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RESILIENCY AND CLIMATE CHANGE

NEWEA

WORKING FOR WATER QUALITY

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NEWEA
WORKING FOR WATER QUALITY

OUR ASSOCIATION WAS ORGANIZED NINETY-ONE 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.

Regulatory Member—this membership category is a NEWEA only membership reserved for New England Environmental Regulatory Agencies, including: USEPA Region 1, Connecticut Department of Energy and Environmental Protection, Maine Department of Environmental Protection, Massachusetts Department of Environmental Protection, New Hampshire Department of Environmental Services, Vermont Department of Environmental Conservation, and Rhode Island Department of Environmental Management.

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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).

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- Complete and mail the membership application form on pages 59–60
- Download a membership application from **newea.org** by selecting—*Join Us/Become a NEWEA Member*
- Join online at **wef.org** by selecting—*Become a Member*

2020 RATES ($)

Professional	185
Executive	355
Corporate	420
Regulatory	50
Academic	185
Young Professional	70
PWO	110
Dual	45
Student	15

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NEWEA
WORKING FOR WATER QUALITY

Jennifer Kelly Lachmayr
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President's Message

My goodness, the world has changed since the spring *Journal* published just a few months ago. I do not think any of us envisioned the new way of life so dramatically altered in such a short time. As a result of the COVID-19 pandemic we are all working, interacting, and living differently. I have spoken with many of you who have implemented new regimens for staffing and operating so many critical facilities. Thank you for all you do.

As you are all aware, NEWEA took a bold step to react to the changing world and new social distancing norms by canceling the Spring Meeting planned for early June in Vermont. We also held our first video conference Executive Committee Meeting on April 7, 2020. Thank you to all who participated. We had an excellent turnout and continue to make progress, including envisioning new ways to support our Operations Challenge teams, conduct the 5S initiation, and keep the technical exchange current and meaningful.

We continue preparing for fall technical conferences. NEWEA staff and committee members continue to plan along parallel tracks for holding either virtual and/or in-person conferences. Stay tuned, as by the printing of this issue new events may have unfolded! As always, you can check the NEWEA website for updates.

In the last two months our advocacy has focused on providing more public information and outreach on what to flush and not to flush. Many of you have contributed, for example Scott Firmin of the Portland (Maine) Water District conducting a video with the local news illustrating how wipes do not break down in water as toilet paper does and the York (Maine) Sewer District parking its new van conspicuously around town. In Massachusetts we have seen the detailed photos of our systems' operational issues as documented on LinkedIn by staff from the Billerica Water Resource Recovery Facility and the Fitchburg Wastewater Division. Great work by all on illustrating the issues affecting our collection systems. Thank you to all the committees who are providing information for NEWEA to post on our website to provide more information on FOG (fats, oils, and greases), wipes, and the appropriate items to flush (just the "three Ps"). I ask all of you to keep it coming and continue the outreach and flow of information.

On a heartbreaking note, I know we all continue to mourn the loss of our wonderful Kate Biedron. We are forming a dedicated task force to partner with many others to best honor her contributions and legacy. Currently we are partnering with Kate's colleagues at CDM Smith, and we invite anyone who has an idea to reach out to me, Mary Barry, or any other member of the NEWEA senior management team (President Elect Virgil Lloyd, Vice President Fred McNeill, Treasurer Mac Richardson, and Past President Ray Vermette).

All the best, and please be safe out there.

The York (Maine) Sewer District's new van provides public information and outreach on what to flush and not to flush

From the Editor

Once upon a time, long, long ago, at the Annual Conference in January, the Journal Committee selected Climate Change and Resiliency as the theme for the summer issue of the *Journal*. Climate change was the star of the show, in my mind. The recent hotter, dryer New England summers compared to decades past, summers that seem to consistently stretch through October, and the droughts and floods that directly impact source water quality for so many communities surely point to a changed climate. Climate change was the focus of this issue; resiliency was just a nice buzz word to complement our globe's "Inconvenient Truth."

Alexandra Bowen, PE
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Never could I have believed that just two months after the Annual Conference, we would be living amidst a global pandemic. This world demands each of us to live every day as the most resilient forms of ourselves. How do we respond to this wildly inopportune disruption to our daily lives? This world has forced each of us to grow accustomed to a "new norm," one unique to each of us; kitchen tables have become offices, project managers have become social studies teachers, and toilet paper is now currency. Many of our colleagues have been deemed essential employees, and for those brave professionals, the show must go on; pumping stations need to pump, wastewater needs to be treated, and sewers need to be repaired.

As methodical, analytical, and practical (sometimes to a fault), like-minded professionals, I think I can speak for most of us when I say change is hard—proof can be found in the law of inertia! Adapting to these new stressors and coming out of "this" unscathed, hopefully with a fresh perspective and more confidence to face the challenges of tomorrow, will be the true indicator of success. After all, is that not how resiliency is defined? Although resilience here refers to us as a population, this same definition fits many different contexts.

We engineers are typically mindful of the physical resiliency built into individual structures. Is the switch gear of the pump station protected from the flood plain elevation (plus 3 ft [0.9 m])? Could a buoyant empty primary clarifier float away during a catastrophic flood? Beyond simplistic physical resiliency, we are typically mindful of maintaining critical operations through deteriorating or devastating circumstances; providing redundant equipment, implementing automation, and bypassing activated sludge processes during high CSO flows.

If we take this a step further, we can find the link between resilient design and sustainable design. As climate change runs its course and the environment experiences more extreme seasons, buildings can withstand more dramatic temperatures with the most efficient insulation. Incorporating renewable energy into facilities cuts ties with a regional power plant susceptible to failure during large storm events. Incorporating varying degrees of resiliency into infrastructure comes with similarly varying levels of capital costs, but these costs surpass "do good" intentions and should be considered necessary investments at all levels and scales of development.

I'm lucky that my company was savvy enough to have the infrastructure in place to make the transition to working from home technologically seamless. While our virtual meeting platforms are great and all, I really, really miss my coworkers, clients, and colleagues.

It's still difficult to comprehend, but I must express my deep sorrow over the tremendous loss of a remarkable colleague and dear friend, Kate Biedron. Kate brought an irrefutable energy to the NEWEA community. Whether she was honking the horn of her scooter, decorated with snowflake-shaped twinkle lights and racing through the Copley Marriot, or soliciting YP Summit attendees to clap as loudly as possible to disrupt the Executive Committee Meeting next door… there's no one like Kate. I take solace in knowing we all have our fond "Kate stories." She positively affected so many; it's comforting to know we're not mourning this loss alone.

As we all continue to find our new daily grooves, we must try our best to remain as positive as possible. To be truly resilient is to have the confidence to remain flexible through uncertain times and to be brave enough to push through times of adversity. Whether we're running a few extra miles each week, perfecting our sourdough loaf recipe, or teaching children the ancient geometry dictum known as "SOH-CAH-TOA," we're lucky to be a part of the NEWEA community—whether or not we're able to share a beer at Champions. We're all in this together. Stay safe!

Industry News

Pilgrim Nuclear Power Station in Plymouth permanently ceased generating electricity on May 31, 2019, yet certain discharges to Cape Cod Bay continue

EPA Announces $200 Million for Infrastructure Projects to Protect Surface and Drinking Water in New England

The U.S. Environmental Protection Agency (EPA) recently announced the availability of $2.7 billion for State Revolving Funds (SRFs), including $200 million across Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. This funding assists states, tribes, and territories with infrastructure projects that help protect surface water and provide safe drinking water to communities across the country.

In 2020, EPA is providing $1.6 billion in new federal grant funding for the Clean Water SRF (CWSRF), including $120 million to assist the six New England states. This funding is available for various water infrastructure projects, including modernizing aging wastewater infrastructure, implementing water reuse and recycling, and addressing stormwater. Some $64 million in CWSRF grant funding is available to tribes, certain U.S. territories, and the District of Columbia for infrastructure projects.

EPA is also making available more than $1 billion in new federal grant funding for the Drinking Water SRF (DWSRF), including more than $80 million to assist the six New England states. This funding can be used for loans that help drinking water systems install treatment for contaminants, improve distribution systems by removing lead service lines, and improve system resiliency to withstand natural disasters such as floods. In addition, $50 million in DWSRF grant funding is available to tribes, U.S. territories, and the District of Columbia for drinking water system upgrades.

The allotments across the two SRF programs for New England are as follows:

- Connecticut: $30,478,000
- Maine: $23,313,000
- Massachusetts: $79,503,000
- New Hampshire: $26,892,000
- Rhode Island: $21,681,000
- Vermont: $18,791,000

Background—Under the CWSRF and DWSRF programs, EPA provides funding to all 50 states and Puerto Rico. The states and Puerto Rico contribute an additional 20 percent to match the federal grants. The 51 SRF programs function like infrastructure banks by providing low-interest loans to eligible recipients for drinking water and clean water infrastructure projects. As the loan principal and interest are repaid over time, it allows the state's DWSRF and CWSRF to be recycled or "revolve." As money is returned to the state's revolving loan fund, the state makes new loans to other eligible recipients. These funds can also be combined with EPA's Water Infrastructure Finance and Innovation Act loans to create a powerful, innovative financing solution for major infrastructure projects.

EPA and MassDEP Issue Updated Wastewater Permit from Pilgrim Facility in Plymouth

EPA and the Massachusetts Department of Environmental Protection (MassDEP) have issued a final permit covering ongoing wastewater discharges at the Pilgrim Nuclear Power Station in Plymouth. While the station permanently ceased generating electricity on May 31, 2019, certain discharges to Cape Cod Bay continue, including non-contact cooling water used to absorb waste heat from the spent fuel pool, process water, and stormwater.

The National Pollutant Discharge Elimination System (NPDES) permit recently issued outlines conditions and requirements to protect the aquatic environment of Cape Cod Bay. The final permit includes effluent limitations, non-numeric limitations, and monitoring requirements—an advancement compared to the previous NPDES permit issued in 1991—that will help protect the aquatic community and designated uses of Cape Cod Bay.

The final permit establishes limitations and requirements, consistent with post-shutdown operations, that reduce the volume of cooling water intake by 92 percent and heat load by 98 percent compared to when the plant was generating electricity. It also establishes effluent limitations and monitoring requirements on discharges of miscellaneous "low-volume" wastes, non-contact cooling water for spent nuclear fuel rods, non-thermal backwash water for biofouling control, and stormwater, including stormwater that accumulates in electrical vaults.

The final permit does not authorize the discharge of spent fuel pool water, stormwater from construction activity, or the discharges of pollutants from contaminated site dewatering, pipeline and tank dewatering, collection structure dewatering, or dredge-related dewatering. This prohibition includes discharges of pollutants during dismantling and decontaminating plant systems and structures and demolishing buildings.

Landmark Agreement Will Enable Faster and More Complete Cleanup of Housatonic River in Berkshire County

Following more than a year of mediated negotiations, EPA and seven parties have agreed to a faster and more comprehensive cleanup plan for the Housatonic River. The settlement will provide major economic benefits for Berkshire County communities.

The seven settling parties in addition to EPA are General Electric, the Rest of River Municipal Committee (the towns of Lenox, Lee, Stockbridge, Great Barrington, and Sheffield), City of Pittsfield, State of Connecticut, C. Jeffrey Cook, Berkshire Environmental Action Team, and Massachusetts Audubon Society.

Under the agreement, highly contaminated sediment will be removed from the river and floodplains and will be transported to licensed hazardous waste landfills elsewhere in the United States. The agreement also calls for removal of more contaminated sediment from the river than previously required by EPA's 2016 cleanup plan, reducing the amount of capping of sediment in the river by one-third. Lower-level PCB contaminated materials will be consolidated into a single upland disposal facility to be constructed adjacent to the Lane gravel pit in Lee.

The updated plans will improve ecological conditions in the river by removing two dams and the contaminated sediment behind all five dams within the affected area. Further, the agreement provides economic benefits for the Berkshire County towns of Lee, Lenox, Stockbridge, Great Barrington, and Sheffield, and for the city of Pittsfield.

Benefits of the agreement include the following:

- Immediate start on investigation and design of the cleanup
- Significant cleanup enhancements to the previously defined remedy
- Hybrid disposal approach, with the most contaminated waste transported out of state to licensed hazardous waste landfills, while the remaining less contaminated materials will be consolidated in a double-lined upland disposal facility
- Substantial economic development package to municipalities of $63 million, potential land transfers, and other benefits
- Reduced impact to the communities and local roadways, and enhanced coordination with stakeholders
- Commitment to further research on innovative technologies, demonstrations, and pilot studies

EPA participated in several public information opportunities to explain the settlement agreement and answer questions from citizens. It also intends to issue a revised permit outlining proposed changes to the cleanup plan and will accept public comment on the revised permit later this year.

Note: All EPA industry news provided by EPA Press Office

In memoriam: Katelyn Biedron 1983 – 2020

Kate was a dedicated water professional and long-time NEWEA member and leader. She spent her entire 15-year professional career with CDM Smith, where she was recently promoted to regional team leader. Within NEWEA, Kate was an active member and a proven leader sought after by many committees. She served terms as chair on both the Public Awareness and Registration committees, and in 2019 she was voted in as director of the Meeting Management Council, an Executive Committee position. In 2017, she was inducted into the NEWEA chapter of the Select Society of Sanitary Sludge Shovelers. For the past decade, Kate's welcoming smile has greeted countless registrants at NEWEA's annual and spring conferences.

Her parents, her siblings with their children, and her friends were of highest importance to Kate. She was also devoted to her workplace, where she was a valued professional and often stepped forward to counsel new staff. During pandemic-era video conference calls, she was known to dress as various humorous TV characters to help people keep smiling during this unprecedented time. A spirited volunteer civil servant, she spent seven years as vice chair of the Lowell Conservation Commission.

Her contributions to her employer and community were perhaps exceeded only by the friendships and personal connections she fostered with everyone she met within NEWEA and the New England water industry. Kate would often be the first person to introduce herself to new NEWEA members, welcome them to the association, and show personal interest in getting to know them. She eagerly stepped forward to mentor Young Professionals (YPs), sharing her philosophy and advice: Don't wait—take control of your career with full force, and whatever you undertake, "kick butt at it" (Kate was not one to mince words). At this past January's NEWEA/NEWWA YP summit in Boston, she shared her experiences and ideas in a career-oriented presentation to more than 100 YPs who attended. Kate always had a bright smile and a bit of humor or a hug to offer, and she made everyone feel like a friend, as so many of us were. With the abundance of energy and passion that Kate applied to everything she did, she was truly a ray of human sunshine.

We will all miss that sunshine.

WEF Releases Water's Worth It Toolkit to Highlight Role of Water Sector in Coronavirus Response

– Travis Loop, WEF

Water Environment Federation
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WEF has released a new Water's Worth It toolkit to raise public awareness about the vital role of water utilities and workers in the coronavirus response. The high-impact materials highlight the critical need for water and wastewater services during this unprecedented time and recognize the dedicated professionals working on the frontlines to provide clean water and sanitation for their communities.

The toolkit is available at watersworthit.org and features a series of graphics for social media as well as for websites and in email.

Every day, communities rely on the knowledge and expertise of water professionals to protect public health, the environment, and economy. During the coronavirus pandemic, water professionals are providing essential services critical to a community's ability to minimize the spread, flatten the curve, and support the medical professionals' efforts to provide care, conduct research, and develop treatments.

"Along with many critical professionals, water workers provide the foundation for the global response to coronavirus while maintaining the uninterrupted services we need for a functioning society," said WEF President Jackie Jarrell. "Their work is often behind the scenes and largely unseen to the public so we want to make sure they are recognized along with other frontline workers."

WEF Convening Blue-Ribbon Panel to Evaluate Biological Hazards and Precautions for Wastewater Workers

– Travis Loop, WEF

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To ensure the protection of wastewater workers during the coronavirus pandemic and beyond, the WEF is convening a blue-ribbon panel of experts to evaluate information on biological hazards and safety precautions.

The panel comprises experts in water operations, science, health, and safety and will provide appropriate input to U.S. government agencies such as the Centers for Disease Control (CDC), Occupational Safety and Health Administration (OSHA), and EPA, as well as the World Health Organization (WHO).

"The top priority of the Water Environment Federation is always to ensure the safety and health of the front-line people in the water workforce, who protect our communities not just during the coronavirus pandemic but every single day," said Ms. Jarrell. "In keeping with the WEF tradition of educational and technical excellence, the blue-ribbon panel will make certain that our information on hazards and safety and the guidance of organizations such as the WHO, CDC, OSHA, and EPA are based on the latest evidence and absolute best science."

The coronavirus pandemic has shown the need for timely, reliable information on biological hazards from wastewater and appropriate protective practices for wastewater workers. The WEF Manual of Practice, *Safety, Health and Security in Wastewater Systems*, includes a chapter that discusses types of hazards, how to prevent and treat infections, and workers at risk. The panel of experts will review the advice provided in the Manual of Practice and other WEF publications and guidance from federal agencies to determine if supplemental advice or recommendations are needed to protect worker health and safety. The panel is expected to work quickly and present its initial findings within a few weeks.

The panel is chaired by Dr. Art Umble, who leads the global wastewater sector for Stantec Consulting and previously managed a publicly owned water and wastewater utility. Dr. Umble also serves on the advisory council of the Water Research Foundation (WRF), the editorial board for the *Water Environment Research (WER) Journal*, and university advisory boards for environmental engineering, and provides peer review for academic journals and collaborative research projects.

Panel members represent a variety of academics, practitioners, and policy makers in disciplines from across the water sector, including public health, safety and security, utility management, collection systems, facility operations, municipal design, industrial, laboratory services, and microbiology.

