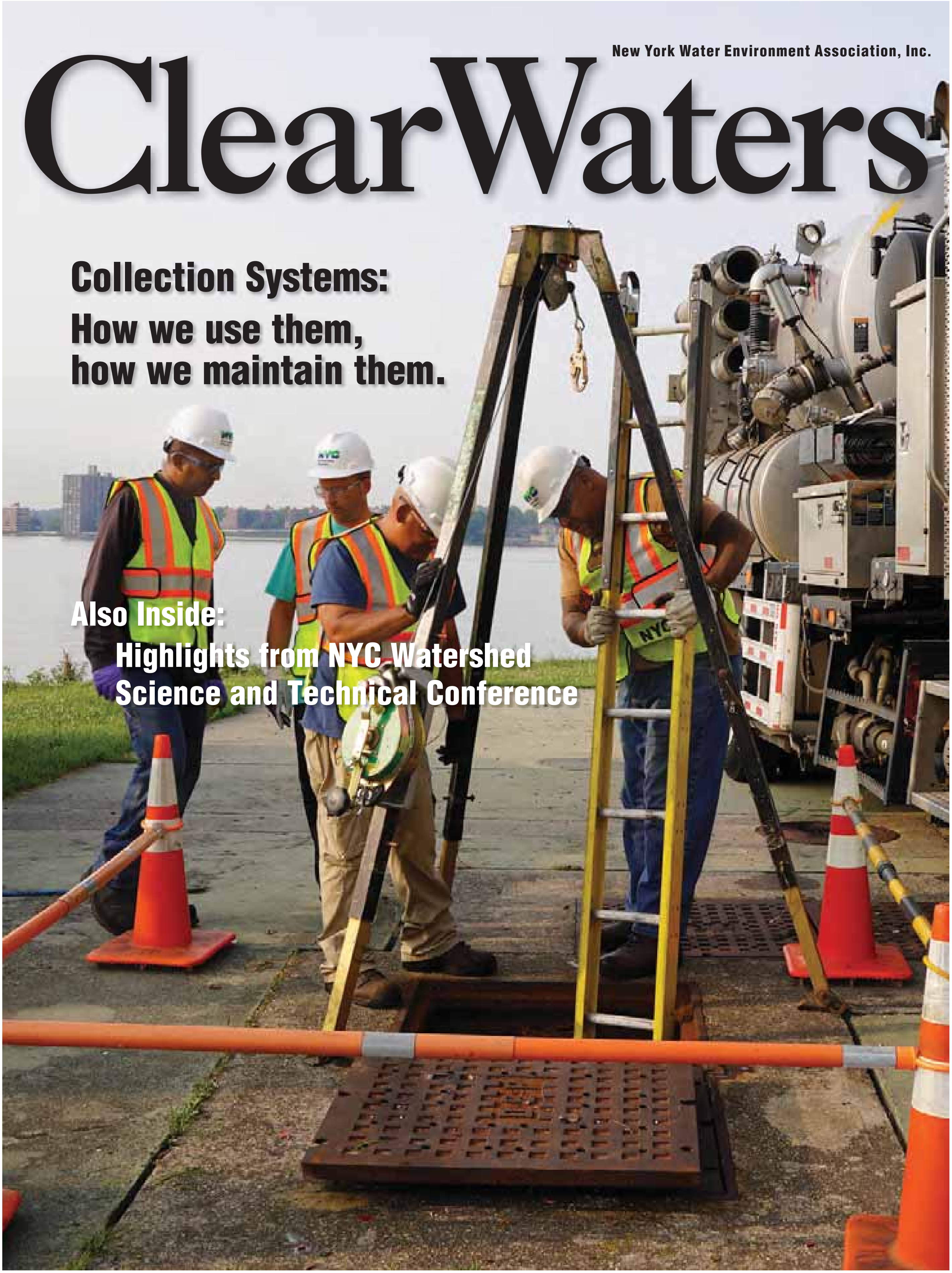
Fall 2019, Vol. 49, No. 3

New York Water Environment Association, Inc.

ClearWaters



Collection Systems:
How we use them, how we maintain them.

Also Inside:

Highlights from NYC Watershed Science and Technical Conference

Fall 2019, Vol. 49, No. 3

Clear Waters

New York Water Environment Association, Inc.

