence of nitrifying and denitrifying bacteria, as well as sulfur-reducing bacteria. Following this observation, the town performed additional chemical resin cleans, with both sodium hydroxide and sodium hypochlorite, that caused some concerns on whether the resin was permanently damaged or not.

Because of the simultaneous WTP changes, no one particular cause could be identified for the sudden presence of foul odor in the finished water. As such, the town developed a systematic approach in an attempt to identify the cause of the odor. The initial phase focused on obtaining and understanding best management practices at other utilities that operate IEX systems, telephone conversations with several strong-base anion resin suppliers, and discussions with IEX system integrators. Also, extensive operational and performance data were reviewed from the town's IEX system, including water quality data. The follow-up phase focused on bench tests performed with new and existing (biofouled) resin under different feed water conditions to test the odor release pathway hypothesis. Subsequent to the bench tests, a temporary carbon dioxide (CO_2) dosing system was installed, the phosphate-based corrosion inhibitor dosing point was relocated to downstream of the IEX system, and the system was recommissioned. Extensive operational and water quality data were collected during this phase to confirm the odor release pathway hypothesis and to optimize the IEX and other treatment systems.

This article presents the experiences of a utility using strong-base anion resin for color removal from groundwater, which is a relatively new type of treatment in Florida. In this particular case, it was revealed that certain feed-water conditions can cause a foul odor in the treated water. Other lessons learned were also obtained from site visits and conversations with suppliers and other utilities utilizing IEX. Extensive water quality data were collected during the bench tests and full-scale commissioning to verify odor release pathway hypothesis, and to optimize the IEX system operations.

Continued on page 32

Table 2. Summary of Information From Utilities and Suppliers

Parameters	Town of Davie, System 3	Palm Beach County, System 8	Pembroke Pines (-)	Supplier(s) Recommended Value
IEX System				
Capacity, mgd	4.0	10.0	12.0	-
Number of Vessels, -	3	7	8	-
Diameter Vessels, ft	12	12	12	12 (standard)
Resin Depth, in.	36	36	36	24 or above
System Supplier, Resin	Tonka, Thermax A-72MP			-
Flow through IEX, percent of total	100%	40-50% (Future 100%)	50%-60%	-
IEX Influent/Effluent Quality				
Color (Raw Water), p.c.u.	50	30	45	-
Color (Effluent), p.c.u.	<5	<5	<10	-
pH, s.u.	9.6	8.7	8.6	<8.5
Hardness, mg/L $CaCO_3$	70	80	60	-
Alkalinity, mg/L $CaCO_3$	60	60	30	-
Chloramine, mg/L	4-5	2-4	1-2	<5 mg/L No free Cl_2
Ammonia, mg/L	1.0	<0.1	<0.1	-
Regeneration, Rinse Procedures				
Backwash Rate, gpm/ft^2	4-5	5-7	3	2-4
Air Scour assist BW, Yes/No	No	Yes	No	Yes (based on lessons learned)
Brine Solution strength for regeneration, -	Saturated solution (13.5%) as recommended by Tonka and Thermax			Saturated (13.5%)
Slow/Fast Rinse, -	Done as recommended by Tonka			
Alkaline-Brine Squeeze, -	Done recently	-	-	To be limited
Sodium Hypochl. Soak, -	Done recently	-	-	To be limited

Figure 2. Existing IEX System at the Town of Davie System 3 Water Treatment Plant

Continued from page 31

IEX System of the Town and Other Utilities

The town's IEX system consists of three carbon steel vessels, with an internal diameter of 12 ft. The design flow rate is 2,800 gal per minute (gpm) or 4 mgd, which equates to a surface water loading rate of 8.26 gpm per sq ft (gpm/ft^2)[1]. Each vessel contains 36 in. of Thermax A-72MP anion exchange resin supported by 3 in. of 0.80-1.20 mm silica sand and 12 in. of graded gravel. This resin has National Sanitation Foundation (NSF) 61 certification.

The system also contains a brine tank, brine pumps, and a brine dilution skid to dilute and feed brine and rinse waters into each of the vessels for resin regeneration. The waste flow of the brine and rinse cycles is discharged to the rinse waste tanks and subsequently bled to the sanitary sewer. Typically, the resin is backwashed prior to a brine regeneration for suspended solids removal through manipulation of isolation valves to reverse the flow through a vessel. The waste backwash water is discharged through the same pipe as the waste flow from the brine and rinse cycles; however, it is discharged through manipulation of isolation valves into the backwash recovery basin for possible recovery to the head of the plant. Some photos of the system are included in Figure 2.

Over time, calcium carbonate and calcium sulfate buildup were observed by the town on the resin; this made the resin heavier and affected its performance, which was evident in shorter run times. The town also experienced some operational challenges that inhibited performance. As a result, the resin was replaced in mid-2014 with new Thermax resin, with the same specifications as the original resin.

Since early 2015, reports of foul odor originating from the IEX system have increased, and by mid-2015, the town executed chemical cleans, in addition to the brine regeneration. In conjunction with Thermax, the town performed a caustic soda squeeze (brine with sodium hydroxide to bring pH to 13.5) and a sodium hypochlorite soak clean (brine with 1 percent chlorine solution). The IEX system was restarted in July 2015, but the foul odor returned quickly and the system was turned off. As will be discussed further, the system remained offline during the period of investigations, bench testing, and modifications, and was only recommissioned in December 2015. Since that time, the IEX system has been online continuously and has operated successfully.

In mid-2015, Thermax representatives visited the WTP site for an inspection of the system and obtained a resin sample. The results indicated the presence of foul odor and organic fouling on multiple resin samples and reduction in dry-weight capacity and moisture content when compared to the specifications of virgin resin; however, the physical appearance, moisture content, and size were within specification. The total anion exchange capacity had dropped slightly below specification, evident in short run times.

The town proceeded to perform site visits to other utilities in southeast Florida that operate IEX systems in an attempt to obtain information and lessons learned from treating raw water with similar elevated levels of color and free ammonia. A summary of the findings from site visits to other anion exchange systems include Palm Beach County (PBC) System 8 WTP and the City of Pembroke Pines (CPP) WTP. Suppliers are listed in Table 2.

The treatment process and performance of the other utilities are similar to the town's, with some distinct differences. For instance, PBC recarbonizes softened water and reduces the pH with CO_2 prior to filters. The PBC also combines all free ammonia to chloramine with sodium hypochlorite prior to the filters and doses of additional sodium hypochlorite and ammonia downstream of the IEX system to maintain a combined chlorine residual of 4 mg/L. Similarly, CPP combines all free ammonia to chloramine with chlorine gas prior to the filters, creates a pH drop with the (acidic) chlorine gas upstream of the IEX system, and adds both chlorine gas and ammonia at the end of the process.

The visited utilities provided improvements over the years based on lessons learned. For instance, PBC discontinued IEX backwash waste recycling to the head of the WTP to reduce the sudden increase in trihalomethanes (THMs) formation, provided more alkaline-brine regeneration to minimize accumulation of foulants on the resin, and added air sparging grids to assist with resin breakup during regeneration, thus improving effectiveness and decreasing regeneration time. Other lessons learned from utilities included reducing vessel height from 12 ft to 8 ft to reduce brine consumption and waste volumes, increasing the volume of the waste rinse tasks in the event that vessels need to be regenerated in series, and adding online water quality monitoring systems to provide a live feedback of how the IEX system was performing.

System integrators and resin suppliers were also contacted to discuss issues surrounding the foul odor from the IEX treatment system, including actual suppliers of the town (e.g., Tonka and Thermax); other parties contacted included Hungerford & Terry, DOW, Resin Tech, and Purolite. Discussions among these suppliers were similar and all focused on the high pH of the IEX influent, which can affect the basic structure of the macroporous strong-base anion resin. Based on this preliminary work, it was believed that the predominant pathway of release of the foul odor is the high pH of the IEX influent water.

There was evidence from prior testing that the resin had lost its dry-weight capacity and treatment capacity through "knocking off functional groups from the resin." A process was recommended to reduce the pH of the IEX influent water to around 8.5–8.8, with CO_2 through the installation of a temporary storage CO_2 system, relocation of the phosphate-based corrosion inhibitor dosing point until after the IEX treatment system, and addition of an online dual-channel ammonia analyzer to monitor free ammonia, total ammonia, monochloramine, and total chlorine in the IEX influent and IEX effluent. Prior to the installation of the CO_2 system, a series of short-term bench tests were performed.

Trimethylamines Odor

Based on feedback from resin suppliers, the fishy odor is believed to be trimethylamines (TMA), with a very low odor threshold of 5 parts per billion (ppb). Wikipedia[(2)] describes TMA as an organic compound, with the formula $N(CH_3)^3$ (see molecule depiction in graphic), and is colorless, hygroscopic, and flammable. It has a strong fish-like odor in low concentrations and an ammonia-like odor at higher concentrations. It is a gas at room temperature. In general, TMA is known as a product of the decomposition of plants and animals, and is also used in the resin manufacturing process.

As referenced, the building structure of macroporous Type-1 strong-base anion exchange resin is cross-linked polystyrene (P) with TMA as the functional group. The characterization Type 1 stands for a quaternized amine product made by the reaction of trimethylamine with the copolymer after chloromethylation. Type 1 is the most strongly basic functional group available in the market and has the greatest affinity for the weak acids, such as silicic and carbonic. The TMA can be released from the resin at very low levels due to slight de-amination of the resin by the Hofmann's reaction at higher pH values, as per equation 1[(3)]:

Equation 1: $P - CH_2 - N^+ (CH_3)_3 + OH^- \leftrightarrow P - CH_2OH + N(CH_3)_3$

Amines are released due to the hydroxyl ions (OH-) in the water seeking to "attract" a proton (H+) from the resin, thereby breaking other molecules' structure bonds. The Hoffman reaction is the primary degradation mechanism for Type-1 anion exchange resins. High temperatures and pH values will accelerate the rate of resin de-amination.

Bench Testing

A series of short-term bench tests were conducted with existing and new IEX resin at the town's System 3 WTP laboratory. The specific objectives of the study were to understand the impacts of pH on the fishy odor released in the treated water and to verify the performance of the existing resin compared to new resin. The bench-test configuration and conditions are included in Table 3, and the photo provides a depiction of the bench-test setup.

The effluent water of the baseline operation (pH 9.6) started to have a fishy odor within a couple of hundred bed volumes (BVs) of operation, and continued to have low to medium odor for the entire duration of the test (Figure 3). The effluents of the tests conducted at pH 9.1 and pH 9.2 also appeared to have low to medium odor; however, the frequency of such low-medium odor samples were not as high as observed in the effluents of the pH 9.6 test. The effluent samples for the tests conducted at pH 8.2 and pH 8.8 remained predominantly odorless

Continued on page 34

Table 3. Bench-Test Configuration and Conditions

Parameter	unit	Value
Column Diameter	mm	15
Packed-bed Length	cm	21.6
Packed-bed Volume	mL	38
Flow Rate	mL/min	21.5
Empty Bed Contact Time	min	1.8
Test Conditions	Existing/New Resin, Feed Water pH and Run Time in Bed Volume (BV)	Existing Resin 8.2 (3,300 BV) 8.8 (6,310 BV) 9.0 (4,540 BV) 9.1 (1,190 BV) 9.2 (1,190 BV) 9.6 (1,670 BV) New Resin 9.6 (1,090 BV)

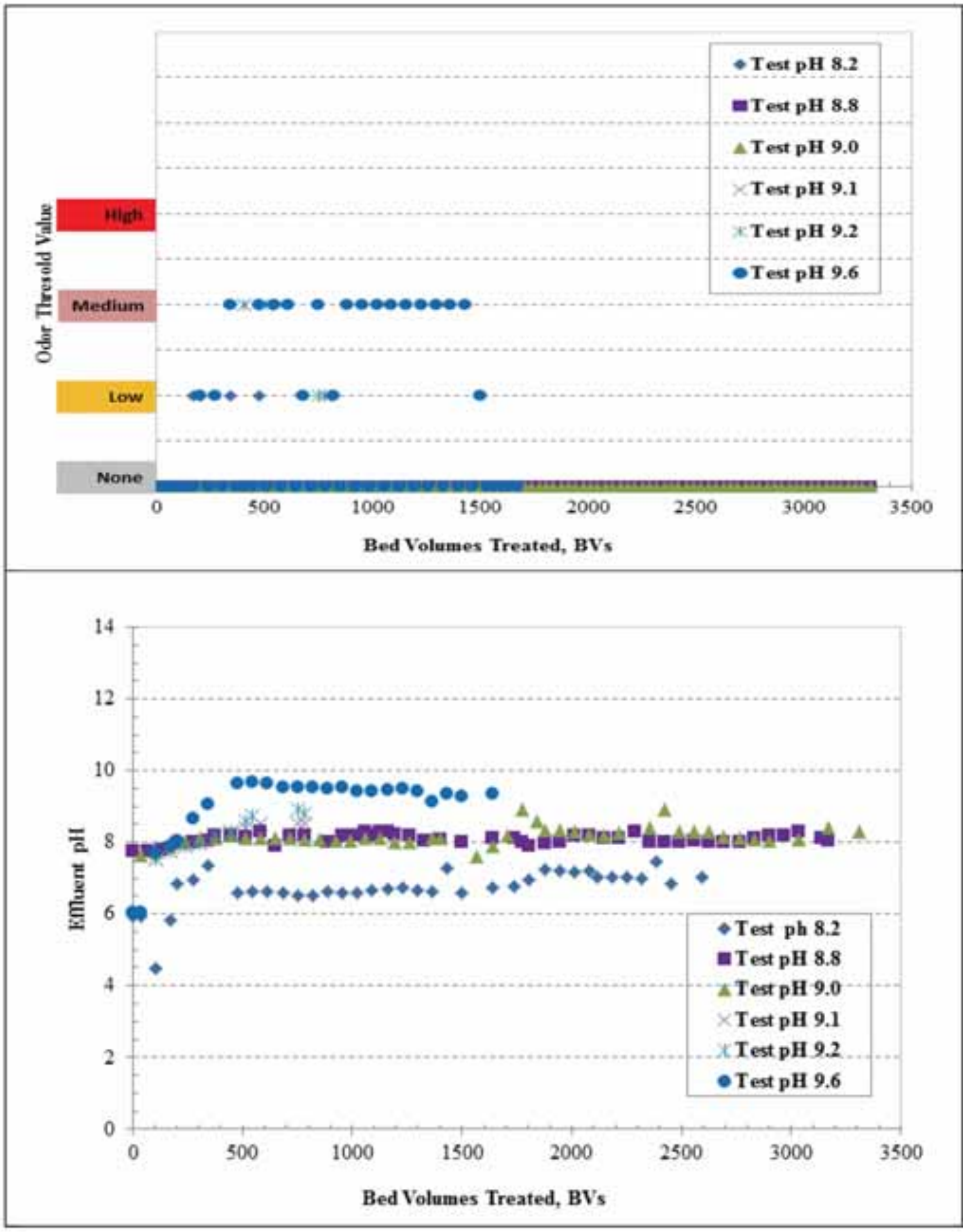
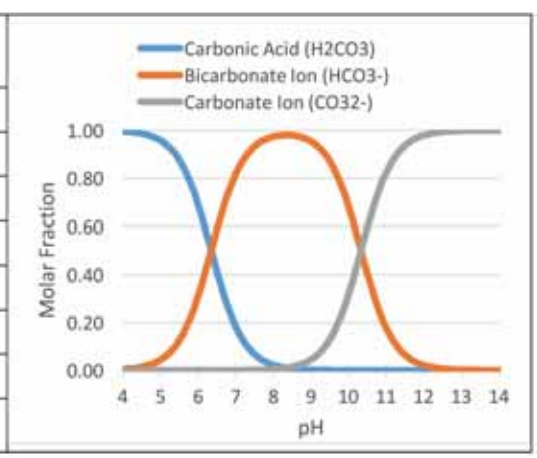


Figure 3. Odor and pH in the IEX Bench Test Influent/Effluent Samples

Table 4. Strong-Base Anion Exchange Resin Relative Selectivity Chart (left) and

Relative Selectivity Chart Strong Base Anion Resin (Type 1)	
Hydroxide (OH^-)	1.0
Fluoride (F^-)	1.6
Bicarbonate (HCO_3^-)	**6**
Chloride	22
Phosphate	40-45
Nitrate	65
Sulfate	85
Dissolved Organic Carbon	>85



Continued from page 33

during the entire duration of the tests. The fishy odor noted in a few samples might be due to the judgment error of the observer or background odor.