The panel members are:

- Dr. Art Umble (Chair), Stantec
- Dr. Allegra da Silva (Vice Chair), Brown and Caldwell
- Tim Page-Bottorff (Vice Chair), SafeStart
- Dr. Charles Gerba, University of Arizona
- Dr. Kyle Bibby, University of Notre Dame
- Dr. Charles Haas, Drexel University
- Dr. Leonard Casson, University of Pittsburgh
- Dr. Kartik Chandran, Columbia University
- Dr. Mark Sobsey, University of North Carolina and World Health Organization
- Dr. Mark LeChevalier, Dr. Water Consulting
- John Bannen, Inframark
- Dr. Earnest Blatchley III, Purdue University
- David Gill, DC Water
- Dr. Naoko Munakata, Los Angeles County Sanitation Districts

WEF's overall response to the coronavirus pandemic has included providing the latest technical and scientific information to the water community, offering educational opportunities through digital programming, and communicating regularly about resources and assistance available to the sector. WEF maintains comprehensive information and resources related to coronavirus at wef.org/coronavirus.

NEWEA
WORKING FOR WATER QUALITY

Steps toward climate change resilience for wastewater utilities

LAUREN MILLER, CC-P, CDM Smith, Boston, Massachusetts

ABSTRACT | The changing climate creates sometimes overwhelming uncertainty for wastewater utilities. This article discusses the climate change impacts in the northeastern United States, explains the vulnerability assessment process, and describes how to mitigate vulnerabilities to increase climate resilience. Incorporating climate uncertainty into short- and long-term planning can help wastewater utilities become stronger and more adaptable, allowing life and business to carry on with minimal interruption and increased reliability.

KEYWORDS | Climate change, resilience, adaptation, resilience planning, resilient design, wastewater utility

INTRODUCTION

Global climate change has local impacts. The changing environment causes increasing financial and physical consequences, creating uncertainty for wastewater utilities. It can be overwhelming to face this uncertainty and to figure out how to prepare for it. Fortunately, most utilities can work within their existing framework to reduce the potential negative impacts of climate change. They can work to become resilient.

This article aims to help wastewater utilities take the first steps to be proactive about improving their resilience to climate change. Strengthening wastewater infrastructure that already exists and weaving resilience into new plans and designs can help wastewater utilities. By carefully considering climate change impacts, wastewater utilities can become stronger and more adaptable, allowing life and business to continue with minimal interruption and increased reliability.

CONTEXT OF CLIMATE CHANGE

The United States experiences multiple billion-dollar weather and climate disasters every year. The National Oceanic and Atmospheric Administration reports that 2019 was the fifth consecutive year with more than 10 such events.

Weather and climate disasters lead to critical infrastructure disruption because most of the wastewater infrastructure in the Northeast is not designed for these new climate conditions. As wastewater infrastructure nears the end of its useful life, wastewater utilities can thoughtfully incorporate future climate conditions into the upgraded infrastructure.

The 2018 National Climate Assessment, developed by U.S. scientists and experts in climate change, evaluates potential regional impacts of climate change. Their predictions are based on peer-reviewed literature and global climate models. According to the assessment, northeastern states—New England states, New Jersey, New York, Pennsylvania, Delaware, Maryland, and West Virginia—can expect higher average annual temperatures with associated heat waves and drought conditions, greater intensity and frequency of heavy precipitation events, strong and more intense severe storms, and sea level rise. The Northeast already experiences most of these events. The climate-driven change is the increased frequency and intensity of these events.

The climate is changing, but we can plan for it. Wastewater utilities can use practical methodologies and tools to incorporate climate change into infrastructure planning and design. The key to it is understanding and quantifying the uncertainty in climate change projections and impacts. Then, wastewater utilities can incorporate uncertainty into system planning and design processes to manage risk and develop practical contingencies.

WHAT IS RESILIENCE?

Merriam-Webster dictionary defines resilience as:

1. "the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress
2. an ability to recover from or adjust easily to misfortune or change"

In the context of climate change, resilience means anticipating and planning for it to manage the risk. Building resilience means that when climate events occur, they do not cause significant or long-term disruption. A resilient wastewater utility is flexible and adaptable to climate change events—whether they be acute, such as a nor'easter, or chronic, like a drought. The first step toward resilience is understanding the utility's vulnerability to climate change.

UNDERSTANDING VULNERABILITY TO CLIMATE CHANGE

Climate change vulnerability assessments can be as broad or detailed as the wastewater utility's resources allow. An in-depth, quantitative vulnerability assessment leads to greater confidence when evaluating climate impacts on assets and thereby supports more appropriate design conditions. The American Society of Mechanical Engineers Innovative Technology Institute's RAMCAP® (Risk Analysis and Management for Critical Asset Protection) is a nationally recognized analytical method for determining the risk of malevolent acts and natural hazards. Many drinking water utilities use the RAMCAP process to comply with America's Water Infrastructure Act. Many drinking water utilities are using the RAMCAP process to comply with the America's Water Infrastructure Act. The concepts outlined in RAMCAP include a process for quantitative risk evaluation that can be applied to climate change hazards.

However, even a broader, qualitative vulnerability assessment can help improve a utility's resilience, because thinking through climate change consequences to your utility at any scale is in and of itself an act of resilience. This could include a process such as that required through the Massachusetts Vulnerability Preparedness (MVP) Program, which uses The Nature Conservancy's Community Resilience Building model. The model allows communities—including wastewater utilities—to identify and document their vulnerabilities and strengths in the face of different climate change impacts.

In either case, the basics of any climate change vulnerability assessment are as follows:

- Determine the future climate change impacts, including the magnitude and period they may occur. A utility may consider focusing on climate change impacts that may be of more consequence to the infrastructure.
- Identify and prioritize the infrastructure affected. Critical infrastructure includes assets or processes that the utility must have to achieve its mission. Evaluating for "criticality" allows the utility to focus resources on what is more important.
- Assess the assets' sensitivity and adaptive capacity to the climate change impacts identified. Sensitivity is the degree to which the asset is affected by the climate change impact and the known or predicted effects. Adaptive capacity is an asset's ability to accommodate the climate change impact and return to normalcy after a disruption. These evaluations can be completed quantitatively, by assigning numeric values, or qualitatively, based on the utility's understanding of conditions.
- Prioritize based on the vulnerability assessment outcomes. Assets more vulnerable to climate change take precedent. The utility may also prioritize outcomes based on qualitative factors, such as funding availability or community needs.
- Develop climate change adaptation—or resilience—strategies for prioritized vulnerabilities.

CLIMATE CHANGE IMPACTS IN THE NORTHEASTERN UNITED STATES

1. EXTREME HEAT
An increase in average annual temperatures. The temperatures will contribute to the increased frequency, intensity, and duration of heat waves. They may also intensify drought conditions in the summer and fall, due to higher evapotranspiration rates and changes in seasonal snowmelt patterns.

2. EXTREME PRECIPITATION
An increase in the intensity and frequency of heavy precipitation events, especially in the winter and spring.

3. SEA LEVEL RISE
Sea level rise throughout the coastal regions, causing higher and more damaging storm surges and high tides—a particular issue in the Northeast due to subsidence in the region.

4. STORM SURGE
Strong and more intense severe storms, such as nor'easters and hurricanes.

Process for Preparing for Climate Change

Determine future climate change impacts → Identify and prioritize the infrastructure affected → Assess sensitivity and adaptive capacity → Prioritize vulnerabilities → Develop adaptation strategies → Systematically implement adaptation strategies

REASSESS REGULARLY

Identify how the utility can reduce the vulnerability and improve the resilience of at-risk assets.

- Systematically implement the identified adaptation strategies and reassess regularly. This includes incorporating the future climate change parameters into design.

The last two bullets—developing and implementing climate change adaptation strategies—are how a wastewater utility can achieve resilience to climate change.

ESTABLISHING CLIMATE RESILIENCE SOLUTIONS

An adaptation strategy reduces asset vulnerability to improve resilience. It provides a path for wastewater utilities to "adapt" to climate change impacts by retaining function during a weather or climate disaster event or resuming operations quickly after an event. The measures can strengthen wastewater infrastructure and weave resilience into new plans and designs. The adaptation strategy may also include future policy or operations and maintenance practices.

The key to successful adaptation strategies is to match the magnitude and timeframe of expected future climate change conditions to the asset useful life. Using historic climate conditions will not lead to effective adaptation. Consider the following questions when creating and implementing adaptation strategies:

1. What are the main concerns regarding climate change effects at a facility or on key assets based on the outcomes of the vulnerability assessment? What is the magnitude of the consequences from climate change impacts the utility may expect over the life of the equipment?
2. What is the useful life of the given facility or key assets?
3. What is the utility's goal for implementing an adaptation strategy? What is the utility's risk appetite? For instance, does the utility wish to reduce risk to near zero or reduce only the most severe risks from climate change?

Answering these questions can help wastewater utilities meet the challenges of future climate change conditions over the asset lifetime. Integrating multiple disciplines—wastewater, environment, and systems analyses—can provide effective, customized solutions. They may also help wastewater utilities decide on phasing certain aspects of the adaptation strategies over time through thoughtful capital improvement planning, therefore avoiding overdesigning.

Although guidance for asset- and location-specific climate resilient design standards is limited, it is growing in certain cities and regions in the United States, such as those developed in Boston, New York City, and Miami-Dade County. These trends are expected to continue.

CLIMATE RESILIENCE AS A MATTER OF PRACTICE

When a wastewater utility plans for climate change—either chronic or acute impacts—they can better withstand it. The plan implementation transforms them into a climate resilient utility.

Wastewater utilities can empower themselves by taking the first steps toward resilience to climate change: evaluating the consequences and thinking through possible solutions quantitatively or qualitatively. Engaging in this process will improve the utility's resilience and move it toward stronger and more adaptable infrastructure. Wastewater utilities have the power to allow life and business to carry on with minimal interruption and increased reliability in the face of climate change.

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COVID-19—implications for the water and wastewater industry

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ABSTRACT | Owing to the high degree of infectivity of the SARS-CoV-2 virus, the COVID-19 pandemic has rapidly spread and infected many individuals worldwide. Although the primary route of transmission is via the respiratory tract, the novel coronavirus SARS-CoV-2 has also been found to be shed from the body through feces. The SARS-CoV-2 virus is similar to the virus that caused the 2003 SARS pandemic, when a cluster of infections was found to have been due to aerosolized sewage. With the presence of this virus a possibility in sewage, water and wastewater professionals must be aware of the potential for infection due to water- and wastewater-borne routes. Research is needed to determine the actual viral load in sewage, the possibility for infection from sewage, the virus's persistence in wastewater treatment facilities and in the environment, and the effectiveness of conventional disinfection processes for inactivating this virus.

KEYWORDS | Coronavirus, COVID-19, pandemic, sanitation, SARS, wastewater

INTRODUCTION

In December 2019, multiple cases of respiratory illness in Wuhan, China, started being reported. Initially the origin of these pneumonia cases could not be identified, but before long a novel severe acute respiratory syndrome (SARS) virus, SARS-CoV-2, was identified as the cause of the coronavirus disease of 2019, COVID-19. Symptoms include dry cough, fever, and respiratory distress. Its initial transmission to people was narrowed to a seafood and animal market in Wuhan, but SARS-CoV-2 may likely have originated in bats (Chan et al., 2020). It was soon determined that person-to-person transmission was occurring, and before long many people in the area became ill. Only through drastic measures, including mandatory shuttering of businesses and quarantining of residents, was the outbreak allegedly mitigated in China after reportedly tens of thousands of illnesses and several thousand deaths. However, by that time, COVID-19 had started spreading around the world, resulting in the WHO declaring a pandemic in early March. As of June 6, 2020, according to the World Health Organization (WHO), nearly 7 million people worldwide were confirmed as having COVID-19 with nearly 400,000 deaths reported, and both numbers were still rising.

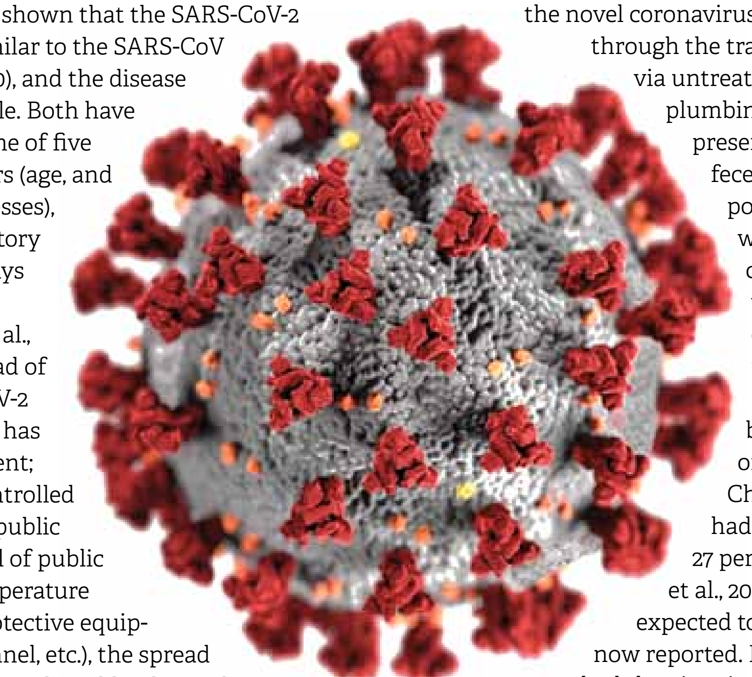
SARS-CoV-2 is a newly discovered strain of coronavirus, related to other serious strains including SARS-CoV and Middle East respiratory syndrome (MERS-CoV). In addition, many other coronaviruses exist that are much less serious to human health, and many are known to infect animals. Both SARS-CoV and MERS-CoV resulted in deadly outbreaks; the SARS outbreak in 2003 infected 8,096 people with 9.6 percent fatality rate, and MERS has infected 2,494 people since 2012 with a 34.4 percent fatality rate (data from the WHO).

As new information about the COVID-19 pandemic emerges, those in the water and wastewater industry have many questions:

- Can we be exposed to SARS-CoV-2 virus through direct, or indirect, contact with wastewater or wastewater droplets?[1]
- Can the SARS-CoV-2 be released to the environment through treatment facility discharges?[2]
- As SARS-CoV-2 is zoonotic, can the virus be passed to animals who contact it after wastewater discharge?[2]
- Can the SARS-CoV-2 virus persist in water sources and be taken into drinking water facilities?[2]
- What are the roles that water/wastewater professionals will play going forward in preparing for future pandemics? Should our approach to infrastructure strive to become more resilient to disruptions from pandemics?[3]

TRANSMISSION, INCLUDING FROM WASTEWATER

The SARS-CoV-2 coronavirus, which causes the COVID-19 disease, has been found to have similarities to the 2003 strain of coronavirus responsible for the deadly 2003 outbreak, SARS-CoV. Research has shown that the SARS-CoV-2 genome is 82 percent similar to the SARS-CoV genome (Chan et al., 2020), and the disease progression is comparable. Both have an incubation (mean) time of five days, identical risk factors (age, and effect of underlying illnesses), and can result in respiratory distress within 8 to 20 days after the first symptoms initiate (Wilder-Smith et al., 2020). However, the spread of SARS-CoV and SARS-CoV-2 through the community has been dramatically different; while SARS-CoV was controlled effectively with applied public health measures (control of public events, quarantines, temperature monitoring, personal protective equipment for hospital personnel, etc.), the spread of SARS-CoV-2 has continued worldwide resulting in a pandemic. Greater population densities and more global travel have certainly contributed to the rapid spread of SARS-CoV-2 compared to SARS-CoV. But the apparent high degree of transmissibility is a likely factor to its wide and rapid spread. And it has been found that the transmission of this virus occurs earlier after initial infection, even before symptoms are obvious (Wilder-Smith et al., 2020). Contributing to its transmission is that this virus has a wide range of symptoms, from asymptomatic, to mild, to severe—yet patients within the full range of symptoms can be infectious. Clearly the effectiveness and complexity of this novel coronavirus contribute to its persistence and transmissivity, and thus contribute greatly to the resulting pandemic.



Because the main symptoms of COVID-19 infection are respiratory (Zhu et al., 2020), the virus may be expected to be shed and transmitted through the respiratory route even when no symptoms are exhibited. Transmission is thought to be through exposure to aerosol/droplets of respiratory origin and through contact with contaminated surfaces. The shedding and movement of the virus through these mechanisms thus requires protective protocols to prevent spread via these routes. Recent research has found that the SARS-CoV-2 virus remains viable in aerosols for hours and can persist as viable on many surfaces for days (van Doremalen et al., 2020).

Recent findings indicate that the virus is also shed in the feces of people infected, suggesting a possible additional route of transmission via the gastrointestinal system (Gu vet al., 2020). Xie et al. (2020) found positive nucleic acid test results for the SARS-CoV-2 virus in the feces of 8 of 19 infected patients. In comparison, nine of these patients had positive throat swabs—currently considered an appropriate test for the novel coronavirus. However, no cases of COVID-19 through the transmission of SARS-CoV-2 virus via untreated wastewater or defective plumbing have been recorded. The presence of SARS-CoV-2 virus in feces raises concern due to the possible effect on public health via water-borne (water, wastewater, contaminated surface water) virus mobility. This issue is exacerbated by the many COVID-19 patients who exhibit diarrhea (Xie et al., 2020). In one report by Wang et al. (2020), 10 percent of COVID-19 infected patients in China had diarrhea. As diarrhea had been reported to be as high as 27 percent for SARS-CoV (Donnelly et al., 2003; He et al., 2020), it may be expected to be higher for COVID-19 than now reported. In addition, infected individuals can shed the virus in their feces for a much longer time than the time that respiratory samples were positive (Ma et al., 2020).

PRESENCE IN WASTEWATER, WITH CONSIDERATION FOR RESIDENTIAL PLUMBING SYSTEMS

Disinfection is a primary approach for controlling pathogens in water and wastewater. As SARS-CoV-2 has a similar genome to SARS-CoV, it should be anticipated to behave similarly. Research by Wang et al. 2005(b) found that SARS-CoV in wastewater was susceptible to sodium hypochlorite and chlorine dioxide, with effective inactivation at reasonable dosages and contact times. In fact, Wang et al. reported that SARS-CoV was inactivated at lower dosages and contact times than required for E. coli and f2 phage. Unfortunately, the persistence of SARS-CoV without disinfection was troubling: Wang et al. 2005(b) found that SARS-CoV persisted for up to 14 days in wastewater and 17 days in feces and urine at 39.2°F (4°C).

