JOURNAL OF THE NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

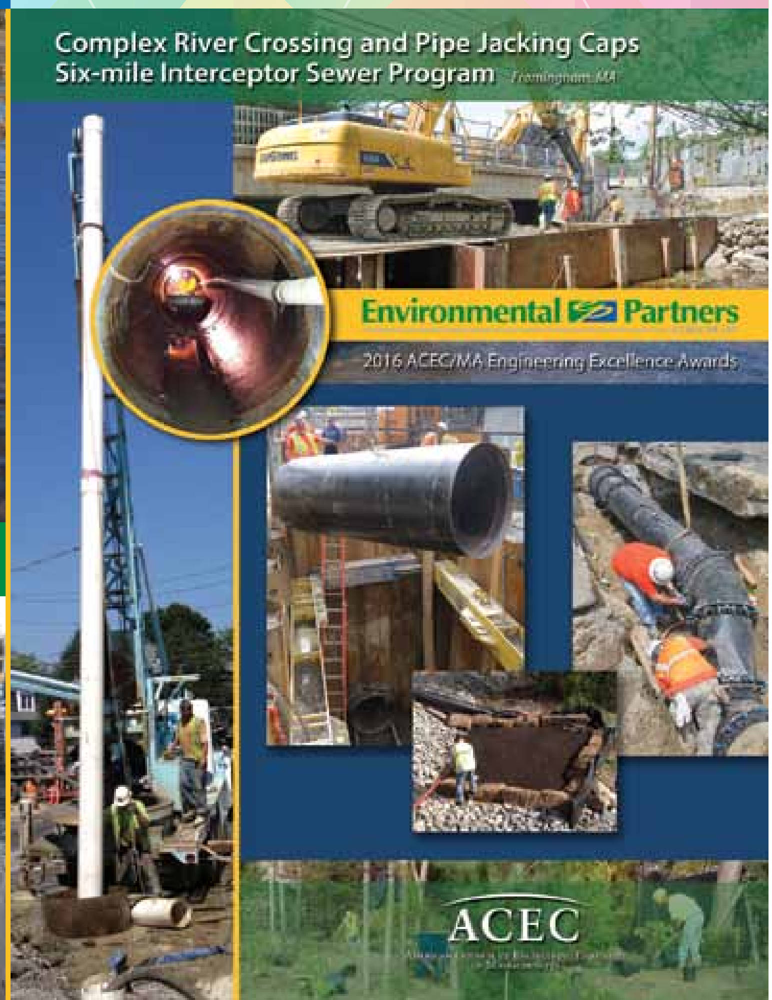
VOLUME 50 NUMBER 2 | ISSN 1077-3002 SUMMER 2016

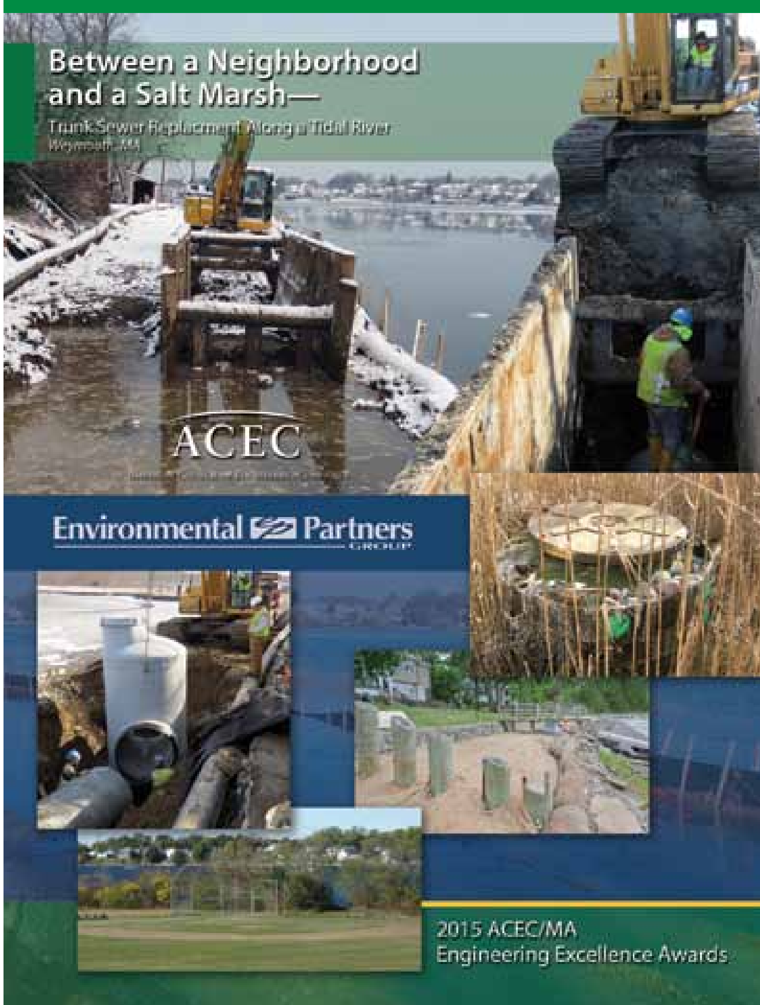
WASTEWATER TREATMENT/ MICROCONSTITUENTS/WATER REUSE

NEWEA
WORKING FOR WATER QUALITY

Environmental Partners

Bringing Integrated and Sustainable Solutions to Life, and Upgrading Critical Infrastructure





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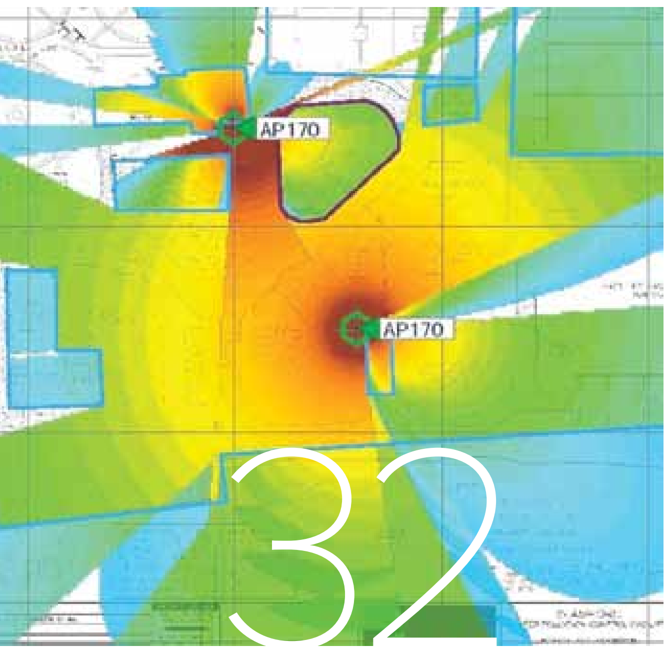

On the cover: Hyperbolic mixer-aerator being installed at the Hockanum River Water Pollution Control Facility, Manchester, Connecticut

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NEWEA
WORKING FOR WATER QUALITY

OUR ASSOCIATION WAS ORGANIZED EIGHTY-SEVEN YEARS AGO in Hartford, Connecticut, on April 23, 1929, with the objectives of advancing the knowledge of design, construction, operation and management of waste treatment works and other water pollution control activities, and encouraging a friendly exchange of information and experience. From 40 charter members, the membership has steadily grown to more than 2,000 today. Membership is divided into the following classes:

Professional Member—shall be any individual involved or interested in water quality including any manager or other officer of a private waste treatment works; any person engaged in the design, construction, financing, operation or supervision of pollution control facilities, or in the sale or manufacture of waste treatment equipment.

Executive Member—shall be an upper level manager interested in water quality and who is interested in receiving an expanded suite of WEF products and services.

Corporate Member—shall be a sewerage board, department or commission; sanitary district; or other body, corporation or organization engaged in the design, consultation, operation or management of water quality systems.

Academic Member—shall be an instructor or professor interested in subjects related to water quality.

Young Professional Member—shall be any individual with five or fewer years of experience in the water quality industry and who is less than 35 years of age.

Professional Wastewater Operations Member (PWO)—shall be any individual who is actively involved on a day-to-day basis with the operation of a wastewater collection, treatment or laboratory facility, or for facilities with a daily flow of <1 million gallons per day. Membership is limited to those actually employed in treatment and collection facilities.

Student Member—shall be a student enrolled for a minimum of six credit hours in an accredited college or university.

WEF Utility Partnership Program (UPP)—NEWEA participates in the WEF Utility Partnership Program (UPP) that supports utilities to join WEF and NEWEA while creating a comprehensive membership package for designated employees. As a UPP a utility can consolidate all members within its organization onto one account and have the flexibility to tailor the appropriate value packages based on the designated employees' needs. Contact WEF for questions & enrollment (703-684-2400 x7213).

BECOME A NEWEA MEMBER TODAY

- Complete and mail the membership application form on pages 75–76
- Download a membership application from **newea.org** by clicking How Do I Join?
- Join online at **wef.org** by clicking Become a Member

2016 RATES

Professional	$174.00
Executive	$338.00
Corporate	$393.00
Academic	$174.00
Young Professional	$67.00
PWO	$105.00
Dual	$40.00
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New England Water Environment Association | Statement of Ownership, Management and Circulation

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	Sales through dealers & carriers	8	8
	Requested copies distributed by other mail classes	0	0
Total paid and/or requested circulation		2,208	2,208
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Total distribution		2,208	2,208
Copies not distributed		292	292
Total		2,500	2,500
Percent paid and/or requested circulation		100	100

Raymond L. Willis III
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President's message

As leaves return to the trees and grass turns green again, we know that spring is upon us and summer is soon to follow. The NEWEA staff, along with New York Water Environment Association (NYWEA) staff, have been working diligently in planning the joint Spring Meeting in Mystic/Groton, Connecticut.

As you read this, the meeting will have passed, but I am happy to report that this year more than 130 abstracts were submitted, and 60 abstracts were selected for presentation; many of those not selected may still be eligible for publication in other NEWEA productions, such as the *Journal*. As I mentioned in my previous address, this year's Spring Meeting theme was Environmental Stewardship and the featured keynote speaker was National Public Radio science correspondent Heather Goldstone, whose reports cover all aspects of the environment; a summary report of the meeting will appear in a forthcoming *Journal* edition. Along with the numerous educational sessions offered, the operations challenge competition featured hands-on teams from New England, New York, Maryland, and Virginia vying for the chance to compete at the national competition in New Orleans.

Seeing firsthand the great work that comes from our committees each year, I want to reiterate that if you are not a member of one our committees, you are missing out. I know well that many of us lead very busy lives, both at and away from work. However, I sense that people have a general misconception that volunteering will take up too much valuable time, and therefore they decide not to get involved. Having been an active volunteer in this association for many years, I cannot adequately express how rewarding the experience has been for me personally and professionally. I believe that if you spoke with any committee member, present or past, he or she would say the same. Whether you can provide a few minutes or several hours each month, every hand on deck lightens the load, reaps the benefits, shares in the fun, and helps the association to continue the important work that will benefit us all!

Since my last address, most of NEWEA's focus has supported our affiliated state associations with legislative events, and preparation for NEWEA's Congressional Briefing in Washington, D.C. I am pleased to report that at least one member of the NEWEA senior management team attended every affiliated state's legislative event this year, and that I attended such events in Connecticut, Massachusetts, and Rhode Island. While the stories at each event were told by people from different states and communities, their message was the same. New England faces a pending crisis with most of our infrastructure beyond its design life and warranting replacement. In addition to the need to replace this antiquated infrastructure, each New England state must meet federally driven nutrient removal requirements from treatment plant discharges as well as address new MS4 stormwater requirements. Meanwhile, the cost of replacing our aging infrastructure and meeting these regulatory requirements far exceeds what the ratepayers can afford.

At the NEWEA Congressional Briefing in April, we heard stories similar to those at the state legislative events. For those who may not have attended this event before, here is an overview. Each year, the NEWEA Government Affairs Committee organizes our part of a national event to provide a forum for Congressional leaders, regulatory agencies, and New England and other communities across the nation, to discuss matters facing the water quality industry. During our time in Washington, NEWEA members meet with their legislators to discuss these matters face-to-face. These meetings provide a format to re-tell the stories, which we have previously heard at the state legislative events, directly to state representatives and/or senators.

This year, the New England breakfast featured two speakers responsible for striking a balance among achieving mandated environmental compliance, replacing antiquated infrastructure, promoting economic growth, and protecting public health within their communities: the Honorable Daniel Rivera, mayor of Lawrence, Massachusetts, and David Allen, deputy city manager of Portsmouth, New Hampshire. The event was once again sponsored by Congressman Jim McGovern of Massachusetts. Along with Congressman McGovern, other Congressional speakers included Senator Sheldon Whitehouse of Rhode Island, Representative Elizabeth Esty of Connecticut, and Representative Peter Welch of Vermont. Jane Downing, associate director, Drinking Water Program, for Region 1 of the Environmental Protection Agency (EPA), also attended.

While the water quality industry faces many challenges, such as climate resiliency, stormwater management, ocean acidification, and non-dispersibles, our main topic this year was budget cuts to the Clean Water State Revolving Fund (SRF) program. This year EPA's Clean Water SRF budget request is proposed to be cut by $414 million, a 30 percent reduction in the allocation from the fiscal year 2016 budget, which itself had been cut by $55 million compared to the fiscal year 2015 budget. During the briefing, as well as in individual meetings with Congressional leaders, we stressed that an additional decrease in this funding source exacerbates an already dire situation for our New England communities. Our communities are already searching for funds to implement projects to comply with federally mandated nutrient and stormwater requirements, while also addressing the need to replace the deteriorating infrastructure and upgrade existing infrastructure for climate resiliency associated with rising sea level and severe weather events. We stressed that a more robust Clean Water SRF program is needed and, no matter which side of the aisle you sit on, investments in water infrastructure create jobs, sustain the economy, and protect public health.

...lasting change does not come easily. It can result from consistent efforts to participate in dialogue with our elected officials, from public outreach, from educational efforts, and from working with our partners in the regulatory community

This is the sixth time I have attended the NEWEA Congressional Briefing, which is of great benefit to our members and the communities in which they live. If you have not attended a NEWEA briefing before, I strongly encourage you to take the trip to Washington with us next year, as we are always attempting to fill the room with advocates involved in the field. This year, I was happy to see some NEWEA members attending the event for the first time, and in speaking with them afterwards I discovered that they found the briefing and the meetings with our Congressional leaders as rewarding and beneficial as I did.

When people ask if there is room at the briefing for them, I tell them about my first trip to D.C. I was having lunch in Longworth Cafeteria and struck up a conversation with another delegation. Asked how many members from NEWEA were in D.C. to meet with legislators, I proudly responded "about 50." When I asked the question in return, the delegation said it had brought 50,000 people to D.C. I quickly realized that NEWEA could never have too many people at the briefing.

In closing, I would like to remind our members that lasting change does not come easily. It can result from consistent efforts to participate in dialogue with our elected officials, from public outreach, from educational efforts, and from working with our partners in the regulatory community. Consistent with NEWEA's mission statement, I hope our continued open dialogue and outreach will be aimed at implementing policies and projects with proven health and economic benefits. We ask for your help and participation in driving positive change in the perception and support of our industry's efforts to improve the environmental quality of life.

From the Editor

Why did we choose our profession? I am sure all of us have fascinating reasons. For some (and this would include your faithful editor), perhaps time has gone by and we need to reconnect with the circumstances or the event—the happening that inspired us to pursue a career in the water quality field. In this edition of the *Journal*, I am sharing my story in the hope that it will move others to do the same, which in turn may reignite passion that could attract others to our field.

For me, the seminal moment came from a newspaper article I read in the 1980s. As a recent high school graduate and college student in my first few years, I was far more interested in the sports page than current events, but on this day something caught my attention: It was an article about pollution on Wollaston Beach in Quincy, Massachusetts. I thought structural engineering was my calling, but the material that I read caused me to change my mind. The article explained a lawsuit filed by the city of Quincy and its then city solicitor, William Golden. He went for a jog on Wollaston Beach and came across a mass of sewage sludge and several other items you might imagine get flushed down the toilet. The cause, the city found out, was inadequate treatment at the Nut Island Wastewater Treatment Plant, discharge of untreated waste during storm periods, and dumping of sludge on the outgoing tide. These practices had been going on for a long time, and were not consistent with 1972 amendments to the Federal Clean Water Act, which required secondary treatment by 1977. This prompted Quincy to sue, and this and other lawsuits led to the creation of the Massachusetts Water Resources Authority (MWRA) in 1985, the agency mostly responsible for the cleanup.

Joe Boccadoro, P.E.
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I did not live near Quincy, but I was shocked—and outraged—by what I read. In a modern era, facilities, equipment, and piping were failing, and operational practices seemed archaic. The public and the environment were directly affected, but the political regime at the time could not seem to improve the situation. These issues motivated me back then to change my focus to environmental engineering. However big or small, I wanted a role in pollution reduction and prevention. That is the path I chose almost 30 years ago, and I am still at it today.

I rarely tell my story of inspiration to others. I am not sure why. It has a lot going for it, including political intrigue, passionate debate, public benefits, activism, and history—the types of interesting things that could convince others to join our industry. I would be remiss if I did not add success to the list. Owing to the efforts of those in our business, Boston Harbor and nearby waters, once considered among the dirtiest in the nation, are nothing like they were in the 1980s, and are now a source of pride.

Perhaps telling our stories might lead to others joining our field because, as we are aware, and as chronicled in a past issue of the *Journal* ("Attracting and retaining the next generation of skilled operators," Volume 49, Number 4, Winter 2015), sectors of our industry need an infusion of youth.

I encouraged my own children to select a career that they were passionate about, but neither chose the water industry. When the career topic came up around the dinner table, my kids usually started by saying, "No offense, Dad, but I don't want to do what you do." From their vantage point, they saw few rewards. I shrugged this off at the time, but now I think I could have been a better spokesperson for our industry. If I told my children the story that inspired my career choice, the passion probably would have come out, and that might have been enough to interest them. If not, perhaps it would have served as a conversation starter among their friends, and maybe that could have roused some curiosity.

So, I ask that you tell your story to a young person. Try to interest that person in the water profession. Our industry needs it.

2016 Northeast Residuals & Biosolids Conference, Exhibit & Tour

This NEWEA/NEBRA conference and exhibit is a great forum to learn the latest trends in the management of biosolids and residuals, and it is a "must" for all those involved in the challenge of managing biosolids and residuals in the Northeast.

This year we will be in Connecticut, where options are being considered for solids management by systems other than incineration. This conference is a wonderful opportunity to network, observe the latest residuals management products and services in the exhibit area, and to have some fun! Contact training hours will be awarded in participating states.

October 19 – 20
Radisson Hotel
Cromwell, CT

Mark Your Calendars

NEWEA 2017 Annual Conference & Exhibit

Save the date! January 22 – 25, 2017
Boston, MA | Boston Marriott Copley Place

This prestigious conference consistently attracts more than 2,200 engineers, consultants, scientists, operators, and students, and features a variety of technical sessions, and more than 200 exhibitor displays. It provides an opportunity for professional exchange of information and state-of-the-art concepts in wastewater treatment and environmental issues.

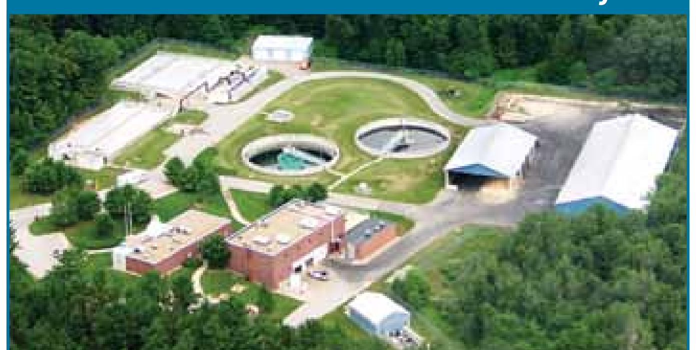
In addition to traditional sessions, exciting new presentations are planned:

- Environmental Stewardship in the 21st Century Series: Attend sessions on many of today's hottest topics including Global Climate Change, Green Building and Green Design, Low Impact Development, and Water Reuse.
- The Young Professionals' Session: Designed exclusively for Young Professionals to build their presenting skills, this new technical session is dedicated to presentations developed and delivered by their peers.

For more information, visit annualconference.newea.org
call: 781-939-0908
email: mail@newea.org

NEWEA
WORKING FOR WATER QUALITY

FACILITY TOUR & TECHNICAL PRESENTATION
Dover Wastewater Treatment Facility



Wednesday, August 24, 2016 • 8 AM to 2:30 PM
484 Middle Road Dover, New Hampshire

NEWEA's Plant Operations Committee in conjunction with the New Hampshire Water Pollution Control Association will conduct a facility tour and technical presentation at the Dover Wastewater Treatment Facility.

Technical presentations will highlight the recent upgrades at the Dover Wastewater Treatment Facility. This facility is a great example of how communities have dealt with the complex issue of upgrading their wastewater facilities to increase performance and meet tighter regulatory limits which has led to the clean-up of the Piscataqua River and the Great Bay.

REGISTRATION DEADLINE—AUGUST 20
Register online at newea.org

SEASONAL IMPACTS ON SMALL COMMUNITY WASTEWATER TREATMENT SYSTEMS

2016 SPECIALTY CONFERENCE & WORKSHOP SERIES

NEWEA Small Community Specialty Seminar
Friday, July 15, 2016 • Seacrest Hotel, Falmouth, MA

This seminar will offer four examples of communities and treatment facilities which see seasonal spikes in flows. We will learn how those situations are addressed. Community level planning, the nuts and bolts of a treatment plant at a resort complex, a summer beach community collection and treatment system, and the operations of a municipal treatment facility will all be discussed.

We are encouraging wastewater treatment plant operators and managers, town managers and engineers, public works directors, regulators, consulting engineers and those providing products and services to the industry to attend.

In addition, a tour will occur of Falmouth's New Silver Beach Wastewater Treatment Facility. Flows to the facility range from 3,000 – 10,000 GPD in the winter, to 15 – 35,000 GPD in the summer.

Register online at newea.org

Industry news

Environmental Protection Agency announces Nutrient Recycling Challenge winners

– EPA Headquarters Press Release

The Environmental Protection Agency (EPA) announced the winners of Phase I of the Nutrient Recycling Challenge—a competition to develop affordable technologies to recycle nutrients from livestock manure. The winners received their awards on March 30, 2016, at a ceremony at the White House Eisenhower Executive Office Building in Washington, D.C., the first day of the two-day Nutrient Recycling Challenge DC Summit.

Every year, livestock producers manage more than 1 billion tons of animal manure, which contains valuable nutrients—nitrogen and phosphorus—that plants need to grow. Manure can be a resource as a renewable fertilizer but needs to be used properly to minimize water pollution and build healthy soils.

In November 2015, EPA launched the Nutrient Recycling Challenge in partnership with pork and dairy producers, the U.S. Department of Agriculture, and environmental and scientific experts. The goal of the challenge is to find affordable technologies that can help farmers manage nutrients, create valuable products, and protect the environment.

"The Nutrient Recycling Challenge is a great example of EPA partnering with farmers to find solutions that benefit everyone," said Ellen Gillinsky, senior policy advisor for the EPA's Office of Water. "Through competition, together we are driving innovation to achieve environmental results."

EPA received 75 concept papers from around the world and selected 34 submissions to continue to Phase II of the challenge. EPA is awarding $30,000 in cash prizes to the top 10 submissions (four "Winners" and six "Honorable Mentions").

The winning concepts are as follows:

- **Slurry Separation with Coanda Effect Separator** (by Ahimbisibwe Micheal of Bravespec Systems Ltd.)—Using centrifuge technology to separate smaller nutrient particles from manure, with fewer energy inputs and lower costs.
- **Manure Convertor** (by Ilan Levy of Paulee Cleantec Ltd.)—Using chemical processes to rapidly turn manure into a non-toxic, fertile ash fertilizer.
- **Producing Nutrient-Concentrated Biosolids via AnSBEARs** (by Bo Hu, Hongjian Lin, and Xin Zhang of the University of Minnesota)—Creating a dry biosolids fertilizer by using a novel anaerobic digestion and solid-liquid separation system.
- **Removal of Dissolved N and P from Livestock Manure by Air Stripping** (by Hiroko Yoshida of Centrisys Corporation)—Using CO2 stripping and other processes to create a range of fertilizers from anaerobically digested manure.

The 34 submissions selected were also invited to the Nutrient Recycling Challenge DC Summit, which provided a forum for innovators to meet experts and other innovators, as well as learn about resources to develop their ideas into real-life technologies. EPA seeks to create a "brain trust" that can design nutrient recovery technologies to meet the needs of both farmers and the environment.

Partners in the Nutrient Recycling Challenge are:

- American Biogas Council
- American Society of Agricultural and Biological Engineers
- Ben & Jerry's
- Cabot Creamery Cooperative
- Cooper Farms
- CowPots
- Dairy Farmers of America
- Innovation Center for U.S. Dairy
- Iowa State University
- Marquette University
- National Milk Producers Federation
- National Pork Producers Council
- Newtrient, LLC
- Smithfield Foods
- Tyson Foods
- U.S. Department of Agriculture
- Washington State University
- Water Environment Research Foundation
- World Wildlife Fund

For more information, visit nutrientrecyclingchallenge.org.

New economic benefits analysis of drinking water and clean water state revolving funds reveals billions in return on federal investment

– WEF News Release

A new economic benefits analysis of the impacts of increased funding for the Drinking Water and Clean Water State Revolving Funds (SRFs), released by the Water Environment Federation (WEF) and the WateReuse Association, reveals that a requested $34.7 billion of federal SRF spending will generate $102.7 billion in total economic input and create more than 500,000 jobs in the United States.

WEF and WateReuse conducted the analysis at the request of the Senate Environment and Public Works Committee for an April 7, 2016 hearing that examined the federal role in water and wastewater infrastructure funding. The preliminary findings were included in the organizations' joint testimony and have since been verified and officially entered into the committee's official record. Using the IMPLAN economic model, which captures the effect of spending as it ripples through the economy, the organizations examined the estimated impacts (output, labor income, jobs, and federal tax revenue) of SRF-funded projects in four states.

The Senate Environment and Public Works Committee included a Sense of the Senate provision in S. 2848, The Water Resources Development Act of 2016, which cited the findings of the WEF/WateReuse analysis, and calls upon Congress to provide robust funding for the SRF programs. The committee passed S. 2848 on April 28, and the bill is now awaiting full Senate consideration.

Based on an assumption that the proposed $34.7 billion in allocations ($14.7 billion for drinking water and $20 billion for clean water) would be spent over 10 years (2017-2026), the final report results include:

- $34.7 billion in federal SRF spending results in $7.43 billion in federal tax revenues.
- When leveraged with the state SRF program funds, a $34.7 billion federal investment will result in $32.3 billion in federal tax revenue, or $0.93 for every dollar spent.
- On average, 16.5 jobs are created for each $1 million of SRF funding, meaning that a $34.7 billion federal investment will result in 506,000 new jobs.
- Every $1 million of SRF spending results in $2.95 million in economic input, meaning that a $34.7 billion federal investment will generate $102.7 billion in total economic input.

"SRFs are widely acknowledged as one of the most successful infrastructure funding programs, yet the resources needed to maintain and upgrade our systems remain out of sync with current investment levels," said WEF Executive Director Eileen O'Neill. "This report shows that water and wastewater infrastructure is a sound and wise economic investment that also provides immeasurable returns for public health, the environment, and our future."

"There's little dispute that our nation's infrastructure is badly in need of repair," said WateReuse Executive Director Melissa Meeker. "With release of this report, it's also abundantly clear that SRFs both contribute to a high quality of life for taxpayers and foster a robust economy."

Water Environment Research open access article investigates the performance of transitioned infiltration basins for effective stormwater runoff management

– WEF News Release

The open access article for the April 2016 edition of *Water Environment Research* (WER) explores the water quality benefits of infiltration basins that have been transitioned into wet pond/wetland-like practices for effective stormwater runoff management.

"In a long-term study of an infiltration basin turned wet pond/wetland, authors Natarajan and Davis found significant reductions in nutrients during storm events," said WER Editor-in-Chief Tim Ellis. "Nutrient export occurred during extreme cold-weather events, but otherwise the "transitioned" infiltration basin managed to remove more than two-thirds of the nutrient load."

Selected WER articles such as this one are available monthly through a free open-access program. Go to the link, ingentaconnect.com/contentone/wef/wer/2016/00000088/00000004/art00001;jsessionid=2os73bvqqri14.alice, to download "Performance of a 'Transitioned Infiltration' Basin Part 2: Nitrogen and Phosphorus Removals," by Poornima Natarajan and Allen P. Davis.

Published by the WEF since 1928, *WER* is a professional journal that features peer-reviewed research papers and research notes, as well as reviews on original, fundamental, and applied research in all scientific and technical areas related to water quality, pollution control, and management. Originally known as the *Sewage Works Journal*, *WER* is available in print and online formats, and receives approximately 400 new research submissions each year.

Final storm sewer general permit issued for 260 Massachusetts municipalities to keep local waters clean

– EPA Region 1 News Release

On April 13, 2016, EPA issued final general permits updating requirements for small Municipal Separate Storm Sewer Systems (MS4) in Massachusetts. The new permits will update stormwater management across Massachusetts, better protecting rivers, streams, ponds, lakes, and wetlands from pollutants such as elevated levels of nutrients, which are causing algae blooms and other problems in many communities. At the same time, the permit maximizes flexibility for municipalities to tailor their efforts.

"Updating these permits is a critical step to ensuring that Massachusetts continues to enjoy clean water and a healthy environment," said Curt Spalding, regional administrator of EPA's New England office. "Addressing stormwater pollution is a major problem in our communities here in New England. EPA has listened to the input of local experts, and we have developed an effective and state-of-the-art permit that allows flexibility for municipal leaders to tailor their efforts to their needs, which will mean better protection for Massachusetts' lakes, streams, and other water bodies."

The updated permits will require covered municipalities to develop, implement, and enforce a Stormwater Management Program to control pollutants to the maximum extent practicable, protect water quality, and satisfy appropriate requirements of the federal Clean Water Act. The final permits maximize flexibility and planning time for municipal officials. For example, the final permit becomes effective July 1, 2017, allowing affected municipalities time to budget and plan for program implementation.

The requirements in the general permits build on the previous general permits issued in 2003. The permits require implementation of six minimum control measures that include the detection and elimination of illicit sewage discharges, public education and outreach, public participation, management of construction site runoff, management of runoff from new development and redevelopment, and good housekeeping in municipal operations.

The updated permits contain requirements that address identified water quality problems, including stormwater discharges to waterbodies with approved Total Maximum Daily Loads (TMDLs) for bacteria, phosphorus, nitrogen, and other pollutants, and discharges to certain impaired waters without an approved TMDL where stormwater discharges are contributing to the impairment.

Regulated MS4s include traditional cities and towns, state and federal facilities such as universities and military bases, and state transportation agencies (except Massachusetts Department of Transportation, which will receive an individual permit).

The general permits will apply to all MS4s in an urbanized area as defined by the 2010 census. Two hundred sixty municipalities are in urbanized areas as defined in the census, of which 17 are potentially eligible for waivers from the permitting requirements. Waiver eligibility is based on the population within the urbanized area (less than 1,000) and the municipality's potential to contribute pollutants to an interconnected MS4 or to an impaired water.

EPA has developed and will continue to provide tools to help municipalities implement the permit, including tools to standardize and streamline required submittals. For example, EPA has suggested a format for the Notice of Intent (NOI) that can be submitted electronically and is due 90 days after the permit's effective date. EPA plans to provide templates for the Stormwater Management Program and the annual reports required by the general permits. To facilitate budget planning, EPA commissioned an estimate of compliance cost, including spreadsheet tools municipalities can use to estimate compliance costs. The cost estimate and associated spreadsheet estimators are available on EPA's website.