Cover: DEP Collections crew prepares to maintain sewer regulator in the Bronx, NY. This kind of routine maintenance can include: clearing obstructions, Vactor cleaning, flushing, lubrication, and exercising of tide gates. Exercising the tide gate entails moving the gate through its entire range of motion to ensure that it adequately seals. The gate is completely opened and closed, and all the pins are greased. *Photograph courtesy of L. McWilliams, NYC DEP*

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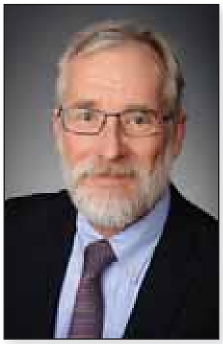
President's Message | Fall 2019



On Aug. 8 and 9, I had the pleasure to attend the Water Environment Federation/American Water Works Association's "Transformative Issues Symposium on Workforce" in Washington, D.C. The program brought together a diverse group of presenters and attendees to discuss the need to build a sustainable water workforce. Overall, the presenters outlined active programs in high schools and on college campuses to begin building that workforce, as well as on-going, career-based programs through employers, government workforce programs and regulatory agencies. The topic of certification challenges was also discussed.

The challenges facing the water workforce were highlighted in the opening session. Jamie Eichenberger, from WEF's board of trustees, discussed the need to develop a water workforce pipeline. Such a pipeline would provide a means of entry for both high school and college-age students, as well as veterans, into the water workforce. The goal for this pipeline is to develop a diverse candidate pool that will help our facilities become inclusive places of employment reflecting the communities that they serve.

The president of AWWA, Jim Williams, provided an overview on the value of the water profession. He highlighted that only 2.5% of the world's water resources are fresh water, and of that only a small fraction is accessible for our use. Over 7.5 billion people in the world rely on this small amount of fresh water, and of those only a very small fraction are responsible for ensuring a clean and safe supply of water. Because of the enormous responsibility placed on these water workers, the water profession is a Vocation of Distinction and the members of this vocation need to take immense pride in our achievements.

So, as employers of water professionals, how do we bring people to this Vocation of Distinction in these challenging economic times with low unemployment? CEO and general manager of DC Water, David Gadis, outlined how DC Water is working to becoming a preferred employer. Mr. Gadis outlined his "three P" concept:

- People: Hire good people and surround them with good people.
- Place: Create a work environment where people want to work and are encouraged to be great. Treat the employees well so that they want to stay.
- Pay: Equitable pay for all employees. Pay must encourage people to enter the field.

Mr. Gadis discussed how their organizational vision is a major contributor to developing their municipal workforce by implementing this concept. Since DC Water is looking to hire within the highly competitive Washington, D.C. area, they found it necessary to conduct periodic regional salary surveys. These surveys provide vital salary information, which helps DC Water to offer competitive salary packages that encourage prospective employees to become members of their water workforce.

Once we have created the ultimate organization and desirable place of employment, then we need to connect employers with students, as Dr. Wayne Frederick, president of Howard University, discussed. Howard University supports the efforts of their students to develop relationships with future employers. The students' viewpoint is that they are investing time and money for a degree and they want some assurances that a future employer will provide the kind of work opportunities the students seek, along with financial security and career growth, to justify their investment.

> *The water profession is a Vocation of Distinction and the members of this vocation need to take immense pride in our achievements.*

Howard University participates in WEFs InFlow program, which serves one of the goals of the university by providing promising students with access to water industry professionals. The InFlow scholarship program targets underserved minority groups who are interested in professional careers in the water industry. The InFlow scholarship program allows students to attend WEFTEC for the opportunity to network with WEF members and potential employers. InFlow is part of Howard University's efforts to bring students into contact with industry leaders by providing students with the tools to be technically proficient and better prepared for quick assimilation culturally into the work environment.

The remainder of the symposium highlighted the many efforts of the water industry to develop a more inclusive and diverse workforce. I especially want to highlight a presentation by Brigadier General (Retired) Marianne Watson, of the Center for America, on hiring veterans. The Center for America *(www.centerforamerica.org)* is a program available to help veterans transition to the workforce following deployment. Their website provides free resources to help associations and employers to hire veterans, National Guard members and reservists. The website provides best management guides to assist employers with recruiting veterans. Brig. Gen. Watson noted that job descriptions are often a hurdle for veterans, such as stating that a skill is *required* when the skill is *desired*. How a job description is written can often dissuade a veteran from applying. She also made note that there are websites targeted to veterans where employers can post jobs *(www.centerforamerica.org* and *https://casy.us/employers)*.

This Symposium on Workforce highlighted many opportunities and programs that exist or can be developed to use in creating a sustainable operator workforce. The information we obtained in this program will be used as we continue our efforts to ensure there is a future operator workforce pipeline.