Because the SARS-CoV-2 and SARS-CoV genomes are so similar, the 2003 SARS outbreak is illuminating. In one cluster

[1] With proper disinfection, this is not likely. Infection is possible from sewage that is not disinfected.
[2] Low likelihood but needs research.
[3] Important that the industry addresses our role in preventing pandemics and providing resilience.

Photo: *SARS-CoV-2 virus* (source: CDC, 2020) of infections in a housing complex (the Amoy Gardens) in Hong Kong during the 2003 SARS epidemic, the primary route of transmission for the cluster was through a defective sewage system in the building (Lee, 2003). A significant viral load was released into the building sewage system from infected individuals who were suffering from diarrhea. The virus was then drawn from the sewage system into the drains in other bathrooms in droplet form, where it deposited on various surfaces in the living spaces. From this mechanism of infection via sewage droplets, the virus infected 321 people in this housing block. This transmission was thought to have occurred because of the water traps in the drains becoming empty of water—proper operation/maintenance of the U-shaped water traps is for water to be maintained in the trap to prohibit passage of noxious gases, insects, etc. The study of this cluster suggests that coronaviruses of the SARS type may be present in domestic wastewater, and depending on the wastewater collection system dynamics, may provide for an infectious situation. Further evidence of the potential for infection via sewage was reported by Wang et al. (2005a) where SARS-CoV nucleic acid was identified in sewage from Hong Kong hospitals treating SARS patients.

More recently, according to a February 12, 2020 CNN report, a Hong Kong building was partially evacuated and some residents quarantined, after two cases of COVID-19 were suspected to be connected as the result of faulty sewage piping. In this case reported by CNN, a 62-year-old female resident contracted COVID-19 approximately 10 days after a 75-year-old male resident had tested positive for COVID-19. While not confirmed as of the date of this publication, a detached sewer vent pipe in the woman's apartment may have been a possible transmission route for aerosolized sewage that may have contained coronavirus.

The confirmed 2003 cases in Hong Kong and the unconfirmed 2020 case also in Hong Kong illustrate the potential exposure risks of aerosolized sewage droplets. While to date there are no confirmed cases of COVID-19 from contact with raw sewage, the transmission of SARS-CoV-2 is not yet fully understood, making it more important than ever to continue proactive sewer system operation and maintenance to help reduce the potential exposure to raw sewage, especially in the aerosol form. Protecting the general public from exposure to raw sewage is fundamental to every sewer authority and is done through various proactive maintenance measures such as cleaning and inspecting, inflow and infiltration investigations, illicit discharge elimination programs, pump station inspections, and other routine and capital improvements. It is equally important for sewer authorities to educate the public on its role in maintaining a functional sewer system by not flushing "disposable" disinfecting wipes or paper towels. The public must understand that these products do not break down like toilet paper, and excessive amounts have led to sewer main blockages, residential backups, and pump station damage. The public should also be aware that sewer blockages can increase the potential exposure to raw sewage when sewage backs up into residential dwellings or raw sewage overflows to surface waters.

BIOSOLIDS/DISPOSAL HANDLING

The persistence of the coronavirus in wastewater also raises concern for the release and transmission of the virus through biosolids handling and disposal operations. Until further investigations are performed, unstabilized primary and secondary sludges generated by wastewater treatment operations can reasonably be assumed to have similar exposure risk and virus viability durations as raw wastewater. Exposure potential occurs during processing operations at wastewater treatment facilities, as well as at disposal sites receiving unstabilized sludges. Biosolids that are land applied typically undergo advanced stabilization (anaerobic digestion, thermal drying, lime stabilization, composting, etc.) to reduce pathogens, as regulated by *40 CFR Part 503 (Standards for the Use or Disposal of Sewage Sludge)*. While these stabilization processes are well-developed, some published research illustrates there still may be viral pathogens present after applying these techniques. In one study by Wong et al. (2010), various enteric viruses were found in biosolids after mesophilic anaerobic digestion (including norovirus and human adenoviruses). Further, the possibility of runoff from biosolids-amended agricultural land containing viral contamination was illustrated by Wong et al. (2012). Additional research is recommended to confirm SARS-CoV-2 is no longer viable following biosolids stabilization processes.

DOMESTIC WASTEWATER REUSE

Domestic wastewater reuse applications must consider possible contamination by the coronavirus. Exposure should be considered from both direct contact as well as aerosols if the water is not properly disinfected. Water reuse projects typically employ disinfection barriers known to be effective for a range of bacteria and viruses, including SARS-CoV and MERS-CoV. Typical disinfection includes chlorination, ozonation, and UV. Regulations such as California Title 22 require extended chlorine contact time or disinfection that provides at least 99.999 percent (i.e., 5-log) removal or inactivation of MS2 (a surrogate virus for polio virus) for tertiary recycled water. Direct and indirect potable reuse applications typically have more advanced disinfection requirements. For example, California Title 22 regulations require indirect potable reuse projects such as groundwater replenishment reuse projects to provide up to 12-log enteric virus reduction. Additional research is recommended to confirm SARS-CoV-2 is no longer viable following typical water reuse disinfection processes.

PROACTIVE COLLECTION SYSTEM OPERATIONS

Proactive measures such as the development of capacity, management, operation, and maintenance (CMOM) programs are even more critical in the time of COVID-19 to help reduce the potential for society to encounter wastewater. Not only are regulators throughout New England emphasizing a need for enhanced CMOM programs through permit requirements and state regulations, communities are becoming more strategic with local budgets by undertaking an asset management approach to utility operations. This approach is resulting in staff and contractors encountering wastewater even more frequently than a decade ago. These entities are completing proactive routine system maintenance (such as jetting, manhole repairs, and pump station visits), studies (such as infiltration and inflow metering and inspections), and capital improvements including collection rehabilitation or replacement and pump station and treatment plant repairs and upgrades.

In addition to the physical maintenance activities, system operators are also investing in public education about the challenges facing the industry from aging assets to operational challenges related to societal issues such as non-flushable wipes. In a March 30, 2020 release, EPA encourages Americans to flush only toilet paper and states the following: "Preventable toilet and sewer backups can pose a threat to human health and present an extra challenge to our water utilities and their workforce. Flushing anything other than toilet paper, including disinfecting wipes, can damage internal plumbing, local sewer systems, and septic systems. Fixing these backups is costly and takes time and resources away from ensuring that wastewater management systems are otherwise working properly." This is a message that system operators must continue to convey to customers.

Each of these efforts helps keep the system functional, reducing the potential for sanitary sewer overflows into private homes or businesses, streets, or local waterbodies, and thereby limits the public's potential contact with COVID-19 in wastewater.

HEALTH AND SAFETY IN THE WASTEWATER INDUSTRY

The presence of a novel coronavirus in wastewater and its possible long-term viability should be a serious concern for the wastewater industry. There is a need to protect ourselves from the many other pathogens known to be present in wastewater, but the high infectivity and possible severe health consequences of COVID-19 require extra precautions. And we should expect an increased SARS-CoV-2 viral load in wastewater as more of the population becomes infected as projected. Protection from raw sewage, and aerosol droplets that may drift from the sewage, is necessary. Deposition of SARS-CoV-2 on surfaces exposed to droplets should be expected. Generally, handling of waste suspected or known to contain SARS-CoV-2 does not require special precautions or personal protection equipment (PPE) beyond those already used to protect workers from the hazards of routine tasks in solid waste and wastewater management.

CONCERNS IN THE DEVELOPING WORLD

In addition to the concerns of the coronavirus pandemic in the United States, the impact may be critical in the developing world. The ability to test for coronavirus in patients and an adequate health care system with the availability of trained health professionals may be compromised in other countries. Both WHO and the U.S. Centers for Disease Control and Prevention (CDC) suggest that people wash their hands frequently (or use an alcohol-based hand sanitizer) to help prevent the spread of the novel coronavirus; yet, many in the developing world do not have adequate access to clean water and sanitation facilities to do this. As of 2017, 2.2 billion people did not have access to safely managed water; 4.2 billion people do not have acceptable sanitation; and 3 billion people do not have access to simple handwashing facilities (according to WHO). In many undeveloped areas of the world, there is direct fecal contamination of surface waters that may be used for drinking, washing, and other domestic activities. As an example, an ongoing shortage of potable water in Rio de Janeiro has existed since early February because of concerns about possible contamination of the city's water supply; CEDAE, the state-owned water utility, had to temporarily shut down a key treatment plant, resulting in water shortages in dozens of neighborhoods. Today, these neighborhoods must go without water for much of the day, impeding their ability to wash their hands and sanitize their homes properly amid the pandemic. Many similar examples exist in the developing world where lack of proper sanitation facilities can lead to illnesses.

Our industry should strengthen the initiative to alleviate these shortcomings throughout the world, as pandemics such as a coronavirus may be controlled with increased access to clean water and sanitation. The world may have been unprepared for COVID-19, and its increased infection rate/death toll due to poor sanitation in the developing world is still unknown as the peak has likely not yet arrived in those countries. However, discussion about increased sanitation investments will be necessary soon as we prepare for future outbreaks in parts of the world where sanitation is lacking.

CONCLUSIONS

Recent findings on the novel coronavirus SARS-CoV-2 infectivity, high degree of shedding from the human body, and persistence in the environment, coupled with our knowledge of the 2003 SARS-CoV epidemic, provide insight into the impacts on the water and wastewater industry. In the 2003 SARS epidemic, many individuals were infected through sewage via droplets. Because the SARS-CoV-2 virus, which causes the COVID-19 infection, resembles the SARS-CoV virus, the water and wastewater industry must be cognizant of the potential for water-borne or sewage-borne routes for infection. While the SARS-CoV-2 virus is thought to be readily inactivated through disinfection processes typical for the industry, extra precautions are probably prudent to prevent infecting both industry personnel and the public. Moreover, preventing both the discharge of the virus to the environment and the contamination of drinking water sources and systems is crucial. Research is needed to determine the persistence of the SARS-CoV-2 virus in water systems, wastewater systems, and the environment, and the best engineering actions to control the pandemic.

| COVID-19 IMPLICATIONS |

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Implementing a wet weather pumping strategy to reduce street flooding within the city of Hoboken, New Jersey

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ABSTRACT | For more than a century, the city of Hoboken, New Jersey, has dealt with flooding during heavy rain events and high tides. Significant wet weather has long overburdened the combined sewer systems of the North Hudson Sewerage Authority (Authority), and as the area has been further developed, the flooding has proven increasingly problematic. The Authority constructed two wet weather pump stations in low-lying areas to minimize flooding and collection system surcharging. This paper discusses the design, challenges, benefits, and performance of these two pump stations to reduce the street flooding during wet weather events.

KEYWORDS | Wet weather, pump station, resiliency, climate change, flooding, adaptation strategies

INTRODUCTION

For more than a century, Hoboken, New Jersey, has dealt with flooding during heavy rain events and high tides. Seventy-five percent of the city is below the 100-year floodplain and several areas, including street surfaces, are below the mean high-tide. This makes draining the city during storm events problematic during high tides and impossible when storm surges raise water surface elevations in the New York/New Jersey Harbor estuary. During Superstorm Sandy much of the city was flooded and damaged. Significant wet weather events have long overburdened the sewer systems of the North Hudson Sewerage Authority (Authority), and as the area has been further developed, the flooding has overwhelmed the combined sewer collection system and proven increasingly problematic. Combined sewer overflows (CSOs) often cannot discharge during high tides and especially during flood tides.

The Authority owns and operates two wastewater treatment plants (WWTPs) and combined sewer systems serving cities (Hoboken, Weehawken, Union City, and West New York) with a total population of 180,000. Many of the combined sewers are more than 100 years old. Persistent leaks from the pressurized drinking water system infiltrate the Authority's sewers. The densely populated cities are mostly built out or being redeveloped, and the Authority owns land at its WWTPs only, thus limiting opportunities to build additional treatment facilities.

To eliminate chronic street flooding in Hoboken, the Authority constructed and now operates two wet weather pump stations in Hoboken to drain streets in the flood zones during high tides. The H1 wet weather pump station (WWPS) was built above flood elevations to drain the south and southwest sections of Hoboken. The H5 WWPS has a minimal footprint in a residential neighborhood but is essential for draining the low-lying central areas of the city.

The Authority expertly managed the design and construction of these facilities to coordinate with the City of Hoboken, NJ Transit, and residents. The facilities are a critical part of the City of Hoboken's "Rebuild by Design" Flood Management Program and are crucial for keeping Hoboken's streets dry during heavy rainfalls, high tides, and storm surges. As sea levels rise, the Authority will continue to benefit from these projects. The WWPSs were designed to be modified to accommodate disinfection or additional features to control CSOs.

DESIGN CONSIDERATIONS

Key elements for pump station design include the following: wetwell/drywell design; pump, motor, and drive selection; instrumentation and controls (I&C) and supervisory control and data acquisition (SCADA) system; electrical system; and visibility and aesthetics. Additional considerations for each of these key elements must be included when designing for flood resiliency.

Wetwell and Wetwell/Drywell Design

Resilient designs should anticipate future needs to prevent major changes to the building and wetwell. Site space, topography, and intended service must be considered when selecting the design. Because pump stations are sited in areas where the hydraulic gradeline must be increased, they are typically in low-lying locations. Upgrade alternatives for pump stations are normally limited to whether the existing system is a wetwell or wetwell/drywell design. Converting a wetwell design to a wetwell/drywell one is not common but is possible depending on building codes and the surrounding area.

The setting and pump location within the wetwell are also important design considerations. Normally pump spacing and baffles are configured such that the inlet has enough submergence to eliminate short-circuiting and vortexing. If pump capacity needs to be increased in the future and the submersible pump has been placed in the wetwell with depth of submergence at the minimum, the pump size or height cannot be increased in the future without modifying level controls. Changing the operating levels in the wetwell may not be possible without a cascading effect on pump operating times. Unless the depth of the pump station has severe restrictions, an extra 2 ft (0.6 m) may be added to the minimum low-level depth of submergence to allow for a future change in pump size.

Pumps, Motors, and Drives

If there are critical systems that require a standby unit, good design practice provides a second spare unit so one unit may be taken offline for maintenance. The number and size of pumps in a multiple pump design must be considered for redundancy. Multiple pumps may be necessary for critical pumping applications. Pump station design should include space to maneuver and remove pumps for maintenance and replacement. The laying length around the pump should accommodate the existing pump as well as a larger replacement pump if future conditions require increased capacity.

Variable frequency drives (VFDs) should be considered in pump stations where they provide an operational benefit or increase energy efficiency. VFDs may be beneficial when flow pacing is required to manage wide variations in diurnal and wet weather flows. They should comply with guidelines for harmonic distortion within the system to account for voltage drop when switched to a standby generator. If transient power surge or harmonics is a potential issue, capacitors may be required for reduced voltage starters on larger motors. Motors and VFDs should be above the 100-year flood elevation, and VFDs should be as close to pump motors as practical.

SCADA and Instrumentation

Implementing the proper level of I&C depends on the SCADA system and operational philosophy. It

Hoboken, New Jersey

Photo 1. H1 wet weather pump station

Photo 2. Location of underground H5 wet weather pump station and valve vault

also depends on the need to obtain historic trends for regulatory compliance and system optimization. Overall planning should consider a strategy for future upgrades to the SCADA platform for new monitoring and control and additional pumps.

Typically, pump stations monitor level, flow, power, and pump runtime. Data communication and trend analysis are important for understanding operations and optimizing the pumping system for future conditions. Adaptive systems and learning networks among multiple pump stations that are networked with programmable logic controls (PLC) make up a new strategy for higher level of control within the collection system. Proactive or predictive controls can provide more resilience and flood protection than reactive controls. Multiple urban wet weather pump systems may be optimized to reduce overflow volumes through balancing pumping during high tide and wet weather events. These strategies are valuable for any coastal urban system threatened by flooding or sea level rise.

Electrical Systems

Both the reliability and location of emergency power are important for urban pump stations with tight site constraints. In some jurisdictions approval is difficult to obtain from the local utility for below-grade transformers, while in most urban areas these are standard. Sound attenuation should be considered in urban areas where buildings and residences are adjacent to the generator.

Remote monitoring of the electrical system is important for below-grade pump stations. Most emergency power systems have some type of SCADA system, annunciator, or phone dialer to alert operations staff of the interruption or restoration of power. Depending on the system's complexity a manual transfer switch may be needed to restore power. Larger systems typically use automatic transfer switches, which can be remotely monitored through the SCADA system.

Visibility and Aesthetics

Pump stations are rarely designed as an aesthetics statement. Most are designed to be out of view. Pump systems can be hidden or at least camouflaged to blend into the surrounding community or designed as a "signature structure." The public and other stakeholders must be considered in site selection and design.

H1 WET WEATHER PUMP STATION

The H1 drainage area is in the southwestern area of Hoboken along Observer Highway. Land uses include high-density residential and commercial/industrial with many paved parking areas for the Hoboken Rail Terminal and local commercial activities. The drainage area is 287 ac (116 ha), and impervious surface cover is approximately 72 percent. This drainage area is about 34 percent of the city and 20 percent of the entire Adams Street WWTP service area.

The Hoboken H1 WWPS is designed to eliminate the combined sewer overflow (CSO) discharge of solids/floatables materials to the Hudson River and to provide southwest Hoboken with protective measures against wet weather street flooding during a five-year storm event that coincides with a high tide. Photo 1 shows the signature design prepared by an architect for the highly traveled urban area.

H5 WET WEATHER PUMP STATION

The H5 drainage area is approximately 215 ac (87 ha) and is tributary to the Adams Street WWTP. The H5 WWPS is in the northern area of the city, below grade along 11th Street. The H5 WWPS protects and reduces street flooding in the north central portion of the city.

Figure 1 and photos 2 and 3 show the locations of the major components of the H5 WWPS most of which, including the electrical vault, was constructed below grade to blend into the urban streetscape. Only the emergency generator is above grade.