EPA released the draft general permits in September 2014 for public comment. The agency received more than 160 comment letters and responded to all comments as part of finalizing these updated permits. Many comments focused on flexibility of program implementation, and the final permits incorporate additional flexibility and planning time for municipal officials that will help with compliance and program effectiveness.

EPA scheduled four workshops in May and June, and will be scheduling other workshops in coming months, to help municipalities become familiar with the updated permits and learn how to use EPA tools to assist with compliance.

For more information:

- The draft general permit, a detailed fact sheet, and information on public meetings and public hearing: epa.gov/region1/npdes/stormwater/MS4_MA.html
- The general permit is published in the Federal Register at: gpo.gov/fdsys/pkg/FR-2016-04-13/pdf/2016-08503.pdf.

Changes to infiltration/inflow requirements for Massachusetts municipalities

– MassDEP

Extraneous water from infiltration/inflow (I/I) sources reduces the capacity and life of sewer systems and treatment facilities, which transport and treat domestic, commercial, and industrial wastewater. Infiltration enters a sewer system through defective sewer pipe joints, breaks, and manhole defects, and when sewer lines are poorly designed and constructed. Inflow normally occurs when rainfall enters the sewer system through direct connections such as roof leaders, yard drains, catch basins, sump pumps, defective manhole covers, and frame seals, or through indirect connections with storm sewers.

Mitigation of I/I by sewer system rehabilitation and inflow source removal, combined with an ongoing operation and maintenance program is essential to protect the significant capital investment in sewers and wastewater treatment facilities by cities, towns, and the commonwealth of Massachusetts, as well as to protect the environment.

Changes to Operation and Maintenance Regulations, 314 CMR 12.04(2), in 2014 required municipalities to:

- Develop and implement an ongoing I/I program
- Identify and eliminate "excessive" I/I sources
- Focus on inflow sources
- Complete a phased evaluation of the sewer system consistent with the Massachusetts Department of Environmental Protection (MassDEP) guidance
- Mitigate I/I for new connections for some systems

By December 2017, municipalities must submit an I/I analysis to MassDEP in accordance with 314 CMR 12.04(2). That analysis at a minimum must:

- Address excessive I/I based on MassDEP's "Guidelines for Performing I/I Analyses & Sewer System Evaluation Survey"
- Assess the risk for sanitary sewer overflows for the five-year, 24-hour storm event

If municipalities have completed the assessment and the Sewer System Evaluation Survey prior to the 2014 changes, and are implementing the recommended actions, those plans, along with an update addressing which recommendations have been completed and what remains to be completed, including a schedule for completion, may be submitted on or before December 31, 2017.

The following is the schedule for the upcoming revisions to the 1993 MassDEP Guidelines for Performing I/I Analyses and Sewer System Evaluation Survey:

- Final Draft for public review and comments early in the summer of 2016
- Notice in Environmental Monitor
- 30-day comment period
- Release Final Guidance document in the fall of 2016

For more information, you can contact the MassDEP regional office. More information on I/I can be found here: 314 CMR 12.00: mass.gov/eea/agencies/massdep/water/regulations/314-cmr-12-00-o-and-m-and-pretreatment-standards-for-wwtps.html.

"Guidelines for Performing I/I Analyses and Sewer System Evaluation Surveys": mass.gov/eea/agencies/massdep/water/regulations/water-resources-policies-and- guidance-documents.html#9.

Maximizing total nitrogen removal using a dual operating mode process

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ABSTRACT | The Windsor Locks, Connecticut Water Pollution Control Facility (WPCF) has implemented a dual operating mode (DOM) configuration of the Modified Ludzack-Ettinger (MLE) process to improve both total nitrogen (TN) removal and wet weather capacity. The facility implemented a step-wise approach to determine: (1) capacity of the system and key operating parameters in nitrogen removal mode; (2) when the system will need to convert operation into a wet weather mode of operation; (3) system capacity in wet weather mode; and (4) flow condition at which the system can safely switch back into the nitrogen removal mode of operation. Changes in operating mode and improved operator understanding of the capabilities of the process have reduced TN by approximately 50 percent compared to prior MLE operation as well as reduced staffing requirements during wet weather events.

KEYWORDS | Nitrogen removal, biological nutrient removal (BNR), wet weather capacity, Modified Ludzack-Ettinger (MLE), nutrient trading, contact stabilization, secondary clarifier capacity, dual operating mode (DOM)

Windsor Locks Water Pollution Control Facility

OVERVIEW OF PROBLEM

Many wastewater treatment facilities, particularly those with older or more porous collection systems, are commonly challenged by significant increases in flow during wet weather conditions. The sources of wet weather flow can include infiltration, inflow, or both, and the magnitude and frequency of these conditions can significantly affect how a treatment plant performs. In activated sludge plants, increases in flow correspond to higher solid loading rates to the secondary clarifiers, potentially increasing sludge blanket depths and, in extreme cases, resulting in solids washout. For any activated sludge process to handle peak flows without upset, utility operations staff must understand and maintain adequate system capacity at all times. This concern is more pronounced with water pollution control facilities (WPCFs) that operate with higher biomass concentrations, such as those that nitrify and denitrify.

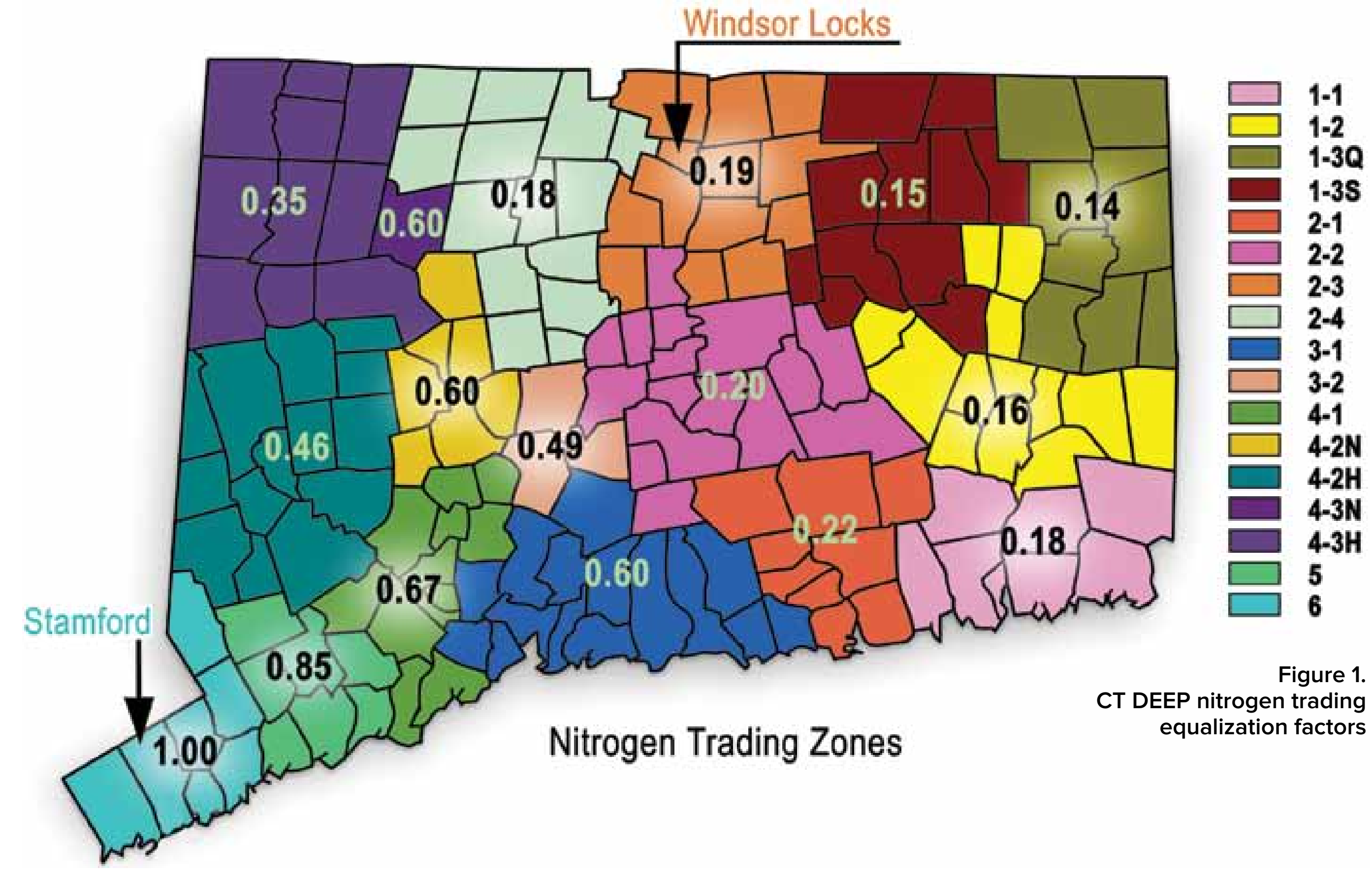

Figure 1.
CT DEEP nitrogen trading equalization factors

The Connecticut Department of Energy and Environmental Protection (CT DEEP) implemented the General Permit for Nitrogen Discharges in 2002 setting target limits for effluent total nitrogen (TN) discharges for Connecticut's 79 municipal wastewater plants. This program monitors TN discharges on an annual average basis and allows pollutant trading via the purchase or sale of nitrogen credits, providing significant regulatory flexibility especially relative to plant performance during limited seasonal and short-term flow variations. The CT DEEP Nitrogen Credit Exchange program provides a regional approach to regulate the Total Maximum Daily Load (TMDL) for nitrogen to Long Island Sound and allows credit trading among participant communities to better achieve that state-wide goal. The program was phased in over 14 years, allowing plants to both phase in improvements and learn how to optimize treatment systems as the limits became more stringent.

The treatment facilities included in the General Permit received the same TN effluent target concentration of 5.4 mg/L, converted to a mass basis under historical flow conditions. In addition, the program established financial incentives for those communities with the greatest potential to improve the water quality in the most affected area of the watershed (the western portions of Long Island Sound). This incentive set equalization factors (EF) based on different trading zones to adjust the purchase or sale price of nitrogen credits relative to the facility's location as shown in Figure 1 (Environmental Protection Agency, CT DEEP). This feature of the trading program results in dischargers such as Stamford purchasing or selling nitrogen credits at 100 percent of the trading price, while others such as Windsor Locks are making transactions at an EF rate of only 19 percent. The flexibility provided by the annual average limit and geographic equalization factors allows communities to make investment decisions relative to the purchase or sale of credits and to "push the limits" of their WPCFs relative to nitrogen removal performance, especially those with lower equalization factors.

WINDSOR LOCKS WPCF

The Windsor Locks WPCF, in the town of Windsor Locks, Connecticut, was upgraded to secondary treatment in 1982 with a permitted capacity of 2.12 mgd (8.03 ML/d). The facility consisted of preliminary treatment with a mechanical screen and aerated grit chamber, four rectangular primary clarifiers, two 0.275 MG (1.0 ML) complete mix aeration tanks, two 60-foot-(18.3-meter)-diameter circular secondary clarifiers and a chlorine contact chamber. Aeration was provided using constant-speed multistage centrifugal blowers, coarse bubble diffusers, and sludge processing consisting of gravity thickeners and belt filter presses. As part of an interim nitrogen

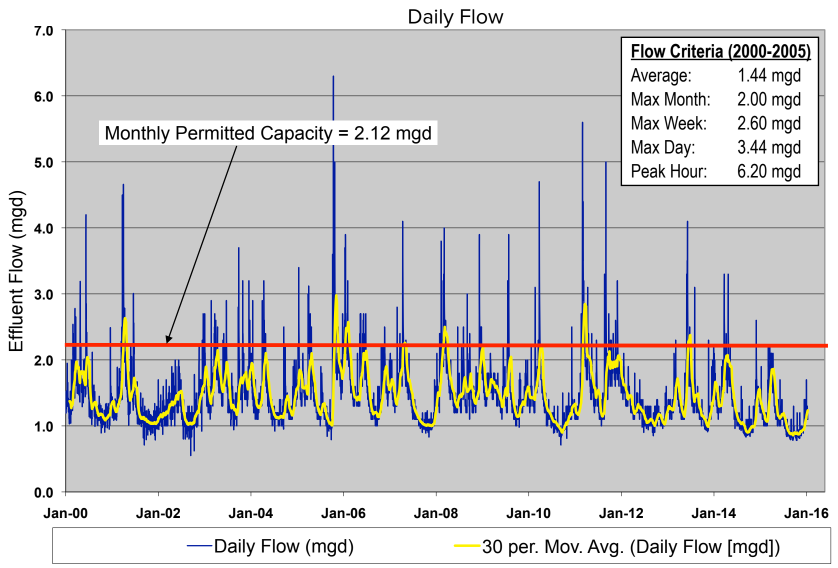

Figure 2. Windsor Locks water pollution control facility flow

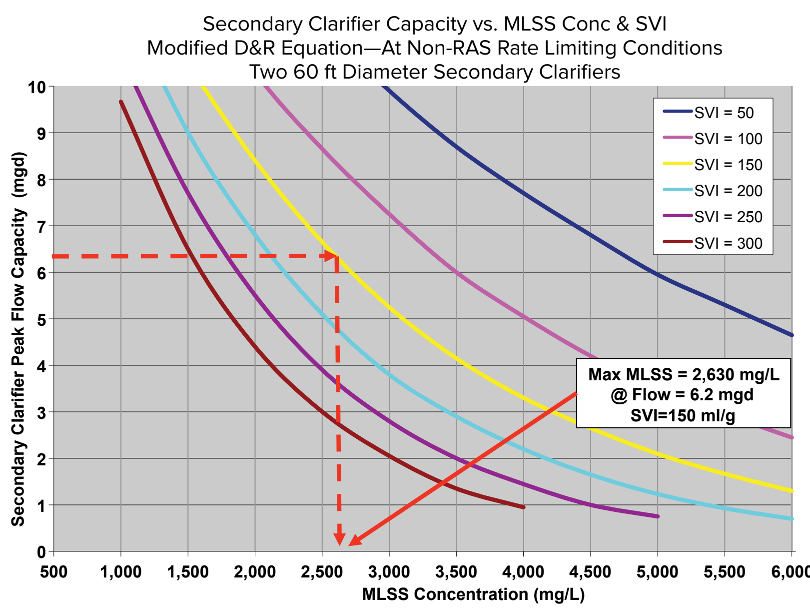

Figure 3. Secondary clarifier capacity at existing peak hourly flow

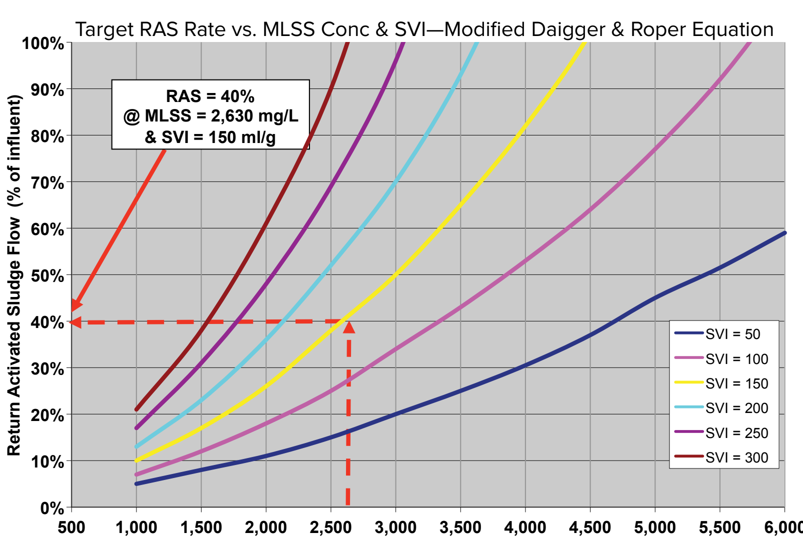

Figure 4. Target return activated sludge required at peak hourly flow

upgrade completed in 2002, the plant was converted to a serpentine-flow Modified Ludzack-Ettinger (MLE) configuration within the existing reactor tanks. The facility also upgraded its aeration system by adding fine bubble diffusers and new variable-speed multistage centrifugal blowers. In lieu of adding new biological reactor or secondary clarifier volume to accomplish year-round nitrification and denitrification, the interim nitrogen upgrade added corded media or an Integrated Fixed Film Activated Sludge (IFAS) media to the activated sludge tanks. Although the IFAS system showed promising performance initially, over time the media was consistently dominated with redworm growth that prevented the system from effectively enhancing nitrification as intended.

Following completion of the interim nitrogen upgrade, the town initiated a comprehensive facilities plan to determine its near- and long-term wastewater collection and treatment needs. Task 1 of the facilities plan was completed in 2006 and included detailed field testing, evaluation, and modeling to identify and address plant bottlenecks (specifically related to the secondary clarifier capacity), and ways to overcome the limitations of the corded media system relative to nitrogen removal. Through that effort, an alternative method was identified to increase wet weather capacity, improve nitrogen removal performance, and eliminate the need for IFAS media.

FACILITY EVALUATION

The Windsor Locks WPCF experiences relatively stable sanitary flows and loads but has an older collection system susceptible to intermittent flow increases due to elusive infiltration and more significant inflow sources. Fortunately, as shown in Figure 2, these flow increases are generally short in duration, presenting an opportunity to minimize the associated impact with a flexible operating approach.

The first step in improvement was to evaluate secondary clarifier capacity over the potential range of operating conditions. The secondary clarifier evaluation included field testing, process modeling, and analysis of plant data. Field testing followed the Water Environment Research Foundation (WERF) Clarifier Research Technical Committee (CRTC) protocols that included site-specific measurement of zone settling velocity (Vesilind settling parameters Vo and k) as well as flocculated and dispersed suspended solids levels. Multiple measurements of these parameters, microbiological evaluations to determine the causes and corrective measures to address intermittent bulking and foaming filaments, and an exhaustive evaluation of plant operating data determined the boundaries of operation of the secondary clarifiers. The secondary clarifier evaluation determined the maximum operating mixed liquor suspended solids (MLSS) concentrations

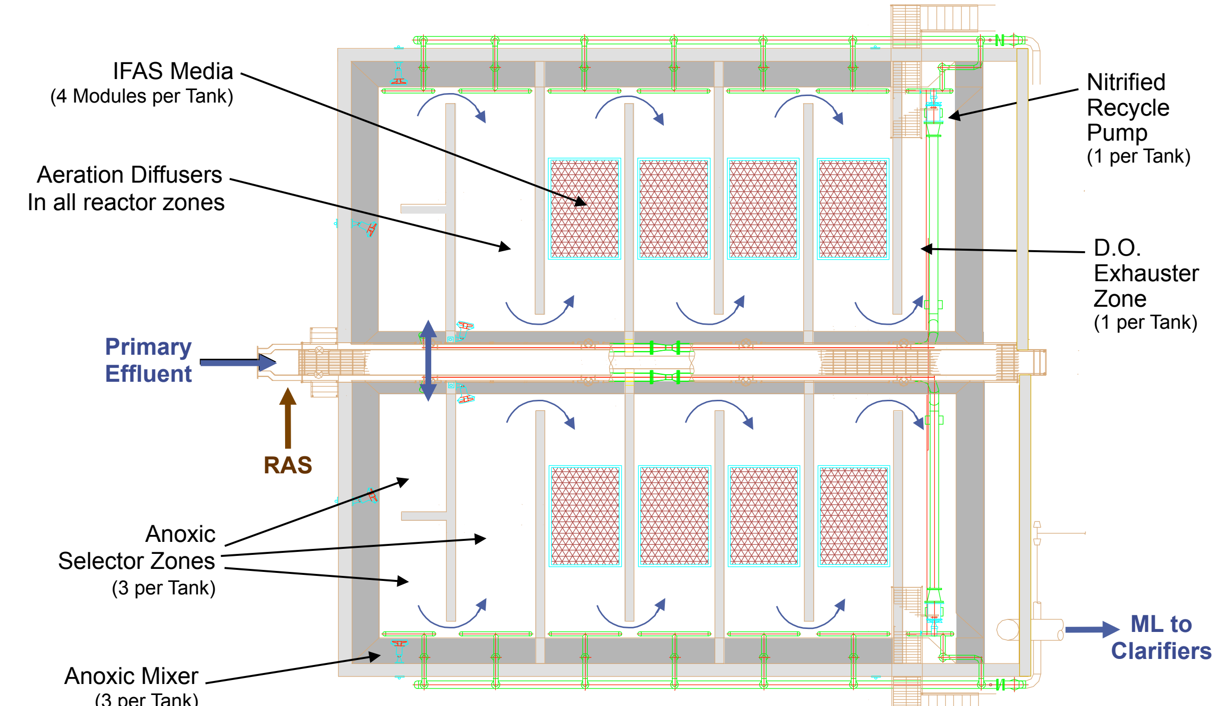

Figure 5. MLE/IFAS reactors as modified in 2002

during peak hourly flow of 6.2 mgd (23.5 ML/d) was limited to 2,630 mg/L at a sludge volume index (SVI) of 150 ml/g. Microscopic evaluation of filamentous organisms in both the MLSS and aeration tank foam also determined the likely cause of high SVI episodes. A mitigation procedure was developed and implemented to maintain SVIs below 150 ml/g.

Figure 3 shows a relationship between secondary clarifier capacity, MLSS concentration, and SVI for the clarifiers at the Windsor Locks WPCF. This graphical approach to secondary clarifier design and operation is based on established state point analysis (SPA) and has been demonstrated at a number of treatment facilities (Dombrowski, 2007). This approach and similar graphical solutions are incorporated into the 2011 edition and 2016 update of Technical Release 16—Guides for the Design of Wastewater Treatment Works (New England Interstate Water Pollution Control Commission). This figure illustrates two key relationships when activated sludge secondary clarifiers are operating under non-RAS (return activated sludge) rate limiting conditions: Capacity increases as MLSS concentration decreases, and capacity increases as SVI decreases. These concepts are coupled with Figure 4, which is the companion graph that provides the target RAS rate based on SVI and MLSS. These two graphs together provide operators both the approach and numerical values needed to determine available capacity and maximize secondary clarifier capacity. The example in Figures 3 and 4 is for the Windsor Locks WPCF at peak hourly flow. In the example two 60-foot-(18.3-meter) diameter circular clarifiers are estimated to handle a peak hourly flow of 6.2 mgd (23.5 ML/d) at an MLSS of 2,630 mg/L and an SVI of 150 ml/g with a target RAS flow of 40 percent (2.48 mgd [9.4 ML/d]). Under these conditions secondary clarifier sludge blankets should be stable—not rising or increasing in depth.

Step two in the process evaluation determined the aerobic and anoxic solids retention time (SRT) needed to achieve consistent nitrification and denitrification. Given the primary effluent organic loading and measured sludge production ratio (sludge yield), the WPCF needed an aerobic SRT of 11.8 days, corresponding to an MLSS concentration of approximately 4,000 mg/L during cold weather operation. Since the previous step in the analysis had established a secondary clarifier limit for MLSS of 2,630 mg/L, well below the targeted MLSS needed to provide consistent nitrification with the MLE mode during cold weather, a change in plant operation or capability was warranted. Options considered included increased biological reactor volume, a third secondary clarifier with chemical addition to enhance performance, and modification of the IFAS system. Since these were viewed as significant modifications, short-term changes were limited to operational measures and/or modest capital improvements.

The third step examined alternative activated sludge operating modes such as step feed and contact stabilization to increase short-term wet weather treatment capacity and to also allow operation with higher MLSS concentrations during dry weather periods to enhance performance of

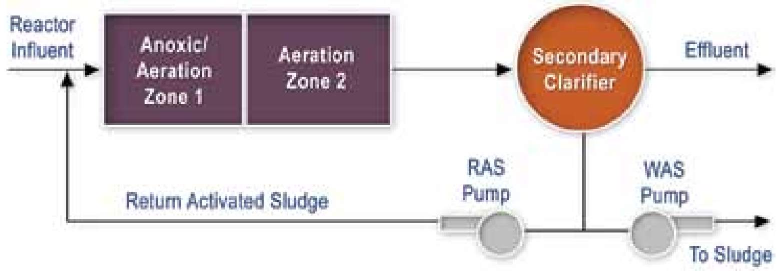

Figure 6. Series flow (MLE or conventional) activated sludge schematic

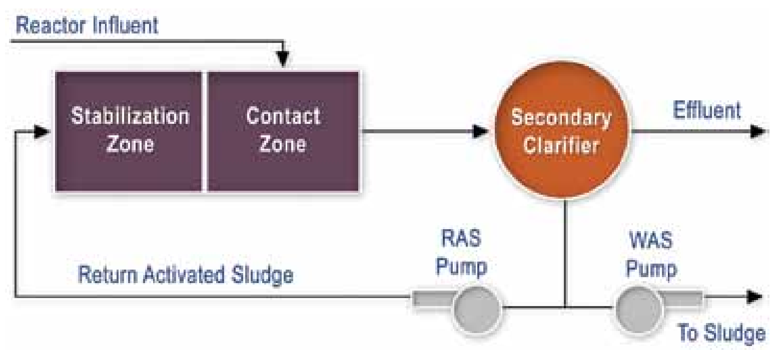

Figure 7. Contact stabilization activated sludge schematic

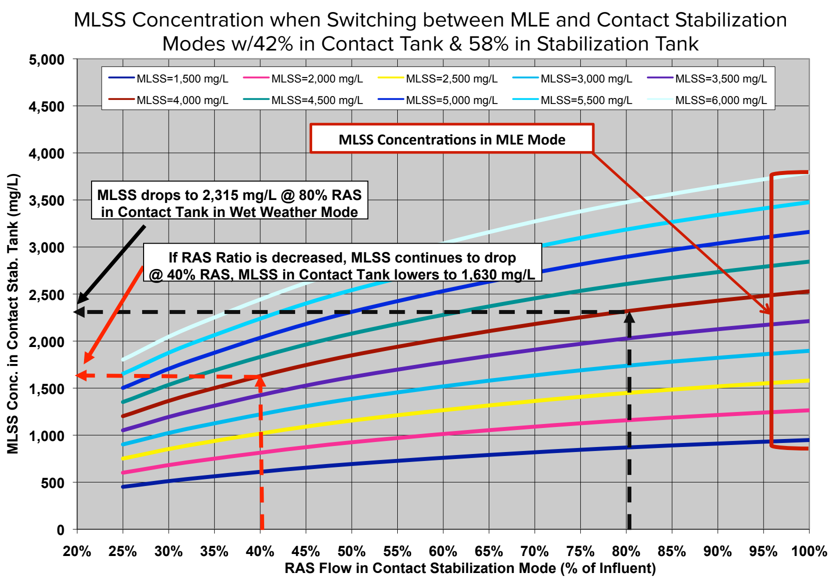

Figure 8. Plug flow (MLE) vs. contact stabilization inventory shifts

biological nutrient removal (BNR). Evaluation of these alternatives considered plant configuration, treatment targets, primary effluent flows and loads, and ease of operation. Existing facility construction and the interim nitrogen upgrade had incorporated a number of features that allow for easy conversion to the contact stabilization mode, including addition of reactor tank baffle walls that divide the tanks into seven (roughly equal) zones, aeration diffusers in all tank zones, and four slide gates per tank to feed primary effluent at a number of locations along the serpentine flow pattern of the seven tank zones. The main limitation of the configuration was that RAS flow is added to the primary effluent channel just upstream of the reactors. This configuration prevented a step-feed or contact stabilization mode of operation without piping modifications. In addition, the hydraulic design of the four slide gates per train does not provide a controlled flow split, limiting the effectiveness in a step-feed configuration. Contact stabilization mode was, therefore, the preferred wet weather mode of operation to further investigate, and the findings may ultimately require modification of the RAS piping.

For comparison, Figures 6 and 7 show schematics of series/plug flow and contact stabilization (C/S) reactors, respectively. The C/S mode of the activated sludge process has been used for decades, and its strengths and weaknesses are relatively well-documented. In particular, this configuration can provide adequate pollutant removals to achieve secondary treatment limits but it is not commonly used for biological nitrogen removal applications. Its weakness relative to use for BNR is mostly due to the typically short solids and hydraulic retention times provided in the contact zone of the process that limits nitrification and denitrification of the reactor influent wastewater. The advantages of the C/S process are the limited tank volumes required and the ability to store a substantial fraction of the system biomass in the stabilization zone, which is essentially a RAS storage and re-aeration reactor. When used as part of a dual operating mode (DOM) strategy, such as a wet weather operating mode with another activated sludge process, the C/S process provides solids inventory storage and will reduce the MLSS concentration substantially in the contact zone and entering the secondary clarifier. Table 1 compares MLSS inventory and concentrations for a series flow configuration (conventional or MLE) to a C/S mode of operation.

The switch from series flow to the C/S mode reduces the MLSS concentration in the secondary clarifiers and correspondingly increases secondary clarifier capacity. For a given split in contact and stabilization zones, the change in solids inventory and MLSS concentration can be calculated based on the RAS rate used during C/S operation. Figure 8 shows this relationship and reflects the tank volumes included in Table 1. For this example at the Windsor Locks WPCF, the RAS rate needed in series flow mode was held or maintained constant to calculate the inventory shift. However, as the shift occurs, a lower RAS rate may be used, resulting in an even greater transfer of inventory to the stabilization zone and a further increase in secondary clarifier capacity.

As noted previously, the C/S mode of operation is not typically effective at nitrifying or removing total nitrogen when used for an extended duration. Because of the combination of higher flows and a modest reaction time in the contact zone, nitrification would be expected to be negatively affected. Further, because anoxic zones are typically reduced or eliminated in the C/S mode, denitrification will also be reduced. However, when used intermittently, for a limited duration of up to one SRT (6 to 12 days), a significant fraction of the nitrifier population is retained in the system, and nitrogen removal generally returns to pre-wet weather performance within a couple days of switching back to MLE mode.