Robert Wither, PE, NYWEA President

WATER'S WORTH IT

Properly maintained collection systems are an essential element in the performance of water resource recovery facilities. This issue of *Clear Waters* takes a comprehensive review of the major components of collection systems including how data can be analyzed, the ubiquitous issue of Inflow and Infiltration (I&I) and inspiring aspects of innovation and efficiencies that we can learn from. We extend our heartfelt appreciation to Rosie Nogle of the Buffalo Sewer Authority (BSA) who nearly single-handedly put together this issue that is so near and dear to the valuable work she performs at BSA. Her passion for Buffalo's water infrastructure history is illustrated in her article on page 37.

On the Horizon

Please join us in Syracuse, New York, Tuesday, November 19, for our Stormwater Specialty conference. This event, co-sponsored with the New York State Floodplain and Stormwater Managers Association (NYSFSMA), will cover all aspects of stormwater management and feature a walking tour of several of Syracuse's award-winning green infrastructure sites. This event will take place in the newly renovated historic Marriott Syracuse Downtown. Many thanks to Michelle Virts, chair of NYWEA's Stormwater Committee, Ethan Sullivan and the members of the committee for putting together such a unique and all-encompassing program. Be sure to also check out the Collection Systems training we have taking place this fall in the calendar below.

Don't miss NYWEA's 92nd Annual Meeting and Exhibition, New York state's largest Water Quality Technical Conference! It will be held at the New York Marriott Marquis in New York City, February 3-5, 2020. The members of the Program Committee have been hard at work developing the technical content. Many thanks to all the members who submitted excellent abstracts that made the selection of papers challenging! To accommodate the volume of abstracts received, we have expanded the total number of technical sessions from 26 to 30. In making that decision, we have reduced the overall number of exhibit booths available, so reserve your booth space soon! Don't forget to save money and take advantage of the early bird reduced registration and hotel rates.

I wish you all an enjoyable fall season! It's delightful to live in a place where we experience the amazing colorful characteristics of each season!

P. Cerro-Reehil

Patricia Cerro-Reehil, pcr@nywea.org

Recent Board Actions

During its September 11th board meeting the NYWEA Board of Directors unanimously approved the following resolutions:

Resolution 2019-25 – WEF House of Delegates Representative, Geoff Baldwin

Resolution 2019-27 – Renewal of Memorandum of Understanding Legislative Liaison: This shared service between NYWEA, the New York Section of American Water Works Association and the New York Rural Water Association will be continued for one year with Leah Harnish serving in this role.

Resolution 2019-28 – Creation of Diversity and Inclusivity Task Force

Resolution 2019-29 – Volunteer Anti-Harassment Policy

Resolution 2019-30 – Addendum of Memorandum of Understanding with the New England Interstate Water Pollution Control Commission for Train-the-Trainer Class

Resolution 2019-31 – NYC Marriott Marquis Hotel Rate Confirmation Letter

Resolution 2019-26 (Approval of Pre-Certification Operator Scholarships) was tabled and referred to the Scholarship Committee for review and recommendation.

NYWEA
LEADING THE WAY IN WATER QUALITY MANAGEMENT

2019-2020 Upcoming Training Classes & NYWEA Meetings

November 6, 2019	Building NY's WRRF Interest in Strategic Energy Management Yonkers Joint WWTP, 1 Fernbrook Street, Yonkers, NY
November 7, 2019	Collection System – Infiltration and Inflow Chenango Town Hall, 1529 State Route 12, Binghamton, NY
November 12, 2019	Mathematics for Water and Wastewater Operators Van Lare Plant Training Room, 1574 Lake Shore Blvd., Rochester, NY
November 19, 2019	Stormwater Specialty Conference Marriott Syracuse Downtown, Syracuse, NY
November 20, 2019	Collection System – Infiltration and Inflow Niagara County Fire Training Center, 5574 Niagara Street Extension, Lockport, NY
February 3-5, 2020	NYWEA 92nd Annual Meeting & Exhibition New York Marriott Marquis, New York, NY

Visit nywea.org for more information.

NYC Watershed Science and Technical Conference
"Clean Water Through Protection and Partnership"

Over 250 people attended the NYC Watershed Science and Technical Conference held Sept. 12 at the Diamond Mills Hotel, Saugerties, New York. Meeting attendees selected from six sessions covering different topics. Many thanks to Lisa Melville and the members of the Watershed Committee, speakers, moderators, sponsors and exhibitors. Special thanks to the members of the Watershed Warriors for performing the Lab Event during the meeting.

NYWEA President Robert Wither welcomes all to the conference.

Lisa Melville, NYS Department of State, welcomes attendees.