The pH values of the effluent samples of different test conditions are also presented in Figure 3. The data suggests that, initially, a slight pH drop occurs across the anion exchange resin, evident from effluent pH values being lower than influent pH values. The total organic carbon (TOC) and color breakthrough were observed after approximately 2000-2500 BVs, which is lower than observed in the full-scale plant. Based on discussions with the system integrator, it is believed that this is due to the Empty Bed Contact Time (EBCT) being lower in the bench-test setup, as compared to the full-scale plant.

Based on the findings from the bench tests, it was concluded that the operation of the IEX plant at a reduced pH (between 8.5 and 8.8) may eliminate the fishy odor in the treated water of the full-scale plant, without impacting color removal. Additional testing and monitoring at the full-scale plant was recommended to understand potential implications of the pH drop in the plant's distribution system after the installation of the temporary CO_2 system.

Why Does the pH Initially Drop During a Run?

The IEX resins, when placed in a solution, reach an equilibrium state between ions in the solution and ions on the resin. From this equilibrium state, selectivity coefficients (equilibrium constants), can be defined based on the ratios of ions in solution versus ions on the resin. Among others, selectivity is determined by ion valence, molecular weight, concentration, and temperature. Table 4 includes the relative selectivity chart for competing anions and, in this particular case, the selectivity of the bicarbonate ion is important[4]. Alkalinity levels in the IEX feed water are between 60 and 80 mg/L, while all alkalinity is in the bicarbonate form at the recarbonized water pH levels between 8 and 9. Therefore, bicarbonate levels in the influent are relatively high and it can be expected that in the initial phases, bicarbonate gets exchanged on the resin until an equilibrium is reached with the ion concentration in the water. Over time, the bicarbonate ions associated with the resin will be exchanged with other anions with higher selectivity to the resin, like organics, such as dissolved organic carbon (DOC) and sulfate.

Calcium and carbonate/bicarbonate are in equilibrium in water, as explained by the calcium-carbonate equilibrium equation frequently used in the water industry (equation 2). At the town's pH values in the IEX influent, almost all alkalinity is in the bicarbonate form (equation 3). During the initial ion exchange process, the bicarbonate (HCO_3^- and CO_3^{2-}) ions will be exchanged on the resin, leaving the calcium ions (Ca^{2+}) unassociated in the water. The Ca^{2+} will then absorb hydroxide (OH^-) from the water and will leave free protons (H^+) behind in the water causing the pH drop.

Equation 2: $CaCO_3\,(s) \leftrightarrow Ca^{2+} + CO_3^{2-}\,(aq)$

Equation 3: $CO_3^{2-} + H_2O \leftrightarrow HCO_3^- + OH^-$ *(pKa=10.3)*

Temporary Carbon Dioxide Dosing System

As a result of the initial investigations and confirmed by the bench tests, a temporary CO_2 dosing system was installed downstream of the filters to reduce the pH of the IEX feed water to between 8.5 and 8.8. Figure 4 shows photos from the CO_2 storage tank and (direct gas) dosing skid. Additionally, the phosphate-based corrosion inhibitor dosing point was relocated downstream of the IEX treatment system, and an online dual-channel ammonia analyzer was added to monitor levels of free ammonia, total ammonia, monochloramine, and total chlorine in the IEX influent and IEX effluent.

The Rothberg Tamburini Windsor (RTW) model[5] for corrosion control and process treatment chemicals was then used to calculate the CO_2 dose required to achieve an IEX feed water pH of around 8.5. Softened and filtered water quality parameters were taken from the WTP's available monthly operation reports (MOR) from January through June 2015. The average calculated CO_2 dose was 10.8 mg/L, and, dependent upon actual softened water pH, alkalinity, and hardness, the dose can range from anywhere between 1 to 20 mg/L, which is dependent upon raw water quality-based actual wells operated and softener performance. The town's target finished water pH in relation to corrosion control is around 8.5.

Recommissioning of the IEX System

After the plant modifications were completed, the IEX system was recommissioned. During the recommissioning phase, which stretched over three runs from Dec. 12, 2015, until Feb. 17, 2016, the town collected extensive operational data from the IEX, chemical systems, and water quality data, as summarized in Table 5. The data were used to verify an odor release pathway hypothesis, and to optimize the IEX system and treatment processes operations.

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Table 5. Data Collected During the Recommissioning Phase

Settled Water Quality	pH and Chlorine Profiling WTP	IEX System Operational Data	Chemical Systems Operational Data	Finished Water Quality
pH Flow Turbidity Alkalinity • m • p Hardness • Total • Ca • Mg Color Chlorine • total • free Free ammonia	For each location: Settled water Re-carbonized water IEX influent IEX effluent GST fill line (finished water): • total • free • ammonia	For each vessel: • Flow • Volume • Color • Odor • pH Alkalinity • Before • After pH • Before • After Pressure • Before • After	Lime • Feed rate • Pressure • Concentration Chlorine • Feed rate • Pressure • Concentration Phosphate • Feed rate • Pressure • Concentration Fluoride • Feed rate • Pressure • Concentration	Turbidity Alkalinity • m • p Hardness • total • Ca • Mg Color pH Phosphate Conductivity Chlorine • Total • Free Free ammonia

Figure 4. Carbon Dioxide Storage Tank and Dissolution Skid During Construction

Continued from page 35

Overall Plant Performance

The overall plant performance was monitored over time to identify concerns and opportunities for improvement. One of the main challenges of the WTP is to maintain a consistent pH profile through the process, evident in the graphics included in Figure 5. The graphic on the left presents the pH value in the softener effluent, which varies in general between 8.9 and 10.6, with some excursions outside that band; the same graphic presents the alkalinity and hardness values in the softener effluent and, as expected, these values vary quite considerably as well. The graphic on the right presents the pH values before and after recarbonation. The values after recarbonation are relevant for this study as they represent the pH values in the IEX influent and vary between 7.9 and 9.2.

Run 1 (Dec. 12-20, 2015)

During Run 1, the town used a target pH in the IEX influent of 8.8. In cooperation with the equipment supplier, the new temporary CO_2 dosing skid was set up to maintain this. Several variables at the dosing skid had to be adjusted to achieve a more stable influent pH profile over time. During Run 1, most of the filtered water was processed through IEX Vessel No. 1, with the remainder processed in Vessel No. 2 and No. 3. The values of color and odor in the IEX effluent of Vessel No. 1 are depicted in the graphic on the left in Figure 6, whereas the pH profiles in the influent and effluent of all vessels are depicted in the graphic on the right. This run was aborted abruptly after 589 BVs due to the presence of odor in a single effluent sample of Vessel No. 1.

Further observations of the data revealed that:

- The pH in the influent was varying extensively around the pH set point of 8.8 due to setup and commissioning issues with the carbon dioxide skid.
- Prior to the presence of odor in the sample, the pH in the IEX influent had been between 9.0 and 9.2 over the prior 24-hour period.
- The pH in the effluent was lower than in the influent, with a reducing gap over time.

It was observed that the town's personnel were still relatively sensitive towards recurring odor in the finished water, evident in the abrupt abortion of Run 1. Also, the town was concerned about the pH drop across the IEX system, causing the finished water pH to be below the target pH of 8.5. The town had no ability to correct the pH downstream of the IEX system, and therefore was reluctant to reduce the IEX influent target pH to below 8.8. The resin was subsequently regenerated with a brine solution and the IEX system was put back in operation as Run 2.

Run 2 (Dec. 21-26, 2015)

During Run 2, the town used the same target pH in the IEX influent of 8.8 as during Run 1. The town tweaked the new temporary CO_2 dosing skid further during this run to create a more stable influent pH profile. Most of the filtered water was processed through IEX Vessel No. 1, with the remainder in Vessel No. 2 and No. 3. The graphics were very similar to Run 1. Run 2 was aborted abruptly after 455 BVs due to the presence of odor in a single effluent sample of Vessel No. 1. Further observations were very similar to those of Run 1.

The resin was subsequently regenerated with a brine solution and put back in operation as Run 3. Further discussions were held regarding pH values and corrosion control and it was decided to reduce the influent IEX target pH slightly.

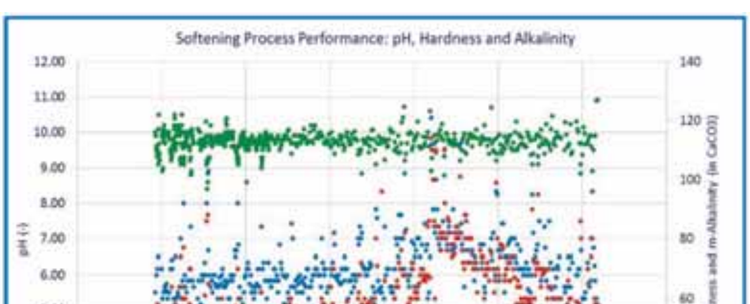
Run 3 (Dec. 29, 2015-Feb. 26, 2016)

During Run 3, the town changed the target pH in the IEX influent to 8.4 to create a little buffer towards the limits of odor release at pH values of around 9. Also, the run was continued (in lieu of abortion as done with runs 1 and 2) when odor was detected after around 500 BVs. At that time, the pH profiles in the influent dropped, causing the odor to disappear instantly. The values of color and odor in the IEX effluent of Vessel No. 1 are depicted in the graphic on the left in Figure 7, whereas the pH profiles in the influent and effluent of Vessel No. 1 are depicted in the graphic on the right. This run was aborted after 5,000 BVs or 12 mil gal (MG) due to color breakthrough.

Further observations revealed that:

- The pH in the influent was still varying; in this case, around the pH set point of 8.4.
- Initially, the effluent pH was lower than in the influent; after 750 BVs, the pH in influent and effluent was the same, and this continued until the end of the run.
- At the end of the run when the loading rate of that vessel was significantly reduced, the pH drop increased again, suggesting that the contact time is a variable.
- The release of TMA is reversible; after odor was detected, the influent pH was reduced to 8.0-8.2, eliminating odor quickly.
- Spikes in influent color resulted in increases in effluent color.
- During the initial phase of the run, some alkalinity was lost between the influent and effluent that coincided with the pH drop, confirming the hypothesis presented.

Continued on page 38



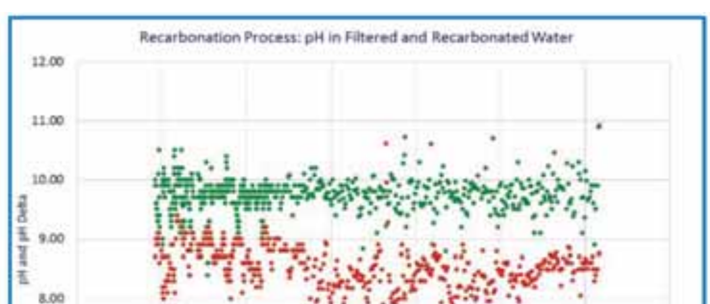
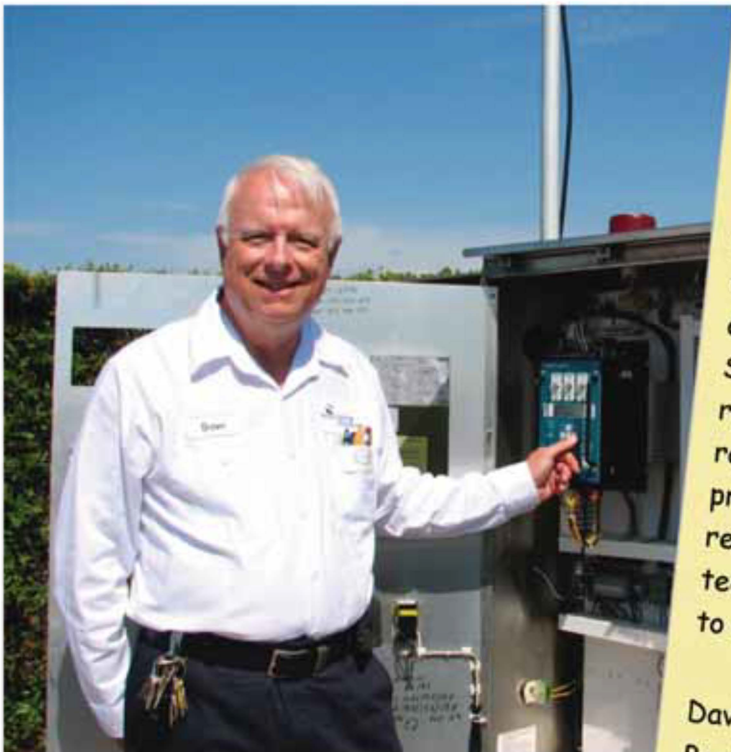


Figure 5. Softener Effluent pH, Hardness and Alkalinity (left), pH Before/After Recarbonation (right)

SCADA SOLUTIONS SINCE 1981



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Continued from page 36

- The graphs for Vessel No. 2 and No. 3 (not shown) were very similar to the graphs shown for Vessel No. 1, demonstrating that the phenomena are repeatable.
- The pressure drop across the IEX system remained low and was measured to be maximum 25 percent of the maximum allowable drop of 10 pounds per sq in. (psi), specified by the system integrator.