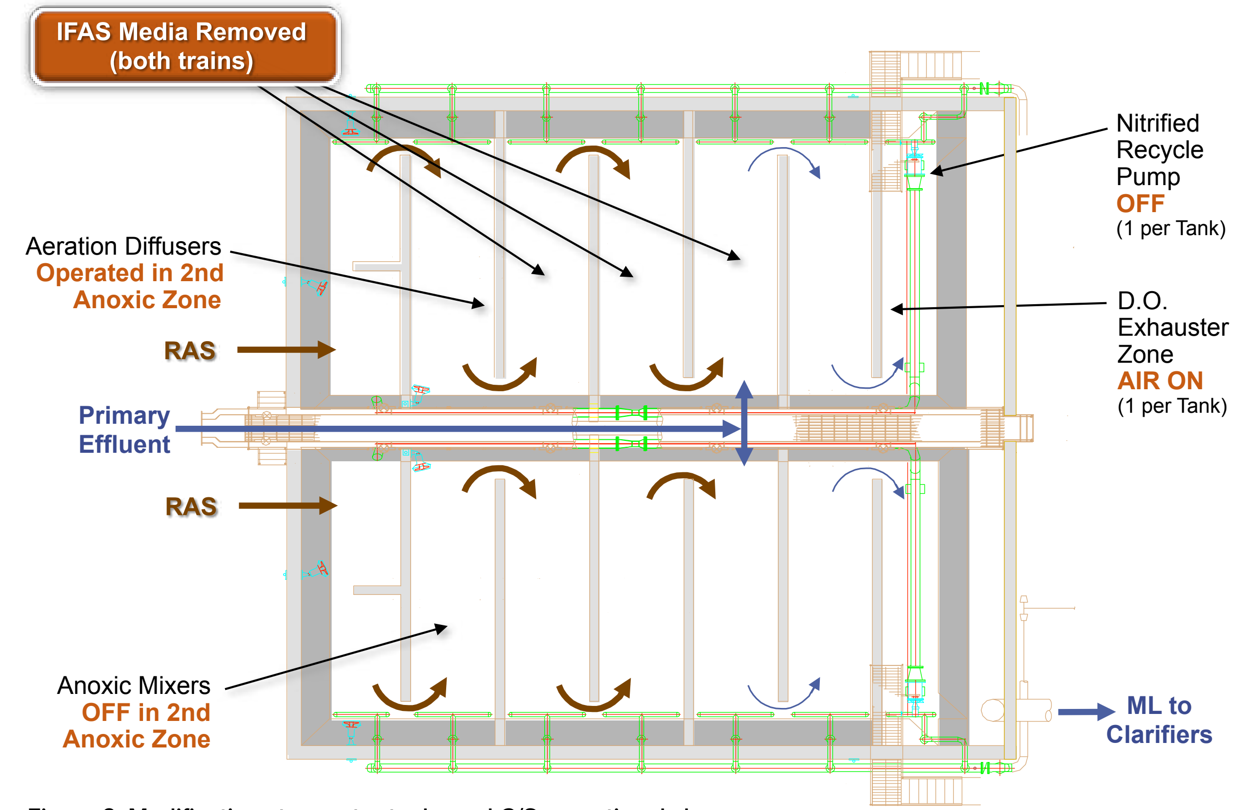

Figure 9. Modifications to reactor tanks and C/S operational changes

MODIFICATIONS AND PERFORMANCE

The original activated sludge process was configured with the RAS and primary effluent combined in the influent channel, upstream of the aeration tanks. To enable the plant to use the contact stabilization mode of the activated sludge process, the RAS piping had to be reconfigured to pump the RAS directly to the first reactor zone and allow the primary effluent to enter the MLE process train in the fifth zone via an existing slide gate. As a result, 58 percent of the tank volume serves as the stabilization zone, and the remaining 42 percent serves as the contact zone. Figure 9 shows the required RAS piping changes as well as the flow pattern and equipment operation necessary for the system to function in the C/S mode. In January 2008, the WPCF completed improvements to allow the facility to use the C/S mode of the activated sludge process during wet weather events. In addition to the RAS piping changes, the process was initially operated with all seven zones being aerated and the nitrified recycle pumps (normally needed for MLE operation) turned off. Further, in December 2010, CT DEEP authorized Windsor Locks to remove the IFAS media modules from the treatment process. After a number of years of operation and a solid record of maintaining a stable nitrifier population during and

Table 1. Example dual operating mode process solids inventory comparison

	MLE Activated Sludge	Contact Stabilization
MLSS Inventory	17,080 lbs	17,080 lbs
Total Reactor Volume	0.512 MG	0.512 MG
MLSS Concentration	4,000 mg/L	N/A
Stabilization Zone Volume	N/A	0.298 MG
Contact Zone Volume	N/A	0.214 MG
RAS Ratio (influent flow %)	80%	80%
RAS Solids Concentration	9,000 mg/L	5,210 mg/L
Stabilization Zone MLSS	N/A	5,210 mg/L
Contact Zone MLSS	N/A	2,315 mg/L

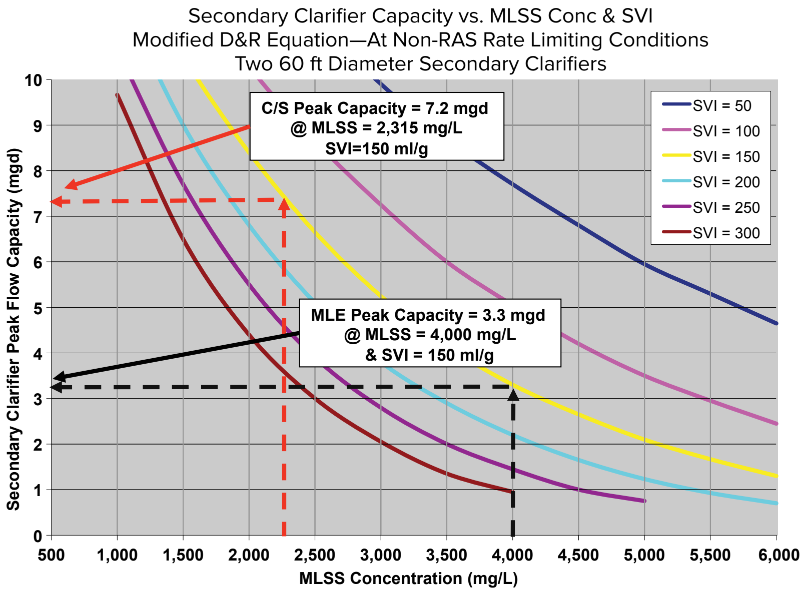

Figure 10. Secondary clarifier capacity in MLE and C/S modes

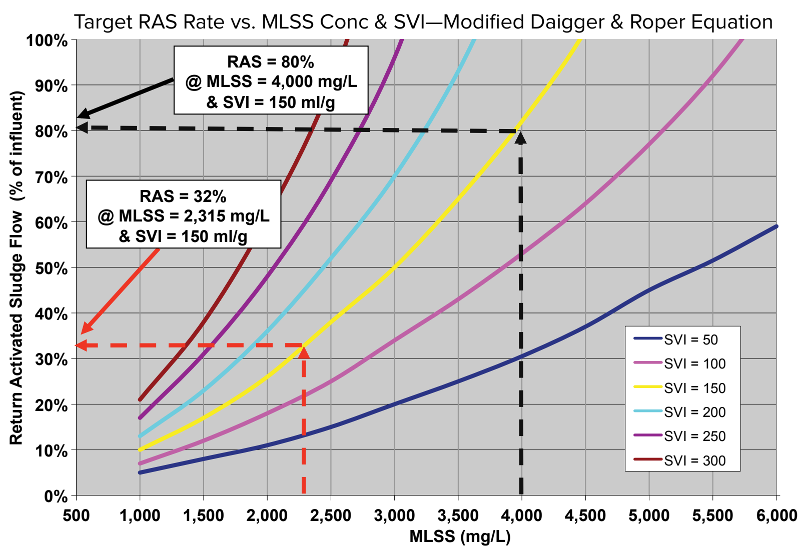

Figure 11. RAS targets in MLE and C/S modes

after numerous C/S operating periods, WPCF staff modified the wet weather operating approach in 2014 to retain the first tank zone as anoxic to promote denitrification of the RAS. This change appears to have further reduced effluent total nitrogen.

The normal operating protocol at the plant proactively provides the needed capacity for a wet weather event. The protocol incorporates the following steps:

1. Monitoring the MLSS and SVI regularly to maintain adequate secondary clarifier capacity under dry weather conditions, and adjusting SRT via wasting and/or SVI via RAS chlorination proactively to maintain adequate capacity and control filamentous growth
2. Comparing MLSS concentration and SVI values to the secondary clarifier capacity chart (Figure 10) to determine the limiting flow when a clarifier solids overload is projected and clarifier blankets are expected to increase; confirming that the operating RAS rate meets the target value from Figure 11
3. Estimating the expected MLSS reduction from the change to the C/S mode (Figure 8), if flows are expected to exceed the projected clarifier capacity
4. Confirming that the MLSS concentration in C/S mode provides adequate capacity to handle the expected peak flow
5. Switching from the MLE to the C/S process when additional wet weather capacity is needed, a change WPCF staff can make in less than 30 minutes
6. Monitoring process performance and especially secondary clarifier blankets during wet weather events
7. Using Figure 8 in reverse, as flows begin to subside, to estimate the MLSS concentrations when returning to MLE mode; reviewing Figure 10 to determine if the system can accommodate this change

In most cases, WPCF staff will proactively switch to the C/S mode when any significant wet weather event is predicted. This has proven to be a simple, effective approach, because the increase in secondary clarifier capacity generally far exceeds the expected wet weather flows, and the nitrogen removal performance during and immediately after exiting the C/S mode has been excellent and had nominal effect on the WPCF's annual total nitrogen mass discharge.

CONCLUSION

Since the DOM process has been incorporated into the Windsor Locks WPCF, operations staff have systematically tested the limits of this configuration by increasing the operating MLSS levels to 4,000 to 5,000 mg/L during cold weather operation and even higher when one train was removed for maintenance. The DOM process has allowed staff to push the limits of the MLE process not previously possible due to having the capability to rapidly and substantially increase the hydraulic capacity of the secondary clarifiers when a high flow event is expected. At the same time, concerns over facility performance and cost impacts regarding staff overtime during wet weather events have dramatically dropped. Operation of this facility has consistently achieved effluent BOD5 and TSS values of less than 5 mg/L and total nitrogen concentrations between 4 and 6 mg/L. Figure 12 illustrates how staff have integrated the minor improvements to the process and used them to reduce effluent total nitrogen significantly. Since the MLE configuration was installed, effluent total nitrogen has been reduced by more than 75 percent. In addition, incorporating the DOM process has helped the WPCF reduce total nitrogen discharges below its Nitrogen General Permit Target

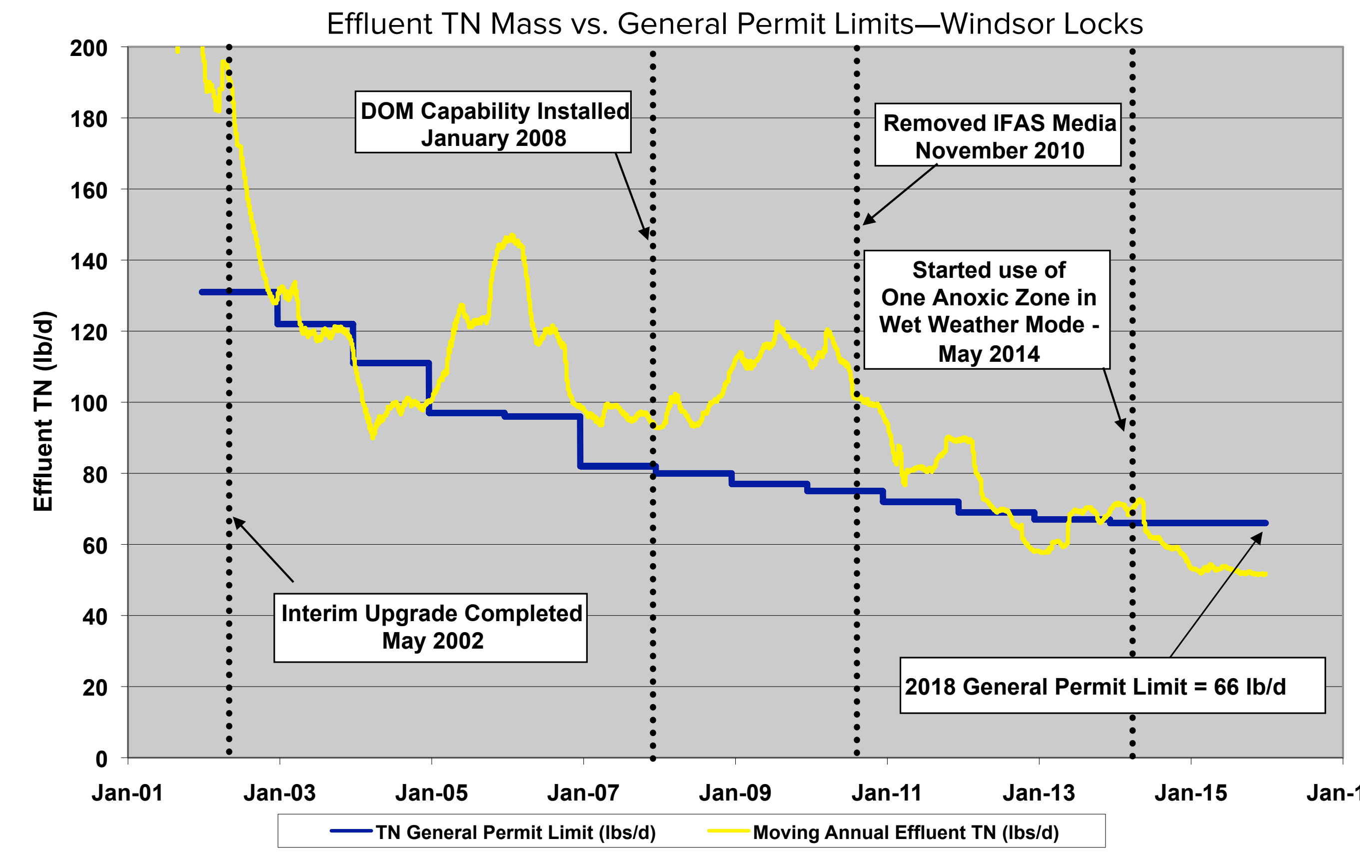

Figure 12. Milestones in plant modifications vs. effluent TN

level of 66 lbs/day (30 kg/day) while significantly improving wet weather capacity.

ABOUT THE AUTHOR

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- Richard Persson is the chief operator of the Windsor Locks WPCF with more than 30 years of experience. He has been recognized with both the NEWEA Operator Award and the WEF Hatfield Award for excellence in plant operations. He holds Massachusetts Grade 7 and Connecticut Class IV operator certifications.

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Wireless local area networks (WLANs) for wastewater treatment facilities

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ABSTRACT | Wireless technology is ubiquitous. This is particularly true in open standard wireless technologies, based upon the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards, colloquially called "WiFi." WiFi is used extensively throughout society, industry, and commerce, except, inexplicably, in the water and wastewater treatment industry. The industry has not taken advantage of the technological and economical benefits of wireless local area networks (WLANs) that have a real and tangible impact on capital costs and process efficiency. The benefits of this technology greatly outweigh the risks; the enormous cost savings realized are justification enough.

KEYWORDS | Wireless, WiFi, wireless local area networks (WLANs), radio frequency (RF), access points (AP), predictive survey, WiHART, translational bridge, gateway, control, wired network, supervisory control and data acquisition (SCADA)

In the spring of 2014, a pilot test of a WLAN was initiated at the Stamford Connecticut Water Pollution Control Authority facility

AN OVERVIEW OF WIRELESS NETWORKING

Wireless networking, or wireless local area networks (WLANs), is the wireless implementation of wired networking technology, with several differences. The most obvious difference is the distinction that wireless is an "unbounded" network, whereas hard wiring is "bounded." While a bounded network is familiar, easy to visualize, and, in comparison, a relatively mature technology, it is limited in capability and flexibility. From the outset, hard wiring is expensive, inflexible, limited, and likely to deteriorate. It has high initial capital costs, a higher cost of ownership, and significant long-term maintenance and upgrade costs. An important point is that wired networks typically provide connectivity at only two points, which are limited in distance by the technology; WLANs provide connectivity at every point within the coverage area, which is virtually unlimited.

WLANs also are flexible by definition. Wireless devices can be placed almost anywhere in a properly designed network. Within a wastewater application, distance restrictions are irrelevant. Line-of-sight transmissions of 300 feet (90 m) are easily attainable with proper link design, including use of directional antennas. A wireless network can provide connectivity over a wide area or be limited to narrow galleries or specific areas of the plant. Moreover, there is no physical transmission medium to deteriorate; radio frequency (RF) is not a physical medium, and issues must be addressed to ensure the best and most efficient signal propagation. Using proven design techniques, especially predictive and physical surveys of the facility, will ensure continuous and reliable coverage of the desired areas in most cases.

Success of any WLAN deployment starts with a realistic design and a thorough site survey. WLAN costs are 65 to 75 percent lower than for a comparable wired network; this is mostly due to the elimination of labor. In larger systems, elimination of capital equipment expenditures can also be a significant factor. As for long-term costs, owing to the lack of deteriorating physical components, maintenance and replacement costs are limited to simple replacement in kind. The cost of technology trends downward over the long-term, while efficiency and wealth of features trend upward. Conversely, labor costs trend upward. Finally, return on investment (ROI) in wireless systems is significant, and payback is almost immediate, based solely on the savings on labor costs.

The typical treatment plant is uniquely suited to RF propagation. Most plants are located away from densely populated areas, presenting a "quiet" RF background. Plant topography is usually flat, with elevated structures surrounding the process areas; these structures are convenient for wireless access points (APs). *A wireless AP is a hardware device or configured node on a local area network (LAN) that allows wireless capable devices and wired networks to connect through a wireless standard, including WiFi or Bluetooth.* Indoor installations are similar to office environments with well-known propagation characteristics. Other areas are open and unobstructed, as in pump or blower buildings, which make RF propagation easy. Electro-magnetic interference (EMI) from plant equipment is not a concern given the inherently robust spread spectrum modulation in the high-frequency spectrum of WLANs. Pipe galleries are not a serious challenge to the deployment of WLANs. Pipe galleries are similar to warehouse environments, where communication must be accomplished between metal racks filled with inventory; manipulation of power and directional antennas provide outstanding coverage in a gallery environment. Overall, the treatment plant environment does not present any significant hurdle to a WLAN.

Compared to other wireless systems such as cellular, satellite, and very-high-frequency (VHF)-based links, open standard WLANs have no recurring costs. While the aforementioned technologies may have definite applications in monitoring and control of remote facilities, they are not cost-effective within a relatively contained plant environment in light of newer technology. Proprietary wireless systems are being marketed emphasizing security benefits, but these systems also have several disadvantages not inherent with open standard WLAN. Proprietary wireless systems are costly to implement, have recurring costs, operate on non-standard frequencies (only with their own equipment), and use proprietary security mechanisms, which periodically require updating by outside vendors. Software and hardware upgrades for proprietary systems cost much more than standards-based equipment. Specialized personnel are required to service and maintain proprietary equipment, also at a higher cost.

Important to consider is that the owner controls completely the open standard WLAN in a plant and the unlicensed frequency spectrum on which it operates. Also, since WLANs are not leased, there are no recurring costs. Within the plant fence line, the unlicensed WLAN spectrum is completely under the owner's control. This is important for design and security of the network, and proper deployment of the network will enable a high level of security to be attained and maintained. Proper design also limits propagation outside the fence line, reducing or eliminating the likelihood of interception or interference to and from neighboring WLANs. Complete control allows the owner to deploy the WLAN as needed, to expand or upgrade as required, and to properly protect network resources, all while using readily available and inexpensive open standard technology.

BENEFITS OF WLANs FOR TREATMENT FACILITIES

When planning the upgrade of the supervisory control and data acquisition (SCADA) network at the Stamford Water Pollution Control Authority (SWPCA), minimizing capital expenditure was a key consideration. A fiber optic network had been installed during the last plant upgrade, and it was operating flawlessly. However, a necessary obligation to ratepayers was to lower future maintenance, replacement, expansion, and upgrade costs to "future-proof" the facility. Wireless technology was among the upgrade options considered because it could benefit ratepayers by achieving several cost control goals:

- Initial capital costs for new or upgraded networks would be greatly reduced.
- Long-term maintenance and repair costs would be minimal, if not insignificant.
- Replacement and upgrade costs are minimal, and were anticipated to naturally decline.
- An increase in control efficiency and flexibility with WLAN could improve operational performance and lower process control costs.
- Recurring costs for proprietary or common carrier technologies would be reduced or eliminated.
- A separate, wireless instrumentation sub-network would provide cost savings and flexibility with future upgrades by using open standard technology.

It was later shown that by using self-contained, independently powered instruments, devices and instrumentation could be placed anywhere with minimal effort and low cost. For example, suppose a requirement is to measure nitrate levels in an anoxic zone after adding carbon. With a fixed, hard-wired instrument, the designer would probably place the transmitter at the baffle and specify a nominal probe cable length (normally between 25 to 50 feet [7 to 15 meters]). However, during testing and commissioning, the "sweet spot" for monitoring this parameter was not within that cable's reach, requiring relocation of the transmitter or lengthening of the probe cable. Consider that with a wireless instrument the solution is merely to unbolt it and move it to the desired location, saving time and money, and enhancing operational control. If the designer uses wireless instrumentation from inception, flexibility and savings are realized from the start. It also future-proofs the plant by building in an open standard wireless infrastructure, which allows various wireless instruments and devices wherever necessary.

WLAN deployment testing at Stamford also revealed other useful benefits that would bring long-term cost savings. An additional benefit beyond data acquisition was possible use of voice over internet protocol (VOIP). Intra-plant communication is typically done with walkie-talkie-style mobile telephones or with dedicated two-way radios. By using an intra-plant wireless network, "convergence" technology can be used to eliminate the recurring costs of common carrier, push-to-talk telephones or proprietary radios. When properly designed, convergence telephones switch from the common carrier network at the plant fence line to the plant WLAN. This is a one-time capital expense and allows the full capabilities of mobile wireless devices to be used both on and off the plant grounds, with no recurring costs. A variant of this strategy is wireless internet protocol (IP) addressable intercoms, which would allow plant areas to be selectively paged or announcements to be broadcast. The message can also show up as a text to any mobile phone or tablet.

Wireless IP security devices are another means by which wiring can be eliminated. Wireless security cameras and entry or occupancy sensors can be placed in any area with WLAN coverage. Video and voice delivery within the WLAN area is easily assured, and multimedia delivery to a smartphone or tablet also has potential for savings, particularly in maintenance and repair of equipment. Accessing the intranet and internet for equipment data such as operations and maintenance manuals, repair procedures, or calibration and upgrade methods at the site of the equipment will significantly reduce lost time by eliminating the need for staff going back to the office and rummaging through binders or paper files. The concept "mobile worker" is now being used across the industry and will require reliable wireless networks to realize its full potential.

Radio frequency identification (RFID) tracking and inventory control also can be exploited using a WLAN. Equipment can be scanned out of the tool room, tracked within the plant, and identified when it leaves the plant. Personnel can be tagged also, for safety purposes; if a plant is evacuated, a wireless head count can easily be done, and a missing worker can be located using his or her wireless tag.

This idea ties in with integrating the WLAN into computerized maintenance management systems (CMMSs). CMMSs can be made extremely powerful through the portability and mobility of a WLAN. As a worker "clocks in" on a tablet or mobile device, work orders for the day are presented. Theoretically, as the worker completes each task, he or she can clock in and out of each while remaining in the field, complete the work order, and adjust inventory for the parts and equipment used. Upon inspection of the equipment, the worker can send a wireless request to the tool room or to inventory to have parts and equipment pulled for later pickup. Any equipment problem that must be referred to the vendor can be done from the mobile device; pictures or video can be sent, and the system even allows for real-time chat with tech support at the equipment site, with no recurring costs.

WIRELESS NETWORK SECURITY

Wireless security is possibly the most sophisticated and mature component of wireless technology. Without effective security, the wireless industry would have been relegated to non-critical applications and would never have reached its true potential. Aside from encryption methods, other dimensions to wireless security should be considered as integral to security policy. Through directional antennas and manipulation of the power output of the AP, the coverage area can be "sculpted" to remain within the plant's fence line or within specific areas, removing the opportunity for interception. A "honey pot" is a decoy WLAN that leads to a dead end and can easily throw off a potential attacker, particularly if the process WLAN is hidden. Hiding the network by turning off its beacon broadcast is not a security measure but can be used as a screening tool if there are other easier decoy targets to occupy attackers. Although our industry does not work with items of high intrinsic value, such as money or cutting edge research and development, the potential exists for creating mayhem and disrupting the treatment process. However, the risk has been shown to be minimal with proper precautions. The classic "hacker in a van" taking over pumps or blowers, or closing valves, is unlikely.

Eighty percent of all network breaches are thought to be inside jobs. The lack of a robust, comprehensive, and enforced security policy will eventually lead to a network breach. This is avoidable if staff protect their passwords or other security credentials and are held responsible for them. Enforcement of a comprehensive security policy also helps.

Network security has filled many books and innumerable webpages. Common sense security measures properly applied and enforced can make a WLAN impenetrable, extremely robust, and trustworthy. Along with cost, security is the next most pressing concern for any WLAN. However, with proper design and management, this concern can be managed.

STAMFORD WATER POLLUTION CONTROL AUTHORITY PROJECT

During the feasibility assessment at the SWPCA facility in Stamford, Connecticut, a trial or "proof of concept" (POC) was performed to determine if open standard WLANs fit the facility's immediate and future needs. In the spring of 2014, a pilot test of a WLAN was initiated at the SWPCA plant. The test aimed to demonstrate the viability of the WLAN and to define benefits and shortcomings of this technology. It monitored a process area at a distance that could accurately compare wired versus wireless technology within the plant.

The primary odor control system (OCS) was chosen as the test bed. The OCS is 330 feet (100 meters) from the control building, approximately the maximum length of a wired Ethernet segment (100 meters by specification). OCS instrumentation is already hardwired into the plant SCADA system, so a comparison of the process data using the two mediums was also valuable and provided further insight into scrubber instrumentation. The area between the control building and the OCS was a mixture of concrete and macadam pavement, with an open grassy area. This helped to determine relative costs for a trenched cable and conduit installation scenario versus a WLAN.

The first step pre-deployment tool in the design of a WLAN is to perform a predictive RF survey, a software-based estimation of the RF propagation in a given environment. A blueprint or similar plan drawing of the desired coverage area is imported into the program, as well as buildings and their materials of construction. Every building material has unique attenuation properties that must be considered prior to WLAN design; reinforced concrete, such as in elevator shafts or large tanks, attenuate RF by a factor of 100, or -20 decibel-milliwatts (dBm). Water also greatly attenuates RF. Figure 1 shows the predicted RF propagation between the two APs (red is the strongest signal, blue the weakest). Note the RF shadows created by the buildings.

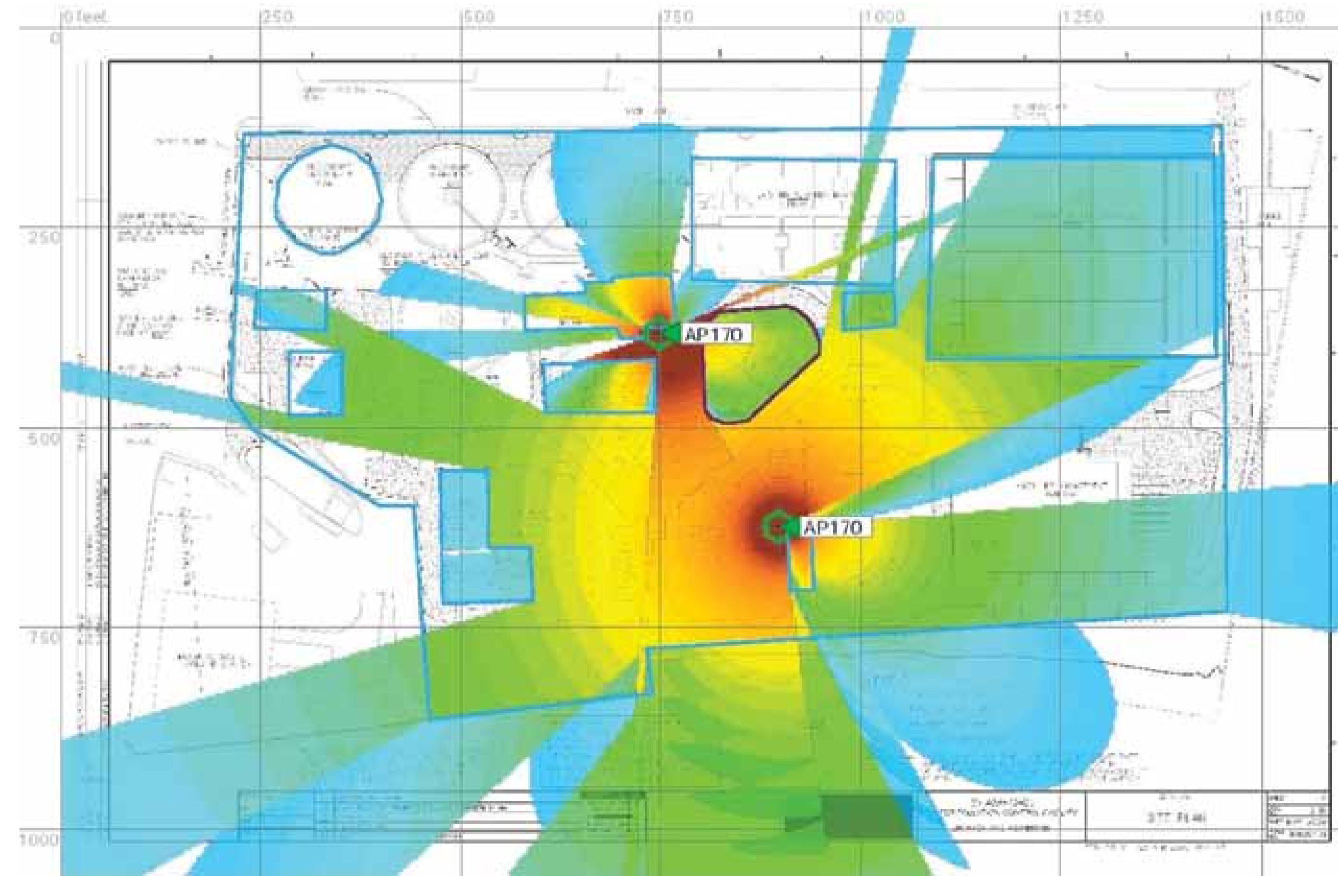

Figure 1. Predictive survey results

Approximately 60 percent of the plant area was predicted to have solid RF coverage using only two APs. Though not relevant to our testing goals, directional antennas could eliminate much of the back lobe effects (RF-generated field behind the antennas), as shown on the survey, and would have allowed lower AP transmit power to be used. Such antennas will be considered in the final design. Another goal of final design is to eliminate propagation over the fence line, reducing eavesdropping or interference to or from neighboring WLANs.

The trial WLAN consists of two dual-band outdoor (AP-170) industrial wireless APs. One AP was placed on the scrubber tower access platform, approximately 15 feet (4.6 meters) above grade. The other AP was mounted on the outside of the control building, approximately 12 feet (3.7 meters) above grade. The APs have a line of sight (LOS) transmission path of 330 feet (100 meters). At this distance, the LOS was not obstructed, and signal levels were not less than -70 dBm throughout. The height and orientation of the APs were not critical for this test; omnidirectional antennas allowed for measurement of the system's total propagation area.

Management and provisioning of the APs was cloud-based and feature-rich. Power levels, security, firewall, virtual local area networks (VLANs), and system upgrades are all features provided and performed through the virtual console. All of the network operations could be monitored, controlled, and modified through the management console, which can be accessed from anywhere with network access, inside or outside the plant. This could easily translate into centralized information technology (IT) resources that do not necessarily need to be stationed at the plant.