Paul Rush, Deputy Commissioner, Bureau of Water Supply, NYC Department of Environmental Protection addresses attendees.

Kerri Alderisio, NYC DEP

Four panelists discuss "Lessons from Hurricane Irene and Superstorm Sandy and Recovery". Top left, Dave Warne, Assistant Commissioner, Bureau of Water Supply, NYC Department of Environmental Protection; top right, David Corrigan, Acting Resident Engineer, NYS Department of Transportation; bottom left, Lori DuBord, Senior Program Manager, Governor's Office of Storm Recovery; and bottom right, Aaron Bennett, Environmental Planner, Ulster County, Department of the Environment

Kathryn Serra, C.T. Male Associates, discusses Batavia Kill Watershed District dams response during Topical Storm Irene.

Laurie Machung, NYC DEP

Kevin Bliss, TRC, talks about Wetland Delination regulatory programs in Session III.

Below, the room is full for the Opening Session.

Esopus Creek is the beautiful background at Diamond Mills Hotel.

Session IV moderators, Christine Abplanalp, Arcadis, and Rich Fiedler, GP Jager, Inc.

Thursday night's Young Professionals Event followed the Conference's conclusion.

The Partition Bar, location of the YP Event, serves its "brand" literally – on their buns.

Right (l-r): NYCDEP's Lori Tsaldaris, Adam Reaves and Ron Bogart watch the Operations Challenge demonstration.

Rich Fiedler, GP Jager, Inc., center, receives NYWEA's Service Award from President Robert Wither. NYWEA Executive Director Patricia Cerro-Reehil, left.

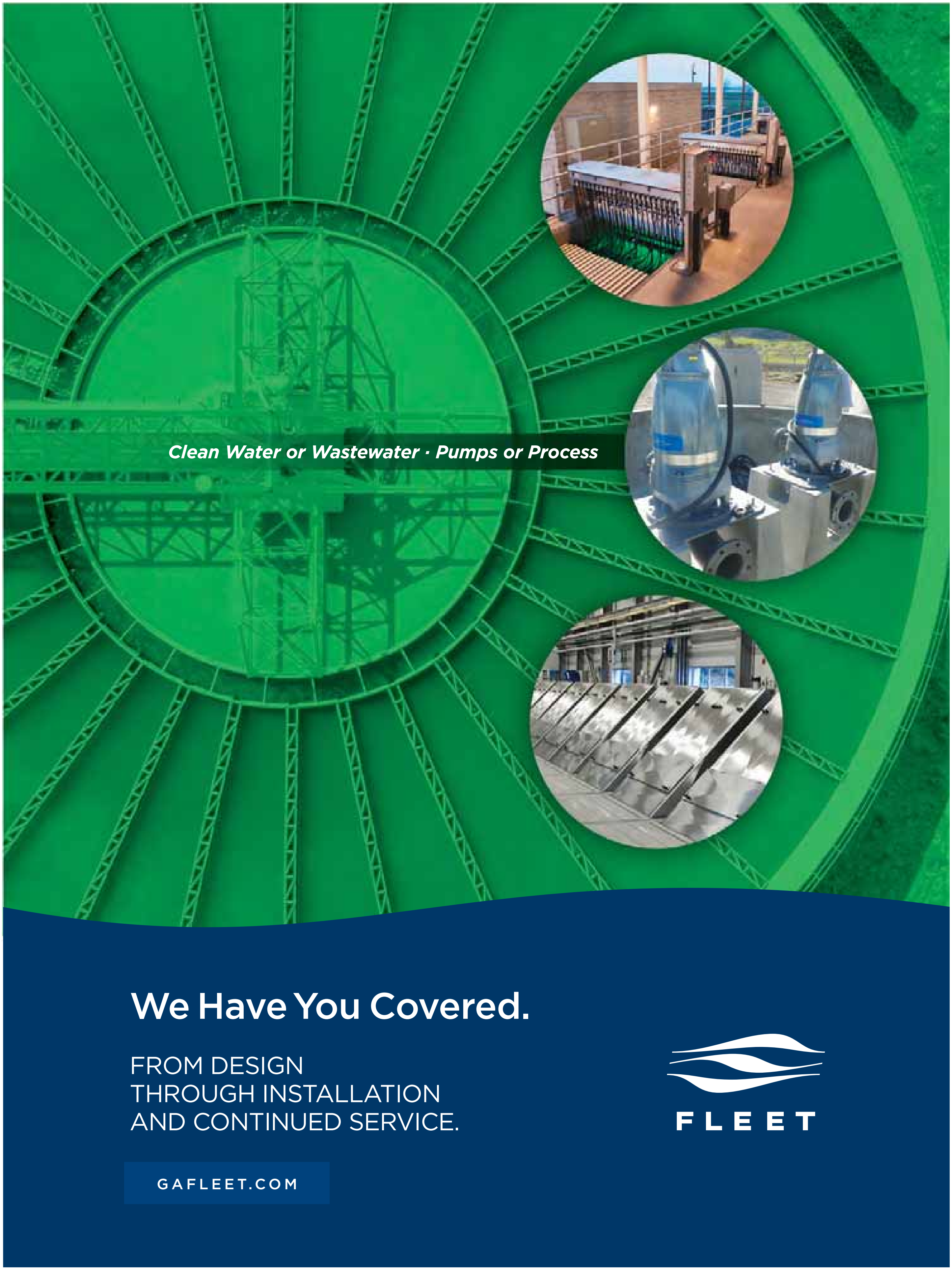
Tom Lauro, left, and Gregory Daviero share a moment at the conference.