Conclusions

Foul odor released by the IEX system at the town's System 3 WTP was caused by high pH values of the IEX influent. The foul odor was identified as TMA. First, bench tests, and then full-scale tests during the IEX system recommissioning, confirmed the pathway hypothesis of the high IEX influent pH conditions, initiating the Hoffman's reaction and causing TMA to release from the resin into the water. The Hoffman's reaction, and therefore the TMA release, can be eliminated by reducing the IEX influent pH to around 8.4 with CO_2, also benefiting alkalinity levels in finished water. Another observation was a pH drop in the initial phases of a run, caused by the absorption of bicarbonate to the resin, leaving Ca^{2+} unassociated. The TOC and color breakthrough in Run 3 were observed after 12 MG treated, or 5,000 BVs, which is considered to be an improvement to prior conditions, potentially saving salt usage.

The town identified measures to enable stable pH conditions of around 8.5 in the finished water for corrosion control under different conditions. The short-term measure is to stagger the run times of IEX vessels to have a finished-water blend to dampen pH and alkalinity swings. The long-term measure, implementation of a sodium hydroxide system downstream of the IEX system to add alkalinity to the treated water, was put in operation in mid-2016. The permanent CO^2 system is anticipated to be operation by 2017.

Since recommissioning of the IEX system, foul odor has been eliminated from the finished water, color levels are low, and recommended pH values for corrosion control have been maintained.

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(3) "Understanding Ion-Exchange Resins for Water Treatment Systems." Miller, W.S.; GE Water & Process Technologies; Castagna, C.J., et al., The Permutit Co. Inc., 1981.

(4) DOW Technical Data Sheet for Ion Exchange Resins, Form No. 177-01755-0207.

(5) AWWATetra Tech (RTW) Model for Water Process and Corrosion Chemistry, Version 2.0.

(6) "Pureflow: The Basics of Water Chemistry" (Part 3). Michaud, C.F. "Chubb."

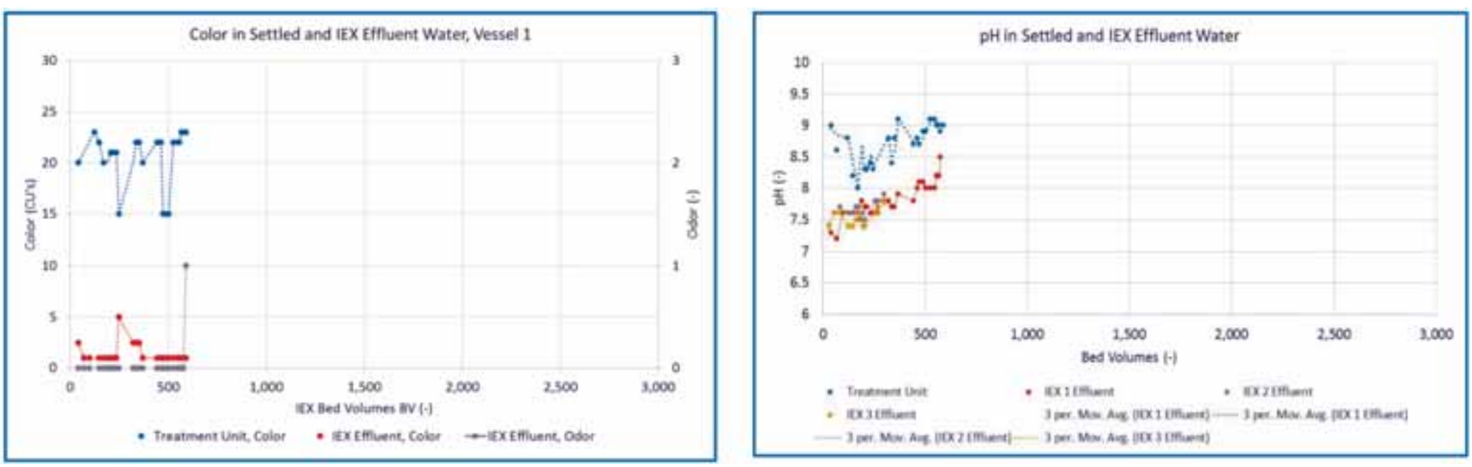

Figure 6. Color, Odor (left), and pH of IEX Influent, Effluent (right) as a Function of Run Time (Run 1)

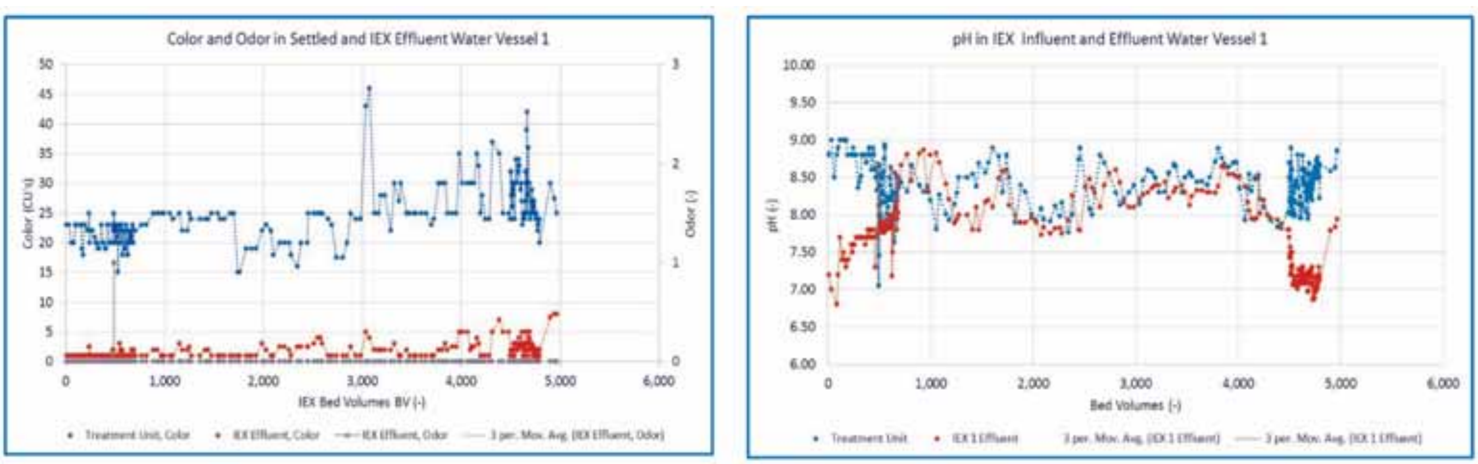

Figure 7. Color, Odor (left) and pH of IEX Influent, Effluent (right) as a Function of Run Time (Run 3)

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Gov. Scott Directs FDEP to Issue Emergency Rule on Notice of Pollution

Gerald Buhr

If you have been out of the state, or you have been living "below the grid" or under a rock somewhere, perhaps you have not heard of the abyss that suddenly developed on property owned by Mosaic, a crop nutrient company near Mulberry, creating concern over some 200 million gallons of contaminated water flowing through the hole, with potential contamination of local water wells, and potentially worse, a direct discharge to the Floridan aquifer. Reports have characterized the debris and water in the hole to be "polluted," "contaminated," "toxic," "fertilizer plant waste," and even "radioactive." The hole measures over 45 feet wide, and is said by Mosaic to be perhaps 300 feet deep, but there is no certainty as to the actual depth. The hole is said to contain phosphogypsum, a fertilizer byproduct with traces of radium. Mosaic has admitted that some contaminants had spread into the groundwater, having found acidity and sulphates in a recovery well, but Mosaic contends that it has not spread to other monitoring wells on or beyond its property. A lot of press has been generated over the sinkhole because Mosaic allegedly did not report the event for some three weeks.

If that wasn't enough, the City of St. Petersburg has an apparent problem with sewage overflows, characterized on Baynews9.com as a "sewage crisis." Apparently, this crisis was then raised to the next level by a whistleblowing operator predicting dire consequences with the shutdown of a city wastewater treatment plant and other circumstances described in an open letter dated September 15, which is now available on St. Petersburg's website at http://www.stpete.org/water/wastewater_collection_and_maintenance.php.

On September 26, Gov. Rick Scott, acting with concern for such alleged "late notices" of pollution events, directed the Florida Department of Environmental Protection (FDEP) to issue an emergency rule requiring 24-hour notice of environmental emergencies. He promised to follow that up by supporting legislation to make the rule permanent in the form of a statute during next year's legislative session. The FDEP complied, and its helpful synopsis of Emergency Rule 62ER16-1, including a list of the *minimum information that must be provided* (not listed in the rule) is located at http://dep.state.fl.us/pollutionnotice.

The rule itself states the following (italics are mine):

62ER16-01Public Notice of Pollution

Any owner or operator of *any installation* who has *knowledge of any pollution at such installation* shall provide notice of the pollution as follows:

(1) *Within 24 hours of the occurrence* of any incident at an installation resulting in pollution, *or the discovery of pollution*, the owner or operator *shall notify the department and the following persons, in writing, of such pollution*:

(a) The mayor, the chair of the county commission, or the comparable senior elected official representing the affected area.

(b) The city manager, the county administrator, or the comparable senior official representing the affected area.

(c) The general public by providing notice to local broadcast television affiliates and a newspaper of general circulation in the area of the contamination.

(2) Within 48 hours of the occurrence of any incident at an installation resulting in pollution, or the discovery of pollution, the owner or operator shall notify the department and persons identified in (1)(a) through (1)(c), in writing, of any potentially affected areas beyond the property boundaries of the installation, and the potential risk to the public health, safety, or welfare.

(3) Within 24 hours of becoming aware of pollution from an installation that has affected areas beyond the property boundaries of the installation, the owner or operator shall notify, in writing, the property owner of any affected area, the department, and the persons identified in (1)(a) through (1)(b).

(4) Such notification to the department shall be accomplished by submitting an email to pollution.notice@dep.state.fl.us.

(5) Failure to provide this notification shall be considered a violation and subject to penalties for purposes of Section 403.161, Florida Statutes. (effective date: Sept. 26, 2016)

Remember that the FDEP definition of "installation" under r. 62-4 F.A.C. is very broad, and includes "any structure, equipment, facility, or appurtenances thereto, operation, or activity, which is or may be a source of pollution as defined in Chapter 403, F.S." and the definition also includes dredge and fill of wetlands. As you might have guessed, "pollution" is also very broadly defined under 403.031(7) F.S., to include:

> "the presence in the outdoor atmosphere or waters of the state of any substances, contaminants, noise, or manmade or human-induced impairment of air or waters or alteration of the chemical, physical, biological, or radiological integrity of air or water in quantities or at levels which are or may be potentially harmful or injurious to human health or welfare, animal or plant life or property, or which unreasonably interfere with the enjoyment of life or property, including outdoor recreation unless authorized by applicable law."

Some information provided by Rebecca O'Hara, senior legislative advocate, Florida League of Cities Inc.; www.reuters.com/article/us-mosaic-sinkhole-idUSKCN11M1QW; http://www.chron.com/news/us/article/Neighbors-anxious-after-Florida-sinkhole-9421142.php; and the FDEP and St. Petersburg websites (Sept. 29, 2016).

Gerald Buhr is a utilities attorney who has held a Class A license in both water and wastewater treatment. A Florida Bar-certified specialist in city, county, and local government law, he is the city attorney for Mulberry, Zolfo Springs, Bowling Green, and Avon Park; represents other public, private, and nonprofit utilities; and teaches hospitality law and human resources at the Art Institute of Tampa.

Water and Wastewater Expo Unites Industry Members

Jeff Poteet

On September 8, FWPCOA Region VIII, the FWEA Southwest Chapter, and FSAWWA Region V held the ninth annual Southwest Florida Water and Wastewater Expo. This one-day event was held in downtown Ft. Myers at the Haborside Convention Center. Industry leaders from around the state shared their knowledge in the four separate trainings tracks that were held at the Expo. Almost 200 students attended the training sessions. It's appropriate to recognize the lecturers that volunteered their time to help improve the knowledge of our industry (see right).

Track A
Asset Management

- Roderick K. Cashe, P.E.
- Michael Condran, P.E.
- Kai Iaukea, P.E.
- Tonya Kay

Track B
Water Resources/ Reuse/Resiliency

- Hal E. Schmidt
- Robert G. Maliva
- John Reed, P.E.
- Michelle Regon, P.G.

Track C
Water and Wastewater Facility Operations

- Andrew J. Coleman, P.E.
- Richard Cummings
- Jennifer Nyfennegger, PhD, P.E.
- Sanjay Puranik

Track D
Potable Water Treatment & Distribution

- Laura Baumberger, P.E.
- Phil Locke, P.E.
- William Lovins, PhD, P.E.
- Brett T. Messner, P.E.








The exhibit hall was opened to the public from 11 a.m. to 4 p.m. Sixty-three vendors shared their products and services with the hundreds of people who walked the floor. Enviro-Tech of America won the drawing for next year's free booth. A lot of people went home with a smile as there were almost 80 door prizes given out.

This great event could not have transpired without the efforts of many volunteers. It's impossible to name them all; however, I will attempt to recognize some of the key volunteers:

- Ron Cavalieri was the FSAWWA Region V representative and set up all of the training sessions and student registration.
- Paul Pinault was the FWEA Southwest Chapter representative and set up the venue, handled the expenses, and collected the revenues.
- Nigel Noone was the FWPCOA representative and handled vendor registration.
- Debra Hogue, Fred Gleim, Jason Sciandra, Cherie Wolter, Dustin Chisum, Jon Meyer and many others helped put together this outstanding event.

A couple of notable guests were in attendance: Kristiana Dragash, vice president of FWEA, and Mike Darrow, vice president of FWPCOA, were there showing their support. Kristiana helped me with the announcements and handing out the door prizes to the lucky winners.

After the doors of the Expo closed, many of us went to the FWEA young professionals social. Free drinks, free food, and socializing with our fellow water professionals made for an awesome end to an outstanding day.

Plans are already being made for next year's Expo. It's bound to be very special as it will be the Expo's diamond anniversary—10 years! I hope to see you there!

Jeff Poteet is general manager of water and sewer at City of Marco Island.

– IN MEMORIAM –
GEORGE HARRY BISHOP

George Harry Bishop, 68, of Lake City, passed away on Aug. 6, 2016, at Shands at the University of Florida Hospital in Gainesville. Bishop was a veteran of the U.S. Navy, serving with the Seabees. He was retired from Orange County Utilities, where he was a wastewater treatment plant operator for 22 years. He was active in FWPCOA Region XIII, serving on the board of directors in various capacities.