The design concept capitalized on the dual-band capability of the APs. All local communication with mobile devices and instruments was accomplished using the 2.4 GHz ISM band. *The ISM band is an internationally reserved radio frequency band dedicated for industrial, scientific and medical (ISM) uses*. The wireless backhaul between the OCS and control building is accomplished using the 5 GHz UNII band channels. *The UNII band is a radio band allocated to the unlicensed national information infrastructure (UNII) spectrum used by IEEE-802 devices (common WiFi).* The dual band wireless APs formed a "hive," which is a group of APs in a mesh configuration. APs can join this group automatically if in possession of the proper "hive key." A mesh configuration, or topology, is inherently formed upon power up and will re-form in the loss of an AP. For example, in a properly designed mesh network, adjoining APs will dynamically reconfigure the network to seal the breach and any network interruption will typically be of short duration. Mesh topologies are similar to a distributed control system (DCS)—a collection of independently

| WIRELESS LOCAL AREA NETWORKS |

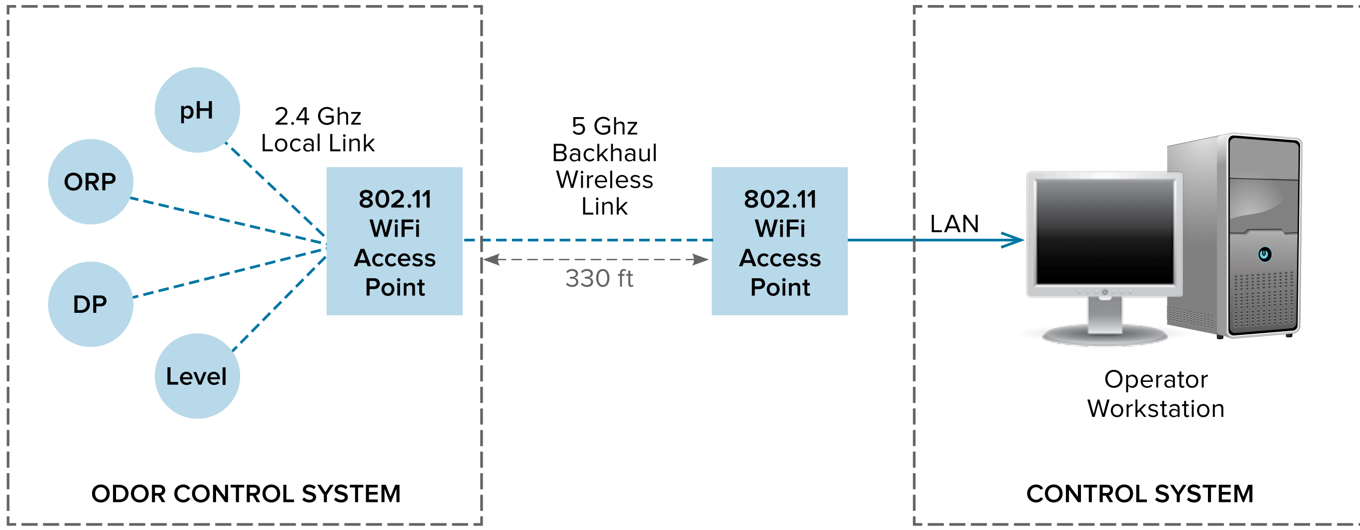

Figure 2. SWPCA trial 1 design concept

operating and networked process area controllers. If a single controller is removed, it has no effect on the function of the overall network. Mesh topologies are well suited to connecting distributed control facilities and equipment because of their fault tolerance and redundancy.

Most mobile devices at the time of the trial could not communicate on the 5 GHz UNII channels; this made the UNII band channels very quiet. The system concept is shown in Figure 2.

In the original concept, the OCS instruments communicate with an AP on the ISM channels while backhauling the data over the UNII channels. At the time of the test, however, no Wi-Fi-capable instrumentation was readily available on the consumer retail market for use in the testing. Wireless instrumentation offered by an industrial market vendor using analog protocols was instead used for the test. This instrumentation uses WiHART protocols and conforms to IEEE 802.15.4. *WiHART is a wireless implementation of the analog wire line HART (highway addressable remote transducer) protocol that has been used extensively with wired instrumentation.* The WiHART system sets up an inherently redundant wireless mesh architecture. Security also conforms to the Advanced Encryption Standard, and the range of the wireless Smart Gateway provided with the system exceeds 500 feet (150 meters). Using this equipment obviated one of the primary goals of the test: proving that data other than low-rate process data could be distributed using a single wireless network.

WiHART was used for the instrumentation sub-network and for short-range transmission locally to the scrubber to acquire real-time operating data from OCS primary instrumentation devices. WiFi has the much broader capability of acquiring and distributing varied data types wirelessly, not only process data but also voice, video, and internet, all simultaneously. Use of the wireless network for other communication was predicated on the idea that typical process data changes slowly and is a low-rate transmission, and, as such, would require insignificant bandwidth. A simple rule of thumb is that the faster a process variable changes, the higher the sampling rate needed, resulting in more bandwidth being required. The instruments used were battery-powered and transmitted infrequently or at discrete instances. This would allow the bulk of the available bandwidth to be used with other, more bandwidth-intensive applications. If all that was desired was to acquire process data, several wireless options are available, and the design would likely have stopped at the WiHART network.

Another problem in using this modified arrangement was translating the data from the IEEE 802.15.4 frequency-hopping spread spectrum (FHSS) technology, to IEEE 802.11, orthogonal frequency division modulation (OFDM) transmission. The solution was a "translational bridge." The estimated cost for the bridge was slightly less than $2,000. These additional components increased the system cost. Subsequent experiments showed that any 802.11 compliant device, such as an inexpensive 802.11g/n travel router, would provide the same WiFi functionality at a much lower cost. A block diagram of the translation bridge arrangement is shown in Figure 3.

As shown in Figure 4, the system concept was little changed; instead of the instruments communicating directly with the 802.11 AP, data was "translated" between the two standards and re-transmitted to the AP. This change established a hierarchical network and introduced a second standard or segment. The intention was to build a "flat" or single segment network based on a single open standard. However, given the dearth of available instrumentation with native WiFi support, the test configuration was the least complex of all those presented. Other methods would have required additional hardwiring into dedicated (and proprietary) conversion modules. This had obvious cost disadvantages; every point would need to be hard-wired into a new marshalling cabinet and converted to 802.11-compliant transmission frames. It was also recognized that an additional wireless standard would add a layer of security at the sub-network level. The sub-network protocol uses robust authentication and authorization to discover compatible instruments, similar to how an 802.11 network authenticates.

Upon powering up the APs, the cloud-based management dashboard immediately populated with the wired portal and mesh APs. The console indicated that both APs were

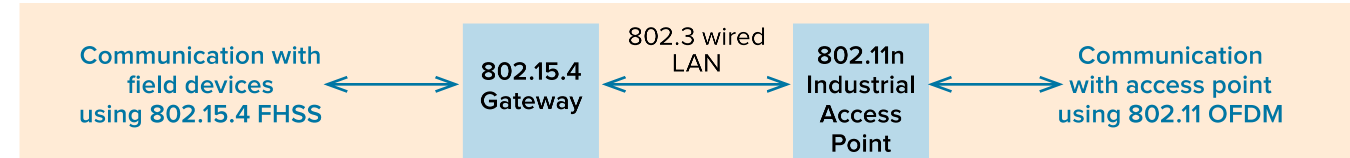

Figure 3. Translational bridge

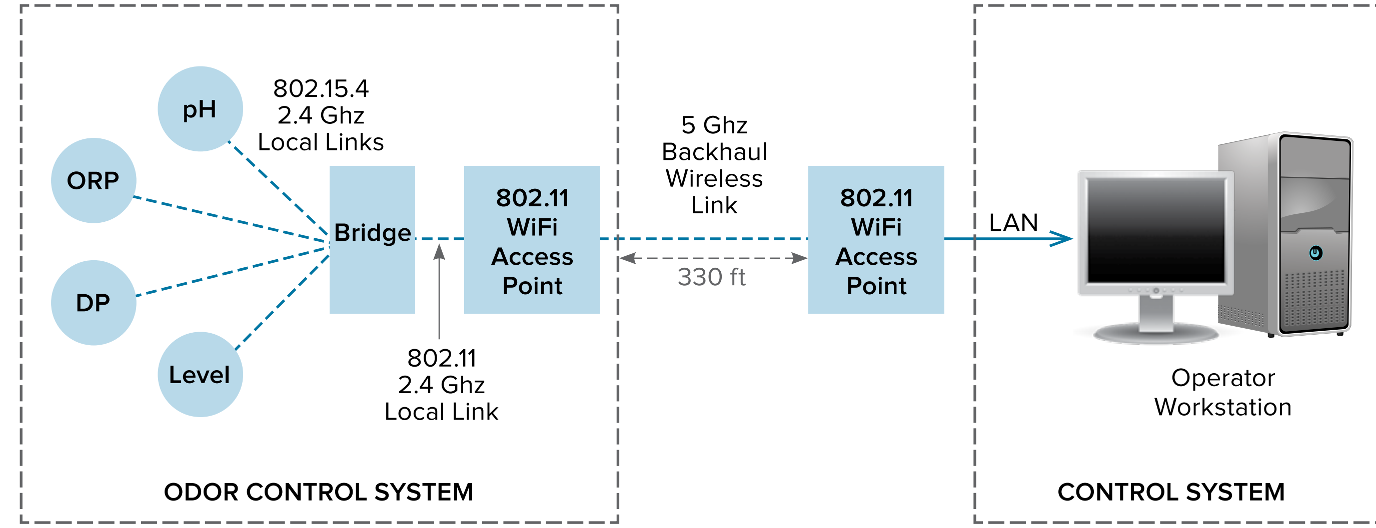

Figure 4. Final system configuration

exchanging control data. A quick check of propagation was done using a WiFi-capable mobile phone. This indicated the extent of coverage in the plant. The coverage slightly exceeded that expected from our survey, but with slight scaling, and the predictive survey was shown to be accurate. Even without directional antennas and with minor manipulation of AP output power, approximately 60 percent of the plant area was afforded solid and reliable coverage. The signal dropped off quite conveniently at the east fence line but spilled over the west fence line. This was not a problem as the west side of the plant is bordered by a canal and the signal levels beyond the canal were unreliable.

The bridge was powered up and began to acquire data from the instrument sub-network. The Smart Gateway was shown in the management console as an attached device with an assigned private IP address. After logging into the Smart Gateway's integral webpage, live process data was immediately available. Instrument health was displayed and various diagnostic data was also available. The WiHART system is useful and functional as a standalone data acquisition network. The entire process of establishing the working network required no additional configuration. The OCS process data was in numerical format only on the Smart Gateway webpage; this data could have been exported to any compatible human machine interface (HMI) package. This was not relevant to the goals of the test, however. In future deployments this data will be input into the plant SCADA appropriately.

Select plant staff were given access to the WLAN and asked to "break it," that is, to determine from normal usage any operational problems. From the management console it could be determined that all sorts of data had been accessed and downloaded. Process data was readily accessible within the coverage area; this particularly impressed the operators. Staff interviews indicated that video performance was exceptional, and internet access was available and fast throughout the coverage area. The feedback was overwhelmingly positive. In one case, an anomaly in an instrument reading was identified by staff from data on the WLAN. Corrections made to the system improved performance.

As a result of allowing the staff to become accustomed to the WLAN, requests were made during SCADA design to include a means to access the WLAN through portable devices. This was a pleasant surprise and vote of support by staff for this new technology. During final WLAN deployment as envisioned, the authority will add between two and three additional strategically placed APs to the WLAN, using directional antennas to restrict propagation to process areas. The predictive survey (without directional antennas) is shown in Figure 5.

The addition of three more APs provides 100 percent coverage to the plant area. Using the proper antennas will likely reduce the number of required APs to four. A high-speed WLAN is expected to become the plant communications backbone in the exterior spaces and become relied on by operators. The fiber optic LAN will still operate as the primary SCADA backbone.

COMPARATIVE CAPITAL COSTS AND RETURN ON INVESTMENT

One surprising finding was the difference in costs between comparable wired and wireless networks. During the design phase of the test, we wanted to determine if the cost of using a WLAN was justified compared to traditional hard wiring. Aside from security, cost savings usually attracts the most interest

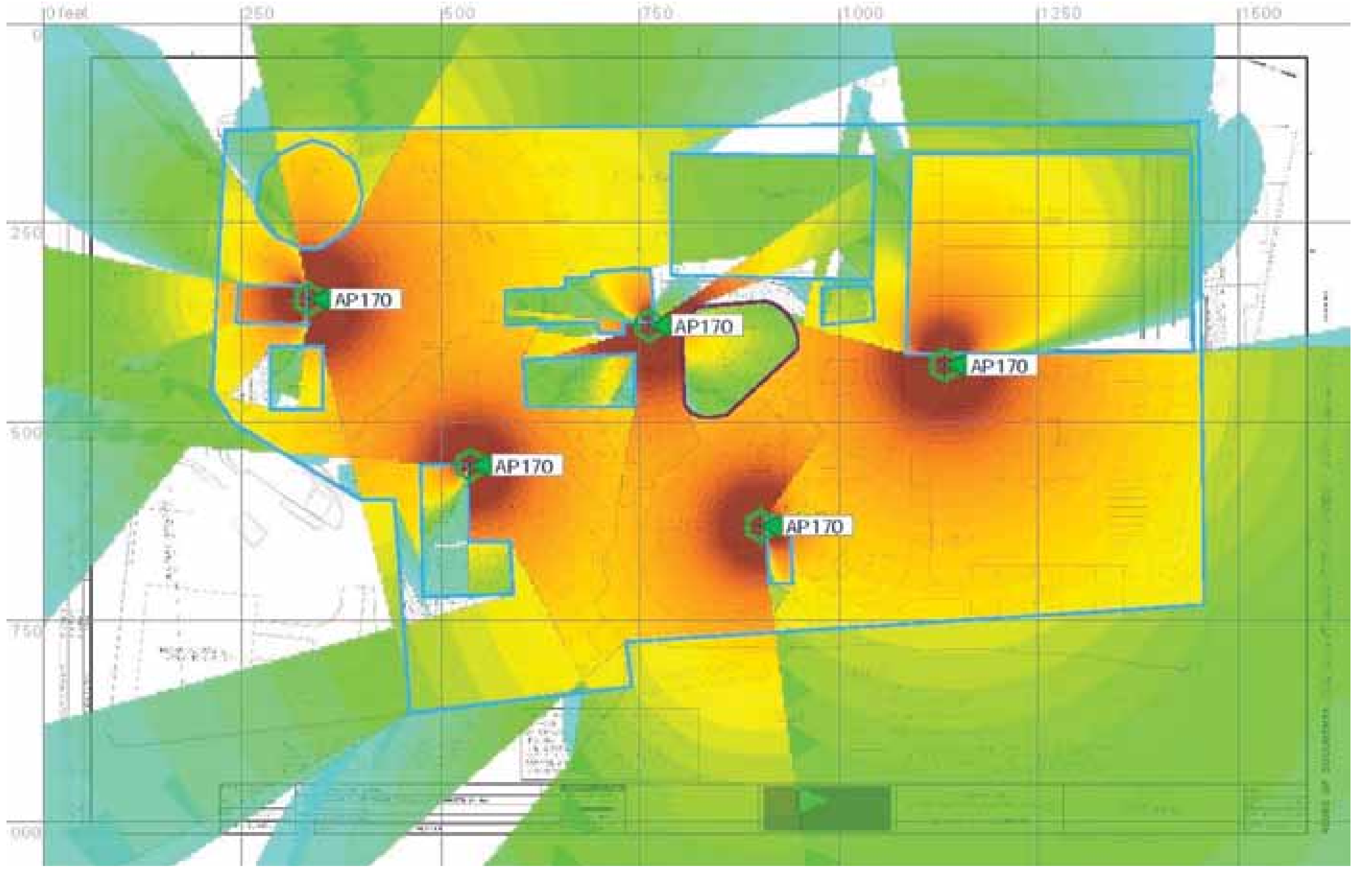

Figure 5. Final network predictive survey

Table 1. Comparative costs wired vs. wireless (330 ft)			
Wired link in trench		**Wireless link**	
Excavation 140 yds (128 m)	$6,500	Design/Site Survey	$2,500
Saw Cut 300 ft pavement (91 m)	$3,000	Wireless Access Points, 2 @ $800	$1,600
Stone Base	$1,000	Electricians, 1 day @ $1,120/day	$1,120
Backfill	$4,500	IT Configuration	$1,200
Patching	$3,500		
Conduit and Cable	$500		
Router and Accessories	$600		
Electricians, 5 days @ $1,120/day	$5,600		
Design, management, IT, misc.	$5,000		
Wired total	**$30,200**	**Wireless total**	**$5,420**

by municipal agencies and their governing boards. Reducing capital costs directly affects bonding costs and user rates. Three professional construction estimates were done for the installation of a wired network segment between the control building and the OCS, a distance of 330 feet (100 meters) through pavement and a landscaped area. The link would consist of (for the purposes of the estimate) a single CAT6e unshielded twisted pair (UTP) cable in galvanized conduit, buried in a trench between the two buildings. The estimate included design, management, and termination at either end of the cable. The estimate was for the link only and not any connected instrumentation or other devices. A cost estimate for the installation is shown in Table 1.

A savings of roughly 78 percent would be realized by the use of a wireless link. Further, connectivity of the wired network would be limited to the terminated ends of the cable and only at those locations. Further connectivity of the wired link would require additional equipment such as repeaters, routers, and/or switches. This installation was estimated to take two weeks and result in a significant physical disturbance. The WLAN took two days to install and become fully operational. The mesh network formed automatically and immediately began to transmit data from the wireless process instrumentation. The WLAN provided WiFi coverage over approximately 60 percent of the plant area and was immediately available for use by the staff. There was no physical disturbance of plant grounds.

These figures were presented to the SWPCA board, who upon review supported it. This technology promised to

significantly reduce long-term costs and virtually eliminate the labor portion of capital costs in constructing a new network. Moreover, savings could contribute to user rate stabilization; this new technology provided a real and tangible benefit to the ratepayers. The benefits described herein allow the Authority to incrementally reduce technology costs by using newer technologies to eliminate many recurring, capital, and long-term maintenance costs.

Short-term costs in deploying a WLAN have been shown to be much less than that of a wired LAN. This is not limited to LAN costs exclusively. Instrument loops rely on individual twisted shielded pairs (TSPs), and most other networks also use some form of cabling unique to their architecture and protocol. Most, if not all of these network cabling systems, can be replaced by a wireless link.

Long-term costs are similarly low. While physical wiring is prone to failure from several modes, the wireless medium is robust. Old and deteriorating wiring is disruptive to business and process operations, and it is costly and time-consuming to troubleshoot, repair, or replace. Plant wiring can fail for many reasons: improper installation, chronic gas or fluid infiltration, physical damage from innumerable causes, and age. A typical scenario in replacement is the necessity to install a parallel wiring system, if space allows, and either demolishing or abandoning in place the older, compromised wiring system. A worst-case scenario would be the need to install a temporary wiring system so the older system can be taken out of service for repair or replacement. Another, perhaps more common occurrence is the accidental severing of a vital communications cable. None of these scenarios is attractive or inexpensive. Conversely, there is no physical medium in a WLAN to deteriorate or to accidentally damage or destroy. WLANs are not susceptible to the "backhoe syndrome" that has disrupted many a communications network.

Long-term costs for a WLAN are insignificant compared to hard-wired systems. The physical medium is eliminated, and with it go numerous and often recurring problems. There are no long-term replacement costs to build into the plant budgets. The APs are typically sealed electronic units; the only physical damage they would sustain would be from some natural disaster, malicious vandalism, or accident. Using current standards, upgrades of the APs would not be necessary for many years. Given the throughput available with current 802.11g/n/ac standards, an AP installed today could provide useful revenue service for the next 10 years in a typical plant environment without upgrade or replacement.

Revisiting the scenario described previously, if the WLAN were to fail from a damaged or defective AP, the AP would simply be replaced. If a spare AP is on site, this task would result in a network outage of less than a few hours. Compare this to the several days if not weeks of work to troubleshoot, repair, or replace a wired network. There is also the cost; over the long term, the price of electronic equipment trends downward and labor costs trend upward. The cost to repair or replace wired systems is disproportionately larger than those of a WLAN. The obvious solution in a hard-wiring failure scenario would be to deploy a wireless network and abandon the wired network, at a much lower overall cost.

SUMMARY

Whenever a new technology is introduced, an older one will likely be pushed aside. The Stamford POC was performed to achieve two goals: to determine if the technology was viable at the site and to establish that it was a cost-effective alternative to physical wiring. After assessment, the SWPCA was pleased with the technology and the promise of short- and long-term cost savings. The ultimate goal was to design a system with lower plant operating costs and increased efficiency. Those in the wastewater industry are obligated to do this as trustees for the ratepayers. WLANs still use a surprisingly large amount of physical wiring; to provide internet and intranet resources, the WLAN must always (at this writing) have at least one wired portal. Hard wiring is not going away any time soon. There will always be room for hard wiring, and wireless technology is not always the best fit or may only be a backup to a wired link. However, for most low-rate, non-critical applications, a WLAN is a cost-effective and reliable alternative to hard wiring.

As WLANs become prevalent in new designs, vendors will begin to migrate to the technology. This has been the model for new and pervasive technologies, and wireless is no exception. The water and wastewater industry is among the last major industrial markets to take advantage of wireless technology. In most everyday data acquisition and even control applications, wireless technology will become dominant. The telephone system and early LAN technologies are examples of how technology evolved and settled on de facto standards that made the old technologies nearly obsolete. For wireless technology, no example is necessary; wireless devices are everywhere and in every corner of modern life. The future is clearly a wireless future.

ABOUT THE AUTHOR

Daniel Capano owns Diversified Technical Services, Inc., of Stamford, Connecticut. He specializes in I&C systems and has been in practice for more than 25 years in the municipal water and wastewater market. He is vice-chairman of SWPCA and chairs its technical committee. Mr. Capano is a certified wireless network administrator (CWNA) and a certified wireless security professional (CWSP), and holds an FCC General Radio Operator's License. For more information on this topic, he also has a tutorial blog on wireless technology at controleng.com/blogs/industrial-wireless-tutorials.html.

The lowdown on meeting low phosphorus limits

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ABSTRACT | Many water resource recovery facilities (WRRFs) in New England and elsewhere around the world are implementing or evaluating methods to meet increasingly stringent effluent phosphorus limits to help prevent eutrophication and harmful algal blooms in surface waters. Many approaches and technologies exist for WRRFs to meet these challenges. Some have been proven for decades, while emerging ones build upon the success of previous generations and aim to address potential shortcomings or new goals in energy neutrality and resource recovery. Optimizing the solution for your utility requires a customized approach to evaluating these alternatives against the unique constraints of your WRRF and lessons learned from peer utilities.

KEYWORDS | Phosphorus, enhanced biological phosphorus removal, fermentation, struvite, chemically enhanced settling, adsorption, clarification, filtration

INTRODUCTION

Many water resource recovery facilities (WRRFs) throughout North America are implementing or evaluating methods to meet increasingly stringent effluent phosphorus limits to help prevent eutrophication and harmful algal blooms in surface waters. In Connecticut, for example, the Department of Energy and Environmental Protection (DEEP) recently proposed performance limits for 45 WRRFs ranging from 2.5 milligrams of phosphorus per liter (mg/L) down to 0.1 mg/L (DEEP, 2014). While the proposed limits are expressed as concentrations, they were derived from receiving-stream load allocations. This is important to WRRFs because future service area development or flow increases are likely to further reduce concentration limits to meet the load allocations and ensure anti-degradation.

WRRFs typically achieve annual average total phosphorus (TP) limits of 1 mg/L by optimizing conventional biological or chemical processes without effluent filtration (U.S Environmental Protection Agency, 2007). However, consistently achieving ever-decreasing effluent TP limits of 0.5 to 0.1 mg/L requires excellent particulate removal, generally from tertiary filtration. If ultralow limits are required (<0.1 mg/L), more specialized tertiary phosphorus removal is generally needed to ensure removal of virtually all reactive and particulate phosphorus. The phosphorus that will remain after tertiary treatment is facility-specific and limited by recalcitrant compounds binding the phosphorous in solution.

From a permitting and compliance standpoint, long averaging periods or excursion allowances become important to WRRFs as concentration limit values decrease because a single excursion can make it virtually impossible to meet stringent monthly average limits. This is especially critical in regions like New England where cold seasons, snowmelt, and wet-weather events generally require treatment changes, and even the best operational responses may not always prevent an excursion.

Many alternatives are available to optimize conventional processes and provide tertiary phosphorus removal, including recent, proven advances in technology. To most effectively achieve lower phosphorus levels consistently, owners and operators should evaluate the best fit for their WRRF, considering constraints such as impacts to interdependent treatment processes, footprint area used, cost, compliance schedule, and regulatory constraints.

QUICK PRIMER: REMOVAL MECHANISMS AND LIMITS

Phosphorus enters the WRRF in particulate and soluble forms, and both forms contain reactive and non-reactive species. Of the non-reactive species a small soluble fraction called recalcitrant compounds (i.e., soluble non-reactive phosphorus or sNRP) cannot be removed by the WRRF (Water Environment Research Foundation [WERF], 2015). Typically these recalcitrant compounds are very low in domestic wastewater; however, they are more of a concern when treating industrial wastewater. The other forms of phosphorous can be treated at the WRRF. Conventional WRRF removal mechanisms include the following:

- **Biological treatment**. Biological treatment incorporates orthophosphate into the microbial cells of activated sludge biomass which is then removed in the waste activated sludge (WAS) stream. Uptake is enhanced by the presence of volatile fatty acids (VFAs) in anaerobic/anoxic zones.
- **Chemical treatment**. Chemical treatment adds aluminum, iron, or calcium salts to precipitate orthophosphate and form hydroxyl flocs through alkalinity side-reactions. The hydroxyl flocs remove additional orthophosphate through adsorption.
- **Solids separation**. In conventional WRRFs the phosphorus contained in floc material formed through either biological or chemical treatment is removed with clarifiers as part of the primary sludge and/or WAS stream. In advanced WRRFs it is removed as part of the filter backwash or tertiary clarifier sludge stream. A large variety of filtration and clarifier technologies are used in WRRFs. Microfiltration (MF) and ultrafiltration (UF) membranes can also be used as a separate tertiary filtration step or integrated into a membrane bioreactor (MBR) process.

While the following technologies are not widely used in WRRF applications, they have been demonstrated in long-term field trials for ultralow phosphorus applications:

- **Media adsorption/ion exchange**. Instead of adsorbing onto hydroxyl flocs, orthophosphate can adsorb onto specialty media, generally composed of some type of metal oxide. Traditional adsorption media were not ion-specific and could not be regenerated in-situ, limiting their feasibility for WRRF applications. A newer media, discussed below, has overcome those limitations.
- **Reverse osmosis (RO)**. RO rejects charged species such as orthophosphate as well as large organic compounds. Consideration must be given to reject brine disposal, permeate remineralization, and the high energy cost of RO in comparison to other alternatives.
- **Algal-based removal**. Instead of bacterial biomass, an activated sludge system based on algal biomass can be used to polish nutrients from effluents.

Table 1. Summary of typical approaches to achieve effluent TP limits

Annual average TP limit (mg/L)	Treatment approach
0.5 to 1	Upgrade/optimize conventional WRRF processes with fermentation to promote enhanced biological phosphorus removal or metal salt addition to promote co-precipitation and adsorption onto hydroxyl flocs
0.1 to 0.5	Add filtration to produce effluent with total suspended solids of less than 5 mg/L
<0.1	Add tertiary process

Depending on the required effluent TP limit, treatment technologies vary and a combination of biological, chemical, and physical methods may be necessary to meet ultralow levels (Table 1). For ultralow TP applications (<0.1 mg/L), laboratory procedures should also be reviewed. A study by WERF in 2009 found considerable variability in reported concentrations when multiple labs analyzed samples with ultralow concentrations of phosphorus. Although the standard ascorbic acid method can have a detection limit in the range of 5 to 10 μg/L, several substances commonly found in effluent samples, tap water, buffer solutions, and lab reagents can interfere with phosphorus analysis. Furthermore, the minimum reporting limit and practical quantification limit are typically 3.18 and 5 times higher, respectively, than the method detection limit.

OPTIMIZE CONVENTIONAL PROCESSES

Conventional biological and chemical phosphorus removal processes can be optimized in a number of ways. These include increasing volatile fatty acids (VFAs) to boost enhanced biological phosphorus removal (EBPR), providing multi-point chemical addition, and improving clarification.

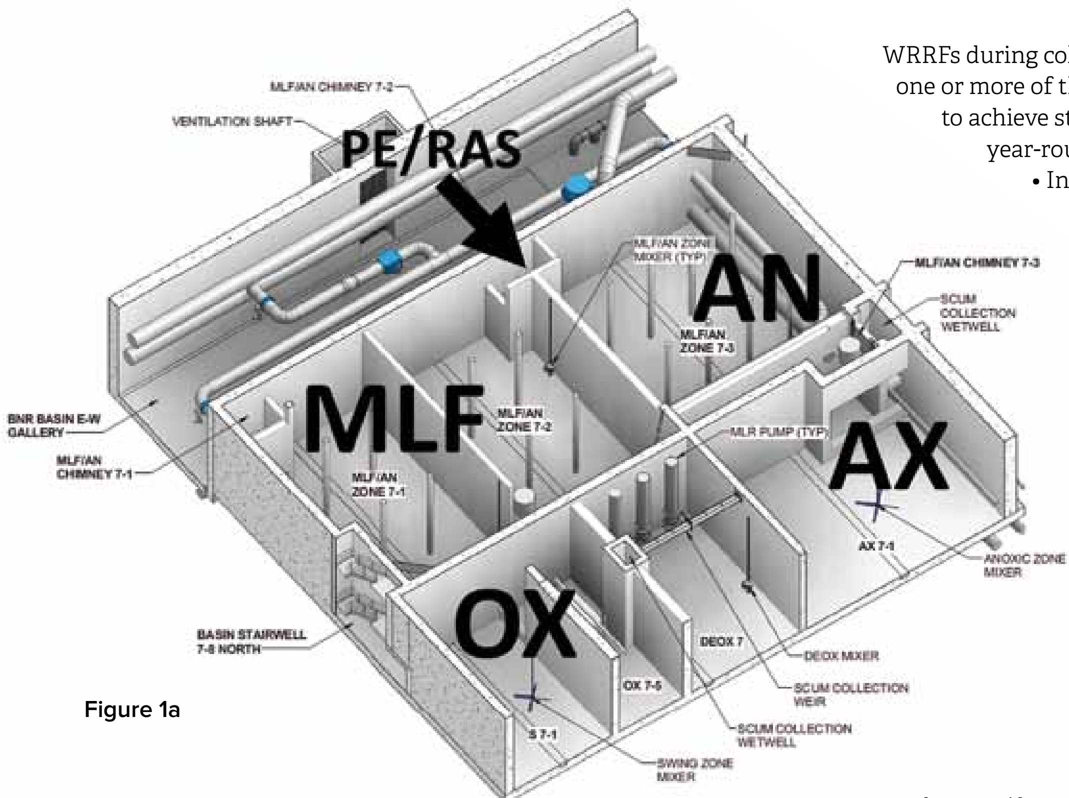

Figure 1a

Figure 1b

Examples of S2EBPR included in the design of biological nutrient removal upgrades for WRRFs in the U.S.:
Figure 1a. Mixed liquor fermenter included with the 181-mgd (685 ML/d) biological nutrient removal facilities of the EchoWater Project (Sacramento, California)
Figure 1b. Mixed liquor fermenter with five-stage Bardenpho process at the 5.3 mgd (20 ML/d) Cedar Creek Wastewater Treatment Facility (Olathe, Kansas)

Increasing volatile fatty acids to boost enhanced biological phosphorus removal

The key to reliable EBPR is sufficient VFA concentrations in anaerobic/anoxic zones to trigger the "luxury uptake" mechanism of phosphorus-accumulating organisms (PAOs) naturally present in activated sludge biomass. EBPR helps to reduce or eliminate the need for metal salt addition and becomes increasingly important as a WRRF desires to not only remove phosphorus but also recover it. However, the influent characteristics of many WRRFs during cold and wet conditions are such that one or more of the following options must be used to achieve stable and more complete EBPR year-round:

- Influent carbon preservation such as minimal air entrainment, volatilization, mixing, weir drops, and dissolved oxygen (DO) or nitrate carryover to the anaerobic zone.
- Fermentation of primary sludge or mixed liquor to boost VFA content is essential for EBPR in cold climates. This was first introduced to the United States in the 1990s at the 5.4 mgd (20.4 ML/d) advanced wastewater treatment facility in Kalispell, Montana. Primary sludge fermentation provides big boosts in VFAs. Mixed liquor fermentation provides smaller boosts, but may have cost savings since minimal or no additional capital is required to cycle mixers in anaerobic zones. The 10 mgd (38 ML/d) Eagles Point Wastewater Treatment Plant in Cottage Grove, Minnesota, optimized EBPR with fermentation in anaerobic zones, primary clarifiers, and a thickener/fermenter to overcome low influent VFAs and save approximately $80,000 per year by virtually eliminating metal salt dosing (Fitzpatrick et al., 2014).
- Sidestream EBPR (S2EBPR) is a promising option that can further improve performance and stability. S2EBPR can more efficiently produce VFAs from fermentation of mixed liquor or return activated sludge (RAS) and more efficiently use influent carbon in the primary sludge. This is done by fermenting secondary solids (mixed liquor or RAS) and as needed supplementing primary sludge fermentate in a sidestream anaerobic zone. Wet-weather stability is improved because fermentation and anaerobic zone processes are not taking place in the mainstream. Furthermore, the sidestream environment may favor bacteria which use VFAs for EBPR more efficiently than in the mainstream. S2EBPR was actually observed by Barnard in his original EBPR pilot studies (Barnard, 1976), and has been designed and is operating at a few WRRFs in the United States (Figures 1a and 1b; Fitzpatrick et al., 2014; Dunlap et al., 2014). Researchers are unraveling the fundamental mechanisms and microbial pathways behind these biological processes (Dunlap et al., 2016; Stokholm-bjerregaard et al., 2015).
- VFAs can drive denitrification and/or EBPR, depending upon permit requirements and the relative amounts of influent carbon, nitrogen, and phosphorus. Even without a total nitrogen limit, maximizing denitrification still aids oxygen and alkalinity recovery, and overall stability of the activated sludge process generally and EBPR particularly.