David Austin, from Jacobs, discusses holistic reservoir management in Session IV.

(L-r) Madison Quinn, Lisa Melville and Maggie Hoose welcome all at the Registration Desk.

IDEXX exhibitor Jamie Brundelle talks with a conference goer during a break.

Lower Hudson's Watershed Warrior, Ken Taylor, hones his skills in an Operations Challenge Lab Event demonstration.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Water Views | Fall 2019

Polluted Runoff

Polluted runoff from urbanized areas, industrial sites and farms is a significant cause of impairment in many New York waters. NYSDEC, under the federal Clean Water Act's framework, has established regulatory and permitting programs to dramatically reduce or even eliminate polluted runoff from regulated sites, while reestablishing a more naturalized hydrology. NYSDEC also has established effective technical methods and programs to help ensure that polluted runoff is treated or abated through infiltration:

- The General Permit for Stormwater Discharges from Construction Activities applies to all construction activities that disturb one or more acres of soil; construction in designated sensitive areas must meet more stringent requirements. Permittees must develop and implement a Stormwater Pollution Prevention Plan (SWPPP) that includes post-construction controls on stormwater.
- The General Permit for Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s) requires urban municipalities to develop stormwater management programs to reduce stormwater pollution from their non-CSO storm sewer systems to the "maximum extent practicable." New York City has an individual MS4 permit with special requirements.
- The Multi-Sector General Permit (MSGP) for Stormwater Discharges Associated with Industrial Activities requires industries in 29 identified sectors to use stormwater controls attuned to their specific activities.
- New York has a general permit to prevent contaminated runoff from Concentrated Animal Feeding Operations (CAFOs) from entering our waters. Permitted CAFOs must follow United States Department of Agriculture's Natural Resources Conservation Service standards. Grants are available to assist with compliance via the state's Agricultural Environmental Management (AEM) program.

There are also many non-regulatory programs in place to address and limit the impacts of polluted runoff. For example:

- Excess nutrients in stormwater runoff contribute to harmful algal blooms (HABs) in waterbodies. NYSDEC's HABs Program works to identify HABs, notify the public, and conduct research on the causes and possible methods to prevent and control HABs. In 2018, the state provided $82 million in grants to abate HABs.
- Water Quality Improvement Project (WQIP) grants provide funding to address the causes of water quality impairments. WQIP includes categories such as Nonpoint Source Green Infrastructure/Stormwater Retrofits and MS4 mapping and vacuum trucks. New in 2019 is the Non-Agricultural Nonpoint Source Planning Grant program, which provides funding for planning nonpoint source control projects, such as green infrastructure. The Environmental Facilities Corporation's Green Innovation Grant Program also provides grants for green infrastructure projects.
- Clean water plans, such as the Total Maximum Daily Loads (TMDLs) and Nine Element watershed plans, provide science-based strategies to improve water quality in specific waterbodies. Many of the pollution budgets in these plans show that unless polluted runoff is reduced, we won't meet water quality goals.
- NYSDEC's Trees for Tribs program facilitates planting trees along waterbodies to create riparian buffers that filter and cool stormwater.

If we "slow down, spread out and soak in" stormwater, we reduce pollution impacts, increase flood resiliency, improve aquatic habitat, and reduce drought risks by recharging our aquifers.

– James Tierney, Deputy Commissioner for Water Resources
NYS Department of Environmental Conservation

Focus on Safety | Fall 2019

The Perils of Stormy Weather

Stormwater is a topic that has different definitions depending on time and circumstance. Just lately, my wife had an encounter with stormwater and neither of us were amused.