He leaves behind his beloved wife of 39 years, Evelyn; his sister, Claire Hayward; three children: Cathy Davis, Don Cato, and Lisa Gates; four grandchildren and four great-grandchildren; and his faithful companion, Sparkle.

From wef hq
Leading-edge updates from the Water Environment Federation

The Economic Impact of Water Infrastructure

Learning from the transportation sector

Marisa Tricas

A paradigm shift in the water sector is taking place, where treated wastewater is being recognized as a high-quality resource that can be recovered. This shift has enhanced the status of water reuse as an alternative water source in integrated water supply planning. Economic evaluations of water reuse often focus on the project itself and its direct benefits to the utility, but as utilities expand their analyses beyond the project, the economic development indicators sometimes are seen in the social leg of the triple bottom line, such as the number of jobs created and the water resources used for recreation.

To help decision makers better quantify the indirect and induced economic development impacts of water investments, the metrics from existing economic frameworks in other sectors, such as transportation, can be considered. These frameworks can be applied to the water sector to help planners see holistic economic alternatives and sustainable investments that water reuse and reclamation projects can contribute to their local communities.

Adopting Tools From Transportation

Other infrastructure sectors are much more developed than the water sector when it comes to identifying the economic impacts for project investments. Full economic frameworks and tools already exist in the transportation sector and have been successfully implemented in communities throughout the country and the world. The Transportation Economic Development Impact System (TREDIS) is a commonly used model that provides economic development impact evaluation and benefit-cost analysis. Currently, 45 governmental agencies in the United States use this tool in 35 states.

In 2014, the Water Research Foundation (Denver, Colo.) and the Water Environment Research Foundation (Alexandria, Va.) released the report, "National Economic and Labor Impacts of the Water Utility Sector." This study examined the actual or planned expenditures of 30 water utilities across the U.S. and quantified direct, indirect, and induced economic benefits. This report was the first to aggregate the national economic impact of water utilities' planned and capital budgets using an economic input-output analysis. The study used the IMPLAN model (impact and planning), which is part of TREDIS to model the way a dollar injected into one sector is spent and re-spent in other sectors of the economy, generating waves of economic activity. The study found the expenditures resulted in a combined total of 289,000 jobs and $52 billion per year generated in economic activity. The utilities involved in the study directly employ 36,500 workers.

In 2016, the Water Environment Federation (WEF) and the WateReuse Association, both headquartered in Alexandria, Va., conducted an analysis to estimate the economic impact of the Clean Water and Drinking Water State Revolving Fund (SRF) programs. These programs are considered to be among the most successful infrastructure funding programs administered by the federal government and implemented by individual states, having provided billions of dollars in low-interest loans for thousands of projects.

The study showed that for every SRF dollar spent, 21.4 percent is returned to the federal government in the form of taxes. An advantage of the SRF program is the leveraging of state program funds to enhance the investment. Thus, the proposed $34.7 billion in federal allocation will leverage an additional $116.2 billion in state spending. Together, the proposed federal allocations and state SRF program funds will result in $32.3 billion in federal tax revenue. When these leveraged state funds are taken into account, $0.93 of federal tax revenue is generated for every $1 of federal investment. The study also documented increased employment and labor income, as well as increases in total economic output.

WateReuse and WEF also used the IMPLAN model to evaluate the economic impacts of proposed federal SRF allocations. The SRF spending generates high-paying jobs, with each job estimated to bring about $60,000 in labor income. On average, 16.5 jobs are generated for every $1 million in water and wastewater capital investments. Figure 1 shows the distribution of employment impacts and compares the water and transportation sectors.

The water sector gains between 10 and 25 jobs per $1 million of capital expenditures.

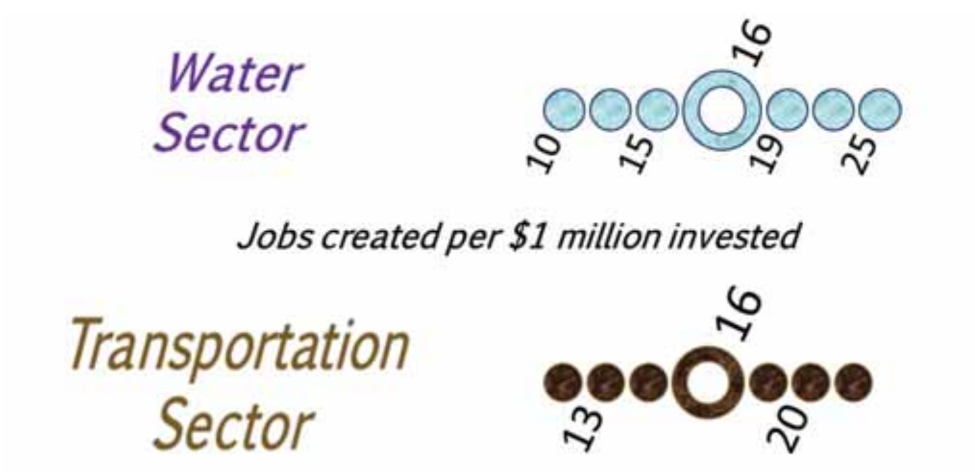

Figure 1. U.S. Jobs Created by Water Investment (16.5 jobs created per $1 million invested)

Comparatively, the transportation sector shows equivalent impacts, with job creation estimates ranging between 13 and 20 jobs per $1 million invested. The most important areas that overlapped in both sectors were syphoned down to six categories: the economic role of water reuse, impact of water spending, benefit of water reuse investment, economic return on investment, impact of future scenarios for strategic planning, and online performance tracking.

The framework developed is outlined, with specific impact measure questions that planners can refer to when evaluating their utilities:

- *Category 1: The economic role of water reuse.* What is the role of current water supply facilities and services in supporting the local economy? What are the stakes associated with failure to continue to support them?
- *Category 2: Impact of water spending.* How does ongoing and planned water spending affect the regional economy, and what is the income benefit from it?
- *Category 3: Benefit of water reuse investment.* How does ongoing and planned spending on water reuse provide benefits for users of those facilities?
- *Category 4: Economic return on investment.* How will planned future capital investments affect the future competitiveness, productivity, and growth of the region's economy? What is the payback from it?
- *Category 5: Impact of future scenarios for strategic planning.* How will alternative scenarios for future water supply capital investments affect the future competitiveness and growth of the region's economy? How can that information help identify investment gaps that require funding to allow economic growth?
- *Category 6: Ongoing performance tracking.* How can the evaluation and selection of future projects incorporate economic impacts and benefit-cost relationships? How can this approach apply to integrated water resources planning?

The water sector can learn from the transportation sector and better identify the indirect and induced impacts of a water project. By highlighting these impact measure categories that help drive economic growth, water reuse projects may have opportunities for additional allies in a region's economic development initiatives, especially since water sector investments are comparable to transportation investments on a job-creation and return-on-investment basis.

The information provided in this article is designed to be educational. It is not intended to provide any type of professional advice, including, without limitation, legal, accounting, or engineering. Your use of the information provided here is voluntary and should be based on your own evaluation and analysis of its accuracy, appropriateness for your use, and any potential risks of using the information. The Water Environment Federation (WEF), author and publisher of this article, assumes no liability of any kind with respect to the accuracy or completeness of the contents and specifically disclaims any implied warranties of merchantability or fitness of use for a particular purpose. Any references included are provided for informational purposes only and do not constitute endorsement of any sources.

Marisa Tricas, MS, ENV SP, is manager, water resources, innovation, and policy, in the Water Science & Engineering Center at the Water Environment Federation.

New Products

The FerroCheck portable magnetometer from **Spectro Scientific** provides accuracy and convenience in measurement of total ferrous wear particulates in lubricating fluids. FerroCheck enables users to perform accurate measurements of ferrous wear particles, both in the field and in the laboratory, where it can be used to analyze gearbox, transmission, and other fluids in fleet and industrial maintenance applications.

The product works by sensing disruption of a magnetic field that is generated due to the presence of ferrous debris, specifically iron, in the oil. Operation involves simply drawing the sample, placing it in the instrument, and using the touchscreen to complete the analysis and view the results. Nonlaboratory personnel can operate it with no solvents or sample preparation required. The lightweight unit weighs less than 5 lbs, is compact, and battery-operated for fast, 30-second testing of small samples.

The magnetometer can detect particles from nanometers to millimeters in size and has a sensitivity range of 0-2500 ppm with a limit of detection of less than 5 ppm. Results are highly repeatable (+/- 5 ppm at concentrations of 0 – 50 ppm).

Coupled with one of Spectro Scientific's condition-based maintenance systems (MiniLab Series, MicroLab Series, and ViscCheck 3000 Series), FerroCheck is part of a comprehensive solution that ensures asset availability and longevity. When performing measurements onsite, it eliminates the wait associated with laboratory-based fluid analysis and enables users to make immediate maintenance decisions that reduce unexpected downtime and costs, and eliminate potential catastrophic machine failures. (www.spectrosci.com)

Fluid Conservation Systems has introduced the next generation of its popular Permalog leak noise logger. The PCorr+ continues to enable water suppliers to quickly locate leaks in a water network, now with advanced features such as remote leak noise sampling and listening, and correlation between loggers.

The PCorr+ loggers are installed magnetically on pipe fittings throughout a distribution system, and continuously monitor for leak noise. If leak noise is identified, the unit immediately enters an alarm state, transmitting a radio signal to indicate a leak condition. Data from the loggers are gathered via drive-by data collection with the new Patroller 3 USB radio receiver, designed to work with both PC and handheld devices. The loggers have improved surveying speed, enabling fast radio download of new data, including a sample of the leak noise for secondary validation. The loggers also feature a correlation mode that allows users to calculate the precise location of a leak without a separate leak noise correlator and are capable of permanent, semipermanent, or "lift and shift" rapid deployment and collection. The unit features a five-year battery life, and an automatic download of up to one month of leak noise history. (www.fluidconservation.com)

Xylem is now offering the Flygt 3000 Series electric submersible pumps as a rental option, ideal for temporary bypass pumping projects at treatment plants and lift stations. The Flygt 3000 Series of small- and mid-sized pumps covers an extensive performance range and are classified as low-, medium-, or high-head pumps. The 3000 Series are nonclog pumps, ideal for handling solids-bearing liquids in a variety of applications. The vast horsepower range enables the customer to meet the requirements of virtually any application.

For municipalities that need to engage in lift station repairs or plant upgrades, the 3000 Series submersible pumps are a cost-effective and environmentally friendly rental alternative that provides a quiet, efficient, and easy-to-install bypass solution for many applications. These pumps are now the go-to rental solution when space is a premium at the jobsite, and reducing footprint is required to complete the bypass setup.

Continued on page 63

Water Industry Gets Smart With Big Data

The water and wastewater industry is in transition to a digital revolution that has the potential to transform the industry from the use of data-driven technologies, with utility sector spending dwarfing the industrial market. This is according to "Water's Digital Future," a new report by Global Water Intelligence (GWI) that provides a detailed guide to the opportunities in this industry.

The global market for control and monitoring systems in the water sector is estimated to be worth $21.3 billion in 2016, growing to $30.1 billion in 2021. Spending on advanced data management and analysis solutions is expected to grow even faster, at 11.9 percent a year. In the utility sector, spending on digital and smart solutions is estimated to be worth $17.7 billion in 2016.

Managing water relies on heavy physical infrastructure and, very often, inherently reactive governing and management attitudes. This is changing with the development of cyber-physical systems, real-time monitoring, big-data analysis, and machine learning with advanced control systems and the Internet of Things (IoT). These smarter systems, in which technology, components, and devices talk and feed information to each other in a more sophisticated way, bring about a more optimized, efficient process.

"Utilities and industrial water users are beginning to understand that there is a big picture here beyond the mosaic of different suppliers. It is a vision of the digital utility that brings together all the different parts of this world of data collection, processing, and automation that promises to deliver significant efficiencies with a high return on investment," said Christopher Gasson, GWI publisher. "The next big consolidation in the water sector is going to involve monitoring, control, and data management."

The report outlines the major opportunities available to those involved in the different layers of monitoring and control systems. It shows the gaps in the market, what is motivating the end user to invest in a solution, and how the solution provider can access the market.

According to the report, the utility sector is the largest part of the market, with numerous opportunities for utilities to save money using smart technologies to improve asset management, process optimization, and interaction with their customers. In the smaller industrial sector, however, process efficiency and product quality are the main factors driving greater adoption of these smart technologies.

In the utility sector, there is a huge opportunity for increasingly sophisticated data analysis as utilities understand the benefits of viewing their networks and assets in a catchment-to-tap way. This is driving spending on sensors and customer metering to obtain greater amounts of data about network and treatment processes, and external data, such as weather and geological information. More advanced data software solutions are needed in order to integrate these increasingly diverse sources.

Within the industrial market, spending across all industries is expected to increase over the forecast period of 2016-2021. Industries, such as microelectronics, are market leaders with advanced solutions, while others, such as food and beverage, lag behind. The most interesting opportunities in the industrial market include: upstream oil and gas, refining and petrochemicals, power generation, mining, pulp and paper, and pharmaceuticals.

The report reveals that the biggest market for smarter control and monitoring systems is the Asia-Pacific region, where spending is expected to reach $10.3 billion in 2021, driven by growing urban populations placing pressure on infrastructure. There is a big focus on leakage management in Japan, and nonrevenue water reduction programs in Malaysia and the Philippines. Leakage management is also a major role in North America and Europe due to aging infrastructure within networks and treatment plants that continue to offer challenges for utilities.

The complete report is available and a free sample chapter can be downloaded at www.globalwaterintel.com/watersdigitalfuture.

What Do You Know About Biological Phosphorus Removal?

Ron Trygar

1. In the luxury uptake method of biological phosphorus removal (BPR), bacteria release phosphorus from their cells during which phase of treatment?

   a. Aerobic phase
   b. Anoxic phase
   c. Anaerobic phase
   d. Bardenpho phase

2. The bacteria most responsible for BPR in the luxury uptake process are known as PAOs. What does PAO stand for?

   a. Phosphate accumulating organism
   b. Phosphate adsorbing oligochete
   c. Preferentially anaerobic organism
   d. Phosphorus anaerobically oxidized

3. Which oxidation-reduction potential (ORP) millivolt (mV) reading best fits the anaerobic selector?

   a. + 200 mV   b. 0 mV
   c. – 50 mV   d. – 200 mV

4. Which organism group(s) is/are given the selective advantage in the anaerobic (fermentation) zone of the luxury uptake process?

   a. Nitrosomonas and nitrobacter
   b. Carbon accumulating organisms
   c. Phosphate accumulating organisms
   d. Aerobic autotrophs

5. The recycling of inplant sidestreams to the headworks of the plant could interfere with phosphorus release if the liquid contains what?

   a. Ammonium/ammonia
   b. Nitrate/nitrite
   c. Calcium bicarbonate
   d. Volatile fatty acids

6. Under which conditions of the luxury uptake method of phosphorus removal do the PAOs oxidize volatile fatty acids, previously stored as a food and energy source for metabolism and reproduction, and restore internal phosphate granules?

   a. Anaerobic conditions
   b. Anoxic conditions
   c. Oxic conditions
   d. Thermophilic conditions

7. How is the phosphorus ultimately removed from the advanced wastewater treatment plant?

   a. With the biosolids disposal.
   b. As a gas, along with nitrogen from the anoxic zones.
   c. It accumulates in the grit as a precipitate in the grit chambers.
   d. It accumulates as struvite in the aerobic digester.