Struvite recovery to avoid unintended consequences

Because of the interrelationships between liquid and solids treatment trains, a change in one unit operation often changes another. For example, EBPR in combination with anaerobic sludge digestion can have unintended effects from increased struvite (magnesium ammonium phosphate) and vivianite (hydrated iron phosphate) crystallization and scaling in digesters, dewatering equipment, and related pumps and piping. Fortunately, struvite recovery mitigates these problems by minimizing nuisance scaling, reducing phosphorus and nitrogen recycle loads, reducing phosphorus content of biosolids, and improving biosolids dewaterability, while generating a high-grade fertilizer product for reuse (Shimp et al., 2014). If a WRRF has anaerobic digesters, struvite recovery should be considered as a part of an EBPR upgrade. This is an important consideration as WRRFs strive toward both energy neutrality and nutrient recovery.

Multi-point chemical addition

High doses of metal salts in the primary treatment step can cause nutrient deficiency and low alkalinity problems for downstream biological processes. Therefore, reaching low effluent limits with metal salts generally requires metal salt dosing points further downstream in the WRRF in the secondary clarifiers or in tertiary clarification or filtration units. At these points, phosphorus removal is dominated by adsorption onto hydroxyl flocs, and metal salt doses are commonly an order of magnitude higher than orthophosphate precipitation demand alone since the stoichiometry is actually governed by alkalinity reactions and physicochemical flocculation mechanisms to form the hydroxyl flocs.

Improve effluent clarification

Both biological and chemical methods convert orthophosphates to a solid form, either through the presence of a biochemical (e.g., VFAs) and subsequent uptake into biological solids or through the addition of metal salts for precipitation and adsorption onto hydroxyl solids. Ultimately solids separation is required to remove phosphorus from the liquid stream in either case. Since both methods increase the phosphorus content of effluent suspended solids, secondary clarifiers are critical to achieving low effluent phosphorus concentrations. Therefore, upgrades to improve clarifier performance should be considered, including the addition of energy-dissipating inlets, low-energy upflow inlets, and density current baffles at both effluent launder and inlet locations. As limits decrease, enhanced filtration becomes more necessary to reliably remove additional effluent total suspended solids (TSS) and the associated particulate phosphorus. Filters are generally added in the range of 0.5 mg/L to 0.1 mg/L of TP, depending largely upon the performance of the clarifiers and the averaging period of the limits in the facility's NPDES permit. Besides conventional granular media filters, pile cloth media and compressible media alternatives should also be considered as they offer similar particle capture but in a significantly smaller footprint.

Table 2. Example facilities achieving TP <0.1 mg/L*

Facility	Capacity mgd (ML/d)	Tertiary treatment approach	Average effluent TP (mg/L)
Snake River WWTP (Summit County, Colorado)	2.6 (9.8)	Alum, plate settlers, mixed media filters	<0.01 – 0.04
Rock Creek AWTF (Hillsboro, Oregon)	39 (148)	EBPR, alum, tertiary clarifiers, granular media filters	0.04 – 0.09
Upper Occoquan WRP (Centreville, Virginia)	42 (159)	High lime clarification, multimedia filters	0.02 – 0.1
Noman M. Cole Jr. WPCP (Fairfax County, Virginia)	67 (254)	EBPR, ferric, tertiary clarifiers, dual/mono media filters	0.02 – 0.13
Iowa Hill WWTF (Breckenridge, Colorado)	1.5 (5.7)	Alum, ballasted flocculation with concentrated sludge clarifier/thickener, continuous backwash upflow sand filter	0.017 – 0.13
Metro Syracuse WWTP (Onandaga County, New York)	126 (477)	Alum, sludge recirculation clarifier/thickener, continuous backwash upflow sand filter	0.05 – 0.09
Sturbridge WPCF (Sturbridge, Massachusetts)	1.6 (6)	Magnetite-ballasted BNR activated sludge, alum, tertiary magnetite-ballasted flocculation	0.039
Hayden Regional WWTP (Hayden, Idaho)	0.25 (0.95)	Ferric, 2-stage upflow reactive sand filter	0.009 – 0.036
Walton WWTP (Walton, New York)	1.6 (6)	PACl, 2-stage upflow sand filter	0.005 – 0.06
Lone Tree WRF (Arapahoe County, Colorado)	7.2 (27)	Membrane bioreactors	<0.05
Bundamba AWTP (Brisbane, Australia)	17 (64)	Clarifiers, MF, RO	<0.01

*USEPA, 2007; deBarbadillo et al., 2011

IF LIMITS GO LOWER

Effluent limits below 0.1 mg/L of TP drive the need to consider tertiary treatment, such as the approaches described below. Table 2 describes the approaches used at example facilities.

| THE LOWDOWN ON MEETING LOW PHOSPHORUS LIMITS |

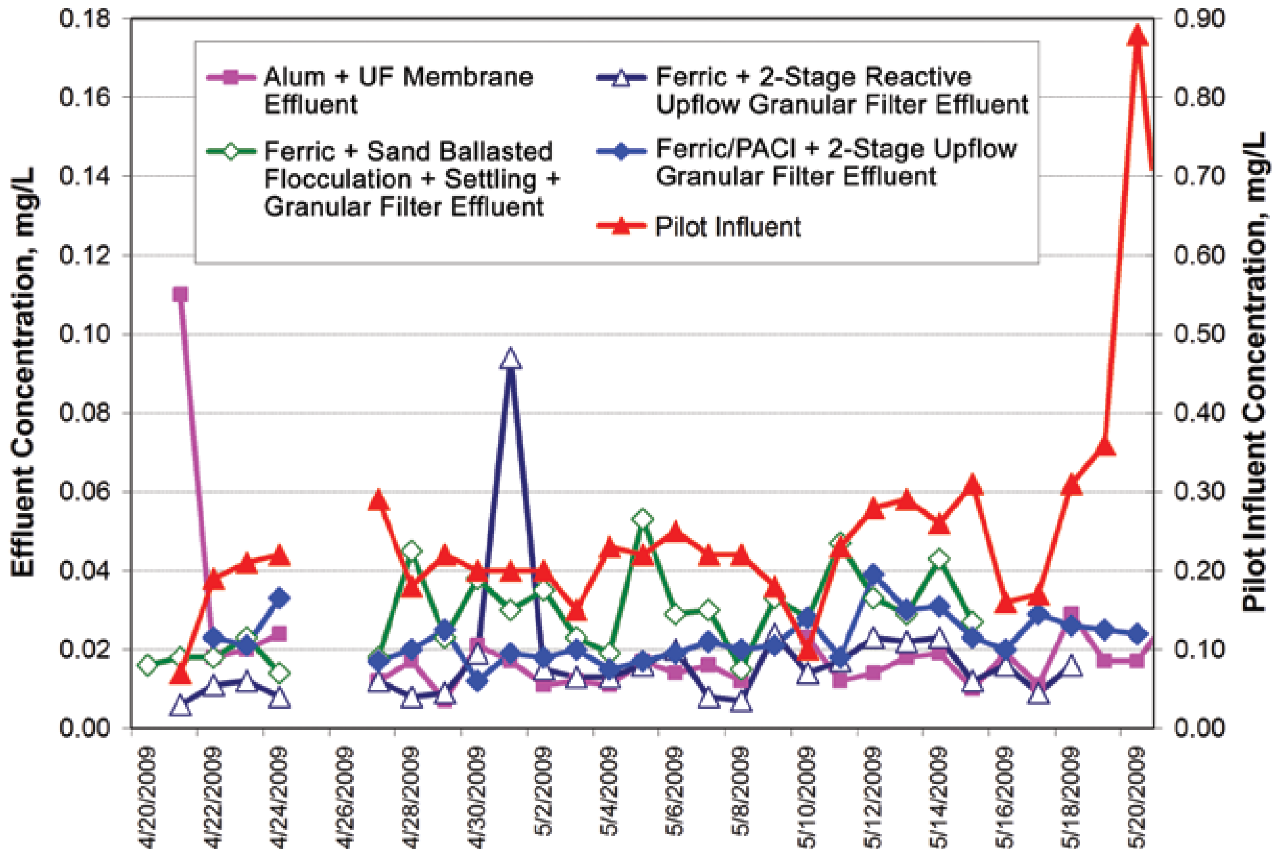

Figure 2. Side-by-side piloting at Innisfil, Ontario, demonstrated effluent TP<0.1 mg/L with four chemically enhanced settling and filtration tertiary treatment alternatives (deBarbadillo et al., 2011)

Tertiary chemical clarifiers and polishing filters
Chemically enhanced clarification followed by filtration has been used for decades to meet ultralow TP limits (deBarbadillo et al., 2011). Similar to conventional drinking water treatment processes, options generally include:

- Coagulant addition. Rapid mixing of aluminum, iron or calcium salts to precipitate orthophosphate, balance particle surface charges, and destabilize colloidal particles.
- Flocculant addition. Sometimes a polymer is added to help agglomerate small particles into large particles.
- Flocculation. Medium to low turbulence to build floc and "sweep" small particles into the flocs, conditioning the particles for efficient removal by settling and filtration.
- Clarification. Quiescent settling and filtration to separate solids from liquids.

Some proprietary processes use sludge recirculation and/or ballasted flocculation to increase floc density and settling rates, thereby decreasing clarifier size and detention. Lamella or plate settlers can also be used to further decrease settling footprint requirements. Effluent polishing filters may also be needed to reliably meet limits, depending upon how low the limit is and its averaging period.

Chemically Enhanced Two-Stage Filtration
Two-stage granular media filtration, which uses two up-flow, continuous backwash filters in series, also produces ultralow TP. The first filter removes the bulk of the phosphate precipitants, while the second polishes the effluent from the first. Two proprietary systems exist. One uses hydrous ferric oxide-coated sand that is continuously regenerated by dosing with a ferric salt. The other uses either ferric or aluminum-based salts to co-precipitate and adsorb phosphates onto hydroxyl flocs that are removed in the filters.

Membrane filtration
Microfiltration (MF) and ultrafiltration (UF) membranes may be used instead of other tertiary filtration technologies. Instead of a separate tertiary filtration step, these membrane filters may be incorporated into a membrane bioreactor (MBR) that can be designed with EBPR and/or chemical phosphorus removal. In reuse applications, membrane filters may also offer effluent polishing and disinfection advantages.

Reverse osmosis (RO) is a high-pressure membrane filtration process with much smaller pores than MF or UF membranes. RO has demonstrated the lowest effluent phosphorus concentrations of current technologies; however, because of high capital and operating costs, RO is usually only selected after

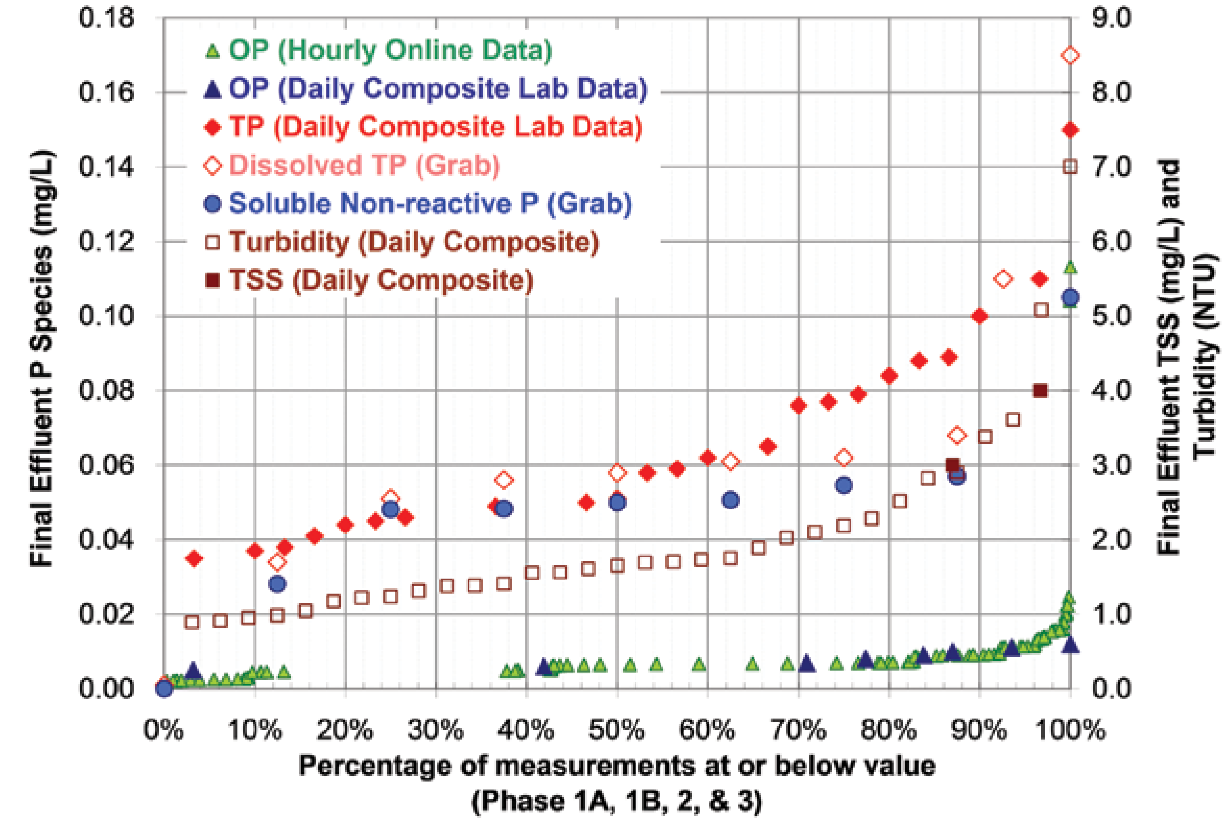

Figure 3. Extensive piloting at a midwestern United States WRRF demonstrated that one company's media adsorption process consistently produced orthophosphate and TP <0.01 and <0.1 mg P/L, respectively. Larger-scale and longer-term pilots in Japan have demonstrated even lower effluent concentrations.

ruling out less expensive alternatives. Permeate remineralization and brine disposal are other challenges with RO-based solutions.

COMPARATIVE PILOT STUDIES

Several side-by-side pilot studies have been conducted using these technologies. For example, the following technologies were tested in 2009 while evaluating possible upgrades to the Lakeshore Water Pollution Control Plant (Innisfil, Ontario): microsand-ballasted flocculation followed by lamella settlers and filtration; two different two-stage filtration systems; and UF membrane filtration. As shown in Figure 2, each technology generally removed phosphorus to below 0.04 mg/L. Pilot testing in Westborough, Massachusetts, and Coeur d'Alene, Idaho, yielded similar results.

OTHER EMERGING TECHNOLOGIES

New technologies continue to be developed and are emerging in the WRRF market, including those described below.

Media adsorption/ion exchange with phosphorus recovery
Instead of adsorbing phosphates onto aqueous metal hydroxyl flocs, these technologies adsorb phosphates onto a fixed media bed and offer minimal sludge formation. Adsorbent media such as activated alumina and iron oxides have been piloted but are not widely used, most likely due to relatively slow removal rates, non-selectivity for phosphates over competing anions, and infeasibility of in-situ regeneration. However, one company has developed a new adsorbent media without these shortcomings and offers a process for removal and recovery of phosphorus as a high-grade fertilizer product. Long-term pilot studies completed at WRRFs in the United States and Japan demonstrated this media's ability to produce effluent with ultralow TP (Figure 3; Fitzpatrick et al., 2016).

As illustrated by Figure 4, the process uses caustic (NaOH) for media desorption and in-situ regeneration followed by an acid rinse for neutralization. Since no ferric or aluminum chemistry is used, adsorption and desorption may be integrated with struvite recovery (see above) instead of the calcium phosphate recovery process shown here. Coupled with EBPR, this alternative would allow a WRRF to achieve ultralow TP limits without the use of ferric or aluminum salts.

Algal-based removal systems
Another class of phosphorus removal technologies uses algae to remove phosphorus from wastewater, effluent or surface water. Algal-based systems have traditionally relied on lagoons or engineered wetlands, which have much larger footprints than

| THE LOWDOWN ON MEETING LOW PHOSPHORUS LIMITS |

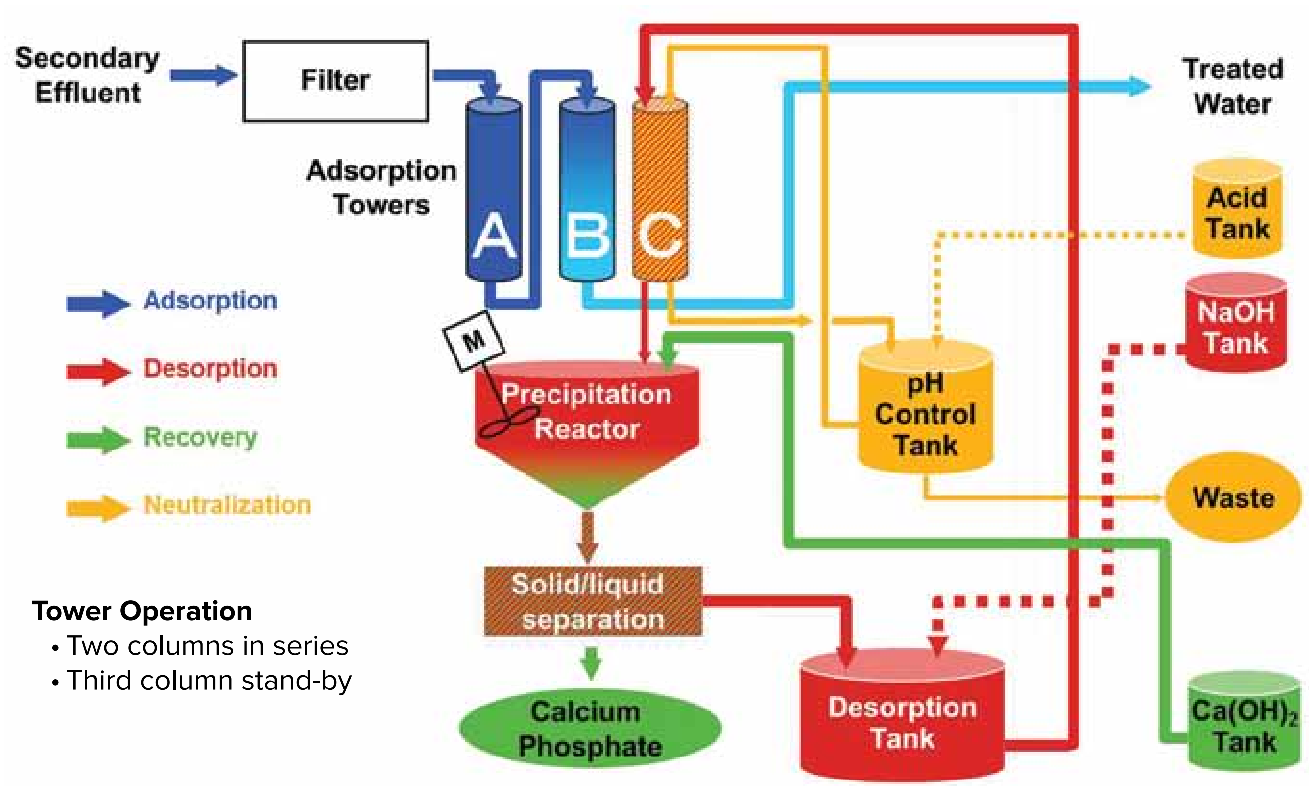

Figure 4. Process flow diagram of adsorption and recovery process to achieve TP<0.1 mg P/L using media discussed in Figure 3

conventional WRRFs and are generally not feasible in urban settings. However, emerging technologies are modeled after traditional activated sludge processes but use algal-based instead of bacterial-based microbiology.

CONCLUSIONS

Many alternatives exist for WRRFs to meet stringent phosphorus limits. Some technologies have been proven for decades, while newer technologies are emerging that build upon the success of previous generations and aim to address potential shortcomings or new needs. Arriving at the best-fit solution requires a customized approach to evaluating these alternatives against the unique constraints of your WRRF, which should include considerations for:

- Characterization of influent carbon, nitrogen, and phosphorus species to help optimize physical, chemical, and biological processes
- Impacts to facilities and operations, including inter-dependent solids and liquid treatment processes (especially anaerobic digestion)
- Site constraints such as available space, geotechnical characteristics, and constructability
- Costs, affordability, and funding
- Schedule
- Regulatory requirements
- Energy neutrality and resource recovery goals of the utility

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Manchester's upgraded treatment facility achieves low nutrient levels—protecting Long Island Sound and the Hockanum River

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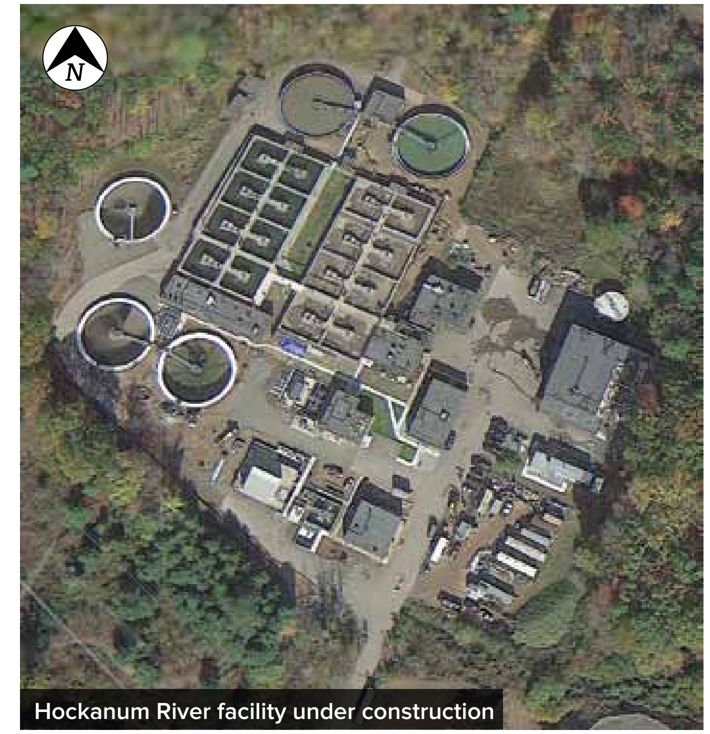
ABSTRACT | The town of Manchester, Connecticut, owns and operates the Hockanum River Water Pollution Control Facility (HRWPCF). Constructed in the 1950s, the HRWPCF was upgraded to secondary treatment in the 1970s and expanded in the 1990s to meet seasonal ammonia limits. Since the last expansion the town has faced a number of challenges, including more stringent nitrogen and phosphorus requirements. A comprehensive upgrade was recently completed including nutrient removal processes and an innovative mixer-aerator system that maximizes performance and operational flexibility. Low-level nitrogen limits were achieved without significant structural modifications existing tanks or construction of additional aeration tanks. The HRWPCF is meeting effluent nitrogen limits without purchasing credits through the state Nitrogen Credit Exchange, saving Manchester more than $200,000 in annual credit purchases. It also achieved effluent phosphorus of less than 0.1 mg/L during performance testing and is meeting new effluent phosphorus limits that went into effect in April 2016.

KEYWORDS | Nitrogen removal, phosphorus removal, mixer-aerator, ballasted flocculation

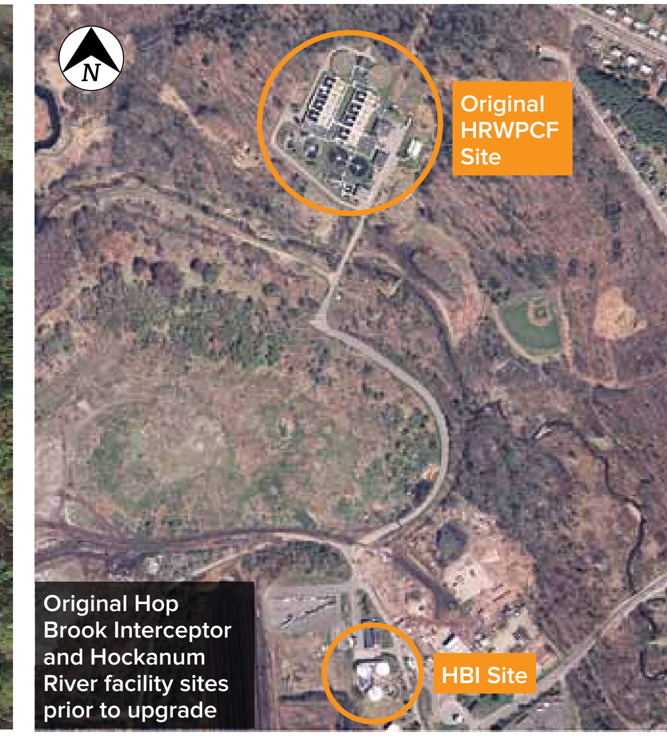
A historic textile mill on the Hockanum River

INTRODUCTION

The town of Manchester, Connecticut, recently completed a comprehensive upgrade of its aging water pollution control facility. Wastewater treatment at the site, located along the Hockanum River, dates to the 1930s when a privately owned and operated treatment facility was designed to treat industrial wastewater from nearby mills. In the mid-1950s, a municipal primary treatment facility was constructed at the site. The process included comminutors, grit removal, primary treatment, disinfection, and anaerobic digestion. This primary treatment portion is known as the Hop Brook Interceptor (HBI) site. A "sister plant" was also constructed across town in the 8th Utilities District section of Manchester.



Hockanum River facility under construction



Original Hop Brook Interceptor and Hockanum River facility sites prior to upgrade

In 1971, a new secondary treatment facility—the Hockanum River Water Pollution Control Facility (HRWPCF)—was constructed to accept primary effluent from the HBI site. The 8th Utilities District treatment facility was abandoned and these flows were redirected to the HRWPCF, where they received preliminary treatment (screening and aerated grit removal) prior to being pumped into the aeration tanks for secondary treatment. Flows from the HBI site continued to receive preliminary and primary treatment locally and then were transported approximately 0.5 miles (0.8 km) to the HRWPCF secondary treatment facilities where it was combined with the 8th Utilities District flows (now known as the North Manchester Interceptor (NMI) flows).

The HRWPCF underwent another major upgrade in the early 1990s. Capacity was expanded to 8.2 million gallons per day (mgd) (31 ML/d) of average daily flow, and the facility was upgraded to meet seasonal ammonia limits. As part of this upgrade, new primary sedimentation tanks were constructed at the HRWPCF site, and the primary clarifiers at the HBI site were demolished. The upgraded HRWPCF also included new aeration tanks and final clarifiers, and the facility later converted from gaseous chlorination and dechlorination to UV disinfection in the mid-2000s.

The HRWPCF had served the community well for many years. However, much of the equipment was more than 20 years old and many of the structures were 40 to 60 years old. The town's Water and Sewer Department faced other long-term operating concerns, including:

- Increasingly stringent nitrogen removal requirements resulting in increasing nitrogen credit costs, along with uncertainty over the long-term viability of the credit trading program. [Note: Nitrogen credits are a regulatory mechanism in the Nitrogen Credit Exchange program implemented in 2002 by the Connecticut Department of Energy and Environmental Protection (CT DEEP), which limits state-wide nitrogen loadings to Long Island Sound.]
- Stringent phosphorus limits anticipated to be part of the HRWPCF's upcoming discharge permit renewal.
- Reduced reliability of sludge digestion and dewatering systems.
- Aging and energy-inefficient unit processes, equipment, and building systems with increasing operating costs and increasing corrective maintenance requirements.
- The need to identify a biosolids disposal plan to address increasing disposal costs and the potential closure of the town's landfill where the HRWPCF disposed of biosolids.

Because of these factors, the Water and Sewer Department upgraded the facility, including converting the HRWPCF's secondary treatment system to a new 8.2 mgd (31 ML/d) four-stage Bardenpho process to reduce Total Nitrogen (TN) to below the 2014 discharge limit of 312 lb/d (141.5 kg/d) (below a concentration of 4.6 mg/L TN at the design flow rate of 8.2 mgd [31 ML/d]). Prior to the upgrade, the HRWPCF was discharging more than 1,000 lb/d (454 kg/d) TN and purchasing more than $200,000 per year in nitrogen credits through the state's Nitrogen Credit Exchange. These costs would only increase as the unit price of nitrogen credits and flows to the facility increased. The upgrade also included the addition of a tertiary ballasted flocculation system for effluent phosphorus removal. Beginning in April 2016, the HRWPCF must meet a seasonal effluent phosphorus limit of 13.21 lb/d (6 kg/d) (equivalent to 0.19 mg/L at the design flow rate).