After receiving the news of her mother's sudden health emergency, my wife hopped into her midsized SUV and hit the road. She traveled up New York State Route 8, hugging the Unadilla River on one side and a hillside on the other. In bygone days, this river was used as a canal, and this road served as the towpath. Route 8 travels through several small hamlets that popped up in the mid-19th century and is increasingly traveled by tractor-trailers.

Fretful that she would not get to her mother in a timely manner, she buzzed up the road, giving the speed limit a run for its money. The sky darkened in the middle of the afternoon. Then the rain came, hard and fast as only summer afternoon thunderstorms can do. Traffic came to a dead stop in the middle of one of those riverside hamlets. She became increasingly anxious about the delay when she saw that a tree had fallen across the road. She called me for help, since I was a little more familiar with that area. She couldn't move forward, and she couldn't cross the river to continue her journey on the other side. So, the only thing left to do was to backtrack and then turn away from the river to head uphill during this monstrous thunderstorm.

In the time that it took for her to make the call (hands-free of course) and consider her options as she turned the SUV around, stormwater runoff came down that hill, surging into the little village's side streets toward the Unadilla River. The water overcame the capacity of the stormwater drains and rose to the floorboards of her SUV. Flash flood! Her voice rose in frustration with the water, while I needed to raise my voice so that she could hear me over the rain drilling down on her roof. Can you see the gas station? Turn right! Go over the hill! Suddenly, our phone connection was lost!

Now, it is easy to say don't drive through rising water, don't drive where you can't see pavement, don't do risky things, a couple of hours in your travel time won't make a difference, better safe than sorry. In that moment, though, confronted with the imperative to reach her mother in time, she didn't feel she had any choice but to take the risk and drive right through. Hindsight is 20/20, and it turned out she did have the time to make it there without taking the risk. Competing priorities are cruel; but this time she had luck on her side and made it safely. It could have gone much worse.

– Eileen M. Reynolds, Certified Safety Professional
Owner, Coracle Safety Management

Barnes Avenue Sanitary Sewer Overflow Correction

by Steven Hearl

The Nassau County sanitary sewer system is separate from its stormwater system. Sanitary sewer overflows (SSOs) have occurred periodically at Barnes Avenue and Third Place in the hamlet of Baldwin, Town of Hempstead, Nassau County, New York. Nassau County Interceptor 2T-4, which passes through this location, has the lowest rim elevation within the entire Baldwin sewage collection system. The Parsonage Creek Siphon, a three-pipe siphon that conveys wastewater flow under Parsonage Creek located approximately 800 feet south of the manhole with the lowest rim, has hydraulic limitations under certain conditions.

The Nassau County Interceptor 2T-4 (also known as the Barnes Avenue Interceptor) was among the public infrastructure severely impacted by Superstorm Sandy due to flooding caused by the storm surge. The storm surge brought by Superstorm Sandy caused the sanitary sewer system flow to reverse. The storm resulted in SSO's through the manholes in the vicinity of Barnes Avenue and Third Place. Residents in the vicinity reported that raw sewage infiltrated the floors and walls of their homes, causing damage and potential health hazards. Due to the severity of the Superstorm Sandy SSO event, a state of emergency was declared in the Barnes Avenue neighborhood. This event renewed the county's interest in preventing future SSOs.

Nassau County funded a study to identify the causes of the SSOs and to provide recommendations for reducing the wastewater flow and eliminating the SSOs. In addition to measures that reduce infiltration and inflow in the service area, the primary mitigation method considered was to reduce the volume of flow in the sewage system upstream of the Barnes Avenue location.

Barnes Avenue Sanitary Sewer Overflow Correction Project

For the sewer system tributary to Barnes Avenue, diversion of sewage flow within the Village of Hempstead (VOH) was determined to be a logical choice for several reasons. The VOH sewer infrastructure assessments conducted by several firms included delineation of service areas to the VOH wastewater pumping stations, as well as development of a hydraulic model of the collection system. All VOH sewage is conveyed to the northernmost boundary of Baldwin's sewage collection system. The sewage ultimately flows to the Nassau County Sewage Disposal District No. 2 for treatment at the Bay Park Sewage Treatment Plant (Bay Park STP).

Although diverting sewage flow within the VOH was identified as the primary method to control SSOs, future property development creates the potential for increased sewage volume in the system. Renaissance Downtowns, a developer, provided information on some of the planning initiatives for the redevelopment of the VOH downtown. These included revising the village code and introducing legislation for implementing smart growth principles. Most of the area targeted for redevelopment is comprised of underutilized properties such as parking fields, multitiered parking structures and commercial properties. Planned redevelopment of the VOH downtown was estimated to add 1.11 million gallons per day (mgd) of design sewage flow. Adding this wastewater volume from the proposed redevelopment would further strain the capacity of the existing Barnes Avenue sewers.