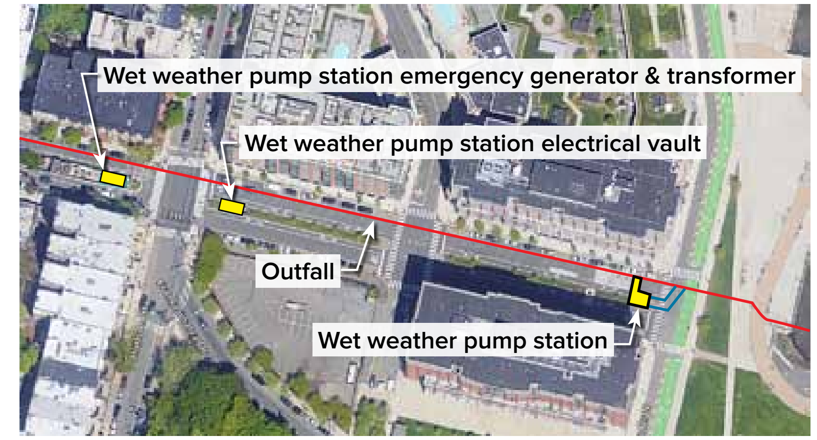

Figure 1. H5 wet weather pump station constructed completely beneath an urban streetscape

Photo 3. H5 wet weather pump station electrical vault

OPTIMIZATION OF PUMPING CONTROL

Since few real-time sensors exist within the city's collection system to indicate elevated sewer levels, approaching flood conditions, the intensity of a wet weather event, or the tide elevation, it was necessary to find other available indicators to enable optimal regulation of storm surge pumping. Data trends during various past wet weather events indicated the rate of water level rise within the pump station wetwell could help predict when an intense wet weather event was occurring simultaneously with high tide. Once these indicator conditions were identified, the lead pump could be brought into service as soon as possible.

A PLC "surge predictor" program was written for a 50 mgd (189 ML/d) WWPS to monitor the rate of change of wetwell elevation over time and respond to the elevations by applying an algorithm. The new PLC program was also modified to account for conditions that had been observed within the wetwell at the end of pumping cycles. At the end of a pumping cycle the wetwell level rises rapidly as the hydraulic gradeline in the collection system equalizes within the wetwell. This observed "rebound" effect is similar to the wetwell surge caused by an intense storm (rapid rate of rise) but cannot be allowed to trigger the surge predictor program.

It helps to know that a wetwell rebound only occurs after a pumping cycle has ended to avoid having the PLC program confuse a wetwell rebound with a surge condition. Therefore, the PLC code was written such that upon ending an automatic pump-down cycle (normal or surge), the surge predictor rate-of-rise program and normal start program would both be Locked Out to account for the rebound. At the end of the pump-down cycle the control system will be made ready to start the lead pump again. Only after a time delay will the rate-of-rise program be released (made active), and the normal start setpoint program will also be made active. Such an approach may be used to optimize a system of storm water pumps to meet the maximum pumping rate within a collection system and balance flows within the system, thereby providing stable flow to the WWTP while minimizing the volume of pumped overflow. Figure 2 presents the overview of the system logic to initiate the optimization program.

Figure 2. Overview of surge predictor logic for pump station optimization

SETPOINT SCREEN

Surge Predictor Wetwell Rate of Rise
Default 0.3 ft/min (9cm/min),
Range 0.3–0.6 ft/min (9–18 cm/min)

Surge Predictor Lead Pump Start Setpoint
Default 16 ft (4.9 m)
Range 15.5–16.5 ft (4.72–5.03 m)

Wetwell Surge Rebound Timer
Default 4.5 min, Range 3–6 min

ALARM SCREEN

Wetwell Surge Predicted
Alarm triggers upon the control system sensing a wetwell surge using the **Surge Predictor Wetwell Rate of Rise** input parameter

MAIN SCREEN

Rebound Timer
Displays how much time is remaining on the rebound timer before the control system will be released to normal mode

FLOOD RESILIENCY

As communities plan and engineer a response for climate change and flood resiliency in urban coastal areas, pump stations should be included. Guarding against flood surge requires predominately a physical barrier. If barriers are constructed, the system must be able to pump from behind the barrier and maintain the operation of the pump station since

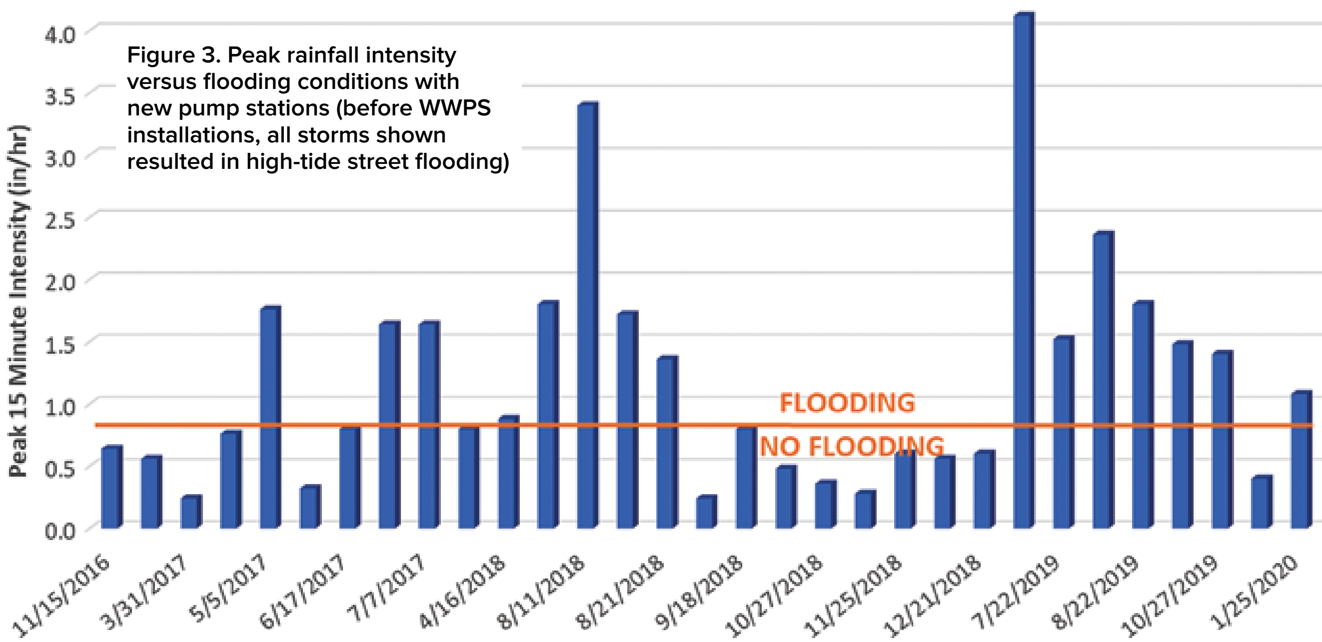

Figure 3. Peak rainfall intensity versus flooding conditions with new pump stations (before WWPS installations, all storms shown resulted in high-tide street flooding)

the pump station is the second line of defense. Engineers have begun to develop better flood mapping and storm surge models to anticipate the effects of increased severity of storm events and how to resist those events at pump stations.

Flood resiliency has four major components:

1. **Resist**: construct walls, berms, and bulkheads within the infrastructure
2. **Delay**: add best management practices, swales, pervious surfaces, and green infrastructure
3. **Store**: construct stormwater basins and tanks, then treat and release after event
4. **Discharge**: manage floodwaters with pumps, pumping systems, and outfalls

Resistance is provided by berms, bulkheads, and deployable flood walls. The delay and store components are created through attenuation through land use and storage in the collection system or detention basins. Discharge is the capacity of the pump station and outfalls. All these components must be designed for a specific storm event, and the pump station stands as the method of defense inside the wall. As the focus on climate change is integrated into new and existing infrastructure, engineers will need to incorporate these features into future pump station designs.

RESULTS

The H1 and H5 WWPSs went online in October 2011 and September 2016, respectively. Both pump stations have performed exceedingly well with significant reductions in street flooding and surcharging.

Figure 3 shows rainfall events that result in street flooding. Before construction of the new pump stations, all storms with intensities >0.2 in./hr (0.5 cm/hr) coincident with high tide resulted in street flooding. Now, with the pump stations online, street flooding occurs only with intensities >0.8 in./hr (2.0 cm/hr).

SUMMARY

Many factors are important to understand in pumping system design to create a long and flexible service life for the infrastructure. Design of these pumping systems is not a commodity. Some of the biggest challenges due to flood resiliency and climate change lie ahead and are only now being included in planning processes. New lessons are seemingly always being learned, but no simple one-size-fits-all solution exists for every utility or community. This paper serves to provide guidance, through shared experience, on building a better pumping solution.

As coastal communities struggle with climate change, holistic plans are needed to control and mitigate the impacts of tidal surge and wet weather events in low-lying areas. These two WWPSs are integral to the Authority's Long-term Control Plan and the City of Hoboken's "rebuild by design" flood management strategy. The goal is to turn back the tide to alleviate and mitigate the impacts of wet weather events on the community's businesses, residents, and property. The strategy has been so successful that the Authority is teaming with the City of Hoboken to develop a 1 mg (3.8 ML) stormwater storage facility to be drained by a third wet weather pump station, the purpose of which is to reduce combined sewer overflows as a part of the CSO Long-term Control Plan.

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Coastal flood protection—TR-16 criteria versus site-specific analysis

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ABSTRACT | Coastal resiliency is critical for low-lying wastewater facilities. TR-16, a guide to the important elements to consider in the design of wastewater treatment works, was revised in 2016 to include guidance on coastal resiliency. A case study is presented for a facility in southern Maine already experiencing flood-level issues during high tides with storm surges. In this study, the TR-16 guidance numbers are compared to those from location-specific analysis for projected sea level rise and wave action together with FEMA 100-year base flood elevations for the tidal river on which the facility is situated. The TR-16 criterion using a 100-year flood elevation plus 3 ft (0.9 m) was in good agreement with location-specific analysis for a 50-year design window, the design flood elevation plus small wave runup, and low to moderate sea level rise projections (minor acceleration). For more exposed coastal sites, longer design windows, and higher sea level rise projections, the current TR-16 flood level criteria may not be adequately conservative.

KEYWORDS | Coastal flood design criteria, wastewater treatment facilities

Coastal resiliency, which may be defined as the ability to bounce back after a storm or flood event, is critical for water and wastewater facilities, which are often located in low-lying areas to optimize gravity flow. The normal order of the civilized world, often taken for granted, would rapidly break down without functioning water and wastewater infrastructure. For many coastal communities, water and wastewater infrastructure is a high-priority capital investment for local coastal resiliency.

TR-16 *Guides for the Design of Wastewater Treatment Works* (2016 rev)[1] is a standard for evaluation and design of wastewater treatment facilities, with general guidance for coastal resiliency; however it lacks a timeline and site-specific considerations. Whereas the FEMA flood hazard elevations do not include provisions for sea level rise, TR-16 includes added elevation increase allowances outlined in an Obama-era Executive Order that federally funded projects be designed for flood resistance to 2 to 3 ft (0.6 to 0.9 m) above the FEMA 100-year (1 percent annual chance) flood elevation, based on how critical the structure is to maintaining adequate service.

Real-world application of the TR-16 sea level rise criteria enters a gray area when evaluating different design and service life windows. If the design life is 100 years rather than 50 years, how should the sea level rise allowance be modified? TR-16 does not address this, other than providing lower flood criteria for existing facilities.

Additional open-ended questions develop, such as the amount of freeboard (height above the water level) to be included in the TR-16 allowance. Will waves overtop the flood wall? How should the pumping system be sized to handle flood wall overtopping? And how will that overtopping water volume increase over the years with rising sea levels? It rapidly becomes apparent that the TR-16 allowances are general and not well-defined for either facility risk assessment or design of enhanced flood protection.

The following is a case study of how these questions can be addressed to better define site conditions relative to the TR-16 sea level rise allowances. The treatment facility in this study is on the tidal portion of a river in southern Maine.

The wastewater treatment plant's (WWTP's) proximity to the tidally influenced river puts this facility at significant risk of the effects of sea level rise as well as flooding during extreme weather events. The facility recently experienced hydraulic impacts due to higher-than-normal tide elevations. Hydraulic backups throughout the gravity flow plant process were seen during especially high tides. These concerns have prompted WWTP staff to seek enhanced resiliency to protect the plant and process from rising sea levels. FEMA defines flood hazards using Flood Insurance Rate Map elevation zones; the "AE zones" on those maps are those flood plains where base flood elevations are provided. The current FEMA-mapped AE zone for this WWTP depicts minor impacts for the facility, flooding the plant access street and driveway in two places. Plant design outfall tailwater conditions and plant hydraulics evaluations included multiple tide elevations and sea level rise projections but did not include wave conditions, given the relative depth of submergence at the outfall diffusers.

As the WWTP is considered a service-critical facility, TR-16 guidance of adding 3 ft (0.9 m) to the 100-year flood level—elevation 9 ft (2.74 m)—leads to a TR-16 design flood level of elevation 12 ft (3.65 m) NAVD 88 (North American Vertical Datum of 1988). This design flood level would have a much greater impact on the facility than the FEMA 100-year flood elevation, as it would flood most plant process structures and more deeply submerge the only access street and driveway, though it would spare the main plant buildings.

With a target project service life extension of 50 years (to 2070), a more detailed look at projected future sea level rise and wave action for this site was performed to confirm the TR-16 guidance. The wave action for this site was calculated based on conventional coastal engineering, with two primary longest wind wave fetches (a fetch is the open water length over which wind waves can grow); the longer 3,700 ft (1,128 m) fetch was used. The wave generation wind speed was based on an 83 mph (134 km/h) fastest-mile wind speed, taken from the American Society of Civil Engineers standard *ASCE 7-10* basic wind gust with load factor removed. For wave generation, the calculated equivalent wind to grow fully developed seas was 70 mph (113 km/h) for at least 16 minutes. These wind conditions would develop a 2.6 ft (0.8 m) significant wave height (average of highest one-third of waves) in deeper water. For initial design, an H10 wave (average of the highest 10 percent of waves) was selected with a height of 3.3 ft (1 m). Transforming this wave onto the shoaling shoreline turns it into a breaking wave (dynamic impact load) with about a 2.6 ft (0.8 m) breaker height at the proposed flood wall location.

For this more detailed flood elevation assessment, the 100-year flood level was also used with an allowance for projected sea level rise over the design life. For this site, the FEMA 100-year flood elevation is 9 ft (2.7 m), rounded to the nearest foot (nearest 0.3 m). The more precise National Oceanic and Atmospheric Administration (NOAA) 100-year flood elevation for 2018 based on tide data is 8.9 feet (2.71 m) for nearby Portland, Maine. The FEMA and NOAA values are very similar and consistent for a site without ocean wave water level setup.

The normal order of the civilized world, often taken for granted, would rapidly break down without functioning water and wastewater infrastructure.

The allowance for future sea level rise for this study was the *2017 NOAA Tech Report 083*[2] with tabulated values for relative sea level every 10 years, considering land and earth crust vertical movement at selected tide gauge cities. Sea level rise may be a global average change in sea level, as typically provided in governmental sea level rise future projections, or it may be the measured change in sea level at a specific site relative to the local land elevation. Globally, the sea level is rising at an estimated average rate, typically between 0.04 to 0.12 in/year (1 to 3 mm/year), and these estimates vary by method, data, and agency reporting. Where the earth's crust is rebounding (rising) since the last ice age, such as portions of Alaska, Canada, and Scandinavia, a relative drop in sea level has been observed locally. In other areas, such as the mid-Atlantic shoreline in the United States, post-glacial crustal subsidence is occurring, often combined with local soil consolidation subsidence, thus increasing the relative local and regional relative sea level rise. Southern Maine is relatively neutral for post glacial crustal/bedrock vertical movement but may experience local soil subsidence, particularly in areas with soft clay or peat deposits or at historically filled sites. The amount of soil subsidence possible at the site should be evaluated when soil borings are conducted, and a subsidence estimate should be included in relative sea level rise design criteria. The soil subsidence contribution to relative sea level rise would affect structures and buildings on spread footings but may not influence adjacent structures supported on pile foundations driven to bedrock.