NITROGEN REMOVAL AT THE HOCKANUM FACILITY

The HRWPCF was upgraded to provide seasonal ammonia removal in the early 1990s. As part of the 1990s upgrade, additional aeration tanks were added so that four trains of aeration tanks held a combined volume of 4.48 million gallons

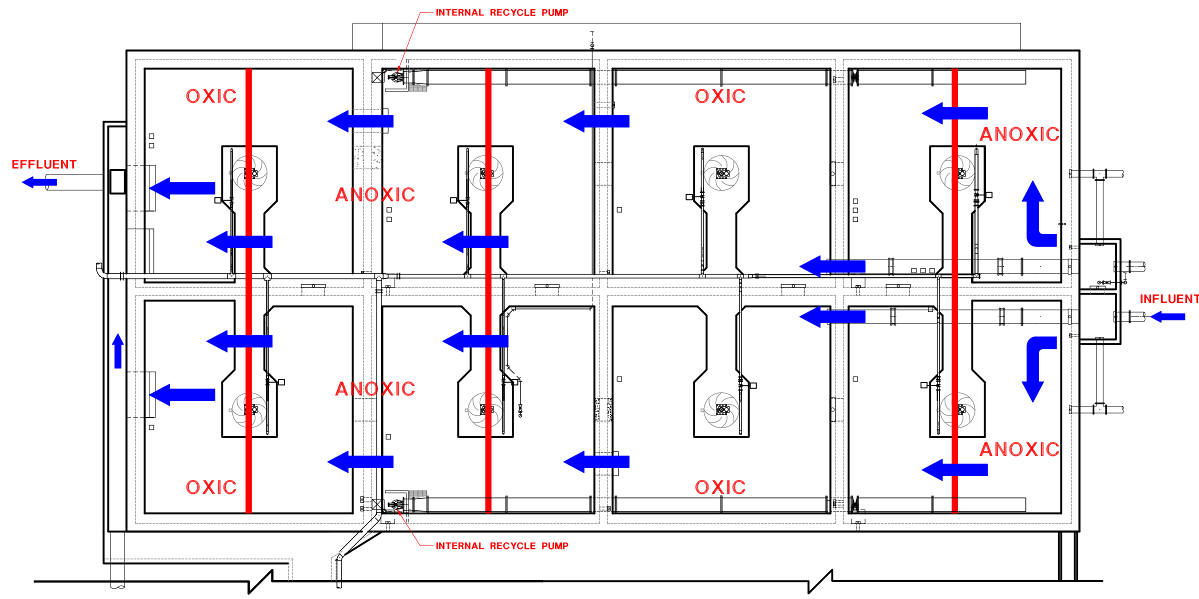


Figure 1. Four-train process alternative

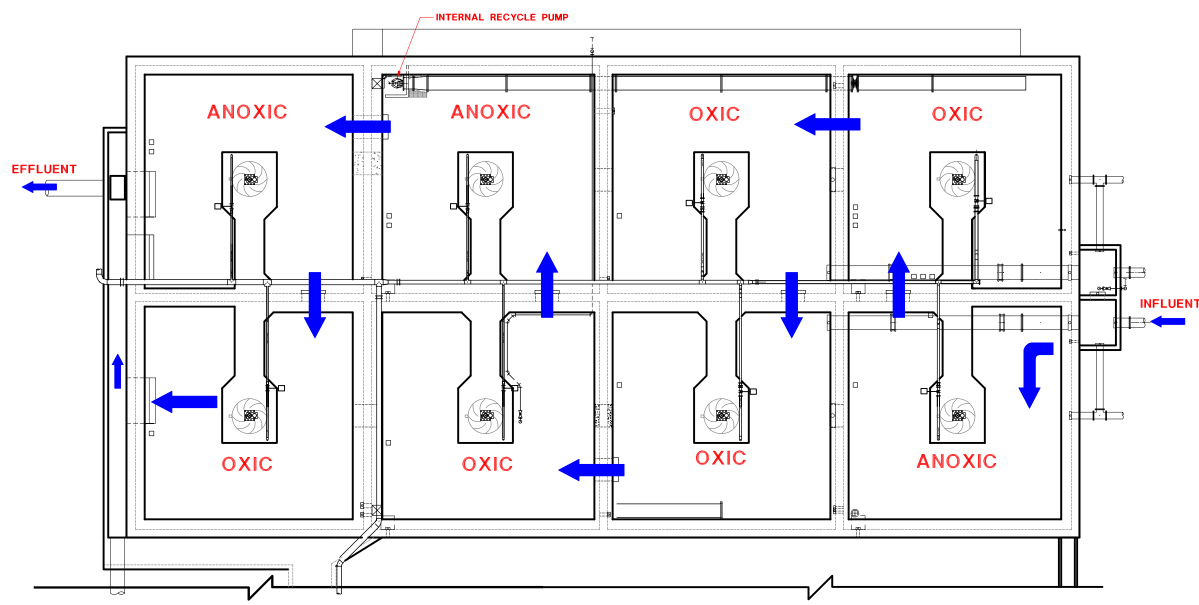


Figure 2. Two-train process alternative

(16.96 ML) each equipped with four individual aeration banks. Each bank had a two-speed mechanical surface aerator, for a total of 16 mechanical aerators. As part of the design of this most recent upgrade, a biological, chemical, and physical treatment process model was developed for the HRWPCF using BioWin modeling software. The model was refined, calibrated, and verified based upon current facility performance. This model was then used to evaluate various process alternatives for biological nitrogen removal as well as for a combination of biological nitrogen and phosphorus removal processes. These evaluations determined there was sufficient available aeration tank volume to convert the HRWPCF to a four-stage Bardenpho process without adding treatment tankage.

Reconfiguring the existing tanks into a four-stage Bardenpho process was a challenge, and two alternatives were devised and evaluated. The conventional approach initially considered maintaining four parallel aeration trains and converting each train into a four-stage Bardenpho process. A fine bubble diffused aeration system would replace the aging and inefficient mechanical surface aerators. New baffle walls within specific banks of the aeration trains would be needed to create the necessary anoxic and aerobic volumes in each train. In addition, separate mixing would be required for the anoxic zones. (See Figure 1) While this approach would work, it would require new baffle walls in 12 of the 16 aeration banks and 12 mechanical mixers in addition to the fine bubble diffused aeration system.

Maintenance of the aeration system was also a concern, especially when the operators learned there would be approximately 8,000 diffuser discs.

Fortunately, some of the operators had been at the plant since before the 1991 upgrade and understood that the two original aeration tanks had been designed to operate as one tank with a serpentine flow path. This knowledge was used to develop an alternative scenario that would include operating two parallel aeration trains of eight banks each rather than four aeration trains of four banks each. If each train was operated in a serpentine flow path, the necessary anoxic and aerobic tank volumes within the existing banks could be achieved without new baffle walls. Structural modifications would be limited to cutting ports between adjacent banks to create the serpentine flow path and adding additional gates. (See Figure 2)

This process alternative, while attractive, still left concerns about system redundancy. With only two aeration trains, there was a concern it would be necessary to take down half of the aeration volume to conduct maintenance. To resolve this, a mixer-aerator system was incorporated into the design. Each of the 16 banks had a hyperbolic mixer-aerator system. (See Figure 3) This provided for numerous process benefits and operational flexibility, including the following:

- The aerator platforms could be reused.
- Each of the 16 banks could be operated in either an anoxic or aerobic condition. Therefore, if one or two banks had to be taken down in an aeration tank, the rest of the tank could be operated in a cyclic aeration mode to maintain nitrogen removal.
- Mixing and aeration of the equipment were independent. Therefore, it was not necessary to over-aerate specific zones to maintain the required mixing intensity. For example, using typical aeration mixing requirements, each bank, which is 50 by 50 feet (15.24 by 15.24 m) or 2,500 square feet (232 m^2), would have mixing air requirements of 0.12 scfm/ft^2 (2.19 $m^3/hr/m^2$) or 300 scfm (509 m^3/hr) in total. However, with the hyperbolic mixer providing the mixing energy, aerobic zones at the end of the process can be maintained at much lower aeration levels, while still meeting process needs for mixing and thus saving significant energy.

PHOSPHORUS REMOVAL AT THE HRWPCF

The town of Manchester has proactively addressed upcoming phosphorus limits. During planning, CT DEEP was beginning to develop its state-wide phosphorus initiative. As the town's project moved into design, CT DEEP's program became more refined, and the HRWPCF learned it would have to meet a seasonal average effluent phosphorus limit of 13.21

Figure 3. Hyperbolic mixer-aerator being installed and operational (top right)

Figure 4. Tertiary treatment facility under construction

lb/d (6 kg/d) between April 1 and October 31 each year. This is equivalent to a concentration of 0.19 mg/L at the design flow rate. However, CT DEEP had also cautioned that limits could go lower in the future.

Several alternatives were considered for phosphorus removal at the HRWPCF. Because of the low limits and possibility of future reduction, a tertiary phosphorus removal system was selected. Combining this with enhanced biological phosphorus removal through a five-stage Bardenpho process was also considered. However, given the relatively low organic loadings at the HRWPCF, it was decided to maximize the use of available carbon for nitrogen reduction and rely on the tertiary process for phosphorus removal.

A ballasted flocculation system was selected and installed as the tertiary process (see Figure 4). The process uses ferric chloride, polymer, and microsand to precipitate and remove effluent phosphorus. In addition, the ability to add ferric chloride to the primary and secondary clarifier influent was provided to help achieve some phosphorus removal prior to the tertiary process

Within the ballasted flocculation system, the floc formed with the microsand settles rapidly and results in a high sedimentation rate in an extremely small footprint. This was a significant benefit at the HRWPCF compared to the results of other phosphorus removal technologies. Although the HRWPCF is designed for 8.2 mgd (31 ML/d), plant flows can increase to greater than 24 mgd (90.9 ML/d during wet weather. To accommodate future peak hour flows, the ballasted flocculation system has two parallel trains, each capable of handling peak flows up to approximately 14 mgd (53 ML/d).

The HRWPCF site is tight with wetlands on three sides and an easement for high-voltage power lines on the fourth. Space for a tertiary process was limited. The ballasted flocculation system, including process tankage, the building for chemical and polymer storage, pumping systems, and electrical equipment was able to be installed in a portion of the space previously occupied by two shallow 80 ft-(24.3 m)-diameter secondary clarifiers. These 1970s clarifiers were typically not used and were demolished as part of this upgrade. This allowed incorporation of the phosphorus removal process without going outside the fence line of the facility.

NITROGEN AND PHOSPHORUS REDUCTION IMPROVEMENTS

Nitrogen removal

The HRWPCF upgrade took nearly four years to complete due to construction sequencing. Because of the tight site, construction had to be sequenced and carefully coordinated to maintain effluent quality within the HRWPCF's permit requirements.

During construction, new processes became partially available to plant staff, so their full functionality was not available immediately. Each aeration train was modified one at a time while the other train operated under original conditions. The first train with the four-stage Bardenpho process had to be brought on line using temporary electrical power and limited process control due to sequencing within the main electrical room. Once the second train was available, the first train had to be taken off line to complete the permanent electrical installations and complete the process and instrumentation control system. Therefore, nitrogen removal processes became available to the operations staff slowly and were not fully available until near the end of construction.

While operating with the mechanical surface aerators, the HRWPCF achieved an effluent TN of between 1,000 lb/d (454 kg/d) and 1,200 lb/d (544 kg/d) (approximately 18 mg/L to 20 mg/L on average). Although the facility fully nitrified, the original facility was not designed to denitrify. The HRWPCF reduced effluent nitrogen some through cycling two of their mechanical surface aerators, allowing dissolved oxygen levels to decrease temporarily. Even with such reductions, by the time the new nitrogen removal facilities became available, the HRWPCF was purchasing more than $200,000 in nitrogen credits.

When the first two aeration tanks came on line, the process control system was not yet available. Staff had to manually set the blower air flow rates and manually adjust valves at each of the eight aeration drop legs. Despite these control limitations, the HRWPCF significantly reduced effluent TN to between 400 lb/d (181 kg/d) and 600 lb/d (272 kg/d) (approximately 7 mg/L to 10 mg/L on average) with only half of the process operational.

The third and fourth aeration tanks became available in early 2015 along with the completed process control system. Prior to these additional tanks coming on line, the HRWPCF had difficulty maintaining nitrification due to the unusually cold winter, a problem experienced by other WPCFs throughout Connecticut. Once the full system came on line, and the water temperature began to increase, the HRWPCF, flowing at 6.2 mgd (23.5 ML/d) on average, reduced effluent TN to 400 lb/d (181 kg/d) (approximately 7.7 mg/L based on plant flows at that time). This was much better than before but not enough to avoid purchasing nitrogen credits.

The last task was getting the supplemental carbon dosing system on-line. As discussed above, the organic loading coming into the HRWPCF is low and not enough carbon was entering the facility. Therefore, a supplemental carbon addition system was provided, which was designed to accommodate either methanol or glycerine-based carbon products. The HRWPCF currently uses a glycerine-based product due to safety concerns over methanol storage and handling, and it began adding supplemental carbon in the summer of 2015. Effluent TN quickly dropped to below their 312 lb/d (141.5 kg/d) (equivalent to less than 6 mg/L TN at current flows) seasonal average goal under the State of Connecticut General Permit for Nitrogen Discharges. Facility staff maximized nitrogen removal for the rest of 2015 by adjusting the dose of supplemental carbon to offset the higher concentrations at the beginning of the year to minimize the need to purchase credits. Loadings were reduced in some instances to about 100 lb/d (45 kg/d) (equivalent to about 2.5 mg/L at the flows during that time). (See Figure 5) Since the beginning of 2016, supplemental carbon dosage is adjusted to keep the facility below its limit without overdosing chemicals. Supplemental carbon dosage and chemical costs have been reduced while still meeting their effluent TN limit.

| MANCHESTER'S UPGRADED TREATMENT FACILITY |

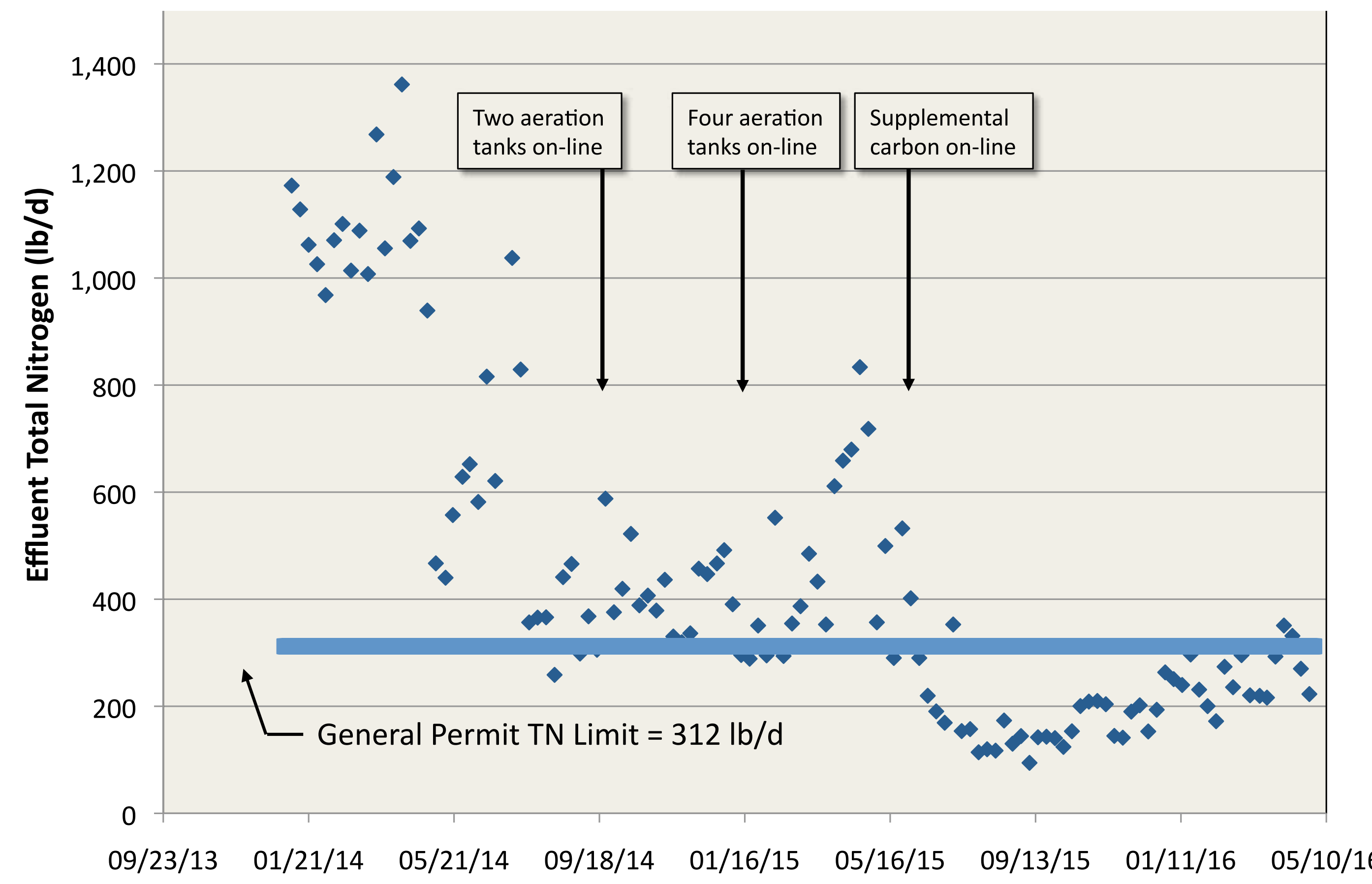


Figure 5. Effluent total nitrogen performance

Phosphorus removal

The HRWPCF typically averaged between 1.5 and 2.5 mg/L in effluent total phosphorus prior to the recent upgrade. The tertiary ballasted flocculation system reduces the effluent phosphorus from approximately 1 mg/L to less than 0.15 mg/L. Performance testing was required to demonstrate that the system could achieve lower concentrations (less than 0.1 mg/L) in case the effluent permit limits are reduced further in the future.

The HRWPCF can add ferric chloride in three locations:

1. The primary distribution box (primary influent)
2. The secondary distribution box (secondary clarifier influent)
3. Influent to the ballasted flocculation system

In addition, the tertiary sludge is sent back to the primary clarifiers for co-settling so that any residual ferric may react with influent phosphorus. The goal of the multi-point addition system is to minimize chemical usage and maintain a phosphorus concentration of less than 1 mg/L going into the ballasted flocculation system.

The HRWPCF initially began adding ferric chloride to the primary distribution box in the summer of 2015. Prior to this, the plant effluent total phosphorus ranged from 40 lb/d (18 kg/d) to as much as 80 lb/d (36 kg/d). By adding ferric at the primaries, effluent total phosphorus was reduced to between 20 and 35 lb/d (9 and 16 kg/d), equivalent to approximately 0.5 to 0.9 mg/L at current flows. The facility then put the tertiary ballasted flocculation system on line and demonstrated it could achieve well below its seasonal permit limit of 13.21 lb/d (6 kg/d). Because the HRWPCF was not required to meet these limits until April 2016, the chemical feed systems were shut down at the end of the demonstration testing with resulting effluent phosphorus concentrations returning to previous levels. (See Figure 6) Since that time, the HRWPCF started up the tertiary system again in the spring of 2016 and is meeting its new effluent total phosphorus limits. Additionally, the facility is finding sufficient unreacted ferric in the tertiary sludge, so no ferric chloride has to be added to the primary influent.

PROJECT SUMMARY

The town of Manchester recognized the need to upgrade its aging facilities. As part of the upgrade, the town wanted to improve the energy efficiency of its facility and reduce the need to purchase nitrogen credits. It also recognized that it would soon face stringent phosphorus limits to improve local water quality. Although the town had not been issued

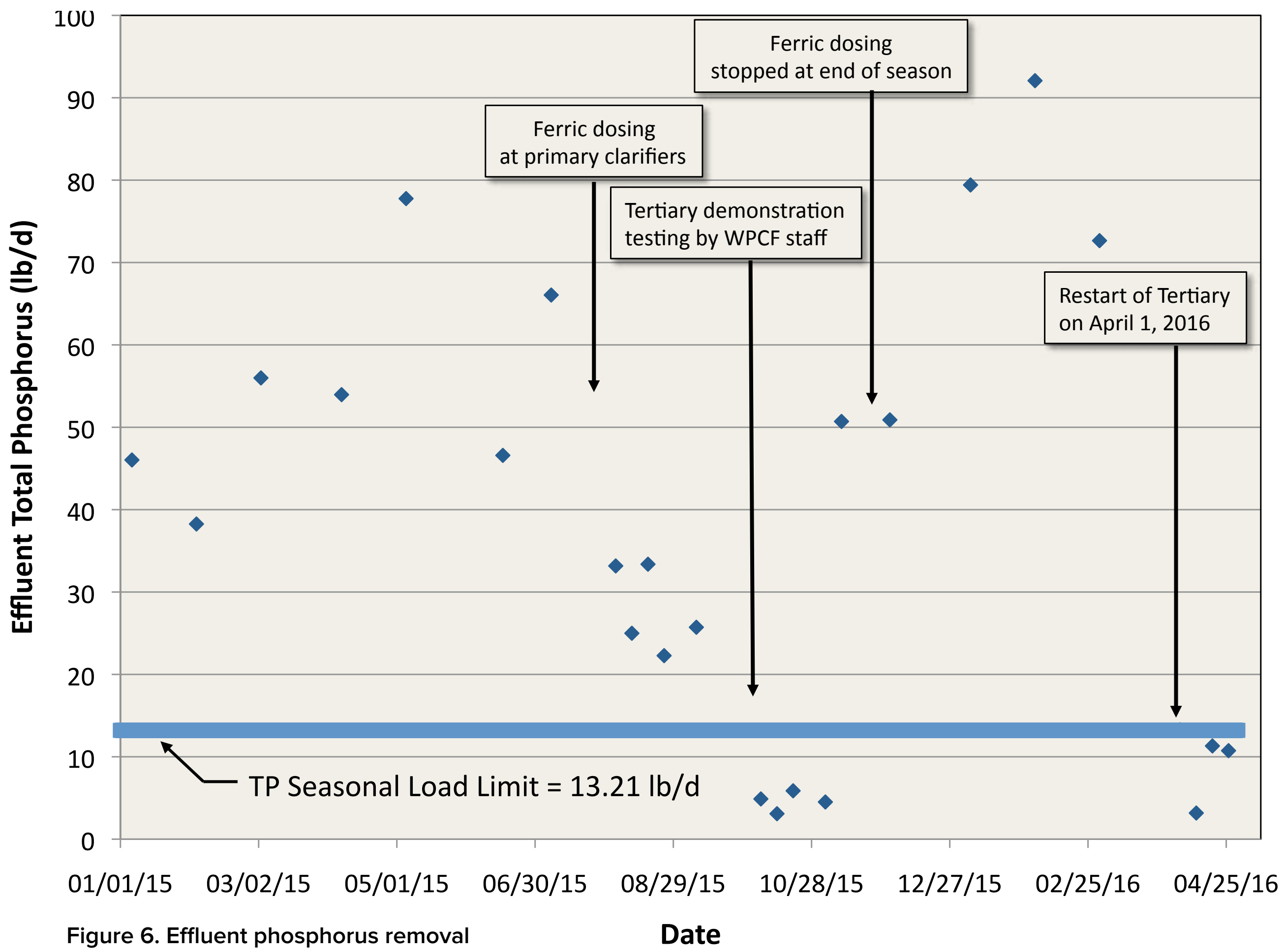


Figure 6. Effluent phosphorus removal

a permit with phosphorus limits prior to starting the design, it proactively incorporated phosphorus removal into the project.

HRWPCF staff was involved in the planning and design of the upgrade. Recognizing that they would be responsible for operating and maintaining these facilities for years to come, they wanted to make sure they had a voice. Because of these joint efforts and their knowledge of the facility, creative solutions were developed to reuse tankage for nitrogen removal with minimal structural improvements. Staff was also open to newer technologies, such as the hyperbolic mixer-aerator system, which allowed creative solutions and maximized operating flexibility.

Through this collaborative partnership, the HRWPCF upgrade has been completed, and the facility has demonstrated it can meet nutrient removal goals. In addition, the facility has a modern control system that allows better operational control, and savings in energy and chemical costs. These new energy-efficient systems also qualified for nearly $300,000 in energy rebate grants from the local power company.

AUTHORS

- Christopher Pierce, P.E., is a vice president in Wright-Pierce's Middletown, Connecticut office.
- W. Douglas Hankins, P.E., is Wright-Pierce's technical leader—secondary and tertiary systems and is located in in Portland, Maine.
- Michael Emond is the superintendent of the HRWPCF in Manchester, Connecticut.
- E. Ray Weaver is the process control supervisor for the HRWPCF in Manchester, Connecticut.

Executive Committee recommends bylaws update

The Executive Committee has voted to recommend amendments to the NEWEA Constitution and Bylaws that would eliminate the officer position of Secretary. The history and background of this recommendation are described below.

BACKGROUND

The Secretary position was created in the 1990s to take some pressure off the increasingly complex role of the Executive Director, whose assignments included recording and distributing the minutes of Executive Committee meetings. Per Bylaws article 9.1.10, the intention of the added secretary office was to fulfill the duty to "Record, finalize and distribute the minutes of the Executive Committee meetings." The position was designated as an officer position in an attempt to make it attractive to those who might be seeking to increase their involvement in NEWEA official activities. However, the nature of the duties made it a challenge to find candidates willing to perform the duty that, while necessary, tends to be mundane and unexciting at best. It has been difficult to find willing candidates for the position, and more difficult to maintain enthusiastic participation once the limited and pedestrian nature of the official duties is realized. In addition, there have been wide swings in the format and timeliness of the recorded minutes over the time that this function has been handled by officers who have often been recruited and cajoled into accepting the position.

> **"…It makes good sense to return the recording secretary duties to the NEWEA Executive Director and staff, and to eliminate the secretary position from the NEWEA officer roster"**

In the time since the position was established, NEWEA has added administrative staff to the Executive Director's office, and it has been determined that there is sufficient staff support to allow the Executive Director's office to comfortably assume the task of recording, finalizing, and distributing the minutes of Executive Committee meetings. In order to reduce the onus placed on the Nominating Committee of finding a candidate for this routine task, and to increase the timeliness and uniformity of Executive Committee record-keeping, the Executive Committee has agreed that it makes good sense to return the recording secretary duties to the NEWEA Executive Director and staff, and to eliminate the secretary position from the NEWEA officer roster. This change requires redrafting of several sections of the bylaws, which also necessitates a review (for uniformity and accuracy) by the WEF Constitution and Bylaws Committee, as NEWEA is a Member Association of WEF.

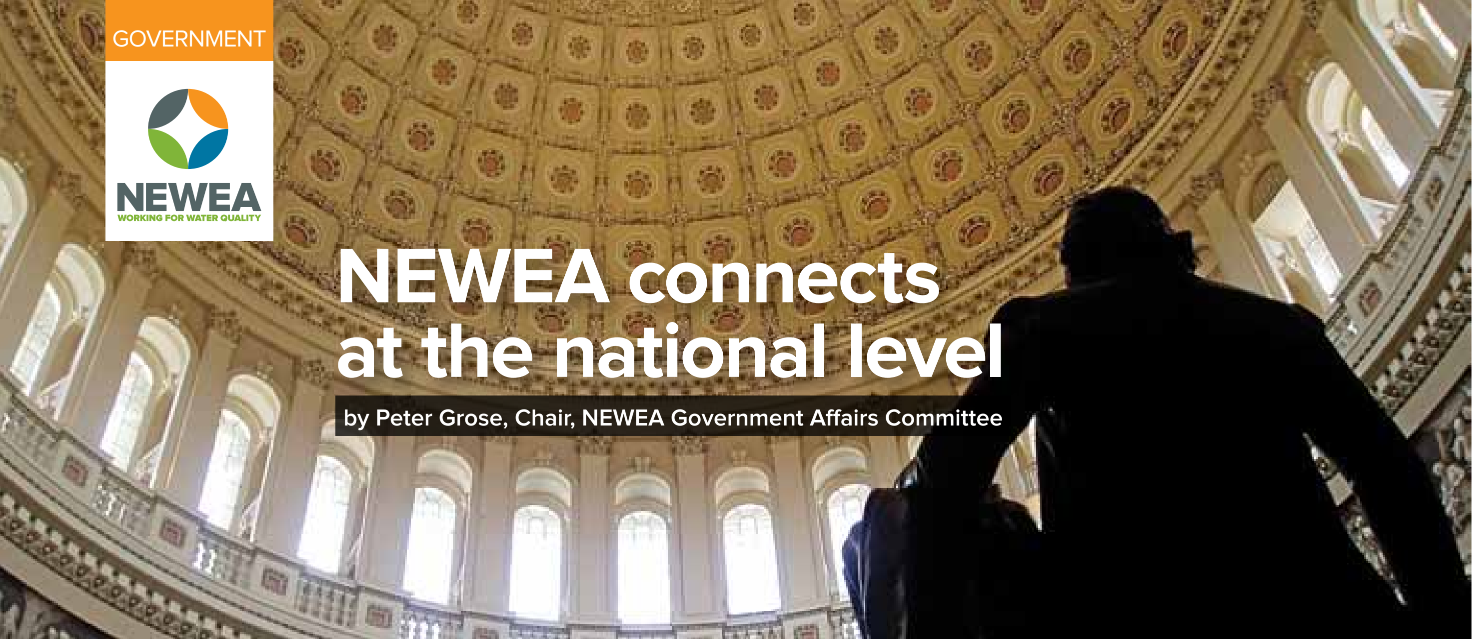
SPECIFIC CHANGES

The changes necessary to accomplish this amendment to the NEWEA Constitution and Bylaws are as follows:

- Add the task currently described in Article 9.1.10.2 to the list of Executive Director duties listed under Article 10.1, and as necessary renumber remaining duties.
- Delete article 9.1.10 and its subarticles entirely from the Bylaws, and renumber the ensuing article accordingly.
- Remove the title "Secretary" from officer listings and notations in the following sections of the NEWEA Bylaws: 6.6.1, 7.1.1, 9.2.1, 9.3.1, and 14.2.4.2.
- There are also some minor typographic errors elsewhere in the bylaws that have been addressed.

The above amendments have been reviewed and approved by the NEWEA Bylaws Committee, the WEF Constitution and Bylaws Committee, and the NEWEA Executive Committee, and this announcement will serve as the formal notification to the NEWEA membership of the recommended changes. The amended Constitution and Bylaws will be submitted to the membership for an adoption vote at the Annual Business Meeting on January 23, 2017 as per the requirements of Article 18 of the NEWEA Bylaws.

Questions regarding this amendment may be directed to the NEWEA Executive office or to Douglas Miller, the chair of the NEWEA Bylaws Committee (dlmiller@maine.rr.com). Please visit the NEWEA member website to review the annotated (or updated) version of the NEWEA Constitution and Bylaws at NEWEA.org, or if preferred, a printed copy of the bylaws with annotated changes may be requested from the NEWEA office.



NEWEA connects at the national level

by Peter Grose, Chair, NEWEA Government Affairs Committee

NEWEA joined many other state, regional, and national water quality organizations in April to speak out to Congress on behalf of our water environment. NEWEA was part of the National Water Policy Fly-in sponsored by the Water Environment Federation (WEF), National Association of Clean Water Agencies (NACWA), and Water Environment Research Foundation (WERF) that engaged in a variety of congressional activities to support our common causes.

The importance of speaking to our congressional representatives was particularly acute this spring, as the Environmental Protection Agency (EPA) has proposed a fiscal year 2017 budget that would cut the Clean Water State Revolving Fund (CWSRF) by 30 percent. This is the main funding that flows through our states to provide critical financial assistance to municipal and regional utilities for wastewater system upgrades. The CWSRF has been funded at about $1.45 billion annually over the past decade, and dropped to $1.39 billion in fiscal year 2016. EPA's budget request for next year is for only $890 million.

Daniel Rivera, mayor of Lawrence, Massachusetts, met with U.S. Senator Ed Markey

The proposed funding reduction is in stark contrast to the ever-increasing infrastructure investments we need to keep our water and wastewater systems running properly. It is estimated that $655 billion is needed over the next 20 years to keep water infrastructure operational, and some believe that is an under-estimate. And these costs do not consider improving the resiliency of our infrastructure in response to rising sea level and more severe weather events. As Jim Moran, a former congressman from Virginia stated at a WEF/NACWA briefing, "What Congress is doing is grossly inadequate."

The good news is that we did hear positives in Washington. There is some support in the House for raising the CWSRF allocation to $2 billion for fiscal year 2017, and a number of representatives, including many from New England, have signed a letter to this effect. (NEWEA sent letters to the leadership of both the House and Senate in early April supporting this funding level.) A bill (S.2532) sponsored by Senator Ben Cardin (Maryland) proposes a more robust approach, ramping up CWSRF funding from $5.18 billion in fiscal year 2017 to $9.06 billion in fiscal year 2020. Furthermore the Senate Environment and Public Works Committee is discussing bill S.4583, which would reauthorize the Clean Water and Drinking Water SRFs, and include funding in the Water Resources Development Act bill, which may have a chance for passage in the current Congress.

While in Washington our members participated in both NEWEA events and in WEF/NACWA activities. NEWEA-specific functions included our annual Congressional Briefing, meetings on Capitol Hill, and a NEWEA dinner.

Representative Peter Welch (VT) spoke at the Briefing Breakfast

Representative James McGovern (MA) was our event sponsor

Representative Niki Tsongas (MA) met with NEWEA constituents

The Congressional Briefing Breakfast was held in the Rayburn House Office Building on April 13. Speakers included Rep. James McGovern (Massachusetts, our event sponsor), Rep. Elizabeth Esty (Connecticut), Rep. Peter Welch (Vermont), Senator Sheldon Whitehouse (Rhode Island), Jane Downing, chief of EPA's New England Region Drinking Water Program, Mayor Daniel Rivera (Lawrence, Massachusetts), David Allen (deputy city manager, Portsmouth, New Hampshire), Paul Bowen (WEF president), and Ray Willis (NEWEA president). Members of Congress all spoke about the importance of the work that we do in the clean water industry and the need for stronger funding. Senator Whitehouse updated us on the deliberations of the Senate Environment and Public Works Committee, of which he is a member. Ms. Downing announced the release that day of the Massachusetts MS4 permit. NEWEA members were able to ask questions of the speakers, providing for further dialog.