As part of the flow diversion, the regional treatment plants were assessed for their capacity. Nassau County has two treatment plants on the south shore of Long Island. Unlike the county's Bay Park STP, the Cedar Creek Water Pollution Control Plant (Cedar Creek WPCP) sustained only minor damage due to Superstorm Sandy. The Cedar Creek WPCP is a relatively newer treatment facility with an excellent compliance record. Cedar Creek also has available capacity. Consequently, flow diversion of a portion of VOH wastewater to the Cedar Creek WPCP was determined to be a long-term regional solution that would benefit both the hamlet of Baldwin and the VOH. Another benefit of the flow diversion project would be to enable greater capacity in the VOH sewage collection system. This would allow for the redevelopment of the village's downtown without the need to provide significant upgrades to the existing infrastructure.

Existing Conditions

There are three main collection zones in the northerly portion of the VOH. Wastewater flows to three pumping stations (PS):

- Weekes Park PS.
- Newman's Court PS.
- Harrison Avenue PS.

The South Harrison and Long Drive sewer sheds, located south of Front Street, were not included in the flow diversion plan.

The Newman's Court PS and Weekes Park PS service areas were selected for transfer to a proposed new pumping station. Of the total 5.7 mgd VOH design flow, 3.74 mgd (65.6%) would be diverted. An allowance of 1.0 mgd was provided for wet-weather inflow. The average daily and peak hourly design flows for the proposed pumping station were 5.85 mgd and 12.11 mgd, respectively.

Weekes Park PS

The VOH Weekes Park Pumping Station is located in the southwest corner of a triangular parcel ***(Photographs 1*** and ***2)***. Each side of the site is bounded by heavily traveled major roadways. The north side is bounded by Front Street, the west side lies along Clinton Street, and the southerly side fronts Peninsula Boulevard. Approximately 900 parcels are served by the existing pumping station, which has a capacity of 2.0 mgd. In addition to the flow generated within its own sewer shed, the pumping station conveys excess flow from the northern collection area serving the Harrison

Photograph 1. The southerly side of the Weekes Park Pump Station site, Aug. 19, 2014, pre-design, viewed looking north. The flagpole, monument and original hydrant location are visible. Access to the original below-grade pump station is located within the green fence.
Steven Hearl, H2M

Avenue Pumping Station. The top half of the 12-inch diameter sewer on Peninsula Boulevard has been removed in a manhole to allow sewage that exceeds the pipe capacity to flow to the Weekes Park PS wet well.

Newman's Court PS

Approximately 790 parcels are served by the Newman's Court PS. Most of the existing station, which is more than 60 years old, is located below grade, with a portion of the wet well located under Peninsula Boulevard. A 15-inch diameter clay pipe enters the north side of the wet well and a 12-inch cast iron sewer enters the south side of the wet well. There are two pumps in the dry well, which discharge into a 12-inch diameter force main.

Proposed New Pumping Station

The existing pumping station at Newman's Court could not be rehabilitated to accommodate the design flow of 5.85 mgd for the proposed diversion pumping station. Therefore, a new pumping station was needed.

Several sites were considered for the new pumping station. Due to the time it would take for potential acquisition and location, the privately-owned parcels were eliminated from consideration. The Weekes Park PS site was deemed the most viable of the publicly-owned parcels for the new pumping station.

Financing and Contracting

The new pumping station was part of the program for the Barnes Avenue Sanitary Sewer Overflow Correction project. Funding was provided by the New York State Clean Water State Revolving Fund Storm Mitigation Loan Program (SMLP) with support from the federal Department of Housing and Urban Development (HUD) Community Block Grant Disaster Recovery (CDBG-DR) program. Since funding for the project came from the state of New York, the contract had an overall goal of 20% for Minority and Women-Owned Business Enterprises (MWBE) participation.

A Project Labor Agreement was put in place by Nassau County prior to bidding. Due to the existing site constraints and volume of traffic in the three adjacent roadways, a comprehensive sequence and staging of the work was included in the general specifications of the construction contract. The construction contract was awarded in the amount of $6.88 million. The consulting engineering team awarded the contract to two companies:

- Cameron Engineering, the lead consulting engineer for the project, was responsible for the planning and design of:
  - o The 14-inch diameter 2,600-foot-long force main to convey flow from the VOH Newman's Court PS to the Hempstead PS.
  - o Upgrade of the existing Newman's Court PS.
  - o Planning and design for the 30-inch-diameter, 14,800-foot-long ductile iron force main from the Hempstead Pumping Station to the Cedar Creek interceptor.
- H2M architects + engineers, sub-consultant on the engineering team, was responsible for the planning and design of the diversion wastewater pumping station known as the Hempstead Wastewater Pumping Station, which would be located at the Weekes PS site.