The baseline minimum sea level rise design criteria should at least allow for continuation of the existing

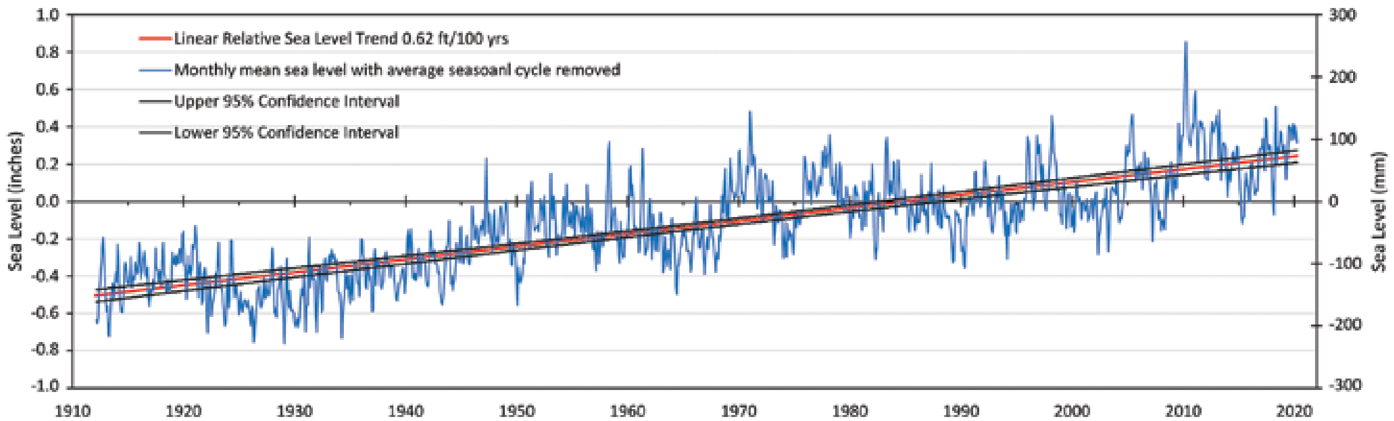

Figure 1. Portland sea level rise trend, NOAA[3]

Table 1. NOAA sea level rise (SLR) projections for Portland

Global SLR Scenario**	Relative SLR by year feet (meters)*			
	2000	2050	2070	2100
Low 0.3 m	0	0.6 (.18)	0.9 (.27)	1.1 (.34)
Inter-low 0.5 m	0	0.8 (.24)	1.2 (.37)	1.5 (.46)
Plausible (RCP 4.5)	**0**	**1.1 (.33)**	**1.6 (.49)**	**2.5 (.76)**
Intermediate 1.0 m	0	1.5 (.46)	2.3 (.7)	3.8 (1.16)
Inter-high 1.5 m	0	2.2 (.67)	3.5 (1)	6.0 (1.83)
High 2.0 m	0	3.0 (.9)	4.9 (1.49)	8.7 (2.65)
Extreme 2.5 m	0	3.4 (1)	5.9 (1.8)	10.8 (3.3)

Source: Sweet et. al. 2017 NOAA tech report Portland ME projections[2]

* Based on zero vertical land movement

** Global SLR projections with Representative Concentration Pathways (RCP) models:
1.9 ft (0.58 m) median for RCP 2.6 by 2100
2.3 ft (0.7 m) median for RCP 4.5 by 2100
2.95 ft (0.9 m) median for RCP 8.5 by 2100

sea level rise trend, which is typically the lower projection curve in most guidelines. For Portland, the NOAA developed trend is 0.6 ft per 100 years (1.83 mm/year).[3]

The latest *U.S. National Climate Assessment* references sea level rise projections in *Sweet et.al. 2017, NOAA Technical Report 083*.[2] This report presents the latest sea level rise projections (using computer models), but the presentation is complicated with multiple greenhouse gas emissions "Representative Concentration Pathways" (RCPs) and assigns exceedance probabilities that are extremely low for the higher sea level rise projection curves. In selecting an RCP for design, RCP 8.5 was dismissed as unrealistic based on *Ritchie & Dowlatabadi, (2017)*[4], and a more plausible interpolated RCP of 4.5 was used instead with a projected sea level rise of 1.6 ft (0.49 m) by 2070. In the comparison of sea level rise data, both tide gauge and satellite altimetry are running below all the NOAA sea level rise acceleration curves, which start in 2000. The sea level rise observations closely follow the low-limit linear projection scenario of 1 ft (0.3 m) rise per century.

As noted by *NOAA Tech Report 083*, these projections for sea level rise do not include an acceleration in polar ice cap melt. The change in trend for ice cap melt may not have been included in the NOAA projections, because the data records for polar ice cap melting or snow mass accumulation cover too short a time to define a trend or support sea level acceleration projections. Some recent papers indicate ice cap melt deceleration, ice cap snow mass gains, and new findings that the ice cliffs are stable.[5,6] Within NASA, opposing journal papers exist, some claiming ice mass loss and others indicating increasing snow mass gains.[7] Two of the last three winters in Greenland have shown above average snow mass gain,[8] but many decades are needed to show a trend of melt or snow mass gain.

Based on the available information and analysis, a new floodwall was recommended for the facility to manage a minimum sea level rise of 0.6 ft (0.18 m) based on the long-term trend measured in Portland. Increasing this sea level rise allowance to 1.6 ft (0.49 m) may be cost-effective to account for the projected accelerating future sea level rise by 2070, even if this expectation is less likely to occur.

The floodwall design must include freeboard above the still water level to account for wave action at the floodwall, with calculations based on allowable wave overtopping and ability to pump away this water. The floodwall height above the 100-year flood level, allowing for accelerating sea level rise and wave overtopping freeboard, is expected to exceed the 100-year flood plus 3 ft (0.9 m) TR-16 criteria for both breaking and non-breaking waves. Since wave heights vary within a statistical range and periodic wave overtopping is likely, a pump station should be considered for rain and floodwater within the floodwall. While wave heights are not included in the hydraulic analysis of the plant and outfall due to water depths at the diffusers, the design does include sea level conditions for analysis of outfall tailwater effects.

Table 2 shows an elevation combination matrix example. The summation to minimum floodwall elevation in Table 2 shows good agreement with the TR-16 guidance for this coastal site having limited wave exposure, minimal vertical land movement, and the RCP 4.5 carbon emissions scenario for a 50-year design window. However, these elevations do not include a freeboard allowance, and additional freeboard allowance is recommended as wave height distribution varies in any given wave field. The freeboard allowance should also be related to the capacity to pump out rain, seepage, and overtopping water from inside the flood barrier. Not clear from TR-16 is if the 100-year flood plus 3 ft (0.9 m) criterion includes a freeboard allowance or how that calculated freeboard could decrease over years of relative sea level rise.

Although TR-16 guidance is a good starting point, every coastal infrastructure project must be evaluated to ensure that resilience designs account for all the site-specific geotechnical and atmospheric variables that apply. Within the relatively sheltered site-specific limitations of the presented case, and for a 50-year design window, the TR-16 guidance fits well when combined with a more detailed flooding analysis. Further evaluation is expected to be needed, however, to ensure effective resilience design for sites with more ocean wave exposure, with relative land/crustal subsidence, or, assuming sea level rise continues, for longer design life windows.

Table 2. Floodwall height matrix with comparison to TR-16 criterion

	Projected Height feet (meters)	
	FEMA	GHG RCP 4.5
FEMA Flood Level Elevation*	9 (2.74)	9 (2.74)
Sea Level Rise Allowance	+ 0.6 (.18)**	+ 1.6 (.49)
Estimate H_{10} Breaking Wave**	+ 2.0 (.6)	+ 2.0 (.6)
(Sum) Minimum Wall Elevation†	**11.6 (3.5)**	**12.6 (3.8)**
*TR-16 100-yr+3 ft**	*12 (3.6)*	*12 (3.6)*

GHG = Greenhouse Gas. RCP = Representative Concentration Pathways
* North American vertical datum of 1988
** Based on +3 mm/year global average rate of sea level rise (various gauges) since 1992
† Breaking wave freeboard allowance

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Green roof incentive—India Street form-based code zone, Portland, Maine

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ABSTRACT | Climate change is creating increasingly intense storm events in New England. Portland, the largest and most developed city in Maine, is a coastal city that relies on the waterfront for tourism and its water-based economy. The City of Portland is deploying various policies and implementation projects to alleviate the impact of stormwater runoff on its valuable water resources. This article describes a green roof incentive as part of a form-based zoning code for the India Street neighborhood. The article outlines a progressive, contextual stormwater policy to address conditions specific to Portland and this neighborhood but that could develop toward broader implementation. It provides context for and describes the stormwater policy in Portland and covers the background of and development process for the green roof incentive approach. Challenges and lessons learned from five years of implementation and enforcement are also discussed.

KEYWORDS | Green roof, stormwater policy, form-based code zoning, real estate development, implementation, stormwater service charge, stormwater credit, resilience, climate change, New England

INTRODUCTION

Climate change is creating more intense storm events in New England. Portland, Maine, is a coastal and historic city located on the Gulf of Maine. The city was established on the Falmouth Neck peninsula and was later infilled during the 19th century on the harbor of Casco Bay and Back Cove waterfronts to increase development opportunity and access to the valuable working waterfront. For this largest and most developed city in the state, protection of the water resources has ecological as well as economic and quality of life implications. Portland's economy depends especially on the waterfront industry, tourism, and recreation. The quality of life for residents is closely related to the beauty and proximity of the environment and natural landscapes. The city's authentic character relies on its historic architecture, which draws residents and visitors alike. Resiliency is especially vital for Portland to survive and thrive across all these sectors.

Portland faces multiple water resource, climate change, and sea level rise challenges including the management of pollution from combined sewer overflows (CSOs) and stormwater runoff from its developed, impervious urban landscape. It must address these issues while trying to protect historic buildings and a vibrant waterfront in increasingly flood-prone infill areas. The Portland peninsula itself features a highly topographic and built-up landscape that is under intense development pressure. Portland Harbor and Casco Bay are also feeling the effects of increasing coastal water temperature, acidification, and nutrient inputs from combined sewer and stormwater runoff, all resulting in an increase in algal blooms, aquatic habitat loss, and a drop in shellfish populations. These challenges are exacerbated by there being minimal local policies preventing the infill of wetlands or flood zone setbacks, although there are Shoreland Zone setback protections.

Common to many historic cities, much of Portland's drainage system, particularly the oldest sections such as the peninsula, is served by an aging combined sewer system subject to discharges to inland and coastal waters due to failures, blockages, and wet weather events. In addition, Portland operates an increasing number of municipal separate storm sewer system (MS4) or storm drains to manage wet weather runoff. These wastewater and stormwater discharges are regulated by the Maine Department of Environmental Protection (Maine DEP) under the Maine Pollutant Discharge Elimination System (MEPDES) program, through delegated authority from the U.S. Environmental Protection Agency (EPA). In 1991 the City of Portland entered a consent decree with EPA requiring it to develop and implement a CSO abatement and long-term control plan to reduce the impacts of wastewater discharges on its water resources, as required by its wastewater management permit. Nearly two decades later, in 2003, Maine's first MS4 General Permit was issued, and Portland was required to develop and implement a program to address the water quality impacts of non-point source pollution (i.e., stormwater runoff) generated by its urbanized landscape.

Portland addresses these concerns mainly by managing the pressures of development and redevelopment on the wastewater and stormwater systems. As an older city, much of the development is infill or replacement of areas previously made impervious rather than new greenfield development. In other words, the impervious surface area in Portland's most densely developed parts is not increasing significantly, but drainage from many new development sites discharges to combined sewers. In some cases, the land use policies and the contemporary sensibility around the detriments of impervious surface have reduced the impervious surface on development sites. Projects are reviewed for compliance with zoning regulations for lot coverage, Maine DEP Chapter 500 regulations, local stormwater management standards, and best practices for stormwater site design. Depending on the scale of the project, a developer may have to install a stormwater management system to reduce the project's impacts. Under the city's stormwater ordinance, for any approved stormwater management system the developer must develop a stormwater maintenance plan and Stormwater Maintenance Agreement to be filed with the Registry of Deeds. More than 200 stormwater management permits exist for the Water Resources Division to oversee, fulfilling an important duty in the view of EPA for managing the health of Portland's water resources. The division has five compliance and technical staff to implement this part of the program.


The India Street green roof zoning incentive is a localized approach to addressing water resources protection

Additional action in response to Portland's Clean Water Act obligations includes a long-range, holistic approach to addressing water resources protection through an overall, integrated plan. Over the last five years, Portland has adopted policies to address its stormwater-related issues. The India Street green roof incentive is a localized approach specific to one neighborhood and is the focus of this article.

In 2016, the City of Portland implemented a city-wide stormwater service charge to address the growing concern over the strain of stormwater runoff on its aging combined sewer and storm drain infrastructure. The fee creates a dedicated funding stream to pay for the city's stormwater management programs and the creation and upkeep of the Water Resources Division housed within the Public Works Department. The fee is based on impervious area of private lots; public parcels are included, but public rights of way are not. The city uses several methods, including satellite imagery, to estimate each

The green roof height zoning incentive aims to slow the rate of stormwater runoff and furnish moderate filtration before draining to the treatment plant or directly to surface waters

c) HEIGHT STANDARDS

1. Height Bonus

a. Applicability:

1. If principal frontage faces a UT street, UN street, or Congress Street, then the building is eligible for a height bonus.
2. Only one height bonus may be applied per structure.

b. One (1) additional story of up to 12' in height is allowed if one of the following provisions is met:

1. For residential development with residential density equal to or greater than 150 dwelling units per acre (density may be achieved with the bonus floor)
2. For any development providing a GREEN ROOF, where:
   i. at least 50% of the cumulative lot area is pervious and,
   ii. at least 50% of the cumulative roof area is a GREEN ROOF. GREEN ROOF area may be applied towards the 50% lot area requirement.
3. For residential development where 20% of the units meet the definition of either "Workforce Housing Unit for Sale" or "Low-income Housing Unit for Rent" as per Section 14-485.

	Height Bonuses						
Subdistrict	Maximum pre-bonus Height	Mid-block permeability (publicly accessible)	Residential Density	GREEN ROOF	Afford. Housing	Maximum Height based w/bonus	Minimum Bonus floor Stepback (from the ground floor building edge facing any public right-of-way)
UN	45' and 4 stories	n/a	n/a	n/a	1 story Up to 12'	57' up to 5 stories	15'
UT	65' and 6 stories	1 story Up to 12'	1 story Up to 12'	1 story Up to 12'	1 story Up to 12'	77' up to 7 stories	15'
UA (Congress Street only)	50' and 4 stories	1 story Up to 12'	1 story Up to 12'	1 story Up to 12'	1 story Up to 12'	62' up to 5 stories	15'

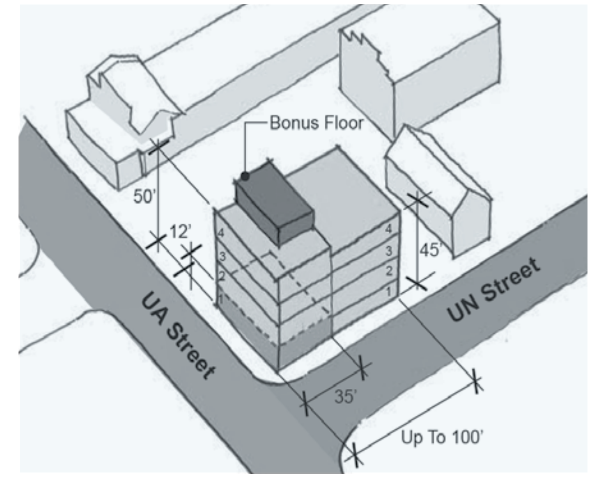
property's impervious surface. The fee rate started at $6.00 per 1,200 ft² (111 m²) of impervious surface, and was raised to $6.30 in 2018. The program allows for credits and incentives to reduce the fee—the India Street green roof zoning plan was intended to provide height incentives as well as relief from this stormwater service fee.

The city tackles the infrastructure upgrades incrementally as sewer and stormwater budgets allow—typically through combined sewer separation and storage projects, and green or grey infrastructure projects. Green infrastructure can be used to mitigate stormwater pollution associated with the MS4, but it can also be used to reduce the burden on the combined sewer system. As Stormwater Coordinator Doug Roncarati describes it, in areas with combined sewer systems the city is "trying to gain on both sides," to reduce the burden at the beginning of the system as well as at the treatment plant. Green infrastructure (public and private) and the green roof height bonus incentive aim to address the front end of the system, slowing the rate of stormwater entry and furnishing moderate filtration before it drains to the treatment plant or directly to surface waters. In Portland, green infrastructure typically includes street tree filter systems, bioswales, rain gardens, under-drained porous pavement, gravel wetlands, and now, in the India Street zone, green roofs.

GREEN ROOFS—FROM CONCEPT TO POLICY

As Portland began to see new development proposals after the Great Recession of 2008, one neighborhood, the India Street neighborhood, was under intense development pressure. The neighborhood is downtown-adjacent, meaning it is urban, mixed-use, walkable, and proximate to retail and offices. But the neighborhood is also adjacent to the waterfront, and the sloping topography and the number of vacant or underdeveloped sites create an attractive prospect for developers. India Street itself was the first street developed in Portland (it was originally King Street) and has direct access to the harbor where immigrants first arrived in the city. The zoning arrangement was a patchwork of retrofitted zones and contract zones without a comprehensive neighborhood plan or vision. The impending onslaught of development worried neighborhood residents, business proprietors, and property owners—the neighborhood is small, containing only 15 blocks. Constituents asked for neighborhood planning and rezoning to guide future development in this increasingly popular neighborhood where growth impacts had not been studied or planned for.

In 2013, the Planning Division applied for the inaugural Urban Sustainability Accelerator grant hosted by Portland State University in Oregon. The grant targeted technical assistance to communities



The zone allows a one-story (12 ft [3.7 m] maximum) height bonus to development projects

for sustainability projects. Part of this assistance came from a cohort from University of California (U.C.) Davis led by Professor Stephen M. Wheeler, MCP, Ph.D, AICP, who explored the potential sustainable opportunities specific to the India Street neighborhood. Ultimately, a report was produced outlining proactive, visionary recommendations that included inspirational and educational as well as practical measures. The U.C. Davis report envisioned the India Street neighborhood as a demonstration ground for sustainable policy and action that could later be applied to the city. Though the exercise was aspirational, the recommendations planted the seed for serious consideration of sustainable measures for pending policies to guide this neighborhood's development. Without this encouragement, policy makers would likely not have considered opportunities for green infrastructure in this small, urban, and historic location.

INCORPORATING STORMWATER MANAGEMENT INTO POLICY

When it came time to draft a zoning policy for the India Street neighborhood, the Urban Sustainability Accelerator program's recommendations were still fresh in the minds of the policy makers. In addition to the goals around building form, transportation management, open space, and historic preservation, stormwater was now present in the conversation. The India Street form-based code (IS-FBC) zone became the platform to incorporate public benefits into policy for private development. Residents were primarily concerned with the character and scale of development, whereas the development community focused on loosening restrictions such as density, lot coverage, and height to make building in the irregular, small urban sites feasible. The solution was to tie these public benefits—affordable housing, density, stormwater management, and pedestrian-scale blocks—to more permissive building envelopes. A height bonus was the solution.

A green roof incentive addresses several conditions specific to this neighborhood:

- Lack of accessible, landscaped open space
- Developed impervious area resulting in large amounts of stormwater entering the city infrastructure—most often a combined sewer in this neighborhood
- High rate of stormwater runoff to the combined sewer or storm drain system, or directly to Portland Harbor due to the steep sloping topography in the neighborhood

INDIA STREET FORM-BASED CODE ZONE—GREEN ROOF HEIGHT BONUS POLICY

As a pilot policy, the green roof incentive is available to projects within one zone in the city only, the IS-FBC zone. The zone allows a one-story (12 ft [3.7 m] maximum) height bonus to development projects in exchange for one of four public benefits:

1. Green roof and pervious surface
2. Affordable housing
3. High-density residential development
4. Publicly accessible mid-block permeability

Scale of development is important in this neighborhood, which includes a historic context. The zoning specifies which streets are eligible for the height bonus—not all parcels within the zone may use the provision. Projects cannot combine height bonuses; only one height bonus may be used per building. To mitigate the additional height's scale impact, the height bonus story has a minimum 15 ft (4.6 m) stepback. Stepbacks are measured from the face of the building below rather than from the property line.