EPA has proposed a fiscal year 2017 budget that would cut the Clean Water State Revolving Fund by 30 percent

Our NEWEA contingent was busy on April 12 and 13 getting our message out and strengthening relationships with our federal legislators in individual meetings on Capitol Hill. We met with more than 30 senators, representatives, and/or their aides at their offices. We had a common message about the importance of adequate funding for wastewater infrastructure, primarily through the CWSRF, but also by funding the Water Infrastructure Finance and Innovation Act and other resources. NEWEA also discussed improving resiliency to climate change, stormwater management, and ocean acidification. Members of each NEWEA state association added their own experience and needs to these fruitful meetings, which serve to inform and grow relationships with our federal legislators and their staffs so that we can remain in contact as issues arise.

NEWEA members attended the NACWA/WEF Congressional Reception during the evening of April 12, which included five representatives from key congressional committees as speakers. We also discussed water quality and government affairs issues with our counterparts from other states and regions at this reception.

Several from NEWEA attended an informative legislative issues briefing by WEF and NACWA on April 11, which updated us on developments at the Capitol and reinforced our talking points.

NEWEA's annual trip to Washington is an important link between the work we do as water quality professionals to protect and preserve our water resources and the national level policy-makers who set the overall course and budgets for the water environment. This national-level interaction dovetails with NEWEA state legislative events held each spring in all six New England states by the NEWEA-affiliated state associations and our state legislators, which focus on the water issues faced by each state. By working together we can make our opinions known, learn from the wider legislative, regulatory, and advocacy communities, and build stronger relationships among these segments and within NEWEA itself.

NEWEA POSITION PAPER

Support for sustainable infrastructure

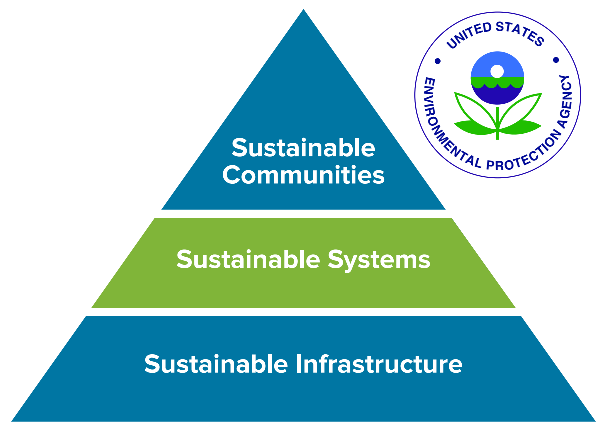
Community stakeholders, utility managers and regulatory agencies are increasingly interested in utility sustainability. Sustainability can and has been defined in many ways but the most broadly accepted definition comes from the United Nations' 1987 Report on Environment and Development: Our Common Future definition: "Meeting the needs of the present without compromising the ability of future generations to meet their own needs."

New England water resource recovery utilities are increasingly faced with achieving higher levels of service which often comes at the price of greater resources used, such as energy, raw materials and chemicals. In addition, utilities are being asked to do more with less financially, making even routine maintenance of systems difficult at best. New England's aging infrastructure will require significant investment of public funds to repair and replace infrastructure to maintain adequate to superior levels of service over the coming decades. The infrastructure that is being invested in now will last for the next 50 to 75 years. Given that, the need to invest in sustainable infrastructure that will be resilient, reliable and efficient is critical and will require a paradigm shift.

NEWEA supports the United States Environmental Protection Agency's (EPA) Clean Water and Drinking Water Infrastructure Policy published in September 2010 (water.epa.gov/infrastructure/sustain/Clean-Water-and-Drinking-Water-Infrastructure-Sustainability-Policy.cfm). The Policy describes "EPA's overall vision and priorities for ensuring the long-term sustainability of water infrastructure and communities throughout the nation." EPA has developed Planning for Sustainability: A Handbook for Water and Wastewater Utilities (water.epa.gov/infrastructure/sustain/upload/EPA-s-Planning-for-Sustainability-Handbook.pdf) to share sustainability best practices.

The Sustainability Handbook, which should be used as a resource for all NEWEA utilities when considering sustainable solutions, is organized around a series of Core Elements, including:

"• Setting utility sustainability goals and objectives that also support relevant community goals
- Analyzing a range of alternatives, including green infrastructure and other innovative approaches, based on full life-cycle costs



SOURCE: US EPA

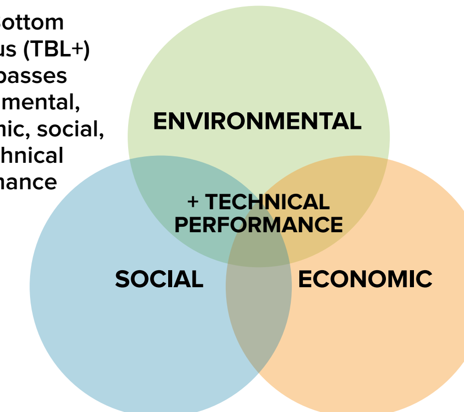
- Implementing a financial strategy, including adequate rate structures, to ensure the alternatives selected are sufficiently funded, operated, maintained, and replaced over time"

NEWEA supports Triple Bottom Line Plus (TBL+) sustainability framework, which encompasses environmental, economic, social and technical performance. Key considerations for sustainable water and water resource recovery systems within the TBL+ framework include:

Environmental	Emissions and Waste
	Resource Use
	Resource Recovery
	Sustainable Materials
	Facility Footprint
Economic	Life-cycle Cost Analysis
	Sustainable Balance Sheet
	Local Purchasing and Hiring
Social	Stakeholder Involvement
	Workforce Sustainability
Technical	Reliability and Redundancy
	Collection System Integrity
	Operations and Maintenance Optimization
	Resiliency and Adaptability

Adapted from the WEF publication, *Sustainability Reporting Statements for Wastewater Systems*

Triple Bottom Line Plus (TBL+) encompasses environmental, economic, social, and technical performance



NEWEA also supports the development and use of tools that promote using a life-cycle approach to evaluate short and long term operations and maintenance, new infrastructure and equipment, planning and management costs.

One such tool that is gaining momentum within the water resource recovery industry is the Envision™ rating system, developed by the Institute for Sustainable Infrastructure. Envision™ provides a holistic framework for evaluating, rating and recognizing projects and utilities that use transformational, collaborative approaches to assess and protect the community, environmental, and economic benefits of all types and sizes of infrastructure projects. Envision™ is most useful in sustainable project planning when the practices can be carried through to design and implementation.

Institute for Sustainable Infrastructure

Envision™ helps utilities to:

- Meet sustainability goals
- Be publicly recognized for high levels of achievement in sustainability
- Help communities and utilities to collaborate and discuss, "Are we doing the right project?" and, "Are we doing the project right?"
- Make decisions about the investment of scarce resources
- Include community priorities in civil infrastructure projects

NEWEA also supports the use of the Water Environment Federation (WEF)'s *Sustainability Reporting Statements for Wastewater Systems.* This tool provides a framework for utilities to monitor, trend and report over time their performance related to sustainable goals and objectives.

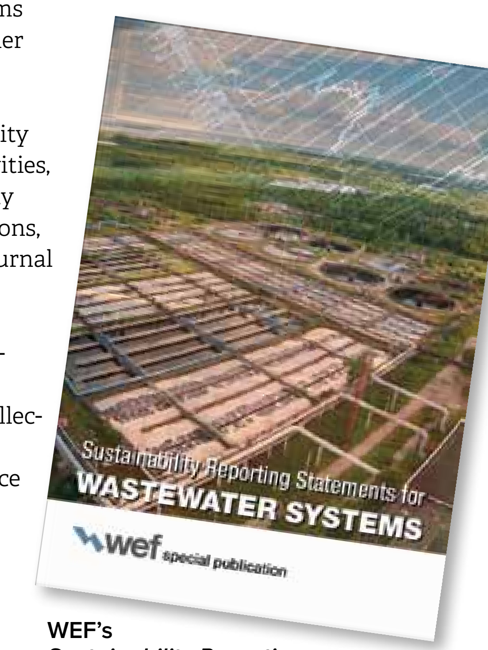
The Sustainable Performance Reporting tool incorporates the TBL+ principles and provides utilities with guidance on:

NEWEA is committed to promoting sustainability within the water and water resource recovery community in New England and as such has established a Sustainability Committee.

- Developing sustainable goals and objectives
- Identifying Key Performance Indicators / Metrics for tracking performance
- Reporting formats for presenting performance to stakeholders

NEWEA is committed to promoting sustainability within the water and water resource recovery community in New England and as such has established a Sustainability Committee. The Sustainability Committee is charged with the following activities:

- Research, review and recommend sustainable solutions for water resource recovery treatment and collection systems
- Collaborate with other NEWEA committees and membership to integrate sustainability into committee activities, conferences, specialty seminars, presentations, keynote speakers, journal articles and other publications
- Encourage the transformation of water resource recovery collection and treatment systems into "resource recovery systems" (hence, the shift in terminology from wastewater to water resource recovery) that use fewer natural resources while recovering more nutrients/biosolids / fertilizer in a way that achieves high economic value, is operator friendly, regulation compliant, technically reliable and flexible, environmentally friendly and socially acceptable—the tenets of the TBL+



WEF's *Sustainability Reporting Statements for Wastewater Systems* provides a framework for utilities to monitor, trend, and report over time their performance related to sustainable goals and objectives.

In brief, NEWEA strives to improve efforts to achieve sustainable water and wastewater infrastructure for the benefit of our existing communities while providing a solid base for continued safe and clean water for generations to come.

NEBRA Highlights

Milwaukee hosted the WEF Residuals & Biosolids Conference

Reporting from the WEF Residuals & Biosolids Conference

Milwaukee sits on the edge of 20 percent of the world's fresh water. As much as anywhere, it is defined by water. Just east of downtown, most of your 360-degree view to the horizon is the water of Lake Michigan. Here, water and wastewater engineering was pioneered. The industry most people associate with Milwaukee—beer—is all about water. But to those in biosolids management, the most famous thing here is Milorganite®, which is celebrating its 90th year in 2016.

Milorganite® was a focus of this year's annual WEF Residuals & Biosolids Conference, and Jeff Spence of the Milwaukee Metropolitan Sewage District (MMSD) discussed its venerable history in the opening plenary session. In other presentations, Tom Nowicki, MMSD's long-time lawyer, provided advice from nine decades of biosolids recycling experience. And Jessica Nanes of MMSD reported that a most important—and challenging—aspect of Milorganite® product distribution is tracking myriad federal and state fertilizer and biosolids regulations that require complicated sampling and testing schedules using at least seven approved laboratories to meet states' varied requirements. In addition to the Milorganite® presentations, the sold-out conference tour was of the Milorganite® facility.

This focus on Milorganite® highlighted how far biosolids product marketing has come. Interestingly, MMSD spearheads the product marketing efforts, even though the operations and maintenance of the fertilizer plant is contracted to a private operator (milorganite.com includes a new video about the product's 90-year history).

Veolia and Milwaukee Metropolitan Sewage District ran a WEF Residuals & Biosolids Conference tour of the Milorganite® production facility for nearly 80 conference attendees

For decades, there have been other "branded" biosolids products, supported by varying levels of marketing, such as Boston's Bay State Fertilizer (baystatefertilizer.com). The marketing is determined by who the customers are, and, when it comes to biosolids, most often the customers have been farmers, landscapers, turf managers, and soil blenders—not the general public. But, recently, the King County biosolids program has set a new high standard for prominent, sophisticated marketing to the broad public with its "Loop" biosolids ingredient brand (loopforyoursoil.com).

Now, joining this elite group of fine product marketing to the general public is the new DC Water "Bloom" brand—the Class A biosolids from the new anaerobic digestion with thermal hydrolysis process from the Blue Plains Advanced Wastewater Treatment Plant (bloomsoil.com—see details and videos). DC Water is refining its biosolids product by researching potential blends, determining the best moisture level, and the effects of curing and aging. This year it will work with several major landscaping and soil products customers, getting their input in developing the most useful, consistent product possible before marketing it broadly next year.

In his conference talk about DC Water's efforts, Ron Alexander, soil amendment analyst and marketing expert, noted that the new focus on product quality and marketing requires attention to many details, including, for example, developing an internal organizational culture that supports the product. "You have to convince your workers that what they are doing is no longer waste management," he said. There was an example of this organizational culture during the conference tour of the Milorganite® fertilizer plant: Every employee naturally and consistently used the term "product" to describe the material being processed. (It has been nearly a century since MMSD has "gotten rid of" its "sludge.")

After the initial focus on the highest-quality biosolids products and marketing, most of the conference discussed current hot topics, with three sessions on anaerobic digestion (AD), two on co-digestion, one on thermal hydrolysis, and presentations on combined heat and power (CHP) and renewable energy, including:

- Explaining and predicting methane production efficiency by 1) analysis of microbial populations and 2) by applying fractal-like kinetic and other models
- Advantages of silo-shaped digesters
- Possible AD configurations to increase biogas yield such as biological hydrolysis, recuperative digestion, and high solids AD
- Where to place thermal hydrolysis in the solids treatment system to optimize efficiencies
- Treatment of AD and thermal hydrolysis sidestreams
- Cooling sludge after thermal hydrolysis
- Lessons learned from co-digestion projects, including how to choose appropriate high-strength wastes
- Impacts—and "unintended consequences"—of food waste and other hauled-in wastes (even bioplastics) on AD and solids quality
- Flexible operation of AD and CHP to meet varying grid electricity demands
- Case studies of new AD and energy systems at Kenosha, Wisconsin; San Francisco (gas turbines); and Green Bay, Wisconsin (replacing incineration with AD and CHP)
- AD system maintenance, including digester cleaning

One session focused on biosolids system planning, with case studies from the United Kingdom, Ontario, the state of Georgia, and Leominster, Massachusetts. Matt van Horne (Hazen and Sawyer) detailed the planning process for Leominster's new installation of rotary drum thickeners. The "Pioneer Plastics City" had long relied on solids incineration at nearby Fitchburg, which shut down its incinerator in October 2012. The project included "on-site validation testing of the selected manufacturer's equipment and a detailed sequence of construction to ensure that the facility can continue operations through the construction period. The project included significant demolition to repurpose the vacuum filter dewatering room, rehabilitation of the major sludge pumping facilities, addition of an emulsion polymer storage and feed system, rehabilitation of the sludge storage tanks, and improvements to the control system." For disposal, Leominster continues to haul solids—now thickened—off-site.

A session sponsored by the Water Environment Research Foundation on thermal processes included preliminary findings of a "state of the science review" on energy recovery from thermal oxidation (incineration) of solids. Webster Hoener explained that the project is evaluating the potential for electricity generation and heat recovery from sewage sludge incinerators (SSIs), comparing solids incineration to coal in a triple-bottom-line analysis, and estimating the amount of energy that might be recovered. He noted that the advanced SSIs in St. Paul, Minnesota, have 10 years' operating experience during which the energy recovery systems have successfully produced a percentage of the plant's energy needs; for example, the main condensing turbine provides 20 percent of the plant's electricity.

> **"For Milorganite® and any other biosolids product in the marketplace, challenges come from three directions: biosolids regulations, fertilizer regulations, and competition. Anyone wanting to succeed in this marketplace must have a plan for addressing each of these challenges." –Thomas Nowicki, MMSD**

Another session focused on perhaps the hottest topic in biosolids recycling: microconstituents (MCs). There were seven papers from research groups around the United States, most of whom are just starting into this complex topic. The groups were from Marquette University, Metropolitan Water Reclamation District of Greater Chicago, Tulane University, University of Minnesota, University of Wisconsin, Virginia Tech, and a Dow Chemical/Alkylphenols & Ethoxylates Research Council team. Three of the papers focused on antibiotic resistance genes and their fate in digesters, biosolids, and soils. In a broad review of the literature, the experienced Chicago team explained that "the uptake of MCs by crops depends on the crop, soil type, and characteristics of the MCs. A review of published literature suggests that in general the concentrations in edible tissues, and thus exposure via ingestion, was small as indicated by hazard coefficients (HQ) < 0.1 for most of the studied compounds. A general risk assessment conducted by following Environmental Protection Agency (EPA) guidelines also showed that the exposure of MCs via land application of biosolids represents a minimal risk to human health."

One of the most extraordinary papers of the conference discussed chemicals in biosolids. Jean Creech and colleagues wrote about dealing with illegal dumping of high-strength polychlorinated biphenyls (PCBs) and trichlorobenzene into Charlotte Water sewers. On February 6, 2014, Mallard Creek treatment facility operators noticed a chemical sheen entering the clarifiers. The plant was shut down, and flow was diverted to an equalization basin. By February 8, all the contaminated wastewater was contained, and the plant resumed treatment of uncontaminated influent. The contaminated wastewater was treated separately, and the resulting dewatered solids tested above 50 mg/kg for PCBs, which classified them as hazardous waste under the EPA' Toxic Substances Controls Act regulations. It took until October 17—and millions of dollars—for all the contaminated solids to be removed and transported safely to a licensed hazardous waste disposal facility. Parts of the plant still have to be decontaminated.

This surprise catastrophe was a huge test of Charlotte Water's resiliency. Through teamwork with their contracted land applier, the utility managed the situation. According to Ms. Creech, it helped that Charlotte Water has been ISO 14001

(Environmental Management System)-certified for many years and has conducted emergency preparedness trainings. "We are ready for emergencies; we just never expected this particular kind of emergency." She says the criminal dumper has been apprehended and may be helping the FBI investigate a larger ring of similar illegal activity, although few details are available as the investigation is ongoing.

One other important biosolids topic, nutrient recovery, was addressed at one conference session, with descriptions of various developed or developing systems that take nitrogen and/or phosphorus out of biosolids. As part of that session, John Donovan, former NEBRA board member and treasurer, and retiring from CDM Smith, presented to this conference. One of his final projects has been engineering for a fertilizer manufacturing facility in Florida, which uses biosolids as the feedstock of organic nutrients in a new high-efficiency fertilizer product.

At the end of his talk, and at the WEF Residuals and Biosolids Committee meeting on the last day of the conference, Mr. Donovan expressed appreciation to the profession and gave some advice. "Public skepticism and distrust regarding biosolids products remains the most significant issue," he said. Odors, emerging contaminants, and limited oversight and testing add to the skepticism. He recommended that the profession increase oversight of itself: choose land application sites carefully, add more testing to have confidence in your products, and hire an independent overseer to check each truckload for malodors and other quality factors. He finished by thanking the committee "for the privilege of bringing this conference to Boston in 2000" and for all the information exchange it has provided.

MA Nutrient Regulations—Update

NEBRA is leading the effort to address the negative impacts on organics recycling of Massachusetts' new nutrient management regulations. In 2015, when the regulations were announced and implemented, many stakeholders assumed they would not affect biosolids and other organic residuals. Through meetings and conversations, NEBRA has received clarification from the Massachusetts Department of Agricultural Resources (MDAR), which promulgated the rule, and it does affect biosolids and organics recycling.

On March 25, MDAR met with key stakeholders, including NEBRA, to discuss likely amendments to the regulations. The agency will propose, through a formal public process, changes suggested by NEBRA and Farm Bureau, including clarification regarding definitions and to what the regulation applies. A summary of the regulation's impacts on the recycling of biosolids and other organic residuals is provided in the MassRecycle presentation mentioned above; download a copy at the "What's New" link at nebiosolids.org.

As the first full growing season under the regulation starts, it remains unclear how many areas in the state will be off-limits for biosolids and other organic residuals products because of high soil phosphorus (P). Under the regulation, no material containing P can be applied unless a soil test and UMass Extension guidelines shows need. While home gardens are exempted from the regulation, lawn and turf and all agricultural operations must apply nutrients (e.g., P) only in accordance with a soil test—and organic residuals will likely not be allowed on many soils, because they contain P. Products affected by this new regulation include biosolids fertilizer (e.g., Bay State Fertilizer from MWRA, biosolids compost, food scrap compost, and digestate).

NEBRA's 2016 Board of Directors

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Urban Soils—New Research Published

A special section of the January 2016 *Journal of Environmental Quality* focuses on "soil in the city." The introduction states: "This special section comprises 12 targeted papers… to make available much-needed information about the characteristics of urban soils. Innovative ways to mitigate the risks from pollutants and to improve the soil quality using local resources are discussed. Such practices include the use of composts and biosolids to grow healthy foods, reclaim brownfields, manage stormwater, and improve the overall ecosystem functioning of urban soils.

"These papers provide a needed resource for educating policymakers, practitioners, and the general public about using locally available resources to restore fertility, productivity, and ecosystem functioning of degraded urban land to revitalize metropolitan areas for improving the overall quality of life for a large segment of a rapidly growing urban population."

The papers are from the "Soil in the City—2014" conference organized by the W-2170 Committee—U.S. Department of Agriculture's sponsored multi-state research project on soil-based use of residuals, wastewater, and reclaimed water.

NEBRA Collaborating on Workshops and Presentations

NEBRA has increased outreach to other organizations and audiences, especially organizations with closely related goals. Two examples are the Northeast Recycling Council (NERC; see nerc.org) and MassRecycle (massrecycle.org), both of which have added organic residuals to their recycling focus.

NEBRA has also partnered this year with the training groups Joint Environmental Training Coordinating Committee (JETCC) and New England Interstate Water Pollution Control Commission (NEIWPCC) on workshops related to process controls for biosolids quality and sewage sludge incinerator operator training.

NEBRA also supports state legislative outreach each year, ensuring biosolids management is mentioned. This year, NEBRA provided a biosolids handout for the Vermont Green Mountain Water Environment Association legislative outreach effort and collaborated again on the New Hampshire legislative breakfast.

Through collaboration, NEBRA's effectiveness is broadened, and new audiences learn about our mission: promoting the environmentally sound and publicly supported recycling of biosolids and other organic residuals.

New Hampshire Department of Environmental Services Commissioner Tom Burack speaks each year at the New Hampshire Water Pollution Control Authority "Water's Worth It" legislative breakfast. This year, the event was March 23.

NEBRA Starts Northeast Digestion Roundtable

Last December, NERC and NEBRA co-hosted a webinar on AD. This new Northeast Digestion Roundtable is an informal quarterly webinar series focused on technical details of managing and operating AD facilities in this region. Participation is free and open to anyone; details and sign-up at nebiosolids.org/ne-digestion-roundtable.

NEBRA Participates in MassRecycle Conference

At the annual MassRecycle R3 Conference on March 29, NEBRA board member Cheri Cousens, executive director at the Greater Lawrence Sanitary District (GLSD), described the new digester and combined heat and power systems being installed at GLSD to enable co-digestion of food scraps. NEBRA board member Michael Lannan, president of Tech Environmental, presented on a new facility that will turn food scraps into animal feed—a higher and best use for food scrap management. At the same conference, NEBRA staff Ned Beecher discussed the Massachusetts nutrient management regulations.

Pennsylvania Supreme Court: Biosolids Use a "Normal Agricultural Activity"

In late December 2015, the Pennsylvania Supreme Court unanimously ruled in favor of biosolids management company Synagro and farmers who use biosolids, finding that biosolids recycling on farms is a "normal agricultural practice" and is therefore protected from untimely and burdensome litigation by the state's "right to farm" law. The case, known as Gilbert v. Synagro, has been watched closely by biosolids managers and farmers, because it occurred in a large, agricultural state in the eastern United States, where conflict over biosolids and other farming practices continue to fester where suburban growth has spread into traditional farming areas.

Right-to-farm laws exist in some form in every state. And a similar ruling in support of biosolids recycling on farms occurred in New York State in 2015. Municipalities everywhere are now on notice that ordinances interfering with agricultural uses of biosolids may be unlawful, depending on the specific provisions of a state's right-to-farm law.

In Massachusetts, Drug Companies Now Responsible For Drug Collection

On March 14, Governor Charlie Baker signed a law (H.4056) that made Massachusetts the first state to require drug companies to establish programs to safely dispose of unwanted medications as part of a comprehensive drug abuse prevention strategy. This "producer responsibility" law is similar to ones adopted in several California counties. The Product Stewardship Institute (PSI), based in Boston, was instrumental in passing the legislation, which will help also reduce releases of unused drugs to the environment, including wastewater systems. "We applaud Massachusetts for recognizing that drug companies are responsible for safely managing leftover medicine…," said Scott Cassel, chief executive officer of PSI.

Ned Beecher, Executive Director
Tamworth, N.H.
603-323-7654 | info@nebiosolids.org

For additional news or to subscribe to NEBRAMail, NEBRA's email newsletter visit nebiosolids.org

nebra
North East Biosolids & Residuals Association

SPOTLIGHT

NEWEA
WORKING FOR WATER QUALITY

Facility Spotlight

Stonington Water Pollution Control Authority

Includes three treatment facilities in Stonington, Connecticut:
Pawcatuck, Borough, and Mystic with a combined treatment capacity of 2.76 mgd (10.4 ML/d)

TREATMENT FACILITIES

Pawcatuck—1.3 mgd (4.9 ML/d)
Built in 1978; Permit # CT0101290 (Expires 5/6/2019); discharges to the Pawcatuck River; process components include primary clarifiers with co-settling, septage receiving, activated sludge treatment, UV disinfection, sludge thickening and storage, and odor control.

Borough—0.66 mgd (2.5 ML/d)
Built in 1975; Permit # CT0101281 (Expires 10/23/2018); discharges to Stonington Harbor; process components include comminutors, raw sewage pumping, primary clarifiers with co-settling, activated sludge treatment, UV disinfection, sludge thickening and storage, and odor control.

Mystic—0.80 mgd (3.0 ML/d)
Built in 1972; Permit # CT0100544 (Expires 5/20/2017); discharges to the Mystic River; components include comminutors, raw sewage pumping, grit and grease removal, primary clarifiers, biological nutrient removal using magnetite-ballasted bio-flocculation system, UV disinfection, sludge thickening and storage, and odor control.

SYSTEM AND OPERATIONS

WPCA Director
Doug Nettleton
152 Elm Street, Stonington, CT

Chief Operators
Gerry Minor (Mystic)
William Waterhouse (Stonington Borough)
John Gates (Pawcatuck)

Contract Operators
Suez Environnement
Project Manager: Jim Nyberg

Engineering Consultant
CDM Smith

Collection System
Ninety miles of sewer, 16 pump stations, two marine pump-out facilities, one remote odor control facility; serviced population of more than 10,500 with an additional summer influx of residents; wastewater flow is 56 percent domestic, 8 percent institutional, 5 percent industrial, and 31 percent commercial.

Operations
Suez Environnement has operated the facilities for more than 20 years. The operational staff manages all day-to-day operations and plans all maintenance projects and schedules. All labor, supervision, and expertise to operate the plant are provided by operational staff in accordance with the Stonington Water Pollution Control Authority (WPCA) and Connecticut Department of Energy and Environmental Protection. Most process control testing, wastewater analysis, and required lab testing are done on site. The staff performs the required and predicted maintenance on plant equipment and the collection system components, including electronic equipment, machinery, lab analysis instruments, and radio equipment.

Awards
2012 Clean Up Sound and Harbors (CUSH) Achievement and Appreciation Award for Environmental Stewardship for the Mainland Coastline of Fishers Island Sound; 2004–2012 Harding Red Sock Award for no lost time injuries.

COMMUNITY AND FACILITY OVERVIEW

Nestled between the Mystic and Pawcatuck rivers, with a front row seat to the Long Island Sound, lies Stonington Connecticut. Made up of three distinct villages—Mystic, Stonington Borough, and Pawcatuck—Stonington is a popular seasonal tourist destination with 10 hotels and numerous country inns. It hosts the Mystic Aquarium and Mystic Seaport, as well as several festivals during the summer. Stonington has numerous retail stores and more than 90 restaurants. The two rivers on its border serve as pathways to Little Narragansett Bay, and Block and Fishers islands, and for recreation such as sport fishing and day sailing. Foxwoods Casino is a short ride to the north, and to the east are the many beaches of nearby Rhode Island.

In 2012, the WPCA began a $17.2 million design-build upgrade with CDM Smith; most of the work was done at the Mystic facility, which has had performance and clarifier settling issues over the years. Facility improvements included the addition of preliminary treatment, a magnetite-ballasted bio-flocculation system (to aid process control and nitrogen removal), a switch from sodium hypochlorite to UV for disinfection, and replacement of aeration equipment with energy-efficient blowers. The facility was also upgraded with new pumping equipment and a new generator, and improvements were made to solids handling. Minor improvements were completed to the holding tanks, clarification system, and odor control system. The addition of the magnetite-ballasted bio-flocculation system required learning of new laboratory techniques to define the difference between the active biomass and the added magnetite in the system. Improvements at the other two facilities, Borough and Pawcatuck, included blower changes, replacement of the older pumping equipment, and conversion to UV disinfection.

Because of the high concentration of restaurants, especially in Mystic, the WPCA has promoted and enforced Connecticut's General Permit for Fats, Oils and Grease (FOG), to prevent problems within the collection system and at the Mystic facility. The WPCA anticipates 100 percent compliance with the General Permit for FOG by July 1, 2016. Given that all three facilities are considered small, the 31 percent commercial-use component of the influent flow can be an issue whether it is from FOG production or laundry wash from hotels.

The financial pressure of operating and maintaining three facilities, each with its own permit, as well as the collection system and pump stations, continues to make it difficult to maintain user rates. The WPCA recently increased user rates by 5 percent after eight years without increases; however, the cost of operating and maintaining aging facilities and infrastructure will require further increases.

Student Competitions

The winning SDC team—NU students: Meghan Bruckman, Greg Coyle, Andrew Gillen, and Alston Potts

The first NEWEA Student Design Competition (SDC) organized by the Student Activity Committee was recently completed. This competition intended to promote "real world" design experience for students interested in an education and/or a career in water engineering and sciences. The competition tasked teams of students within NEWEA to design a project as a team. Teams submitted reports and presented their findings to judges during the SDC reception and presentation on April 27 at Northeastern University. The competing teams were from Northeastern University (NU), University of Rhode Island (URI), and Wentworth Institute of Technology (WIT).

Projects were as follows:

- NU team: Restoring the cycle—Northeastern University On-site Wastewater Reclamation and Reuse
- WIT team: Solar Powered Desalination and Purification Pod
- URI team: Sustainable Water Systems for Climate Change—A Case Study in Rural Dominican Republic

The judges evaluated the technical aspects, appearance, and structure of the written report, and the content organization and effectiveness of the presentation. The panel included:

- Jonathan Kunay, Maureen Neville, Alexandra Doody, CDM Smith
- Justin L. Skelly, Tighe and Bond
- Vanessa Borkowski, Stantec
- Udayarka Karra, Wright-Pierce
- Sahar Hasan Kunay, Green Mountain Pipeline Services
- Yuqi Wang, Alpha Analytical
- Jasper Hobbs, New England Interstate Water Pollution Control Commission.

The judges awarded the contest to the NU team, for its project of designing, constructing, operating, and testing of a tidal wetland pilot system. To show full-scale feasibility, a conceptual tidal flow wetland treatment system was also designed to treat flows from three Northeastern dormitories. This design consisted of pre-screening, primary clarification, flow equalization, tidal wetlands, and ultraviolet (UV) disinfection, with the effluent treated to Massachusetts Class A water reuse standards for toilet flushing and surface irrigation.