8. When the PAOs release phosphate from their cells though osmosis, what other elements or compounds are released that help transport the phosphate through the cell membrane?

   a. Magnesium and potassium
   b. Chloride and hydrogen
   c. Oxygen and nitrogen
   d. Sulfate and sulfide

9. At an advanced wastewater treatment plant, an operator is experiencing very high plant effluent phosphorus readings. An investigation into the plant problem reveals the following information:
   - Influent phosphorus levels are normal
   - Influent flow is normal
   - All plant process equipment appears to be operating normally
   - Dissolved oxygen (DO) in aeration basins is 2.0 mg/L, with zero mg/L DO in anaerobic zones
   - ORP in anaerobic zones is 190 mV
   - All secondary clarifiers are in operation
   - Sludge blankets are at 5 ft
   - Return activated sludge to influent (RAS:Q) flow ratio is 35 percent
   - Waste activated sludge (WAS) rate is normal

   From the information given, what is the *most* likely cause of the elevated phosphorus readings?

   a. The DO in anaerobic basins is too low.
   b. The RAS rate is too low.
   c. The ORP in anaerobic zones is too low.
   d. The DO in aeration tanks too low.

10. In question 9, which condition allowed the phosphorus to become elevated in the plant effluent?

    a. The 2.0 mg/L DO in the aeration tank prevented phosphorus uptake by PAOs.
    b. The -190 mV ORP in the anaerobic zone allowed the system to become septic.
    c. The zero mg/L DO in the anaerobic zone prevented phosphorus release.
    d. The 35 percent RAS:Q ratio allowed secondary release of the phosphorus in clarifiers.

Reference used for this quiz: "Biological Nutrient Removal (BNR) Operation in Wastewater Treatment Plants, WEF Manual of Practice 29." Water Environment Federation, 2005.

Answers on page 70

SEND US YOUR QUESTIONS

Readers are welcome to submit questions or exercises on water or wastewater treatment plant operations for publication in Test Yourself. Send your question (with the answer) or your exercise (with the solution) by email to:

rtrygar@treeo.ufl.edu

or by mail to:

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Greetings from the FWEA Wastewater Process Committee! This month's column highlights Pinellas County's South Cross Bayou Water Reclamation Facility. This facility took the runner-up Earle B. Phelps Award in the category of advanced wastewater treatment (greater than 15 mgd in capacity) in 2015.

Pinellas County's South Cross Bayou Water Reclamation Facility Stresses Environmental Commitment Through Resource Recovery

Jacob Porter, Josefin Hirst, Ivy Drexler,
Megan Ross, and Nestor Sotelo

Pinellas County's South Cross Bayou Water Reclamation Facility (WRF), first built in 1962 as a 5-mil-gal-per-day (mgd) trickling filter plant, has evolved to a 33-mgd advanced wastewater treatment plant and resource recovery facility. With its focus on sustainability, the facility has a successful resource recovery program as demonstrated with the production of 3.5 bil gal of reclaimed water for irrigation and over 6,000 tons of fertilizer annually through pelletization. By achieving Class AA biosolids, with a solids content of 99 percent, the utility realizes significant savings in hauling and disposal costs. By utilizing digester biogas in the pelletizing process, the facility is able to offset the use of natural gas, saving costs by reducing fossil fuel usage. Last year, this equated to a savings of approximately $140,000 in natural gas expenses.

The WRF is the largest wastewater treatment facility in Pinellas County, averaging 22 mgd annually. Facility staff is also responsible for the operation and maintenance of 174 pump stations. The WRF is configured in two parallel Modified Ludzack Ettinger (MLE) process trains, followed by denitrification filters for nitrate and suspended solids removal. The facility employs two independent and parallel disinfection methods: ultraviolet for surface water discharge, and chlorine for use in its reclaimed system. The facility distributes an average of 11.7 mgd of reclaimed water to over 21,000 residential and commercial customers and also discharges to a Class III marine water. The WRF dewaters the solids generated within the facility and blends it with an annual average of 1,500 dry tons of dewatered solids received from the county's northern plant, the W. E. Dunn WRF, prior to heat drying. Dewatering at both facilities is managed by county staff and heat drying is achieved through a partnership with Synagro Technologies Inc., a waste recycling company, that handles pelletizing as well as the marketing and distribution of the finished product.

The facility includes the following major unit processes:

- Headworks with perforated plate band screens followed by teacup grit removal
- Activated sludge treatment in an anoxic/aerobic (MLE) configuration
- Deep-bed denitrification filters with methanol addition
- Effluent disinfection using chlorine and sodium hypochlorite for reclaimed water
- Effluent disinfection using ultraviolet disinfection for surface water discharge
- Odor control
- Reclaimed water storage and pumping
- Egg- and round-shaped digesters
- Fats, oils, and grease (FOG) receiving station
- Septage receiving station

- Sludge thickening (rotary drum thickeners) and dewatering (centrifuges)
- Thermal dryer with dried pellet storage

The facility is highly automated and has provided excellent treatment that is well below permit limits, as summarized in Table 1.

The WRF has a long history of community outreach and public education and is currently in the midst of expanding its program. Working under the tagline, "Innovate ~ Create ~ Educate," utility staff is promoting the facility as an experiential learning platform to link classroom learning to real-world applications. Tours and presentations emphasize the importance of resource recovery from wastewater, describing the facility as a "factory" that produces reclaimed water, fertilizer, and energy. Over 15 diverse groups took the tour on the 42-seat tram around the 3-acre complex in 2015, and over 300 students and residents have visited the facility so far this year. Tour groups have included elementary and college students, Public Works Academy participants, and even two groups from Southeastern Guide Dogs Inc. (see photos). Facility staff has also participated in the Great American Teach-In and local science, technology, engineering, and math (STEM) camps, reaching over 300 elementary and middle school students who were unable to visit the plant. Recognizing the need to attract more people to the wastewater industry, the education program also promotes career opportunities in STEM, management, and public service.

The WRF prides itself on its diverse workforce, where over 40 percent of the staff are women and/or minorities. The range of perspectives, problem-solving skills, and experiences encourage proactive approaches to complex issues. Staff satisfaction is evidenced through long-term workforce retention, with several staff employed at the facility for over 20 years. Their institutional and historical knowledge has proven invaluable to system troubleshooting.

The WRF puts Pinellas County's mission, "To Be the Standard for Public Service in America," into action by prioritizing its community's environmental and public health. By investing in technologies that enable potable water conservation through distribution of reclaimed water, nearly 100 percent of recycling of biosolids at both county plants, and green-energy capture of digester gas, WRF is truly more than a water reclamation facility; it is a resource recovery facility.

Jacob Porter and Josefin Hirst are associates with Hazen and Sawyer in Tampa. Ivy Drexler, Ph.D., is the technical project coordinator, Megan Ross is the wastewater treatment manager, and Nestor Sotelo is senior engineer with Pinellas County Utilities in Clearwater.

Table 1. Summary of Influent and Effluent Water Quality (annual average)

	$CBOD_5$	Total Suspended Solids	Total Nitrogen	Total Phosphorus	Coliforms
Influent	128 mg/L	138 mg/L	33.1 mg/L	4.06 mg/L	N/A
Effluent	2 mg/L	<1 mg/L	2.84 mg/L	0.35 mg/L	1.67/100 mL
Permit Limit (annual average)	5 mg/L	5 mg/L	3 mg/L	1 mg/L	Maximum single grab sample of 25/100 mL
Percent Removal	98	99	91.4	91.4	N/A

A Rising Superstar: Kristiana Dragash

Lisa Prieto
President, FWEA

Over the last few years, I have had the honor to serve alongside some wonderful people on our board of directors. In an effort to share a little more about who we are, I am going to profile a few over the next six months.

Kristiana Dragash is a senior engineer with Carollo Engineers in Sarasota. She has a degree in civil engineering from the University of South Florida and is currently serving as vice president of FWEA. If you have ever met Kristiana, her passion for life, her family, and her profession is contagious. She has been a true asset to FWEA and a great friend.

I recently interviewed Kristiana about how she got involved in FWEA and what her favorite things are about the organization and being an engineer.

How did you get involved in FWEA and what has been your progression to vice president?

I joined the West Coast Chapter shortly after graduating college. I attended a meeting and was intrigued so I stuck around for the steering committee meeting. I volunteered that day to become the West Coast Chapter secretary. Then, in 2010, a colleague and I recognized that the chapter was far from a lot of the folks in the Sarasota area, so we created the Manasota Chapter to serve the profession in Sarasota, Manatee, Hardee, Highlands, and Desoto counties. I served as a co-chair of the new chapter for three years until I was invited to be an FWEA director at large in 2014. I served in that office for two years until I was recently nominated as vice president.

What are your favorite things about FWEA?

My favorite things about FWEA are the people, the relationships, and the friendships I has developed over the years serving in my different roles. I feel that FWEA exposes you to a broader group of people than just the people you work with day to day. The organization keeps me on my toes, whether it be dealing with hot environmental issues or new technology. I feel that FWEA is truly a forum where my voice is heard and I can make a difference.

What do you like about being an engineer?

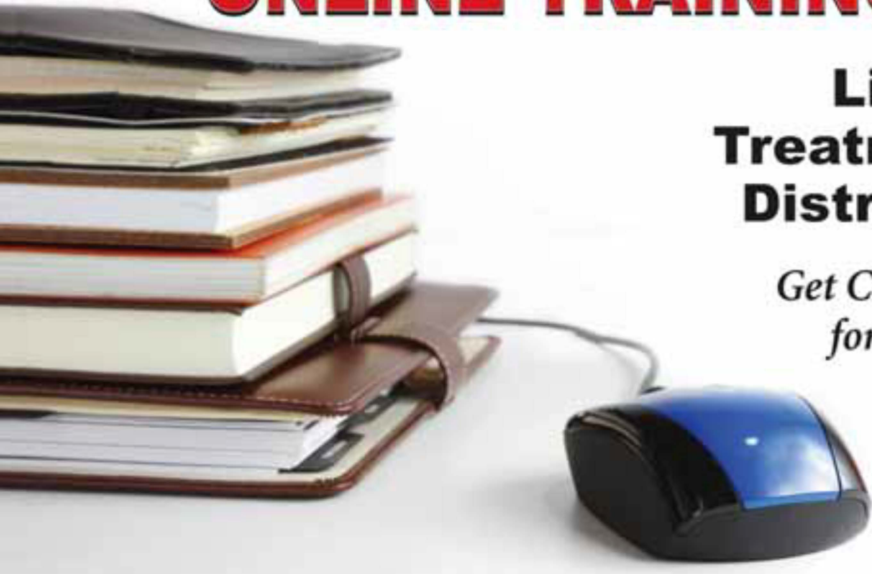
As an engineer, I love to solve problems, protect the environment and public health, and educate the public about our industry. At Carollo, I enjoy working on hydraulic modeling, condition assessment, asset management, geographic information systems, and master planning. And, I love the exhilaration of calibrating a hydraulic model and using it as a tool to help clients solve real-world problems.

What do you like to do for fun (other than hydraulic modeling)?

Even though I have a lot of fun at work, it is not nearly as much fun or demanding as my other full-time job of being wife to Rod and mom

to Brody, my 18-month-old son. In my free time I love to spend it with my family, play with my dogs, work out, swim, have Lularoe parties, and do yoga. I also love mentoring, encouraging, and inspiring young engineers. Also, this fall I am running for public office in my community, for the Lakewood Ranch Community Development District 1, Seat 2 position (the chairwoman). When the long-time incumbent decided to step down, my peers asked me to run. They graciously stated that I had the knowledge, enthusiasm, and passion for the position and that I would be an ideal candidate to serve my community, and I humbly accepted.

To know Kristiana is to love her. She is a terrific person and her enthusiasm has and will continue to propel FWEA to new heights. She has been a great friend and huge help through my time at FWEA. Kristiana is a great resource when it comes to holding events, mentoring young engineers, and building a new chapter. Feel free to reach out to her and get to know her better—she always finds time to help an FWEA friend in need!



This column highlights a committee, division, council, or other volunteer group of FSAWWA, FWEA, and FWPCOA.

Collection Systems Committee

Affiliation: FWEA

Current chair: Walt Schwarz, P.E., program manager with CH2M.

Scope of work:
The focus of the committee is to provide a forum for collection system issues with both internal and external focus, provide educational opportunities for membership, and provide an opportunity for collection system practitioners to network and expand their professional interests. The committee activities provide awareness to the rest of the FWEA community on collection system issues that affect how a utility operates.

Recent accomplishments:
- Held monthly meetings (conference calls) to discuss issues and plan activities.
- Planned and produced workshops annually at the Florida Water Resources Conference (FWRC) since 2014; the latest was on the impact of nondispersibles on collection systems in 2016. A follow-up half-day workshop on solutions will be held at the 2017 FWRC in West Palm Beach.
- Have held three P/M/LACP training sessions, with the next one planned for November 2016.
- Sponsored a one-day collection systems seminar held in Boca Raton in January 2015. The next installment of this annual series will be held in Orlando in February 2017.
- Continued presentation of the annual collection systems awards and added the Golden Manhole Award to the annual list of awards presented by FWEA to honor member contributions.
- Rudy Fernandez, past chair of the committee, has been serving as the chair of the WEF Collection Systems Committee for the past two years.

Current and future projects (in addition to those described above):
- Preparation of an informational brochure for distribution to high school guidance counselors describing noncollege-track career opportunities in the public utilities field.
- Planning an event for the 2017 FWRC to bring attention to the committee's activities and encourage participation.
- Updating the committee website to be a more useful tool for membership. The committee website can be viewed at http://www.fwea.org/collection_systems_committee.php.
- Improve coordination with the WEF Collection System Committee to provide more national focus.