The zoning language defines "green roof" as follows:

> GREEN ROOF means a roof of a building that is partially or completely covered with vegetation and designed to meet the Maine Stormwater Best Management Practices Manual standards and recommendations. A green roof installation must serve the purpose of reducing stormwater runoff through retention or slowing and consist of an assembly that at a minimum includes a root repellent system, a drainage system, a filtering layer, a growing medium and plants, and shall be installed on a waterproof membrane. The vegetated area of a green roof may be considered pervious for zoning impervious calculations.

To receive the height bonus for a green roof, new developments must meet the following:

- At least 50 percent of the cumulative lot area is pervious
- At least 50 percent of the cumulative roof area is a green roof, which may be counted toward the overall required 50 percent pervious lot area

The Luminato condominium project is the first green roof constructed within the zone

Though not specified within the zoning language, the green roof must meet Maine DEP Chapter 500 requirements for stormwater management.

REVIEW PROCESS

Projects under Site Plan review must submit plans showing how the 50 percent pervious area is achieved, green roof details and specifications, and stormwater treatment calculations for a 1 in. (2.5 cm) storm event. A stormwater maintenance agreement is required and is recorded with the Registry of Deeds as a means of enforcement. In addition, if applicable, these conditions (50 percent pervious area and maintenance of green roof performance) must be recorded on the plat and in condominium documents as notice and record to future property owners that these building and property elements are part of the zoning requirements.

EVALUATION AND UNINTENDED CONSEQUENCES RELATED TO IMPLEMENTATION AND ENFORCEMENT

Since the IS-FBC was adopted at the end of 2015, 12 new construction proposals have been eligible for a height bonus. Of those 12 proposal, five used the green roof provision to achieve the additional height. Those five buildings represent 42 percent of all eligible proposals and 20 percent of all new construction projects within the zone.

To date, just one of those green roofs has been constructed as part of a condominium project called Luminato. Another two projects were approved and are under construction. The remaining two green roof proposals have been put on hold and have not completed the approvals process. Worth noting, however, is that the proposals are not on hold because of the green roofs. In each case, the projects are ambitious mixed-use proposals on constrained lots and would likely not be financially feasible without the height bonus.

The high uptake in use of the height bonus and resulting implementation of green roofs could be considered a success of the incentive. When drafting the height bonus provisions of the zone, the policy makers did not anticipate such a high adoption rate—but the increase in height has become a typical condition rather than the exception. Even more surprising was the popularity of the green roof option, which until then had appeared to be unrealistic and progressive for a small, New England community in a neighborhood predominantly comprising small, urban infill lots. In all cases, the green roof design has been extensive rather than intensive in type.

How are the developers benefiting? Staff and the community were surprised that so many projects took advantage of this height bonus. Of the four methods available for a height bonus, the green roof option has been the most used. Green roofs are financially advantageous to building owners for several reasons: they increase the longevity of the roof, reducing future costs; the height bonus allows for a larger development and a more feasible pro forma return on investment for a dense urban neighborhood with irregular and sometimes small blocks; if documented properly, the green roof can reduce the cost of the city's stormwater service charge, which is based on impervious surface; green roofs often reduce building heating and cooling costs significantly, helping to improve the return on investment while reducing energy usage, generation of greenhouse gas emissions, and the "heat island" effect; and the green roof, if made accessible, is marketed as an amenity to the residents or business workers and can command a higher rent or selling price.

The India Street neighborhood has seen many new construction projects largely because of the more permissive IS-FBC zoning. The pro forma return for many of these projects would not pencil out without access to a height bonus—buildings are four and six stories high and the ability to add floor area to a project reduces the development cost per square foot. Among the four methods available for the height bonus, the green roof option is the most cost-effective for the developer. Real estate developers do, however, cite several advantages to green roofs in addition to accessing the additional floor of height. Residential development green roofs, if visible or accessible to residents, provide a highly desirable outdoor amenity for a small, urban neighborhood with a lack of proximate open space. The developers can upmarket residential units with green roof access as another building amenity. The additional story also adds value because of the access to views. Therefore, the value to the developer is not only the additional floor area but the higher price it can sell it for.

Precedent has also shown that a green roof extends the roof lifespan. The initial higher installation costs are therefore offset by not having to replace the roof as often. In recent projects in Portland with proposed green roofs, this consideration is less of an incentive, because the projects are condominium buildings and long-range costs to the building are not considered by the initial developers. However, all these factors contribute to the financial argument for a green roof from the perspective of private development.

As part of the adoption of the IS-FBC zone, a condition was set to require an audit of the zone after three years of implementation. This audit is under way; the zoning plan, as a pilot endeavor, is complex and neighborhood-specific. It is unlikely this approach will be spread across the city, though some components, such as the green roof height bonus incentive, could easily be applied to other zones. The future of the green roof incentive is uncertain and depends on meeting the original intent and stormwater goals and justifying the cost of taller buildings.

A review of green roof policy in other communities reveals that mandating a green roof for certain categories of development is common practice. In that scenario, the policy creates more controlled and predictable outcomes. One drawback of a height bonus incentive, compared to a mandate for green roof, is the lack of predictability and control over the new development's scale and form. Policy makers and the community at large, perhaps naively, did not anticipate such a high percentage of uptake, and the resulting built outcomes are of a taller scale than forecast.

In addition to the scale impacts of the additional building height, the policy did not adequately cover rooftop design. To facilitate roof access for maintenance or enjoyment, rooftop appurtenances appear on the buildings and can detract from the building forms and increase the height. Rooftop appurtenances are currently exempt from the maximum height standards—another area for consideration in the zone audit.

One policy oversight was a lack of explicit standards and requirements, terms of agreement, design expectations, or performance standards. Review of green roof design so far has relied on the City of Portland Technical Manual, which includes the Maine DEP Chapter 500 stormwater controls. Measures such as the stormwater maintenance agreements and recording of green roof requirements on the plat and in condominium documents have been stopgap measures for enforcement.

Another challenge has been the interaction of the green roof policy, the Maine Stormwater Best Management Practices (BMP) Manual, and the city's Stormwater Credit Manual incentives. The Stormwater Credit Manual generally aligns with the Maine Stormwater BMP Manual; however, in recognition that most green infrastructure is too expensive for homeowners to install and maintain, separate, more affordable incentives with fewer requirements were created, particularly for homeowners interested in retrofits. Larger-scale or commercial residential projects would be eligible for all the commercial/industrial credits, including green roofs, only if they met the state standards. Contractors who did not read the Stormwater Credit Manual and Maine Stormwater BMP Manual closely enough, however, failed to recognize that green roofs were viable options for meeting both stormwater development regulations and credit requirements. Confusion also arose as to whether green roof areas would be calculated as part of a site's impervious area. Maine DEP considers green roofs to be developed impervious space for that calculation, but then also allows it to be calculated as part of the stormwater treatment area. The resulting uncertainty required city staff support to correctly calculate impervious surface under the stormwater regulations and credit program and to apply incentives to the properties. The green roof policy, which came after the development of the stormwater service charge program and credit system, was not crafted in tandem with those programs or with any coordination of language or corresponding streamlining of administration. Such confusion across city policy and administration is not uncommon in local government.

Enforcement is important in implementing an incentive-based program. To allow use of the height bonus, the zone requires 50 percent of the lot to be pervious with at least 50 percent of the roof contributing to that pervious area. Confirming that a project's requirements are met is easy during initial review, as the pervious area is reviewed and documented in the site plan approval process. Once the project is constructed, how is long-term continuation of this zoning requirement enforced? Future property owners, if unaware of this unique zoning requirement, may unintentionally bring the property out of conformance with zoning if they convert some of the pervious area to impervious (for example, by creating a new walkway in a side yard). So far, three methods have been implemented to enforce the zoning. First, a stormwater maintenance agreement must be filed with the Registry of Deeds.

Second, if applicable, the requirement for pervious area must be documented on a recorded plat. Third, if applicable, condominium documents must also reference the zoning pervious area requirement.

CONCLUSION

In a pending India Street zone audit, city staff may propose revisions to or elimination of the height bonus provision. The challenge is to weigh the public benefit of the green roofs against the enforcement limitations and neighborhood concerns over the scale of new buildings. Without quantitative analysis of the impact of these roofs on the city's infrastructure, making an informed, data-driven determination of the benefits for the city's system is difficult.

A height bonus is a desirable, clear incentive separate from the stormwater regulations and credit incentives under the city's stormwater service charge program. Incentives appeal more to developers than firm mandates and are more likely to persuade them to action. The apparent success of the green roof incentive begs the question: Are there other incentives or planning policies the city should consider? Additional measures certainly could be taken, such as prohibiting the infill and development of wetlands, and requiring flooding setbacks.

Maine DEP recently audited the City of Portland's water management programs for compliance with its MS4 General Permit decree. Pressure is intensifying, as state and federal regulatory agencies ramp up water quality management and monitoring, emphasizing community enforcement of non-stormwater discharge ordinances. Additional pressure is coming from having to respond to the increasing impact of climate change and sea level rise on Portland's most vulnerable areas, which are increasingly also experiencing some of the highest development stress. Changing Portland's local policy to be stricter than the state standards, while offering valuable incentives, can mitigate the impacts of these factors on the city's infrastructure (especially given the cost to the city). However, it is still too early to determine how the green roof policy will affect stormwater management in the city.

The India Street green roof incentive policy won a New England Stormwater Collaborative STORMY Award in 2019 as one of the three best stormwater ideas in New England. But this program is a drop in the bucket (forgive the pun) compared to the change needed to address resiliency in the face of climate change in New England. City staff hope programs like this serve as a model for broader implementation. The City of Portland is working on an integrated water resources plan with the goal of comprehensively addressing the myriad challenges it faces, including the possibility of supporting regional watershed planning involving the offices of Water Resources, Planning and Urban Development, and City Manager, along with Maine DEP, EPA, and local environmental organizations and community representatives. Neighboring communities have been invited to participate in the work to resolve this need more regionally, but their participation has been limited. Ultimately, local municipal efforts help drive incremental improvement and set a good example, but a coordinated, regional effort would be the optimal approach.

ABOUT THE AUTHORS

- Caitlin Cameron has been the urban designer for the City of Portland, Maine, since 2013. Recent projects and responsibilities include project management for the Congress Square Redesign, India Street Neighborhood Plan and Form-based Code, management of ongoing development design review, and staffing the Public Art Committee. Her previous experience is in architecture both in private firms and as a volunteer with Architecture for Humanity San Francisco Chapter.
- Douglas Roncarati, Jr. is the City or Portland's stormwater program coordinator since 2009, responsible for the MS4 Permit program, watershed planning, and water resources protection. Mr. Roncarati has a background in open space, conservation, and environmental planning. He has volunteered as chairman of the South Portland Conservation Commission, director of the South Portland Land Trust, and with Massachusetts Audubon. He is also on the board of directors of the Friends of the Presumpscot River and the Long Creek Watershed Management District.

REFERENCES

Review of Stormwater Fee Implementation in Portland, Maine Report prepared by Nancy Leahy Martin. Edited by Tamara Risser, PE, Sevee and Maher Engineers, Inc., on behalf of Casco Bay Estuary Partnership–University of Southern Maine August 2017. Updated November 2018.

NEBRA Highlights

NEBRA Board Establishes COVID-19 Task Force to Address Impacts on Biosolids

At its meeting on April 8, the NEBRA Board of Directors discussed COVID-19 and its challenges to NEBRA members and the organization. The biggest concern was the impact on biosolids end markets, especially landfill disposal. Although it appears the supply of biosolids will remain constant, decreases in construction and demolition (C&D) wastes going to landfill have been observed. Some states in the Northeast region have banned all C&D, at least temporarily under COVID-19 conditions. Because C&D is needed to mix with wetter biosolids to help ensure slope stability, a decrease in C&D will restrict the amount of biosolids landfills can accept. A concern in Canada—at least for the provinces with well-established composting programs—is that the supply of cement kiln ash, a key ingredient in compost, has decreased significantly with many cement plants shut down due to the COVID-19 pandemic.

In response to these concerns, NEBRA President Tom Schwartz established a "COVID-19 Biosolids Contingency Planning" Task Force to look at COVID-19 impacts on the biosolids market and recommend temporary biosolids outlets/management options in the Northeast region if needed to respond to expected market disruptions. The task force includes representatives from biosolids management companies in the United States and Canada as well as several utilities and engineering consultants. Task force discussions have included other market stressors such as perfluoroalkyl and polyfluoroalkyl substances (PFAS).

The task force developed options for improving biosolids management and reducing risks for utilities and other generators of residuals. The solutions include any/all known options for short- and long-term end markets for biosolids—even those not currently allowed by regulation. Information has been provided about each option regarding advantages, disadvantages, stumbling blocks to implementation, likelihood of success, and whether the solution affects a specific individual biosolids generator or biosolids generators as a group. In collaboration with the New England Interstate Water Pollution Control Commission (NEIWPCC), NEBRA has initiated a discussion about the short-term options to address market issues due to COVID-19 as well as the long-term capacity issues in the biosolids market in the Northeast.

NEBRA, similarly to NEWEA, has embraced the US Water Alliance's *COVID-19 Relief and Recovery: Guiding Principles to Securing Our Water Future,* including the following:

- Ensure water is reliable and affordable for all
- Strengthen water utilities of all sizes
- Close the water access gap
- Fuel economic recovery by investing in water systems

NEBRA supports and encourages discussions about a COVID-19 economic stimulus package, which should include water infrastructure projects.

Biosolids Recycling in Vermont

On April 7, NEBRA submitted comments on the Vermont Department of Environmental Conservation's (VTDEC's) final Solid Waste Management Rules, which include significant updates to biosolids regulations. The comment letter urges policy makers and legislators to consider "the big picture" of environmental sustainability when it comes to biosolids management. In Vermont and other states, increasingly conservative regulations are discouraging recycling to soils, thus negating the benefits of biosolids and adding to landfill disposal and methane (greenhouse gas) emissions. Seeing biosolids recycling threatened in a progressive state like Vermont is eye-opening even as its counterpart on the West Coast, California, is eliminating landfilling of biosolids and relying on recycling to soil as the best environmental option.

To read NEBRA's comment letter in full, see link in the 4/8/2020 item at nebiosolids.org/news

UPCOMING LUNCH & LEARN WEBINARS		
DATE	**TITLE**	**PRESENTER**
July 10	PFAS & Biosolids/Residuals Nationwide Update	Ned Beecher, NEBRA
July 24	The State of Biosolids Management in the Maritimes	Lise LeBlanc, LP Consulting
Aug 21	California's Healthy Soils Initiative	Greg Kester, California Association of Sanitation Agencies
Sept. 11	Biosolids Master Planning	Natalie Sierra, Brown & Caldwell
Oct. 23	Biohubs & Other Biosolids Disposal Strategies in Australia	Peter Hillis, pH2O Consulting

All sessions start at noon (EST) and last an hour. Check the NEBRA website for changes and updates, especially additional webinars as they get scheduled.

REVIEW OF PFAS DATA FROM VERMONT LAND APPLICATION SITES UNDERWAY

On April 13, *VTDigger* published an article about PFAS-contaminated groundwater at a few biosolids land application sites in Vermont. (Link to article in the 4/14/2020 item at nebiosolids.org/news) NEBRA has been reviewing the VTDEC soil and groundwater data that both *VTDigger* and NEBRA received on April 3. So far, that review finds that at least one detection of Vermont-regulated PFAS at these few biosolids fields has a confounding factor. And the testing did not include testing of non-biosolids "control" fields nearby. While biosolids use is likely a source of some of the PFAS, other sources of these kinds of low levels of PFAS exist in the environment. NEBRA is collecting more information to better understand the circumstances at each site.

Two posters from the PFAS public information campaign by NEBRA and NEWEA

Most of the biosolids sites in Vermont do not show PFAS levels in groundwater above the state's groundwater standard of 20 ppt for 5 PFAS combined—despite years of biosolids use in some cases. And no drinking water has been affected. NEBRA is working with utilities and farmers at the impacted sites.

NEBRA notes that the Vermont Department of Agriculture is concerned about plant uptake of PFAS and contamination of feed going to dairy operations. NEBRA believes little evidence exists of plant uptake being a significant concern in real-world field conditions at typical biosolids land application sites. Analysis of feed and milk in Maine in 2019 and of milk in New Hampshire in 2018 found non-detects only, even at farms using biosolids annually for decades—except for the highly publicized Maine farm where municipal biosolids were not the cause of the perfluorooctanesulfonic acid (PFOS) concern.

Updates on Ongoing PFAS Projects

NEBRA's collaboration with NEWEA on a PFAS public information campaign has been fruitful. The products include posters and bill stuffers to initiate a conversation with elected officials, customers, and the public. Thank you to NEWEA's Government Affairs Committee Chair Scott Firmin and Residuals Committee Chair Eric Spargimino (among others) for their ideas, input, and constructive criticism. We are pleased with the results, and we hope NEBRA and NEWEA members will use the artwork and messages to create their own outreach materials. We even left spaces for adding your utility or business logo.

Another PFAS-related project is a study of the influences PFAS has on the costs of managing biosolids. The project is a collaboration with the National Association of Clean Water Agencies (NACWA) and the Water Environment Federation (WEF). The concept came out of discussions in the national PFAS "Receivers Group" as well as a NEBRA/NEWEA meeting at the 2020 NEWEA Annual Conference in Boston. On March 30, NEBRA issued a request for proposals (RFP) for cost analysis of the impacts on municipal utilities and biosolids management to address PFAS contamination. Four proposals were received, but no award has been made yet as of this writing. Project deliverables include collection of cost (and non-cost) impact data, several in-depth cost case studies of utilities (mostly in the Northeast), a report, and fact sheets. The materials are intended for advocacy purposes by NACWA and WEF and their members, many of whom are NEWEA and NEBRA members.