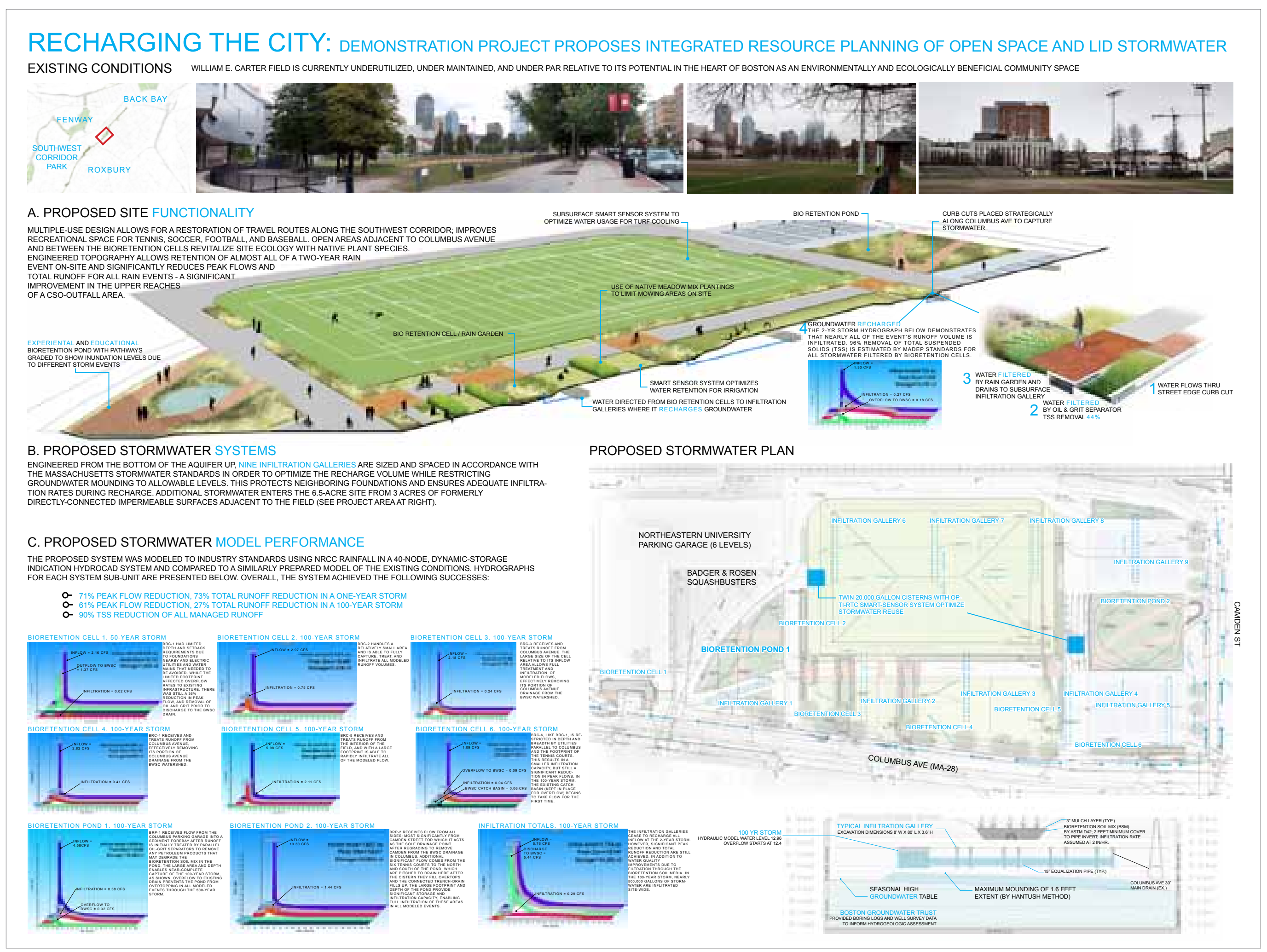
The winning team will receive a $1,000 prize and an allowance of up to $2,000 to travel to WEFTEC 16 in New Orleans, in September 2016. The team will present its project at the Water Environment Federation (WEF) Student Design Competition.

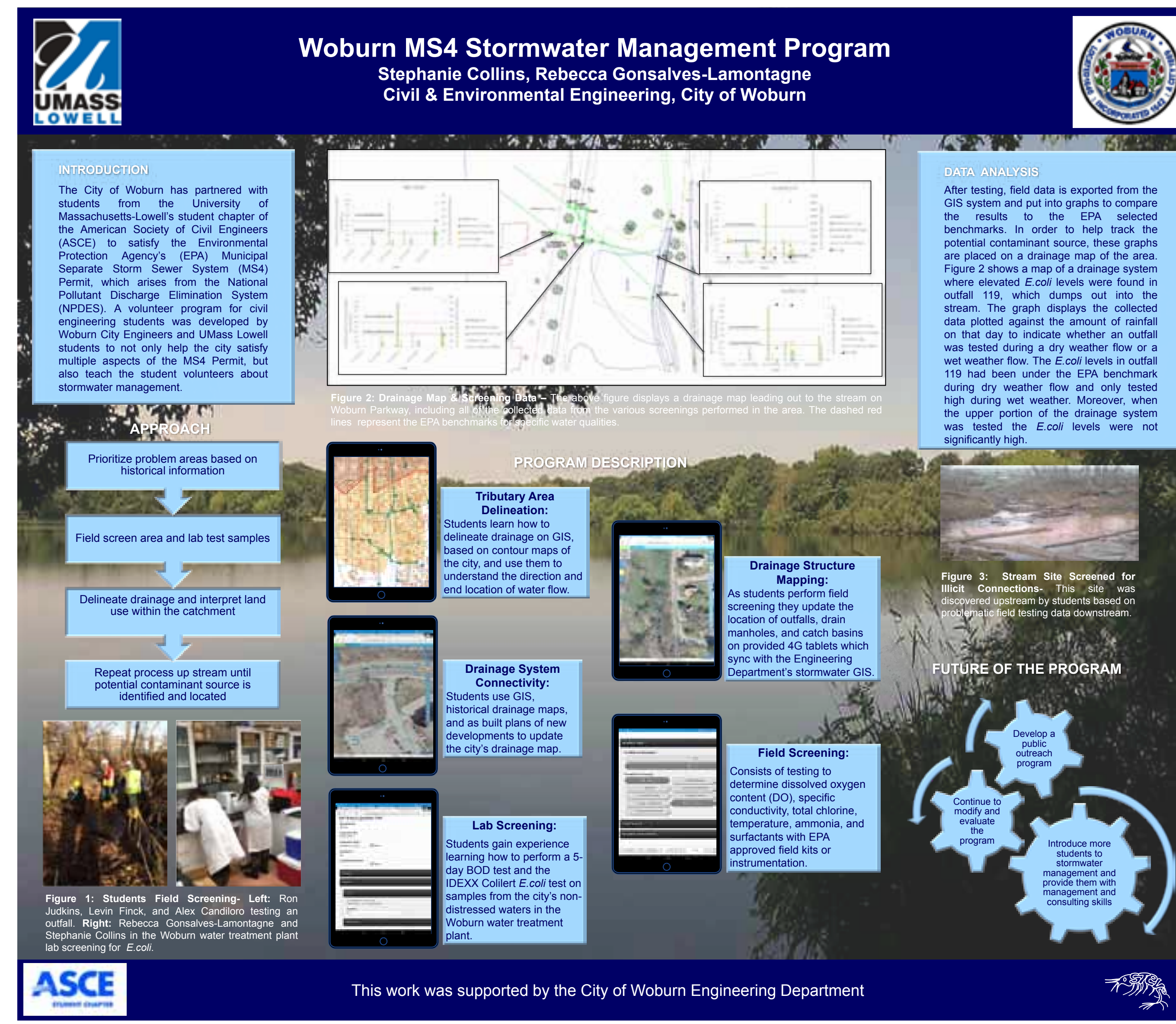
NEWEA 2016 student poster competition winners

During the Annual Conference students were given the opportunity to present posters in a session organized by the Student Activities Committee. The winners are...

Below: Greg Coyle, Northeastern University

Right: Stephanie Collins & Rebecca Gonsalves-Lamontagne, University of Massachusetts Lowell





WEF delegate report

HOD LEADERSHIP

NEWEA's Water Environment Federation (WEF) delegates have been active in the leadership of the House of Delegates (HOD) and WEF workgroups. NEWEA is well represented on the WEF leadership committees: Budgeting (Mike Wilson), Stormwater (Dan Bisson), Nominating (Susan Sullivan), Member Association (MA) Outreach (Howard Carter), Steering (Dan Bisson, Howard Carter), and WEFMAX. Also, Howard Carter is the speaker-elect of HOD.

Susan Sullivan is one of the HOD representatives on the WEF Nominating Committee. This spring, the committee sought candidates for WEF vice president, WEF board of trustees (two positions), and WEF HOD delegate-at-large (four positions). WEF's mission is to connect water professionals, enrich the expertise of water professionals, increase awareness of the impact and value of water, and provide a platform for water sector innovation. This mission is executed through the dedication and active involvement of WEF members. If you are interested in joining WEF leadership in advancing our mission and vision by nominating WEF members who have distinguished themselves as leaders to the water environment profession, please let Susan Sullivan know. The deadline for this year's WEF nominations was April 11, 2016, but potential candidates for next year's positions can submit information for future consideration.

Ms. Sullivan also sits on the NEWEA Nominating Committee. Please reach out to her if you are interested in either a regional or national position.

WEFMAX

At the first 2016 WEFMAX in Orlando, Florida, March 9-11, 65 people attended from as far away as Hawaii. NEWEA was well represented with Howard Carter emceeing the event, and Mike Wilson, Dan Bisson, and Susan Sullivan participating in the event. During the first day—designated the Leaders' Summit—there were reports from the HOD standing committees (Howard Carter and Mike Wilson), workgroup updates, including Innovative Utility Management, Membership, Stormwater, and Value of Water (Susan Sullivan), and a WEF Budget Committee presentation, led by Howard Carter.

One WEFMAX message that resonated with the group was delivered by WEF's president, Paul Bowen: "We must embrace the future to remain relevant with the way we communicate with and educate the next generation of professionals. We will need to remain flexible and consider changes to the way we communicate and provide conferences and professional development contact hours so that we can continue to grow and remain sustainable as an organization."

WEF/MA Dialogue Sessions took place on March 10, including one on public education. NEWEA presented its Public Involvement and Awareness Campaign during this time. Mike Wilson led the preparation for the presentation, and he jointly presented with Susan Sullivan and support from Dan Bisson. Representatives of 25 MAs found the presentation engaging and timely; it was so well received that the NEWEA delegates were asked to present it again at the Philadelphia WEFMAX.

Much discussion and exchange of ideas occurred over the three-day event. Topics included alternative ways to generate revenue, growing and mentoring Young Professionals and student chapters, and assessing budget priorities to align WEF's strategic goals with programs. NEWEA was the first MA to respond to WEF's call to action on providing guidance on the budget alignment with the strategic plan and prioritizing WEF's critical mission.

During the last session on Day 2, Mike Wilson, an active member in the HOD Budget Committee, assisted with the WEFMAX budget presentation and budget prioritization. He is looking forward to continued participation and plans to attend HOD meetings at WEFTEC this fall.

wefmax
connecting ideas | inspiring leaders

WORKGROUP UPDATES

NEWEA's WEF delegates have also been active in the WEF national workgroups (Innovative Utility Management, Membership, Stormwater, and Value of Water). Susan Sullivan participates on the Value of Water and Water Advocates workgroup and has joined many monthly conference calls. This workgroup works with the WEF staff and board of trustees on the Strategic Plan critical objective to "Increase the Awareness of the Value of Water." This is conducted around two initiatives—the Water Advocates program and the Value of Water coalition.

Workgroup activities have been divided into three sub-workgroups: Messaging and Visuals Development for MAs, MA Awareness, and A Day without Water.

The Messaging and Visuals Development sub-workgroup is tasked with developing images and messages more specific to wastewater that can be used in the Value of Water coalition. The group is brainstorming and soliciting ideas from the MAs. The goal of MA Awareness is to get the message out to MAs on both the Water Advocates and Value of Water coalition activities. The third group is focusing on "A Day without Water" 2016 to make it as effective as possible with the materials available. The Value of Water and Water Advocates workgroups will combine the sub-workgroups and collaborate activities in one monthly conference call.

The Stormwater workgroup is reaching out to MAs to identify stormwater committees, level of awareness of WEF national stormwater initiatives, barriers to creating MA-level stormwater committees, and other regional and national organizations that may be likely partners in expanding stormwater programs to more members. The goal is to assimilate best practices and successes of MAs and other organizations to incorporate stormwater into our organization. Dan Bisson serves as the Stormwater Steering Committee representative.

Upcoming meetings & events

YP POO & BREW #4 NETWORKING EVENT
June 30, 2016
Stratford, CT WWTF

NEWEA COMMITTEE APPRECIATION EVENT
July 21, 2016
Kimball Farms, Westford, MA

PLANT TECHNICAL SESSION & TOUR
August 24, 2016
Dover, NH WWTF

ASCE-EWRI LOW IMPACT DESIGN CONFERENCE
August 29-31, 2016
Holiday Inn by the Bay, Portland, ME

COLLECTION SYSTEMS SPECIALTY CONFERENCE
September 12, 2016
Holiday Inn, Boxborough, MA

WEFTEC ANNUAL CONFERENCE
September 24-28, 2016
New Orleans, LA

NEWEA RECEPTION AT WEFTEC
September 25, 2016
New Orleans, LA

NORTH EAST RESIDUALS & BIOSOLIDS CONFERENCE
October 19-20, 2016
Radisson Hotel, Cromwell, CT

ANNUAL GOLF CLASSIC BENEFIT
October 3, 2016
The Country Club of New Bedford, MA

EXECUTIVE COMMITTEE MEETING WITH ALL CHAIRS
January 22, 2017
Boston Marriott Copley Place Hotel, Boston, MA

NEWEA ANNUAL CONFERENCE & EXHIBIT
January 22-25, 2017
Boston Marriott Copley Place Hotel, Boston, MA

AFFILIATED STATE ASSOCIATIONS AND OTHER EVENTS

RI NWPCA GOLF TOURNAMENT
June 27, 2016
Potowomut Country Club, Warwick, RI

RI NWPCA HOT DOG ROAST/ GENERAL BUSINESS MEETING
July 12, 2016
Smithfield WWTP

NHWPCA GOLF TOURNAMENT
August 4, 2016

RI NWPCA CHOWDER COOK-OFF
August 9, 2016
Narragansett WWTF

GMWEA GEORGE DOW MEMORIAL GOLF TOURNAMENT
August 19, 2016
Cedar Knoll Country Club
Hinesburg, VT

MWPCA ANNUAL TRADE SHOW
September 20, 2016
Wachusett Mountain Resort
Princeton, MA

RI NWPCA TRADE SHOW EXHIBITION & CLAM BAKE
September 9, 2016
Twelve Acres Banquet Facilty
Smithfield, RI

MEWEA FALL CONFERENCE
September 14-16, 2016
Sugarloaf USA
Carrabassett Valley, ME

NEWWA ANNUAL CONFERENCE
September 18-21, 2016
Omni Providence, Providence, RI

GMWEA FALL TRADE SHOW
November 10, 2016
Sheraton Hotel & Conference Center
Burlington, VT

This is a partial list. Please visit the state association websites and NEWEA.org for complete and current listings.

Specialty conferences and networking proceedings

On April 21, young professionals toured the Framingham, Massachusetts water infrastucture

2016 LABORATORY PRACTICES CONFERENCE

Laboratory Information Management Systems & Emerging Technologies

The New England Water Environment Association's Laboratory Practices Committee held a specialty conference in Providence, Rhode Island on May 3, 2016, at Narragansett Bay Commission. Over 40 attendees participated in the one-day conference.

The technical presentations commenced in the morning with NEWEA President Ray Willis and NEWEA Laboratory Practices Chair James Galasyn providing the Welcome and Opening Remarks to meeting attendees. An afternoon facility tour of the Narragansett Bay Commission's laboratory and Field's Point WWTF was offered.

TECHNICAL PRESENTATIONS

Laboratory Data Exchange for Small Treatment Facilities
- Walter Palm, Narragansett Bay Commission

The Electronic Laboratory Notebook (ELN)—Design and Implementation of an ELN in the Microbiology Area of a Wastewater Laboratory
- Nora Lough, Narragansett Bay Commission

LIMS—A Progressive Data Exchange System
- Kathy Smith, Narragansett Bay Commission

Looking Back at Our New LIMS
- Michael Delaney, MWRA

LIMS—Managing Critical Data in the Small Laboratory
- Pam Moss, HACH

The Detection of Metal-Based Nanoparticles in Environment Matrices by Single Particle ICP-MS
- Lee Davidowski, Perkin Elmer

MWRA Data Integrity & Ethics
- Michael Delaney, MWRA

Communications, LIMS and Process Analyzers
- Giovanni De Dona and Margie Bower, Thermo Fisher Scientific

Overview of Field's Point BNR Process
- Paul Desrosiers, Narragansett Bay Commission

SPONSORS

AquaGen
ARCADIS
CDM Smith
Perkin Elmer (lunch sponsor)
Tata & Howard
Thermo Fisher Scientific

2016 UTILTY MANAGEMENT CONFERENCE

Managing Risk and Resiliency

NEWEA's Utility Management Committee and the New England Water Works Association (NEWWA) held a joint specialty conference on April 26, 2016, at the Best Western Royal Plaza Hotel in Marlborough, Massachusetts. Over 50 attendees participated in the specialty conference.

The specialty conference focused on risk assessment, emergency preparedness and business continuity planning. The technical presentations commenced with NEWEA President-elect Jim Barsanti and NEWEA Utility Management Committee Chair Brian Armet providing the Welcome and Opening Remarks to meeting attendees.

In addition to the program, a keynote presentation on Current and Emerging Risks was given by John Laws, chief, water infrastructure, Department of Homeland Security (DHS) via remote conferencing with Kevin Morely, American Water Works Association (AWWA), and colleagues from DHS and FBI

TECHNICAL PRESENTATIONS

Case Study—Building Resiliency in Narragansett Bay
- Jan Greenwood, Woodard & Curran

Case Study—Comparison of Risk/ Vulnerability Assessment Tools for the Water Sector
- Kate Novick, Gradient Planning

Lessons Learned from Tropical Storm Irene Specific to the Wastewater Sector
- Ernie Kelley, VT Department of Environmental Conservation and Ben Rose, VT Division of Emergency Management and Homeland Security

Critical Tools and Data to Support Forecasting and Preplanning
- Ed Capone and Glenn Field, National Weather Service

Active Shooter Training
- Bob Marquis, Massachusetts State Police

SPONSORS

AECOM
ARCADIS
Blake Equipment
Brown and Caldwell
CDM Smith
CH2M
EST Associates
FCB Insurance
Flow Assessment Services
Fuss & O'Neill
SUEZ
Tata & Howard
Weston & Sampson
Woodard & Curran

2016 YOUNG PROFESSIONALS NETWORKING EVENT

NEWEA's Young Professionals Committee along with the NEWWA Young Professionals Committee and the NE APWA Young Professional's Committee held a joint networking event in Framingham, Massachusetts, on April 21, 2016. The event had 62 attendees participate.

This popular multi-discipline networking event, aptly named "Poo & Brew," featured a tour highlighting the design and construction of the Henry King Wastewater Management Facility in Framingham. Following the tour, attendees gathered at Jack's Abby to network. This event was open to organization members and non-members consisting of professionals in the early stages of their water industry careers.

SPONSORS

ADS Environmental Service
AECOM
ARCADIS
CDM Smith
Environmental Partners Group
EST Associates
NEFCO
Tata & Howard
The MAHER Corporation
Weston & Sampson
Woodard & Curran
Wright-Pierce

New England Water Environment Association, Inc.

Statement of activities
For the years ended September 30, 2015 and 2014

Changes in unrestricted net assets:	**2015**	**2014**
Revenues and gains:		
Registration Fees	$447,778	$477,366
Exhibitor Fees	266,562	259,350
Membership Dues	10,388	56,083
Pass Through Dues	77,495	29,912
Advertising and Subscriptions	86,171	87,070
Sponsorships	72,015	65,129
Certification Fees	12,235	16,100
NEBRA Management revenue	–	8,803
Other Income	10,214	33,393
Total unrestricted revenues and gains	**982,858**	**1,033,206**
Total unrestricted revenues and gains and other support	**982,858**	**1,033,206**
Expenses:		
Program services	714,472	867,279
Management and general	245,343	332,570
Pass Through Dues	25,636	13,413
NEBRA Management expense	–	12,310
Total expenses	**985,451**	**1,225,572**
(Decrease) Increase in unrestricted net assets	(2,593)	(192,366)
Changes in temporarily restricted net assets:		
Endowment income	3,411	12,163
Scholarship expense	9,000	9,000
Increase (decrease) in temporarily restricted net assets	(5,589)	3,163
(Decrease) increase in net assets	**(8,181)**	**(189,203)**
Net assets, beginning of year	**672,637**	**861,840**
Net assets, end of year	**$664,456**	**$672,637**

New members March – May 2016

Ahmed Abouhend
Amherst, MA (STU)

Brandon Beauregard
ARCADIS
Wakefield, MA (YP)

Daniel Bourdeau
Geosyntec Consultants
Portsmouth, NH (PRO)

Meghan Bruckman
Boston, MA (STU)

Debbie Cheng
Cambridge Public Works
Cambridge, MA (YP)

Cameron Chrystal
Brookline, NH (STU)

Anatoly Darov
Burns & Levinson LLP
Boston, MA (EXEC)

Francis Davenport
Whitewater Inc.
Rockdale, MA (PWO)

Nicholas Alfred Degemmis
CH2M
Woonsocket, RI (PWO)

Marcos Do Canto
Medfield, MA (STU)

Richard Dolata
Woodard & Curran Inc.
Concord, MA (PRO)

Craig Douglas
Brunswick & Topsham
Water District
Topsham, ME (PWO)

Jack Duggan
Wentworth Institute
of Technology
Boston, MA (PRO)

Hayley Franz
AECOM
Danville, NH (YP)

Jim Gannon
Limitorque Valve Controls
Douglas, MA (PRO)

Andrew Gillen
Boston, MA (STU)

Peter T Ginaitt
Warwick Sewer Authority
Warwick, RI (PRO)

Vicki Halmen
Town of Ipswich WWTP
Ipswich, MA (PRO)

Kevin Hanley
Surveying & Mapping
Consultants Inc.
Braintree, MA (PRO)

Richard Hudson
Town of Ayer DPW
Ayer, MA (PWO)

Joseph A Laverriere
City of Saco
Saco, ME (PRO)

Michel Lemieux
Premier Tech Aqua
Terrebonne, QC (PRO)

Justin Martinez
Quincy, MA (YP)

Theresa McGovern
VHB Inc.
Watertown, MA (PRO)

Heather Miller
City of Westfield
Westfield, MA (YP)

Alexander Milley
CUES
Rye, NH (PRO)

Eliza Morrison
Wright-Pierce
Manchester, NH (YP)

John Nelson
South Yarmouth, MA (PWO)

Michael Oxford
Synagro Technologies Inc.
Baltimore, MD (PRO)

Marc Pariseault
Narragansett Bay Commission
Warwick, RI (PRO)

James Patterson
JBS Solutions Inc.
Southampton, MA (PRO)

Carl Pawlowski
Quincy, MA (PWO)

Vince Rocca
Fab Tech Inc.
Colchester, VT (PRO)

Daniel Roman
MA DEP
Ashland, MA (YP)

Taylor Rowles
Holliston, MA (STU)

Dennis Rutland
Omya
Florence, VT (PRO)

Stephen Ryan
Holliston, MA (PRO)

Ben Smith
NEIWPCC
Lowell, MA (YP)

Clint Stetson
Marshfield WWTP
Brant Rock, MA (PRO)

Kevin Stetson
Woodard & Curran Inc.
Hull, MA (PWO)

Diane Stokes
Cambridge, MA (PRO)

Samuel Sullivan
West Warwick Regional WWTF
Wakefield, RI (PWO)

Galen Swan
City of Bangor WWTP
Bangor, ME (PWO)

Jean-Luc Teixeira
Boston Water & Sewer Commission
Roxbury, MA (YP)

Bruce Thibodeau
Town of North Andover
North Andover, MA (PRO)

Nick Valinski
Berlin, CT (YP)

Daniel Vendettuoli
Scituate, RI (PRO)

Dennis Vigliotte
North Berwick, ME (PRO)

Peter Waldron
Toray Membrane USA Inc.
Poway, CA (PRO)

Brian Walker
PC Construction Company
South Burlington, VT (PRO)

Taylor Walter
Geosyntec Consultants
Portsmouth, NH (YP)

Marc Weller
Pare Engineering Corp.
Lincoln, RI (YP)

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Affiliate (AFF)
Complimentary (COMP)
Corporate (COR)
Dual (DUAL)
Executive (EXEC)
Honorary (HON)
Life (LIFE)
Professional (PRO)
Professional WW/OPS (PWO)
Student (STU)
Young Professional (YP)

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Sponsorship Benefits:

- Increased corporate visibility and marketing opportunities within a wide audience of water industry professionals
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For more information contact Mary Barry:
EMAIL: mbarry@newea.org
CALL: 781-939-0908

NEWEA
WORKING FOR WATER QUALITY

Advertiser index

NEWEA/WEF* Membership Application 2016

Personal Information

Last name | M.I. | First Name | (jr. sr. etc)

Business Name (if applicable)

Street or P.O. Box (☐ Business Address ☐ Home Address)

City, State, Zip, Country

Home Phone Number | Mobile Phone Number | Business Phone number

Email Address | Date of birth (month/day/year)

☐ Please send me information on special offers, discounts, training, and educational events, and new product information to enhance my career ☐ by e-mail ☐ by fax

☐ Check here if renewing, please provide current member I.D.

***NEWEA is a member association of WEF (Water Environment Federation). By joining NEWEA, you also become a member of WEF.**

Employment Information (see back page for codes)

1. ORG Code: | Other (please specify): | 2. JOB Code: | Other (please specify):

3. Focus Area Codes: | Other (please specify:

Signature (required for all new memberships) | *Date*

Sponsorship Information

WEF Sponsor name (optional) | Sponsor I.D. Number | ACQ. Code for WEF use only I WEF 15

Membership Categories (select one only)

		Member Benefit Subscription	Dues
☐ **Professional Package**	Individuals involved in or interested in water quality	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$174
☐ **Young Professional Package**	New members or formerly student members with 5 or less years of experience in the industry and less than 35 years of age. This package is available for 3 years.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$67
☐ **Professional Wastewater Operations (PWO) Package**	Individuals in the day-to-day operation of wastewater collection, treatment or laboratory facility, or for facilities with a daily flow of < 1 mgd or 40 L/sec.	■ WE&T (including *Operations Forum*) ■ *WEF Highlights Online*	$105
☐ **Academic Package**	Instructors/Professors interested in subjects related to water quality.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$174
☐ **Student Package**	Students enrolled for a minimum of six credit hours in an accredited college or university. Must provide written documentation on school letterhead verifying status, signed by an advisor or faculty member.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$10
☐ **Executive Package**	Upper level managers interested in an expanded suite of WEF products/services.	■ *WE&T* (including *Operations Forum*) ■ *World Water* ■ *Water Environment Research* (Online) ■ *Water Environment Regulation Watch* ■ *WEF Highlights Online*	$338
☐ **Dual**	If you are already a member of WEF and wish to join NEWEA		$40
☐ **Corporate Membership** (member benefits for one person)	Companies engaged in the design, construction, operation or management of water quality systems. Designate one membership contact.	■ *WE&T* (including *Operations Forum*) ■ *Water Environment Research* (Print) ■ *Water Environment Regulation Watch* ■ *WEF Highlights Online*	$393

WEF Utility Partnership Program (UPP): NEWEA participates in the WEF Utility Partnership Program (UPP) that supports utilities to join WEF and NEWEA while creating a comprehensive membership package for designated employees. As a UPP Utilities can consolidate all members within their organization onto one account and have the flexibility to tailor the appropriate value packages based on the designated employees' needs. Contact WEF for questions & enrollment (703-684-2400 x7213).

Payment

☐ **Check or money order enclosed**
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10 Tower Office Park, Suite 601
Woburn, MA 01801
For more information: 781.939.0908
Fax 781.939.0907 NEWEA.org

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Depending upon your membership level, $10 of your dues is allocated towards a subscription to the NEWEA Journal.

NEWEA/WEF* Membership Application 2016

To help us serve you better, please complete the following:
(choose the one that most closely describes your organization and job function)
***NEWEA is a member association of WEF (Water Environment Federation). By joining NEWEA, you also become a member of WEF.**

What is the nature of your ORGANIZATION?

(circle one only) (ORG)

1
Municipal/district Water and Wastewater Plants and/or Systems

2
Municipal/district Wastewater Only Systems and/or Plants

3
Municipal/district Water Only Systems and/or Plants

4
Industrial Systems/Plants (Manufacturing, Processing, Extraction)

5
Consulting or Contracting Firm (e.g., Engineering, Contracting Environmental, Landscape Architecture)

6
Government Agency (e.g., U.S. EPA, State Agency, etc.)

7
Research or Analytical Laboratories

8
Educational Institution (Colleges and Universities, libraries, and other related organizations)

9
Manufacturer of Water/Wastewater Equipment or Products

10
Water/Wastewater Product Distributor or Manufacturer's Rep.

11
Stormwater (MS4) Program Only

12
Public Financing, Investment Banking

13
Non-profits (e.g., Trade, Association, NGO, Advocacy, etc.)

99
Other ______________
(please specify)

What is your Primary JOB FUNCTION?

(circle one only) (JOB)

1
1. Upper or Senior Management (e.g., President, Vice President, Owner, Director, Executive Director, General Manager, etc.)

2
Engineering, Laboratory and Operations Management (e.g., Superintendent, Manager, Section Head, Department Head, Chief Engineer, Division Head, Landscape Architect etc.,)

3
Engineering and Design Staff (e.g., Consulting Engineer, Civil Engineer, Mechanical Engineer, Chemical Engineer, Planning Engineer, Landscape Architect, Environmental/ Wetland Scientist etc.)

4
Scientific and Research Staff (e.g., Chemist, Biologist, Analyst, Lab Technician, Environmental/Wetland Scientist etc.)

5
Operations/Inspection & Maintenance (e.g., Shift Supervisor, Foreman, Plant Operator, Service Representative, Collection Systems Operator, BMP Inspector, Maintenance, etc.)

6
Purchasing/Marketing/Sales (e.g., Purchasing, Sales Person, Market Representative, Market Analyst, etc.)

7
Educator (e.g., Professor, Teacher, etc.)

8
Student

9
Elected or Appointed Public Official (Mayor, Commissioner, Board or Council Member)

10
Other ______________

What are your KEY FOCUS AREAS?

(circle all that apply) (FOC)

1
Collection Systems

2
Drinking Water

3
Industrial Water/Wastewater/ Process Water

4
Groundwater

5
Odor/Air Emissions

6
Land and Soil Systems

7
Legislation (Policy, Legislation, Regulation)

8
Public Education/Information

9
Residuals/Sludge/Biosolids/Solid Waste

10
Stormwater Management/ Floodplain Management/Wet Weather

11
Toxic and Hazardous Material

12
Utility Management and Environmental

13
Wastewater

14
Water Reuse and/or Recycle

15
Watershed/Surface Water Systems

16
Water/Wastewater Analysis and Health/ Safety Water Systems

17
Other ______________

Optional Items (OPT)

Years of industry employment? _______
1 (1 to 5) **2** (6 to 10) **3** (11 to 20)
4 (21 to 30) **5** (>30 years)

Gender? _______
1 Female **2** Male

Education level? (ED) _______
1 High School **2** Technical School
3 Some College **4** Associates Degree
5 Bachelors Degree
6 Masters Degree **7** JD **8** PhD

Education/Concentration Area(s) (CON) _____
1 Physical Sciences (Chemistry, Physics, etc.)
2 Biological Sciences **3** Engineering Sciences
4 Liberal Arts **5** Law **6** Business

Water quality professionals, with fewer than 5 years working experience and under the age of 35, are eligible to join WEF as an Active Member, while participating in the NEWEA/WEF Young Professionals Program. This program allows up to 50% off of the Active Member dues, valid for the first three years of membership. This program is available for new member applicants and Student Members.


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