Committee members:

Members comprise a diverse cross section of utility, consulting, and manufacturing companies:

Walt Schwarz, chair	CH2M
Joan Fernandez, co-vice chair	Black and Veatch
Lane Longley, co-vice chair	City of St. Petersburg
Dorian Modjeski	Modjeski Engineering
Brad Hayes	City of Tavares
Clay Tappan	CDM Smith
Don McCullers	Cardno
Fred Nugent	FJ Nugent and Associates
Freddy Betancourt	Arcadis
Glen Hill	Carylon
Gui DeReamer	Brown and Caldwell
Isabel Botero	Black and Veatch
Jamison Tondreault	Kimley-Horn
Kevin Becotte	Pinellas County
Mike Kahren	Ebara Pumps
Nick Wagner	Manatee County
Oscar Bello	Layne Heavy Civil
Tad Parker	Orange County
Rudy Fernandez	PB America
Scott Kelly	City of West Palm Beach
Scott Helfrick	ADS Environmental Services
Susanna Littell	Orange County
Wes Haskell	Ebara Pumps

The committee has no limit on membership and encourages anyone with an interest in wastewater collection and transmission to join and participate. The more members we have, the more we can contribute and the less stress there is on everyone!

Operators: Take the CEU Challenge!

Members of Florida Water and Pollution Control Association (FWPCOA) may earn continuing education units through CEU Challenge! Answer the questions published on this page, based on the technical articles in this month's issue. Circle the letter of each correct answer; there is only one correct answer to each question! Answer 80 percent of the questions on any article correctly to earn 0.1 CEU for your license. Retests are available.

This month's editorial theme is **Water Treatment.** Look above each set of questions to see if it is for water operators (DW), distribution system operators (DS), or wastewater operators (WW). Mail the completed page (or a photocopy) to: Florida Environmental Professionals Training, P.O. Box 33119, Palm Beach Gardens, Fla., 33420-3119. Enclose $15 for **each set** of questions you choose to answer (make checks payable to FWPCOA). **You MUST be an FWPCOA member before you can submit your answers!**

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Contact FWPCOA at membership@fwpcoa.org or at 561-840-0340.
Articles from past issues can be viewed on the *Journal* website, www.fwrj.com.

First of Its Kind: City of Bunnell Utilizes Cutting-Edge Technology to Address Water Quality Consent Order Issues

Phil Locke and Nichole Smith

(Article 1: CEU = 0.1 DW/DS)

1. The useful life of a water well is often considered to be ____ years.
   a. 10 b. 20
   c. 30 d. 40

2. The _____________ of a well is equal to the well discharge per unit of drawdown.
   a. efficiency b. viability
   c. performance d. specific capacity

3. Raw water quality issues revealed by this study seem to be
   a. regional in nature.
   b. specific to certain wells.
   c. unique to this aquifer system.
   d. those that need not be addressed by the water treatment process.

4. Changes in static water levels
   a. could not be measured.
   b. averaged 5.62 ft from original to present.
   c. reflect a change in potentiometric Floridan aquifer surface elevation.
   d. are dictated by sea level changes.

5. Following this study, wells having which issue were assigned the highest priority for rehabilitation?
   a. Reduction in pump rate
   b. Bacteriological issues
   c. Water level monitoring access
   d. Sand production

Anion Exchange Treatment for Color Removal: How a Utility Experienced Finished Water Foul Odor and Eliminated It

Renuka Mohammed-Bajnath, Jeffrey Pinter, GJ Schers, and Andre McBarnette

(Article 2: CEU = 0.1 DW/DS)

1. The authors cite a concern that the use of ___________ to remove biological growth on resin in 2014 might have permanently damaged the resin.
   a. sodium hypochlorite
   b. sodium bisulfite
   c. aqueous ammonia
   d. sulfuric acid

2. A primary cause of initial pH drop through the ion exchange resin is the removal of ________________ from the water.
   a. hydroxide b. bicarbonate
   c. hydrogen d. ammonia

3. Following bench-scale testing, which of the following chemicals was added upstream of the ion exchange unit to lower feed water pH?
   a. Sulfuric acid b. Hydrochloric acid
   c. Carbon dioxide d. Sodium chloride

4. The fishy odor detected in ion exchange-treated water was found to be
   a. hydrogen sulfide.
   b. a combination of mercaptans.
   c. trimethylamines.
   d. plankton.

5. This facility's ion exchange treatment system uses what kind of resin?
   a. Cation b. Anion
   c. Combined cation and anion d. Neutral

Evaluation of Alternatives for Iron and Manganese Removal for a Panhandle Water System

Bruce A. Neu

(Article 3: CEU = 0.1 DW/DS)

1. The iron and manganese treatment process that requires pre- and post-pH conditioning and prefiltration oxidant application is
   a. manganese greensand filtration.
   b. chemical oxidation.
   c. granular activated carbon filtration.
   d. multimedia filtration.

2. Which of the following is not included among the chemicals applied at the Davis Highway Well treatment system?
   a. Hydrofluosilicic acid
   b. Sodium hypochlorite
   c. Calcium hydroxide
   d. Phosphoric acid

3. Which of the following treatment alternatives tested required no chemical oxidant to meet discharge criteria?
   a. Tonka b. Purifics
   c. Layne d. Hungerford & Terry

4. Only one Emerald Coast Utilities Authority well is known to produce water exceeding iron and manganese drinking water maximum contaminant levels, and water from that well will be treated by
   a. chemical sequestration.
   b. greensand filters.
   c. chemical oxidation.
   d. powdered activated carbon.

5. Pipeline materials in use within the Marie Avenue area include
   a. galvanized.
   b. reinforced concrete cylinder.
   c. polyvinyl chloride.
   d. cast iron.

Evaluation of Alternatives for Iron and Manganese Removal for a Panhandle Water System

Bruce A. Neu

The Emerald Coast Utilities Authority (ECUA) is located in Escambia County, on the westernmost Florida Panhandle along the Gulf of Mexico. The ECUA has a potable water supply system consisting of 33 wells that draw from the Coastal Plain aquifer, a sand and gravel formation, to meet the needs of its water customers. Depending on system demand, ECUA customers can receive water from two to five wells located closest to their point of use. Hence, the water delivered to a customer, at any set time, can vary slightly, based on the characteristics of each well's source water. Each well is considered a separate treatment plant, where water quality chemistry must comply with Florida Department of Environmental Protection (FDEP) water quality standards. The ECUA's Davis Highway Well (well) has been in service since spring 1963. The ECUA's Northwest Florida Water Management District Consumptive Use Permit, in effect at the time of the initial water quality evaluations performed for this well, authorized the pumpage at an annual average daily rate of 2000 gal per minute (gpm), or 2.88 mil gal per day (mgd). Under the permit in effect, the well had been pumped at up to a daily rate of 2584 gpm (3.72 mgd).

The water from the sand and gravel aquifer is plentiful and generally of high quality, with the exception of localized fluctuation in its quality, with low alkalinity, hardness, and pH. The U.S. Environmental Protection Agency (EPA) Safe Drinking Water Act National Secondary Drinking Water Standards have been adopted by FDEP in Rule 62-550.320 F.A.C.(1). According to the Drinking Water Quality Report and backup analytical data that were posted on ECUA's website in 2009, the well iron and manganese concentrations were under the USEPA/FDEP Secondary Drinking Water Standards limit. However, this well had the highest reported raw water concentrations of these elements in the ECUA's 33 water production wells.

At this well, calcium hydroxide (hydrated lime) is added for pH adjustment and alkalinity addition; phosphoric acid, with a 75 percent orthophosphate blend, is added for corrosion control in the distribution system; and chlorine gas is added for water disinfection. Hydrofluosilicic acid is also added as a source of dental fluoride treatment.

In 2010, ECUA started receiving complaints of "dirty water" in the Marie Avenue neighborhood, within the well's service area. Several of the water customers in this area installed point-of-entry (POE) water filters on the service line to their residential dwellings to eliminate the orange-brown, cloudy water and rust-colored specs found on the filter media. Both filter and water samples from the customers were presented to ECUA, where both its staff and representatives of Hatch Mott MacDonald (HMM) observed them in October 2010. The porous filters showed staining consistent with iron in suspension in water. The submitted jar samples of tap water also showed signs of the orange-brown color and small particulate matter suspended in the water upon shaking of the jars.

The Marie Avenue area was the only neighborhood in the well service area with this water quality complaint. The area is in the center of an established residential area, with no known large water users in the immediate vicinity. The street in question is served by a 3-in. polyvinyl chloride (PVC) water main that is fed by a looped network of 4-in., 6-in., and 8-in. cement asbestos (CA) and PVC distribution mains.

Upon receipt of water quality complaints, ECUA performed localized system flushing in response, requiring about one hour for the system in the area of Marie Avenue to flow clear. After responding to the regular complaints with response flushing, ECUA installed an automatic flush stand that operated automatically, once a week, at 2:00 am. The ECUA has a four-level water distribution system flushing program in place, which is implemented upon a confirmed water quality complaint from its customers. Due to limited resources and water system priorities, ECUA currently does not have a preventative maintenance flushing protocol for its entire water distribution system.

Bruce A. Neu, P.E., is a principal project manager with Mott MacDonald (formerly Hatch Mott MacDonald) in Jacksonville.

During the fall of 2010, when consumer complaints became more frequent, the well was taken offline and its service area supplied by adjoining wells operating in ECUA's water network. Initial recommendations were made to ECUA by HMM for actions to be taken to improve the water quality in the localized complaint area.

Water Quality Evaluation Report

In April 2011, ECUA authorized HMM to review available options to eliminate the dirty water complaints being regularly received from the specific area within its well service area, along with a "magnitude of dollars" 20-year life cycle cost estimate for each. Options evaluated by HMM ranged from regular maintenance operations to major water treatment capital improvements for improving the water quality from the ECUA distribution system from this well as described.

Systematic Flushing of Distribution System

One potential source of water quality degradation in the distribution system area in question is residual sediments. Without a scheduled, systematic water distribution system flushing program in place, sediments may have accumulated over the years that ECUA and its predecessor, the City of Pensacola, have operated the water system. These sediments are subject to disturbance and transport with any change in the operation of the system, from seasonal demand changes in flow to fire-flow demand or water main break. Proactive, scheduled, systemwide flushing is a recognized best management practice by the American Water Works Association (AWWA), and is referenced

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in almost every manual, standard, and publication addressing finished water quality delivery. Resources are available from AWWA to provide guidance on unidirectional flushing, which is currently recognized by the water industry as the most effective means of distribution flushing, while utilizing the least amount of potable water.

Due to its current level of resources, ECUA staff is only able to respond to confirmed water quality complaint areas of the system. Staff with ECUA and HMM identified the approximate limits of the well service area, and utilizing ECUA's geographic information system (GIS) database, determined the approximate length of the various-sized water mains within its service area, from which a budget quote was solicited from a water main cleaning contractor. The estimated cost of cleaning the service area water mains with nonabrasive poly pig swabs was approximately $490,000.

Systemwide Confirmation of Existing Water Treatment Chemical Dosages

With 33 water supply wells serving the system, the variations in water flow, pressure, and direction of flow can be significant, with system demands and the wells in operation at any one period of time. Adding to the potential sediment collection is the use of an oxidant, chlorine, and lime as part of the treatment process. The chlorine dosage utilized at each well needs to be a function of the raw water iron and manganese concentrations, as well as the amount needed for maintaining a uniform disinfectant residual in the system. Lime can be used as an iron and manganese precipitant in water treatment, as well as its primary use by ECUA as a pH buffer (i.e., adds alkalinity). Bench testing of each ECUA well's raw water to confirm the correct dosage of chlorine as a disinfectant with a residual in the distribution system, and iron, manganese oxidant, and lime, was recommended.

Sequestration Chemicals

The ECUA used a phosphoric acid chemical (75 percent orthophosphate blend) as a corrosion inhibitor in its distribution system for compliance with the EPA Lead and Copper Rule (LCR).

During the time of HMM's review of options to address the iron and manganese from the well, ECUA was evaluating the use of a proprietary iron and manganese sequestration chemical, which is a blended phosphate liquid. Typically, the initial dosage of the sequestration product is at a level to stabilize the existing iron and manganese concentrations in a distribution system. Once a sequestration equalization is attained, a lower maintenance dosage is implemented. Prior to the implementation of sequestration chemical addition, bench testing is recommended to determine the effectiveness of the proposed chemical, as well as any impact upon the water distribution system with regard to copper and lead leaching. This is especially important if the system is currently in compliance with the LCR and a change in sequestering agents is proposed. Based on published maintenance dosage criteria by the manufacturer of the sequestering chemical under evaluation by ECUA, the estimated 20-year life cycle cost for the application of this sequestration chemical would be approximately $380,000.

Point-of-Use/Point-of-Entry Devices

Point-of-use (POU) devices are water filtration and/or treatment devices that are installed at individual water fixtures. A POE device is installed on a building service line to serve all potable water consumption within the building. A specific POU device for removal of iron and manganese would be a Water Quality Association S-200/ANSI/NSF 42 "Drinking Water Treatment Unit-Aesthetic Effects" unit. There are a number of whole-house POE units available on the market. If ECUA were to consider the furnishing, installation, and maintenance of a whole-house POE device, an outside, above ground assembly in an insulated enclosure would be recommended. As this unit would be installed after the water meter, it was suggested that it be installed as close to the home or building as possible. Based on the purchase price and recommended filter replacement schedule from a recognized manufacturer, the estimated 20-year life cycle cost for a single, whole-house, POE device was approximately $19,000.

Oxidation by Aeration

A common method of oxidizing iron and manganese that are in low concentrations is through aeration. The most cost-effective method is by a static aeration device, either an in-tank aerator or cascading tower-type device. In this method, the raw well water is discharged to the static aeration device in or on top of a ground storage tank. The oxidized iron and manganese are then allowed to settle to the bottom of the tank as a precipitate, where it is then pumped off to the sanitary sewer. The clarified raw water is then repumped from the tank through the water treatment facilities to the water distribution system.

For the well, the water would be pumped through the aeration device to a ground storage tank of at least a 300,000-gal capacity to allow for a minimum two-hour precipitate settling time. The precipitate would be pumped, via internal tank-mounted submersible pumps, to the sanitary sewer. A 2,500-gpm variable-frequency-drive (VFD) booster pump system would pump the clarified water through the existing treatment process to the system. Bench-scale testing is recommended prior to project design, and an evaluation on the resizing of the well pump and/or motor would be conducted due to the reduced discharge head. Under the assumption that this static aeration option would be part of an overall upgrade of the existing well treatment facilities, its 20-year life cycle cost was estimated at $4.25 million.

Chemical Oxidation

Another common method of oxidizing iron and manganese that are in low concentrations is through chemical oxidation. The most cost-effective method is by using chlorination. The chlorine is injected into the raw well water at a calculated dosage to oxidize the iron and manganese, and is then discharged to a ground storage tank. The same size and capacity tank and pumping equipment would be required for this option as the static oxidation by aeration option. Under the assumption that this chemical oxidation and precipitation option would be part of an upgrade of the existing well treatment facilities, its 20-year life cycle cost was estimated at $4.25 million.