A final note about PFAS: The Interstate Technology and Regulatory Council (ITRC) issued its long-awaited PFAS technical guidance, a 400-page document. The effort took three years and involved more than 500 PFAS experts in developing detailed guidance on the technical challenges of PFAS. The document, fact sheets, and online training videos are available at the ITRC PFAS website.

North East Digestion Roundtable

NEBRA hosted its 16th North East Digestion Roundtable (NEDR) on April 24. The session discussed funding opportunities for anaerobic digester and other biogas projects. The information was presented by Sarah Deslauriers of Carollo Engineers and Dave Baran, who has done a lot of work with Quasar Energy Group. Ms. Deslauriers and Mr. Baran have written various WEF documents on the topic and know what is involved in championing a resource recovery project. The NEDR #16 recording, presentation slides, and links to WEF and other guidance documents are on the NEBRA website.

Janine Burke-Wells, Executive Director
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For additional news or to subscribe to NEBRAMail, NEBRA's email newsletter, visit nebiosolids.org

nebra
North East Biosolids & Residuals Association

Watershed Management

The small-but-mighty Watershed Management Committee (WMC) has been planning several NEWEA events this year, most notably the first ReACT Resilient Infrastructure in Action Specialty Conference and Exhibit and the third annual Source Water Brewers Competition. In a recent interview, WMC Chair Sara Greenberg and Vice-Chair Steven Wolosoff discussed the committee's history and goals as well as their upcoming events.

ReACT: Resiliency Infrastructure in Action Conference & Exhibit

The WMC's mission is to champion interdisciplinary discussions surrounding watershed management techniques with an emphasis on climate change, stormwater frequencies and intensities, and groundwater management. The last Watersheds Specialty Conference hosted by the WMC in 2017 focused on climate change, resilience in the built environment, and how municipalities and utilities can plan to fund projects. Three years later, many of these projects have been implemented, and the need for these projects across New England continues to increase. To highlight these projects, the WMC has aptly decided to build the synergy among the WMC, Sustainability, and Stormwater Committees by collaboratively hosting the ReACT conference.

The conference will be held November 19–20, 2020, at the AC Hotel in Worcester, Massachusetts. The WMC is reviewing the abstracts from various stakeholders regarding the projects they have been implementing to make infrastructure more resilient in a changing world.

Based on the success of the ReACT conference, the WMC is hoping it will become an annual event. Resilient infrastructure in the face of a lack of funding (strained even further due to the COVID-19 Pandemic) will require information sharing and a combining of forces. And do not forget the conference hashtag: #ReACT2020.

Annual Source Water Brewers Competition

The WMC is also excited about its Annual Source Water Brewers Competition. Participation is free, and homebrewers are challenged to create an original beer using a local water supply. Mr. Wolosoff was inspired to bring a home brewing competition to NEWEA after a trip to WEFTEC and observation of the success of PURE water brewing, which involves use of reclaimed wastewater to brew beer. In New England, source water protection was the driver for the formation of the Source Water Brewers, a group comprising water quality professionals that also are homebrewers. The competition entries are all brewed from a common local surface water supply.

The Source Water Brewers competition has quickly gained popularity, growing from only two brewers in the first competition to 10 homebrewers in last year's event hosted during the NEWEA Committee Member Appreciation Event. Last year's champion brew was a tasty New England IPA brewed by Jim Callahan using water from the Merrimack River in Massachusetts provided to brewers by Lowell Water. The source water brewers aim to make homebrewers and beer drinkers feel more connected to their local water supplies, one growler at a time. Clean water is critical to every beer, and the WMC hopes that this event will continue to spur conversation around the importance of protecting our source waters.

With the COVID-19 outbreak and the health and safety concerns, the Source Water Brewers Competition may be put on hold, but as soon as we can convene again, please consider rolling up your sleeves and participating in this fun and collaborative competition. Mr. Wolosoff can be contacted at WolosoffSE@cdmsmith.com.

Watershed Management Committee Membership

The WMC wants to expand membership across all sectors, to make the committee even more diverse and far-reaching. Are you passionate about watershed protection and broadening inter-committee communications at NEWEA? Then you are an ideal candidate to join! For more information, please contact Ms. Greenberg, committee chair, at sara.greenberg@ghd.com.

WEF Delegate Report

Despite the challenges of the COVID-19 pandemic, our WEF delegates have continued to represent NEWEA nationally and remain active and engaged on several WEF initiatives. NEWEA's WEF delegates are Matt Formica, Susan Guswa, Jim Barsanti, and incoming delegate Peter Garvey, who starts his official term in the fall. Susan Sullivan is also one of WEF's national delegates-at-large.

WEFMAX UPDATE

One responsibility of the WEF delegates is participating in WEFMAX events. These WEF-sponsored member association (MA) exchange meetings allow members from around the United States and Canada to come together to trade information and ideas and to discuss various topics. This year's events were planned to be hosted by MAs in New Jersey, Hawaii, South Carolina, and North Dakota. Unfortunately, COVID-19 required the cancellation of these events in their planned live settings. However, the WEFMAX Committee that plans these events each year quickly shifted gears and initiated planning and scheduling for three "virtual" WEFMAX meetings, which occurred in late May and early June. Topics covered diversity and inclusion, member engagement, communications, MA sharing of resources, and more. Members of the WEF Board of Trustees also attended events and gave updates on WEF's initiatives such as member training, innovation, public awareness, and pandemic response. Ms. Guswa and Mr. Garvey presented on NEWEA's member engagement at two of the WEFMAX events.

HOUSE OF DELEGATES MEETING HELD IN VIRTUAL SETTING

WEF House of Delegates (HOD) leadership also convened its first virtual HOD meeting, held on May 4 with more than 100 people attending. The meeting discussed the organization's financial health and the *Brave Blue World* (a WEF-produced documentary film) rollout. It also included updates by the chairs of the several committees and workgroups WEF delegates serve on, including the steering, nominating, and outreach committees and public education, stormwater, and workforce development workgroups.

WEFTEC UPDATE

WEFTEC 2020 will be a fully virtual event, called WEFTEC Connect, that will offer attendees interactive education, an exhibitor showcase, and networking experiences. This unique event, brought about by the COVID-19 pandemic, will use the latest online learning platform to create an immersive experience for attendees.

WEFTEC Connect will include the following:

- Blend of live and pre-recorded technical content
- Data-driven connections between participants
- 1:1 appointment scheduling with exhibitors
- Live chats between individuals or groups
- Virtual meeting rooms for networking and product demonstrations
- Access to educational content and the exhibitor showcase for a full year

Your WEF delegates hope to "see you there" in this international digital gathering place for water professionals scheduled for October 5–9. For more details, please visit weftec.org.

Matt Formica

The WEF HOD Steering Committee has not missed a beat in adjusting to our "new reality." In many ways, things have not changed regarding committee meetings; they have often been held as conference calls due to the committee's geographic diversity. However, the annual WEFMAX meetings have traditionally been in-person formal meetings of the HOD at each WEFMAX location. These meetings allow HOD committees and workgroups to update attendees on their work (since the last WEFTEC) and enable delegates to advocate for the initiatives and needs of their MAs (such as NEWEA). As noted above, the first virtual HOD meeting was held due to the cancellation of the WEFMAX events. The success of this virtual event was largely due to the quick planning of the HOD Steering Committee, which rallied to develop the meeting format and support the meeting-content presentation. The committee continues to work with all other HOD committees and workgroups to forward WEF's mission and strategic plan. These efforts will continue throughout the summer and leading into the now-virtual WEFTEC Connect in October. The committee will be critical in managing the meeting format and determining how the delegates will participate remotely in the WEFTEC Connect HOD meetings; it will also help steer the focus development of the HOD committees and workgroups into 2021. I have also supported the *Brave Blue World* workgroup under the leadership and direction of Ms. Guswa. It has been an honor and pleasure to support this public outreach on behalf of WEF and NEWEA.

Sue Guswa

WEF HOD's response to COVID-19 may be paraphrased, "I'll see your pandemic and raise you three virtual video conferences." As fellow delegate Mr. Formica said, "We have not missed a beat these past few months and in fact we have increased the quality of our virtual meetings by adding video." This spring, I represented NEWEA (with NEWEA's executive director, Mary Barry) at the first of three virtual WEFMAX meetings, participating on the HOD Nominating Committee, continuing to lead the Public Education workgroup's *Brave Blue World* effort, and presenting at our HOD meeting (held at the second virtual WEFMAX) and at the third virtual WEFMAX on our workgroup's activities. Except for the first virtual video call with the workgroup, the transition to virtual format has been smooth. On the first call, the first item on the agenda was "Tips for Running an Effective Virtual Video Conference," but as I began that presentation, my home WiFi glitched and I was unable to lead the meeting! After some confusion and a Homer Simpson quote or two, we regained the WiFi and continued reporting on the important work we were doing to support screenings of the *Brave Blue World* movie for all 75 of the WEF MAs across the world. The movie premiered in Los Angeles in December, and NEWEA hosted the first MA screening at our YP Summit during the January NEWEA Annual Conference in Boston. At that event, more than 100 YPs viewed the movie and then participated in a panel discussion about the importance of public outreach and advocacy for water. Thank you, Mr. Formica, for leading the planning and facilitating the workgroup's first successful MA screening of this star-studded documentary promoting sustainability and awareness of our water environment. The workgroup had planned several more MA screenings across North America, but these were put on hold due to the emerging pandemic. In the meantime, the workgroup continued to develop supporting materials, including a slide deck about the film and screening logistics, to make it easier for interested MAs to plan screenings. Happily, the film's production company has pivoted to virtual screenings, and we are again planning MA virtual screenings and panel discussions. This summer, my work on the Nominating Committee picks up as we work to review applications for next year's HOD leadership and committees. Thank you to our current and past WEF delegates from NEWEA who have set a high bar for participation and impact at the WEF level.

Jim Barsanti

I continue as chair of the HOD Outreach Committee. This committee creates awareness of HOD activities and work products within the HOD at-large and to MA leadership. This includes providing resources and training to WEF delegates and MA leaders and ensuring that WEF work products are available on the WEF website and WEFCOM (WEF's member involvement communication platform). Currently we are working on a WEF delegate toolkit that will provide incoming delegates with information about their roles as liaisons between their MAs and WEF. The toolkit can also be used by MAs for recruiting delegates. We are also working on a WEF career toolkit for incoming delegates that describes the various committees, workgroups, and other activities available at the WEF level. I am participating on the Water Utility Workforce of the Future workgroup. This workgroup coordinates with the WEF operator advisory panel and the WEF Plant Operations and Maintenance Committee to enhance programs and practices that promote the water utility workforce of the future. Over the last several months, our workgroup has conducted over 30 interviews with operators across the country about their training and recruiting practices and programs. We will prepare a summary of the results. I have also been on the operator advisory panel. This panel promotes the professional status of operators, licensure, training, and retention, as well as aims to increase the number of operator-oriented events at future WEFTECs. We have been discussing how operations have been affected by the COVID-19 pandemic and more importantly how we have responded to ensure continuity of public health and water quality services in our local communities. We are also evaluating operator training materials available from WEF and state sources and providing input into the development of WEF operator fact sheets.

For more information on WEF delegate activities and the important and productive interface between WEF and NEWEA, please reach out to any of our WEF delegates through the NEWEA office at Mail@NEWEA.org.

Student Design Competition

by Nick Tooker, PE, Student Activity Committee chair

The NEWEA Student Design Competition (SDC) had a record-breaking year, with five teams representing four universities and three New England states! This competition, organized by the Student Activities Committee (SAC), promotes "real-world" design experience for students interested in pursuing education and/or careers in water engineering and sciences.

The UVM team on a sampling trip to the South Burlington WWTF

Two categories make up the competition, one for "wastewater" that includes treatment facility design and one for "water environment" that includes just about anything else related to water in the environment. The competition tasked teams of NEWEA student members to select a design project they have worked on together. Most of the teams used their senior capstone projects as the basis for their written reports and presentations. The teams presented their designs to judges, peers, and mentors during the SDC presentations, held on May 4 via video conference. While the video conference presentations were required this year because of social distancing, the competition was such a success that the SAC has decided to host future SDC presentations in the same way.

The teams with the best combined report and presentation will represent NEWEA at the national competition during the now all-virtual WEFTEC Connect in October. Congratulations to all the teams for a robust competition! The participating teams included the following:

WASTEWATER CATEGORY

- **University of Hartford**, "How to Deal with Cake: Chicopee Dewatering and Sludge Disposal Upgrade." Students: Nicole Kibbe, Hailey Kukowski, Andre Mayers, and Lillian Orelup. Faculty advisor: Todd Brown. Professional Mentor: Chris Bone (Tighe & Bond).
- **University of Vermont**, "South Burlington WWTF Chemical Reduction." Students: Ian Kosnik, Sam Mikell, Olivia Nachbauer, Jake Senecal. Faculty advisor: Matt Scarborough. Professional Mentor: Bob Fischer (South Burlington WWTF).

WATER ENVIRONMENT CATEGORY

- **Northeastern University**, "Rock Meadow Parking Lot & Stormwater Design." Students: Kate Engler, Samantha Kinnaly, Annie Lamonte, Emma Totsubo. Faculty Advisor: Annalisa Onnis-Hayden. Professional Mentor: Chris Morris (Avangrid Renewables).
- **Tufts University**, "Malden Oxbow Storm Water Loading Mitigation Design." Students: Isaac Mudge, Jim Finnegan, Sarah Dawson, Kate Lamberti. Faculty Advisor: John Durant.
- **University of Vermont**, "Bristol, Vermont PFAS Treatment." Students: Daniel Cliche, Lucy Murphy, Julia Szymanski, Zhiyi Wan. Faculty Advisor: John Lens. Professional Mentor: Jill Marsano (Bristol Municipal Water).

The University of Vermont and Northeastern University won the wastewater and water environment categories, respectively. Their projects are summarized below.

The UVM wastewater team's project was on the South Burlington Wastewater Treatment Facility, which operates with high quantity chemical addition of aluminum sulfate and caustic soda. This operation results in adverse effects on the symbiotic relationship between the biological and chemical processes. Through field and laboratory testing and research, the wastewater team proposed reworking the current biological nutrient removal system to incorporate a return activated sludge fermentation stream. BioWin modeling for this proposed alternative predicted lower chemical usage, higher biological nutrient removal (BNR) system performance, and a 75 percent and 35 percent cost reduction for alum and caustic soda, respectively.

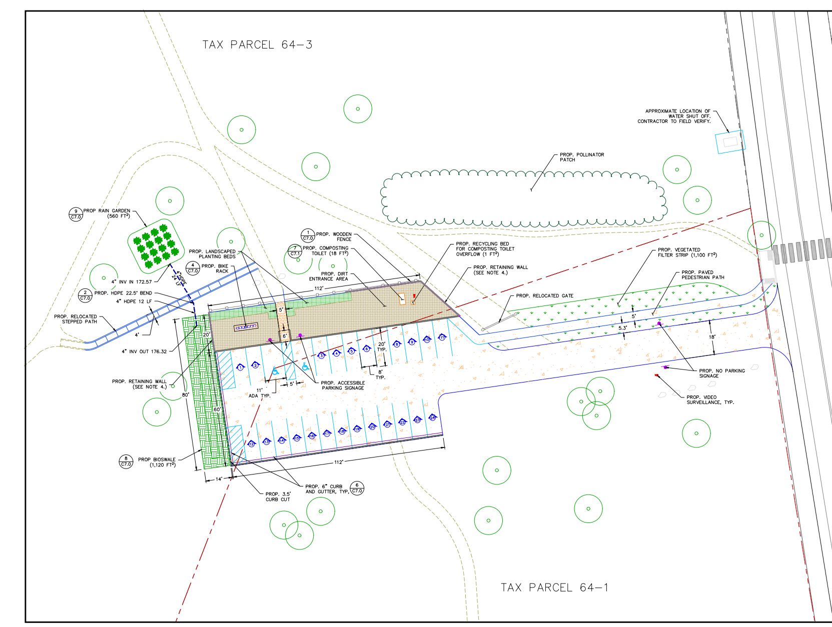
The Northeastern University water environment team's project redesigned the entrance and parking lot at Rock Meadow Conservation Area in Belmont, Massachusetts. The proposed design aimed to improve the existing conditions: an undersized lot, an eroded and uneven surface, and no stormwater management system. The team's proposed design included a 117 percent increase in parking capacity, a 3 percent to 4 percent decrease in maximum driveway slope and cross slopes, and the sizing of three green infrastructure elements (vegetated filter strip, bioswale, and rain garden).

The winning teams have the chance to present their projects under NEWEA sponsorship at the international WEFTEC Connect virtual conference in early October. Good luck to the teams; we know that you will do a great job and make NEWEA proud!

Thank you to our volunteer judges for the competition: Marissa Dreyer (Applied Materials), Helen Gordon (Environmental Partners Group), Jerry Hopcroft (WIT), Ben Stoddard (Kleinfelder), Jim Barsanti (Town of Framingham), Joanna Sullivan (Hazen & Sawyer), Kestral Johnston (PhD student), John Adie (New Hampshire Department of Environmental Services), Sally Kramer (Kleinfelder), Adam Higgins (Wright-Pierce), and Austin Weidner (Tighe & Bond).

For more information about sponsoring our NEWEA Student Design Teams in preparing and presenting their projects at the 2020 WEFTEC Connect, please contact Nick Tooker (nbtooker@umass.edu) or Jordan Gosselin (jgosselin@newea.org).

The Northeastern University team presenting its work remotely as part of its senior capstone project presentation



The Northeastern University team's rendering of its site plan improvements

Specialty Conference, Workshops, & Networking Proceedings

NEWEA/NEWWA INFORMATION TECHNOLOGY & ASSET MANAGEMENT FAIR

NEWEA's Asset Management Committee joined with New England Water Works Association (NEWWA) IT Technology Committee to host a joint workshop in Holliston, Massachusetts, on November 5, 2019. This joint event had over 50 attendees and featured technical presentations with interactive learning stations.

The technical presentations commenced on Tuesday, November 5, with Mark Wetzel, NEWWA and John Sykora, NEWEA providing the welcome and opening remarks to meeting attendees.

TECHNICAL PRESENTATIONS

Asset Management: Cybersecurity Risks and Best Practices
- Jonathon Grant, Woodard & Curran, and Alice Lara, BNC Insurance Agency

The Benefits of Strategic Energy Management at Wastewater Treatment Facilities
- Carina Hart, Senior Project Engineer, and Alex Rozen, Project Engineer, JKMuir

Interceptor and Collection System Investigation Program
- Matt Timberlake and Dave Beauchamp, Ted Berry Co.
- Shawn Syde, City of New Bedford, MA

What Pump Efficiency Testing Can Reveal About Your Pumping Systems
- Molly Keleher and Alex Rozen, JKMuir

Follow-Up Methods of Multi-Sensor Inspection and Cleaning of Interceptor and Collection Sewers
- Matt Timberlake and Dave Beauchamp, Ted Berry Co.
- Shawn Syde, City of New Bedford, MA

Using Drones & Unmanned Aerial Vehicles for Asset Inspection & Protection
- Tracy C. Wadsworth, Massachusetts Water Resources Authority

Best Practices in Operational Data Collection & Reporting
- Monica FitzPatrick, Utility Cloud

Dashboards: Your Assets at a Glance
- Dan Shinnick, Weston & Sampson

The Goldilocks Question: Finding the 'Just Right' Asset Management Software Tool
- Rachel Osborn and Chelsea Bierkan, Woodard & Curran

UTILITY MANAGEMENT CONFERENCE

NEWEA's Utility Management Committee held a specialty conference in Cromwell, Connecticut on November 14, 2019. The event attracted over 40 attendees.

The one-day conference kicked off with NEWEA President Ray Vermette and Utility Management Committee Chair Gary Zrelak, providing the Welcome and Opening remarks to meeting attendees.

TECHNICAL PRESENTATIONS

Right Now: The Best Time to be in Water - Keynote Speaker -
- Tom Kunetz, WEF Past President

Engaging Youth in the Environment: Successful Summer City Programs for Youth
- Thomas Groves, NEIWPCC

Building Sustainable Talent Pipelines
- Christopher Leveque, Ray Baral, Susan Negrelli and Marcy Wright, Hartford MDC

Planning for the Future—Success Stories from New England Wastewater Management Programs
- Thomas Groves, NEIWPCC and Leeann Hanson, JETCC (Maine)

Attracting, Retaining and Growing Young Professionals
- Colin O'Brien, Brown and Caldwell

Infusing Youth in the Water Industry
- Tyler Feeney, Woodard & Curran

RWA's Transformational Journey
- Beth Nesteriak and Salvatore Nesci, Regional Water Authority, New Haven, CT

What We've Learned from Training 10,000 Operators
- John Rickerman, Jacobs

Smart Utility and Technology for the Next Generation of Workers
- Michael Karl, Brown and Caldwell

YOUNG PROFESSIONALS NETWORKING EVENT

NEWEA's Young Professionals Committee hosts a popular multi-discipline networking event aptly named Poo & Brew. this event features a tour of a local wastewater treatment facility followed by networking at a brewery. These events are open to organization members and non-members, consisting of professionals in the early stages of their water industry careers.

Sponsored by: ADS Environmental Services, AECOM, Aqua Solutions, Arcadis, Brown and Caldwell, Carlsen Systems, CDM Smith, David F. Sullivan & Associates, Dewberry, Edward N. Nazaretian Memorial Fund, Environmental Partners Group, EST Associates, Flow Assessment Services, Fuss & O'Neill, GHD, Hazen and Sawyer, Hoyle Tanner & Associates, Inc., Jacobs, Kleinfelder, Mott MacDonald, Stantec, SUEZ, The MAHER Corporation, Tighe & Bond, Weston & Sampson, Woodard & Curran, Wright-Pierce

POO & BREW #25

More than 40 attendees toured REM Industrial Solutions in Hartford, Connecticut, on Friday, February 12, 2020, and learned about municipal wastewater pumps. A networking reception was held afterward at the Thomas Hooker Brewing Company, also in Hartford. REM Industrial Solutions and Carlsen Systems were event supporters.

New England Water Environment Association, Inc.

Statement of activities
For the years ended September 30, 2019 and 2018

Changes in unrestricted net assets:	2019	2018
Revenues and gains:		
Registration Fees	$ 503,516	$ 514,447
Exhibitor Fees	283,980	270,315
Membership Dues	50,726	52,852
Pass Through Dues	55,844	58,405
Advertising and Subscriptions	93,315	117,741
Sponsorships	103,199	75,584
Certification Fees	19,560	17,377
Investment Income	19,095	45,599
Other Income	30,743	29,648
Total unrestricted revenues and gains	**1,159,978**	**1,181,968**
Total unrestricted revenues, gains and other support	**1,159,978**	**1,181,968**
Expenses:		
Program services	874,101	844,935
Management and general	304,308	256,934
Pass Through Dues	38,729	44,751
Total expenses	**1,217,138**	**1,146,620**
(Decrease) Increase in unrestricted net assets	(57,160)	35,348
Net assets, beginning of year	**770,523**	**735,175**
Net assets, end of year	**$ 713,363**	**$ 770,523**

New Members February – April 2020

Alexander Train
City of Chelsea
Chelsea, MA (PRO)

Alison Eliot
City of Framingham
Framingham, MA (YP)

Andrew Stone
American Ground Water Trust
Concord, NH (PRO)

April Locke
Tighe & Bond
Worcester, MA (YP)

Bob Hopkins
BAU/Hopkins
Plainville, MA (PRO)

Bradford Vasseur
Greater New Haven WPCA
New Haven, CT (PWO)

Brian Cruz
Loureiro Engineering Associates
Plainville, CT (YP)

Brody Campbell
Wright-Pierce
Topsham, ME (YP)

Charles Evans
Massachusetts Water
Resources Authority
Winthrop, MA (PWO)

Chris Ciaramella
Revere, MA (YP)

Chris Fabiano
City of Revere
Dept of Public Works
Revere, MA (PRO)

Chris Fittante
Massachusetts Water
Resources Authority
Winthrop, MA (PWO)

Christine Micciulla
City of Revere
Dept of Public Works
Revere, MA (YP)

Colin Speaker
Greenwich High School
Greenwich, CT (STU)

Don LeBlanc
DLVEWS, Inc.
Auburn, ME (PRO)

Donald Ciaramella
City of Revere
Dept of Public Works
Revere, MA (PRO)

Donald Lussier
City of Keene
Public Works Department
Keene, NH (PRO)

Edward Gentile
Town of Darien
Darien, CT (PRO)

Edwin Castilla-Rodriguez
Wright-Pierce
Andover, MA (PRO)

Emma Williamson
Haley and Ward, Inc.
Cambridge, MA (YP)

Eric Bogosian
Narragansett Bay Commission
Fields Point
Providence, RI (PWO)

Eric Dickinson
Holliston, MA (PRO)

Ernesto Trujillo
Greater New Haven WPCA
New Haven, CT (PWO)

Evelyn Ramos
Tufts University
Medford, MA (STU)

Finethy Dave
Biosafe Systems
Hartford, CT (PRO)

Hailey Kukowski
University of Hartford
Wolcott, CT (STU)

Ilana Ton
Somerville, MA (YP)

Jack Gafney
Ridgefield, CT (STU)

Jake Moorman
Coughlin Environmental
Services, LLC
Stoneham, MA (YP)

James Peterson
Crystal IS
Troy, NY (YP)

James Rivers
Longmeadow, MA (YP)

Jason Sorenson
USGS
Northborough, MA (PRO)

JL Lagos
Delta Electro Power Inc.
Cranston, RI (PRO)

John Anderson
Arcadis
Portland, ME (PRO)

John Doherty
CDM Smith
Boston, MA (PRO)

John Feeney
Massachusetts Water
Resources Authority
Dorchester, MA (PRO)

John Wujek
Mott Macdonald
West Springfield, MA (PRO)

Jonathan Smith
City of Somerville
Somerville, MA (PRO)

Joseph Fedorchuck
Bethany, CT (YP)

Joseph Lake
City of Revere
Revere, MA (PRO)

Karina Massey
Jacobs
East Hartford, CT (YP)

Kathryn Swanson
CDM Smith
Boston, MA (PRO)

Kenny Cousins
Cityworks | Azteca Systems LLC
Sandy, UT (PRO)

Kim Hoffman
SUEZ
Prospect, NY (PRO)

Kirk Cram
Enthalpy Analytical, LLC
Hampton, NH (PRO)

Ko Ishikura
Green International Affliates Inc
Westford, MA (PRO)

Kori O'Hara
City of Revere
Dept of Public Works
Revere, MA (YP)

Kurt West
Utility Cloud
Salem, NH (PRO)

Marc Hilton
City of Revere
Dept of Public Works
Revere, MA (PRO)

Mariush Zmiejko
Waste Management
Stoughton, MA (PRO)

Mark Cressotti
City of Westfield
Westfield, MA EXEC

Matt Kibble
The Maher Corporation
Rockland, MA (YP)

Maxwell Ye
Stoneham, MA (YP)

Megan Olson
Tighe & Bond
Brookline, NH (YP)

Michael Mills
Eversource
Northbridge, MA (PRO)

Milagros Puello
City of Lawrence
Lawrence, MA (PRO)

Daniel Pelletier
Topsham, ME (STU

Ngodoo Atume
Tufts University
Medford, MA (STU)

Nicholas Leblanc
Englobe Corp
Sherbrooke, QC (PRO)

Nicholas M Champagne
Kennebec Sanitary Treatment
District
Waterville, ME (PRO)

Nick Rancis
Fraunhofer USA
Marblehead, MA (PRO)

Oswaldo Pedrosa
SUEZ
Holyoke, MA (PWO)

Padmalathika Varanasi
JK Muir LLC
Rocky Hill, CT (PRO)

Patrick Hickey
Oak Bluffs Waterwater
Oak Bluffs, MA (PWO)

Peter Elias
Anson Madison Sanitary District
Madison, ME (PWO)

Peter Pelletier
Town of Medway
Medway, MA (PRO)

Philip Jordan
BW Research Partnership
Wrentham, MA (PRO)

Philip Pino
Pureflow Filtration Systems
Whittier, CA (PRO)

Rahul Raina
Rocky Hill, CT (YP)

Richard Dalton
Massachusetts Water
Resources Authority
Winthrop, MA (PWO)

Riley Greene
Jamestown, RI (YP)

Robert Langley
City of Peabody
Peabody, MA (PRO)

Rodrick Ventura
Veolia North America
New London, CT (PWO)

Samantha McKinney
Waste Management
Portsmouth, NH (YP)

Scott Charpentier
Town of Northborough
Northborough, MA (PWO)

Stephen Leone
City of Framingham
Framingham, MA (EXEC)

Theresa Tucker
Sanford Sewerage District
Springvale, ME (PWO)

Timothy Wales
Albany, CT (DUAL)

Tina Douk
Town of Dracut
Dracut, MA (YP)

Tony Orefice
SUEZ
Holyoke, MA (PWO)

Tyler Feeney
Woodard & Curran
Springfield, MA (YP)

Will Walkup
Black & Veatch
Burlington, MA (PRO)

William Lane
Massachusetts Water
Resources Authority
Chelsea, MA (PWO)

William McGloin
Special Breaks LLC
Southington, CT (PRO)

Zach Cronin
City of Portsmouth
Portsmouth, NH (YP)

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

Upcoming Meetings & Events

COLLECTION SYSTEMS CONFERENCE & EXHIBIT
September 10, 2020
Boxboro Regency Hotel, Boxborough, MA

NEWEA/NEWWA WATER FOR PEOPLE GALA
September 11, 2020
Boston, MA

WEFTEC CONNECT VIRTUAL CONFERENCE
October 5 – 9, 2020

NORTHEAST RESIDUALS & BIOSOLIDS CONFERENCE & EXHIBIT
October 19 – 20, 2020
Wentworth, New Castle, NH

PLANT OPERATIONS TECHNICAL SESSION & TOUR
October 21, 2020
Uxbridge, MA

NEWEA/NEWWA ASSET MGMT & IT WORKSHOP
November 17, 2020
NEWWA Training Center, Holliston, MA

REACT: RESILIENCY INFRASTRUCTURE IN ACTION CONFERENCE & EXHIBIT
November 19 – 20, 2020
AC Hotel, Worcester, MA

NEWEA ANNUAL CONFERENCE & EXHIBIT
January 24 – 27, 2021
Boston Marriott Copley Place Hotel, Boston, MA

Because of to the continually unfolding situation surrounding COVID-19 (Coronavirus), NEWEA and Affiliated State Association events may have to be postponed or canceled. Stay up-to-date on event dates at newea.org/events/calendar.

AFFILIATED STATE ASSOCIATIONS AND OTHER EVENTS

NHWPCA ANNUAL GOLF TOURNAMENT
August 6, 2020
Beaver Meadows, Concord, NH

CTWEA 2020 SEWER OPEN
August 14, 2020
Skunkamaug River Golf Club, Coventry, CT

MEWEA GOLF TOURNAMENT
September 17, 2020
Sunday River Resort, Newry, ME

NEWWA ANNUAL CONFERENCE
September 20 – 23, 2020
Omni Mt. Washington Bretton Woods, NH

NHWPCA TRADE SHOW
September 25, 2020
Radisson Hotel, Nashua, NH

MAWEA ANNUAL GOLF TOURNAMENT
September 30, 2020
Heritage Country Club, Charlton, MA

NERPCA PRETREATMENT WORKSHOP
October 27 – 29, 2020
Lowell, MA

NHWPCA WINTER MEETING
December 11, 2020
Peirce Island WWTF, Portsmouth, NH

Measurement unit conversions and (abbreviations) used in the *Journal*

U.S.	International System of Units (SI)
Liquid volume	
gallon (gal)	liter (L)
cubic feet (ft^3)	cubic meters (m^3)
cubic yards (yd^3)	cubic meters (m^3)
acre-feet (ac ft)	cubic meters (m^3)
Flow	
million gallons per day (mgd)	million liters per day (ML/d)
for larger flows (over 264 mgd)	cubic meters per day (m^3/d)
gallons per minute (gpm)	liters per minute (L/min)
Power	
horsepower (hp)	kilowatts (kW)
British Thermal Units (BTUs)	kilojoules (kJ) / watt-hours (Wh)
Velocity	
feet per second (fps)	meters per second (m/s)
miles per hour (mph)	kilometers per hour (km/h)
Gas	
cubic feet per minute (ft^3/min)	cubic meters per minute (m^3/min)

U.S.	International System of Units (SI)
Length	
inches (in.)	centimeters (cm)
feet (ft)	meters (m)
miles (mi)	kilometers (km)
Area	
square feet (ft^2) or yards (yd^2)	square meters (m^2)
acre (ac)	hectare (ha)
square miles (mi^2)	square kilometers (km^2)
Weight	
pounds (lb)	kilograms (kg)
pounds per day (lb/d)	kilograms per day (kg/d)
ton – aka short ton (tn)	metric ton or tonne (MT)
Pressure	
pounds/square inch (psi)	kiloPascals (kPa)
Inches water column (in wc)	kiloPascals (kPa)
Head	
feet of head (ft of head)	meters of head (m of head)

Advertiser Index

Upcoming *Journal* Themes

Fall 2020—**Energy Efficiency**

Winter 2020—**Stormwater**

NEWEA/WEF* Membership Application 2020

Water Environment Federation — the water quality people

NEWEA — WORKING FOR WATER QUALITY

Personal Information (please print clearly)

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

☐ 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 20

Membership Categories (select one only)

Membership Categories		Member Benefit Subscription	Dues
☐ **Professional Package**	Individuals involved in or interested in water quality	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$185
☐ **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. Date of birth (mm/yy) ________	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$70
☐ **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. License # ________________	■ WE&T (including *Operations Forum*) ■ *WEF Highlights Online*	$110
☐ **Academic Package**	Instructors/Professors interested in subjects related to water quality.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$185
☐ **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)	$15
☐ **Executive Package**	Upper level managers interested in an expanded suite of WEF products/services.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *World Water* ■ *Water Environment Research* (Online) ■ *Water Environment Regulation Watch*	$355
☐ **Dual**	If you are already a member of WEF and wish to join NEWEA		$45
☐ **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*	$420
☐ **New England Regulatory Membership**	This membership category is a NEWEA only membership reserved for New England Environmental Regulatory Agencies, including: USEPA Region 1, CT Department of Energy and Environmental Protection, ME Department of Environmental Protection, MA Department of Environmental Protection, NH Department of Environmental Services, VT Department of Environmental Conservation, and RI Department of Environmental Management		$50

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 x7750).

Payment

☐ **Check or money order enclosed**
Made payable to NEWEA
10 Tower Office Park, Suite 601
Woburn, MA 01801
For more information: 781.939.0908
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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 2020

To help us serve you better, please complete the following:
(choose the one that most closely describes your organization and job function)

What is the nature of your ORGANIZATION?

(circle one only–required) (ORG)

1 Public/Private Wastewater Plants and/or Drinking Water and/or Stormwater

2 Public/Private Wastewater Only

3 Public/Private Drinking Water Only (e.g. municipality, utility, authority)

4 Industrial Systems/Plants

5 Consulting or Contracting Firm

6 State, Federal, Regional Government Agency

7 Research or Analytical Laboratories

8 Educational Institution

9 Manufacturer of Water/Wastewater/ Stormwater Equipment or Products

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

11 Public/Private Stormwater (MS4) Program Only

12 Public Financing, Investment and Banking

13 Non-profits

99 Other ______________ (please specify)

What is your Primary JOB FUNCTION?

(circle one only) (JOB)

1 Management: Upper or Senior

2 Management: Engineering, Laboratory, Operations, inspection, Maintenance

3 Engineering and Design Staff

4 Scientific and Research Staff

5 Operations/Inspection Maintenance

6 Purchasing/Marketing/Sales

7 Educator

8 Student

9 Elected or Appointed Public Official

10 Other ______________ (please specify)

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 ______________ (please specify)

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.

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

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