Granular Activated Carbon Filtration

The ECUA had successfully used vertical pressure filters with the Calgon Carbon Corp. (Calgon) CENTAUR® HSL granular activated carbon (GAC) for iron removal by adsorption at its Lillian and Villa wells for several years. The raw water is pumped through the GAC filters prior to any chemical addition for further treatment. The GAC is long-lasting and can be regenerated by backwash with potable water. Calgon was requested to provide a preliminary cost estimate for an iron and manganese removal system, with filter vessels, stainless steel piping, tubing, and control valves. Under the assumption that this GAC filtration system would be part of an overall upgrade of the existing well treatment facilities, its 20-year life cycle cost was estimated at $2.08 million.

Manganese Greensand Filtration

Manganese greensand filtration is a well-recognized and utilized method of iron and manganese removal from groundwater. It requires that the raw water be pH-conditioned, as required by the specific water chemistry, both before and after the filtration, as an oxidant; in this site's case, chlorine, which is added prefilter. The combination of lime and chlorine will cause the iron and manganese particulates to be absorbed onto the manganese-coated sand filter media.

Once it's determined that the sand needs to be cleaned by elapsed time, cumulative flow, and/or differential pressure across the sand bed, it is agitated with potable water, and the loosened iron and manganese particulate matter is discharged directly to a sanitary sewer or a backwash recovery tank. Filter media is also cleaned with a compressed air wash, which scours the media of the iron and manganese particulate matter, as a "deep cleaning" process to further enhance the media operation and longevity. The scoured particulate matter is also discharged to the sanitary sewer or backwash recovery tank. The filter is then placed back into operation.

Multiple-cell or individual filter vessels are provided to keep the filtration system functioning during a backwash cycle; the backwash recovery tank would function much like treatment options described previously. Under the assumption that this filtration system would be part of an overall upgrade of the existing well treatment facilities, its 20-year life cycle cost was estimated at $2.80 million. If ECUA desired a backwash recover tank system, the 20-year life cycle cost is estimated at $3.10 million.

Initial Conclusions and Recommendations from April 2011 Well Water Quality Evaluation Report

Before ECUA pursued a significant capital expenditure for iron and manganese removal from the raw water of the well, HMM recommended that a proactive program of unidirectional system flushing be established, at least for the well service area. As resources allow, the entire ECUA distribution system's water quality would benefit by an ongoing, comprehensive cleaning and flushing maintenance program. As the ECUA's 2009 Drinking Water Quality Report did not identify iron or manganese as being in excess of the USEPA/FDEP guidelines at the well, it initially appeared that the Marie Avenue area water quality issue was a localized, isolated one, which may be improved by the maintenance flushing program. In conjunction with the flushing program, the chemical addition dosages for iron and manganese oxidation should be bench-tested against AWWA reference dosages to ensure that the optimum level of oxidant is being administered at each of the ECUA's wells for systemwide equalization. While sequestering agents are recommended for small water utilities with a single or small number of supply sources (wells), if ECUA desired to utilize sequestering agents at the well, bench testing prior to implementation, followed by close application and result monitoring, was recommended.

If further treatment is required, ECUA should determine if POU unit installation and maintenance is more effective in instances of continuous, confirmed, and isolated water consumer complaints than a source point-of-treatment system. Based on its current usage by ECUA, the GAC filtration system appeared to be the most cost-effective option at that time.

2011 Pilot Studies of Treatment Alternatives

After submission of the April 2011 well water quality evaluation report to ECUA, it proceeded with the pilot test evaluation of raw water treatment options from the well. It was requested of HMM to evaluate the three pilot testing program results, as well as the feasibility of several additional treatment alternatives. In order to make a fair comparison, HMM solicited a budgetary treatment equipment cost estimate for each alternative based on a pumped well flow of 2,500 gpm.

For these preliminary estimates, it was assumed that the treatment system would be installed inside a building and that the filtration system should be capable of backwashing/cleaning without taking the well out of service. The only cost that diverges from these assumptions is from Filtronics, with the backwash cycle for each filter at approximately four minutes when a well is usually shut off. Capital and operation and maintenance (O&M) costs, as well as noneconomic criteria such as long-term experience in iron and manganese removal for a potable water supply, were taken into account when making recommendations for treatment alternatives.

Calgon Pilot Test

Calgon performed two rounds of pilot testing to determine the effectiveness of its proprietary GAC filtration system for the well. The product is liquid-phase, virgin, and activated carbon-manufactured, and produced from bituminous coal to enhance catalytic functionality. The product is unique in that it concentrates reactants via adsorption and then promotes their reactions on the surface of the carbon pores. Although it is not impregnated with transition metals or alkali, the product displays the catalytic function of impregnated materials. While the product's filtration system had been successfully used at ECUA's Lillian and Villa wells to remove low concentrations of iron in the raw water, neither of the pilot tests produced the desired results for iron and manganese removal.

Tonka Equipment Co. Pilot Test

Tonka Equipment Co. (Tonka) performed pilot testing using three pilot plant filters, each 8 in. in diameter and approximately 7 ft tall. The three filters were each bedded with a different media and operated in parallel for comparison. One filter was bedded with 30 in. of Ironman-coated IMAR, anthracite, and silica sand filter media; another was bedded with 19 in. of Manganese GreensandPlus media, with a 12-in. anthracite cap; and the third filter had 30 in. of IMAX media containing pyrolusite, a manganese dioxide mineral. All three filters used a simultaneous air scour and water backwash system (Simul-Wash), underdrain system, air release valve, flow rate control meters, sample taps, and the separate filter medias. Aeration was used to oxidize the iron, followed by pressure vessel detention. After detention, two chemical feed pumps supplied sodium bicarbonate to raise the raw water pH above 6.4, followed by sodium hypochlorite to allow contact oxidation of the manganese and any remaining, unreacted iron in the manganese dioxide-coated media.

All three media options removed iron to below detectable levels, but only the IMAX and Manganese GreensandPlus media successfully removed the manganese. The proprietary IMAX media was recommended by Tonka over Manganese GreensandPlus because it does not require periodic recharge, is filtered at higher rates, was better suited to intermittent use, and can be cleaned with just the air scour and Simul-Wash. The IMAX media contains a naturally occurring manganese mineral base, which allows high-rate oxidation of manganese and iron using a continuously regenerated filter media. The Tonka media is specifically designed for catalytic oxidation of dissolved manganese and iron, unlike activated carbons, which catalytically destroy the oxidant. Tonka had demonstrated experience with iron and manganese removal systems with a large range of flow rates, including 2 to 3 mgd, which is within the permitted withdrawal range of the well.

Purifics ES Inc. Pilot Test

The Purifics ES Inc. (Purifics) ceramic ultrafiltration (Cuf) treatment system was pilot-tested for two brief periods over a two-week duration. Before starting the pilot test, the well was pumped overboard by ECUA staff for a short period of time. The first week's testing

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demonstrated that iron and manganese levels could be reduced below MCLs without the addition of chlorine or any other chemical oxidants for their removal. An inline neutralization system was used in the Cuf pilot system to dose sodium hydroxide to obtain pH set points; in the first week, the unit treated 3,900 gal of raw well water. Considering that the pilot treatment system's inlet flow rate was limited by the ECUA furnished supply well pump, which could not provide more than 4.8 gpm and was not able to run for an extended length of time, the Purifics pilot system ran for under 14 hours total the first week.

The second week of testing was used to determine the minimum operating pH that would still provide reduction of iron and manganese below maximum contaminant levels (MCLs) in order to optimize sodium hydroxide dosage requirements. Three more samples were taken during this period, which showed that the Cuf unit removed iron and manganese below MCL standards, even within a range of reduced pH levels.

Based on its current design advances, three smaller skid-mounted units, each with a 1-mgd capacity, were recommended by Purifics. This would provide some redundancy, but was not sufficient to treat the full permitted pump rate of the well flow with one unit out of service.

Although the initial short-term pilot testing that was performed showed the desired reductions in iron and manganese levels, there were no long-term performance data from Purifics for its Cuf treatment system. In addition, Purifics could not supply references for installations in the United States similar to the well permitted peak capacity of 2500 gpm, or greater; it was installing a smaller capacity unit in Mississippi at the time of the pilot study. Discussions would also have to be held with the FDEP potable water section on its requirements to consider this new treatment process for use by ECUA.

Additional Water Quality Improvement Treatment Options

Although Tonka satisfied ECUA's pilot testing objectives, HMM identified several other established suppliers that were capable of cost-effectively removing iron and manganese: Hungerford & Terry Inc. (Hungerford & Terry), Filtronics Inc. (Filtronics), and Layne Christensen Company (Layne), which are all established, experienced public water system treatment equipment manufacturers with multiple client installations at least equal to the capacity and iron and manganese removal requirements of the ECUA well. These three manufacturers were evaluated by HMM for their respective iron and manganese removal systems for the well.

Layne

Layne offers its treatment process, LayneOx, which operates both as a filter working with an oxidant addition and as a catalytic media with the ability to accelerate the reaction between the oxidant and the iron and manganese present in the raw water. This media is 75 to 80 percent manganese dioxide by weight. The process enhances the kinetics of the conventional removal process by serving as a catalyst in the presence of a pre-oxidant, such as chlorine. The surface loading rate is up to 15 gpm per sq ft (gpm/sf^2). Conceptually, the filter media bed depth would be 36 in. and the media contact time is a minimum of two minutes. The absorbed contaminants are expelled during the media backwash, which is typically done once every 24 to 48 hours, with a backwash rate of 25 gpm/sf^2 for five minutes, depending on temperature. Chlorine is used for oxidation, and chemical adjustment for pH is on a case-by-case basis. Backwashing expels the absorbed contaminants, as well as any insoluble ferric hydroxide particulate growths.

Filtronics

Filtronics offers Electromedia I (EM-I), which is a granulated, naturally occurring sand-like filter material. The filtration process is used to remove iron and manganese without the use of greensand media or potassium permanganate. Typically, the system includes an 8-in. anthracite cap and 30 in. of total media depth, including support levels. The process has a source loading rate of 15 to 18 gpm/sf^2, depending on the levels of iron and manganese in the raw water. A chlorine feed is used for oxidation of iron and manganese, and a chemical feed pH adjustment is used prefilter. For media backwash, a four-minute cycle is required, with a backwash rate of 20 gpm/sf^2. No chemical regeneration or preparation of the media is required. Some media replenishment is required after 10 to 15 years of service, but full media replenishment is not required unless damage is done to the filter underdrain. Operating conditions and chemistry for treatment (e.g., 24/7 versus intermittent or heavy chemical dosing of coagulants) affect media life.

Hungerford & Terry

Hungerford & Terry has been a manufacturer of Manganese GreensandPlus filtration systems for small- to large-capacity potable and industrial water systems for over 50 years. At the time of the April 2011 HMM report, Hungerford & Terry was requested to provide a preliminary budget cost estimate for a 2,500-gpm-rated manganese greensand filtration system using the well raw water analyses provided by ECUA. The provided cost estimate also included a preliminary analysis of the required filter vessel size, flow capacity, filtration efficiencies, air scour and backwash rates, capacities required, and estimated filtrate volumes. Bench-scale testing would be required before the treatment system design and filter media selection were finalized.

The filtration system is a well-recognized and utilized method of iron and manganese removal from groundwater. It requires any raw water pH increase with an oxidant, and in the case of the well, chlorine should be added prefilter. The iron and manganese will be removed by the manganese-coated sand filter media. Once it is determined that the sand needs to be cleaned by elapsed time, cumulative flow, and/or differential pressure across the sand filter bed, it is agitated with potable water. The loosened iron and manganese particulate matter is then discharged directly to a sanitary sewer or to a backwash recovery tank. The filter is then placed back into operation. Multiple filter vessels and/or multicell filter vessels are provided to keep the filtration system functioning at required well capacity during a backwash cycle.

Although the company did not perform pilot testing using its system for the well, a pilot using this media was completed by Tonka. The pilot test indicated that the system effectively removes iron and manganese.

Conclusions and Recommendations for Water Quality Improvement Treatment

The selection of the most appropriate water quality treatment technology for the ECUA well depends on the capital, operating, and scheduled maintenance cost constraints of ECUA, along with noneconomic criteria, such as ease of use, process flexibility, and residuals generation.

Table 1 presents a comparison of the treatment options evaluated by HMM. This initial evaluation consisted of obtaining conceptual design information from representative manufacturers of each of the systems, and then preparing a cost and noneconomic comparison.

Based on the information presented in Table 1, HMM recommended that ECUA consider the traditional, proven method of iron and manganese removal by pre-oxidation of the two elements in the well raw water, followed by pressure filtration. Layne, Tonka, and Hungerford & Terry are all recognized water treatment facility manufacturers with a proven track record in providing equipment of a capacity needed for treating the sand and gravel aquifer water pumped at the well. Tonka's and Hungerford & Terry's media were pilot-tested by Tonka, and both achieved the pilot testing objectives. While Hungerford & Terry's system was not pilot-tested, its media was tested and the equipment cost was competitive with the other systems. Layne's system was also not pilot-tested, but it is a cost-effective option with proven technology. As Hungerford & Terry has a long history of treating similar waters and its equipment price is similar to Tonka's, it was recommended that ECUA consider proceeding with the design of a 2,500-gpm capacity treatment system based on the use of Greensand-Plus. As described by Tonka's pilot report, it is capable of providing pressure filters with GreensandPlus media.

It was also recommended that ECUA's contract documents be developed to allow "or equal" suppliers of the filters. The ECUA should prequalify all prospective vendors, based on iron and manganese groundwater treatment systems that have prior FDEP (or southern U.S. region regulatory) approval and facilities of a capacity similar to that of the well in operation for at least five continuous years.

Both Filtronics and Purifics could not be recommended to ECUA due to the fact that each manufacturer did not have a proven track record available for iron and manganese removal from groundwater for a public water utility supply with a sustained capacity equal to that of the well. While Purifics did pilot-test the raw well water, the length of continuous testing and responses to HMM inquiries for detailed follow-up information did not demonstrate the process's long-term operational requirements that would be expected by the ECUA. Filtronics would not pilot-test its process without reimbursement and a contractual commitment by ECUA to utilize its process at the conclusion of an acceptable pilot study.

Status of Water Quality Improvement Implementation

Since the submission of HMM's conclusions and recommendations for water quality improvement treatment at ECUA's well, one of the supply wells in the ECUA system was ob-

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Table 1. Comparison of Treatment Alternatives

	Tonka Water	Purifics	Layne	Filtronics	Hungerford & Terry
Type of Media	IMAX media	Ceramic Ultra Filtration System	LayneOx	Electromedia I – granulated, naturally occurring sandlike filter media	GreensandPlus
Surface Loading Rate	6 gpm/sf²		Up to 15 gpm/sf²	15 to 18 gpm/sf²	2-12 gpm/sf²
Backwash Rate	Simul-Wash system. Air flow for each filter was 3 cf/min/sf² during pilot test.	NA	25 gpm/sf² for five minutes, temperature dependent.	20 gpm/sf² with 68°F supply water temperature. Air scour never used.	Minimum 12 gpm/sf² at 55°F
Chemical Feed	Sodium bicarbonate was piloted, but other alkalis, such as lime or calcite, could be useful. Oxidation with low levels of free chlorine (2 to 3 mg/L at Davis).	Discharge criteria was met without the addition of chlorine or any other chemical oxidants. Sodium hydroxide used to obtain pH set points.	Chlorine for oxidation, pH adjustment on a case-by-case application.	The pH would need to be raised to 7.8 via lime addition and monitored prefilter. Chlorine dose is estimated at 2 mg/L for oxidation of iron and manganese.	A chlorine residual will maintain GreensandPlus in a continuously regenerated condition. Chlorine fed at least 10-20 seconds upstream of filter will ensure adequate contact time.
Bed Depth	30-in. IMAX media		36-in. LayneOx, single media	8-in. anthracite cap 30-in. total media depth, including support levels.	15 in.-24 in. each for dual media beds with 15-in.-18-in. anthracite cap, or 30 in. of GreensandPlus alone.
Media Characteristics					
Manganese Dioxide Content by Weight	50/50 blend of silica sand and pyrolusite		75-80 percent manganese dioxide by weight	Not a manganese-based product	3 percent - Media is manganese dioxide-coated silica sand.
Estimated Capital Cost*	$1,704,000	$4,259,000	$1,586,000	$2,049,000	$1,654,000
Estimated 20-Year O&M Costs Present Worth	$654,290	$1,766,000	$1,447,750	$713,605	$589,833
Total 20-Year Present Worth	$2,358,290	$6,025,000	$3,033,750	$2,762,605	$2,243,833
Media Life	15 years	25 years	Over 10 years	Seven to 15 years until some replenishment is needed.	Over 10 years

*These values are based on the budget capital and O&M costs provided by each manufacturer. These values also include conceptual costs for additional building area, site piping, backwash recovery, and storage tank, as applicable, and an overall construction and installation cost estimate of 25 percent of the vendor's equipment/material costs provided. A project construction cost contingency of 15 percent was used per HMM's facility design guidelines for a Class 4 estimate.

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served to have iron and manganese concentrations in its raw water just above the Safe Drinking Water Act secondary standard MCLs. This well was taken out of service and ECUA began working with the local vendor of a proprietary iron and manganese sequestration chemical, which is a blended phosphate liquid, to initiate a pilot program using this sequestering chemical for this well's service area. If the sequestering chemical addition could be successfully implemented for the raw water from this well, ECUA will evaluate the implementation of its use at the well thereafter.

Working with the sequestering chemical manufacturer and its local vendor, as well as ECUA, HMM provided recommended protocols for the evaluation of the water quality within this well's service area during presequestering chemical implementation to establish background water quality (upon initiation of the initial chemical dosing of the water and any adjustment of this dosage) to reach the required reduction in iron and manganese in the finished water, and during the initial maintenance dosage application to ensure water quality equilibrium.

Both ECUA and HMM are currently pursuing the design and installation of the iron and manganese oxidation and pressure filtration treatment options for the well.

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YOU ARE REQUIRED TO HAVE YOUR OWN CALCULATOR AT STATE SHORT SCHOOLS AND MOST OTHER COURSES.

The Tampa Augmentation Project (TAP), directed by the **City of Tampa**, will evaluate the cost and feasibility of increasing the use of reclaimed water from the Howard F. Curren Advanced Wastewater Treatment Plant to augment the region's potable water supplies. **Carollo Engineers** will be a partner on the project.

In addition to Carollo's overall project management responsibility, the company will also be responsible for regulatory coordination, hydrogeologic and environmental investigations, alternatives analyses, and a public outreach and communications plan.

"Finding new water supply sources is key to our region's growth," said Braid Baird, the city's public works and utilities administrator. "The Curren plant is a big part of the success we've had using reclaimed water to offset drinking water demands, but now it's time to take the next step toward true potable reuse."

Carollo will collaborate with the agency, regulators, and other stakeholders to evaluate two main alternatives for delivering reclaimed water to the existing potable water supply system. The first alternative involves creating a wetlands treatment system and infiltration basins on Southwest Florida Water Management District property. This alternative will use natural systems to treat the reclaimed water before delivering it to the Tampa Bypass Canal, a 14-mi waterway that provides flood protection to the region and water to the city.

The second alternative will look at using the Florida aquifer system to store water that can be retrieved later and delivered to the Hillsborough River Reservoir, which has served as the city's primary source of drinking water since the mid-1920s.

Before either of these alternatives becomes reality, the city will construct a small wetland at the treatment plant site to demonstrate the treatment capabilities of these natural treatment systems to municipal stakeholders, regulators, and the general public.

"Public outreach is the key to implementing a potable reuse project of any kind," asserts David Ammerman, Carollo's project manager. "The technical aspects of this project are fascinating and potentially historic in the region, but the public is also concerned about how a project of this type will disrupt their neighborhoods, schools, parks, riding trails, and golf courses. We understand that keeping the public informed and soliciting their input will be key to acceptance and ultimately, project success."

The project's other partners, Katz & Associates and Vistra Communications, are developing a public communications plan that will be designed to keep the public informed and involved as the project becomes better defined.

The project will unfold over the next 20 months, culminating in a comprehensive analysis of technical, cost, regulatory, and public-impact considerations for the two alternatives. From there, the city will review the findings and determine the best course of action to ensure that it enjoys a reliable, sustainable potable water supply.

The **Water Environment & Reuse Foundation** (WE&RF) has awarded a contract to Virginia Tech for work to evaluate the health of the Potomac River Watershed. With funding from the U.S. Environmental Protection Agency (EPA), the research team includes long-time WE&RF partners: D.C. Water, State University of New York at Buffalo, and the University of Maryland. This illustrates the strength of the new WE&RF organization, which joined the Water Environment Research Foundation and the WateReuse Research Foundation, combining key research areas of both previous organizations to make a healthier watershed and assess reuse and conservation efforts. The research team also includes Hazen and Sawyer, which has worked with both research foundations in the past.

The project is titled, "Improving Water Reuse to Assess the Impact and Outcomes of Reuse and Conservation Measures on Ecological and Human Health on the Potomac River Watershed." The Potomac River serves as an excellent illustration of the water cycle as it's a drinking water source, a national environmental treasure, and an integral component of the region's stormwater and wastewater management systems. The researchers will perform a triple-bottom-line analysis on treatment strategies used in the study to determine costs, impact, and benefits of reuse and reclamation strategies for improving water quality.

The research aims to actively identify "hot spots" and quantify the impact of reuse and management solutions on these endpoints. The researchers will conduct focused pilot-level studies on two subwatersheds to compare the impact of planned and unplanned water reuse on supply and quality management. With Occoquan Watershed Monitoring Laboratory (OWML), Virginia Tech will use paired watershed studies to evaluate impacts of current reclamation, reuse, harvesting, and management strategies on source controls of pollutants. Two pairs of sites representing advanced versus conventional reclamation practices, with similar land use, will be selected to examine the effect of reclamation upgrades. Similarly, another two pairs of sites representing stormwater reuse will be chosen for examining effects of stormwater upgrades on sources, as well as two pairs of agricultural sites sampled to examine focused effects of agricultural management.

Data collected in the first and second year will be used to create a temporally/spatially-based framework to help make decisions regarding type and location of reclamation, reuse, harvesting, and management strategies. In the project's third year, a framework will be developed to facilitate prioritization of reuse and management strategies for the watershed for federal agencies, local governments, water utilities, and other stakeholders as they shape future management approaches in large human-impacted watersheds.

The **U.S. Department of Energy** (DOE) and the **Water Environment Federation** (WEF) have signed a Memorandum of Understanding (MOU) in support of the DOE's Better Buildings Wastewater Infrastructure Accelerator Initiative. The initiative engages state, regional, and local agencies working with water resource recovery facilities (WRRFs) to accelerate innovative approaches to sustainable infrastructure of the future.

"WEF is committed to providing a platform for water sector innovation focusing on approaches and technologies that benefit utilities on the path to sustainable energy management," said Eileen O'Neill, WEF executive director. "To that end, we are excited to be collaborating with DOE to promote the benefits of its initiative."

The initiative's goals include:

- Demonstrate best-practice/cutting-edge approaches and tools toward a sustainable wastewater infrastructure and yield road-tested examples for other facilities.
- Document model plans for transitioning to a sustainable infrastructure that will help drive more solutions in the industry.
- Develop assessment and decision tools for selecting best-practice approaches and tools on the pathway toward a sustainable infrastructure.
- Develop recommendations for post-initiative next steps.

Specifically, the MOU partners will jointly promote the initiative, encouraging innovative approaches for water resource recovery facilities in accelerating improvements in energy efficiency, and facilitating and collaborating on technical peer exchange opportunities to share best practices and solutions.

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As part of the Xylem rental fleet, Flygt 3000 Series pumps are available from rental locations across the U.S. Hoses, HDPE piping, and generators, as well as high-tech monitoring and control systems, are also available from any Xylem rental location. By partnering with Xylem, the customer can rent best-in-class pumping equipment, while gaining access to skilled engineers, product experts, and service technicians to ensure the right solution for the job. (www.xylem.com)

FATHOM Water Management Inc., a Software-as-a-Service (SaaS) provider for water utilities, has contracted with the City of Zephyrhills to provide the FATHOM Smart Grid for Water, an integrated, end-to-end solution, including infrastructure, software, services, utility billing, and customer care operations. With the software, Zephyrhills residents will enjoy increased transparency with real-time access to water usage data, as well as access to online and mobile account management and bill pay.

"We are excited to be the first water utility in Florida to implement the FATHOM Smart Grid for Water," said Steve Spina, city manager of Zephyrhills. "We pride ourselves on providing stellar service to our residents and are committed to bringing our utility customers new tools, like an easy-to-use mobile app, to help them better manage and monitor their water consumption. Through FATHOM, we've upgraded our metering infrastructure and are using big data to increase utility revenue and improve operational efficiency and customer experience."

By adopting the software, the city's water utility is enhancing its fiscal stewardship through high-revenue assurance metrics, which reduces accounts receivable, while improving the level of customer service and customer self-service. The FATHOM platform sets in motion exacting performance standards, designed to quickly deliver returns and positive cash flow at a reduced cost compared to previous systems.

"Florida is an exciting market for us, as the region is grappling with challenges related to water quality and supply," said Trevor Hill, chief executive officer of FATHOM. "We are delighted to begin a partnership with Zephyrhills and bring the utility and its customers the usage information and billing integrity they need."

Known as "The City of Pure Water," Zephyrhills is located in Pasco County. The project, which includes FATHOM's customer information system (CIS), meter data management (MDM) platforms, and implementation of advanced metering infrastructure (AMI), was completed in August 2016, and includes 12,768 water meters. (www.gwfathom.com)

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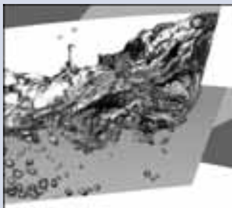

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Electrician

The City of Melbourne, Florida is accepting applications for an Electrician at our water treatment facility. Applicants must meet the following requirements: High school diploma or GED required. Must possess a Journeyman Electrical Certificate of Competency as recognized by the State of Florida. Must have a minimum of five years experience in the direct operation, maintenance and repair of electrical and electronic equipment associated with water/wastewater treatment facilities or heavy industrial manufacturing facility. A two-year Associates Degree in Electronics may be substituted for two years actual experience on a year per year basis for a total minimum experience of five years. Must possess a valid State of Florida Driver's license and an acceptable driving record. Applicants may possess a valid out of state driver's license and obtain the Florida driver's license within 10 days of employment.
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Test Yourself Answer Key

From page 47

1. **C) Anaerobic phase**
   Anaerobic zones or phases are also known as fermentation basins and require that no dissolved oxygen be present.

2. **A) Phosphate Accumulating Organism**

3. **D) -200 mV**
   The ORP values of negative 150 millivolts (-150 mV) or greater are more conducive to phosphorus release from the PAOs in anaerobic zones.

4. **C) Phosphate Accumulating Organisms**
   Even though PAOs prefer aerobic environments, they have the unique ability to continue consuming organic material (especially volatile fatty acids) under anaerobic conditions, whereas carbon or glycogen accumulating bacteria cannot. The PAOs can store volatile fatty acids (VFAs) for later oxidation in the aerobic zones, but must release phosphate to accomplish this.

5. **B) Nitrate/nitrite**
   Nitrate and nitrite each contain oxygen, which would interfere with the anaerobic zone from being truly anaerobic, and subsequent release of phosphate by the PAOs. A basin that contains nitrite or nitrate would be considered anoxic, not anaerobic.

6. **C) Oxic conditions**
   The PAOs must re-establish the phosphate within their cells before metabolism of stored VFAs and cell reproduction can take place. This occurs under oxic (aerobic) conditions. The phosphate that was released, and excess phosphorus, are absorbed and stored in granules called adenosine triphosphate (ATP). The PAOs will take in more than is necessary for normal cellular growth, which leads to the removal of the phosphorus that came into the plant in the influent waste stream.

7. **A) With the biosolids disposal.**
   Once the PAOs have taken in the phosphate they originally released, along with the excess phosphate from the influent, the phosphate is now stored inside the PAO cells. Wasting this phosphate-rich sludge from the treatment system and ultimate disposal of the sludge is the final step in biological phosphorus removal.

8. **A) Magnesium and potassium**
   Magnesium and potassium are positively charged cations that help neutralize the negative charge of the phosphate. A neutral-charged compound can move across the negatively charged cell membrane and out of the PAO cell.

9. **B) The RAS rate is too low.**
   While many treatment plants run a low RAS:Q flow ratio, low RAS rates can allow settled solids to remain in clarifiers too long, which could create anaerobic conditions within deep sludge blankets. The PAOs will re-release stored phosphorus under anaerobic conditions.

10. **D) The 35 percent RAS:Q ratio allowed secondary release of the phosphorus in the clarifiers.**
    If bacterial cells begin dying, or organic acids are available, this material becomes food for PAOs, which will release phosphate in order to consume the food. This re-release causes effluent phosphorus values to climb and exceed permitted discharge limits. With BPR facilities, a re-release of phosphate outside an anaerobic zone is called secondary release and is common in very low DO environments like aerobic digesters left off too long, anaerobic digesters, sludge accumulating in corners of tanks and clarifiers, and off-line basins within the treatment plant.

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