Photograph 2. The northern portion of the Weekes Park PS site, Aug. 19, 2014, pre-design, viewed looking toward the southwest from the intersection of Front Street and Peninsula Boulevard.

Steven Hearl, H2M

Pre-Construction

Before construction of the new pumping station could proceed, several tasks needed to be completed:

- The removal of a flagpole, which was provided to the VOH.
- Relocation of a monument in honor of Casmir Pulaski and Tadeusz Kosciusko to a nearby parcel.
- Relocation of traffic signal lines.
- Installation of a new fire hydrant near the northerly curb line to allow removal of the water line and fire hydrant on the southerly side of the site.
- A bus stop was relocated one block to the west.
- Construction fencing was installed along the curb line except for a spot to maintain access of the Weekes Park PS by VOH personnel.

Based on the age of the existing Weekes Park PS, and since the structure was to be demolished, lead paint and asbestos surveys were conducted of the facility at the start of the design phase. Lead paint was found on only two surfaces. The only asbestos-containing material was a collar on the U-vent.

The existing Weekes Park PS's 12-inch-diameter force main was drained and modified with piping and valves to allow a portion of the design wastewater flow to be conveyed by portable pumps in an emergency.

Construction

Two new precast concrete buildings were designed to house the new equipment. Installation of pre-engineered buildings reduced the time for on-site construction. Metal wall panels were installed for the exterior finish. One building housed the motor control centers, transfer switch, main incoming service panel, pump variable-frequency drives (VFDs) and pump control panel on the first floor. The valve chamber (***Photograph 3)*** was in the lower level.

The second building housed the standby 300-kilowatt generator on a double-walled diesel fuel tank. In accordance with county requirements, the tank was sized to provide a three-day supply. In addition to the on-site generator, a manual power transfer switch, connected on the load side of the automatic transfer switch, was provided to allow connection of a portable generator unit to a receptacle outside the station.

A new wet well and dry pit were constructed adjacent to the existing pumping station. The pumping configuration consists of two wet wells each with two submersible pumps. Three of the four pumps will operate to convey the peak flow. Operating three pumps to convey the peak flow provides for greater operation flexibility

continued on page 12

continued from page 11

Photograph 3. Valve chamber located on the lower level of one of the buildings of the new pump station. *Steven Hearl, H2M*

Photograph 4. Placement of the first precast wet well base section. *Steven Hearl, H2M*

over the initial and design flows compared to a system with two operating pumps.

During construction, the contractor Stratis Contracting Corporation, of Peekskill, New York, offered to install the junction chamber and wet well using precast concrete sections. This reduced the duration needed to operate the dewatering system during construction of the wet well. Each wet well had a base section, two risers and a top slab ***(Photograph 4)***.

Each wet well measured 12 feet by 20 feet. A junction chamber allows the flow to be distributed to the wet wells. Sluice gates allow each chamber to be isolated. Air from each wet well is ventilated through a carbon adsorption canister. A hoist with electric winch was provided for removal of the submersible pumps from the wet well. A T-Lock® PVC liner was installed on the walls and underside of the junction chamber top slab and on the underside of the wet well top slab. A fall protection grating system was included under access doors.

A level sensor in each wet well is the primary element for pump control. The operator can select which sensor will be in service. Non-mercury float switches provide backup control. A reduce-voltage solid state starter, with a full-voltage non-reversing starter bypass, was provided for each pump in the motor control center.

Photograph 5. Pumping Station building and pump hoist, with security fence. *Steven Hearl, H2M*

Based on anticipated flow variability, VFDs were provided for the pumps. A plug and a corresponding receptacle were provided for each pump's power and control cord to simplify the removal process.

Pump discharge piping with a check and plug valve is connected to a header located in the lower level of the control building. A surge relief valve was provided on the header with relief piping to the wet well. To measure flow, a magnetic flow meter was provided on the header with a digital chart recorder located on the first floor of the control building.

For site security, an 8-foot-high, palisade-type fence with a gauntlet top was installed ***(Photograph 5)***.

Post-Construction

In February 2019, the Hempstead Pumping Station Control Building, Generator Building and equipment were turned over to Nassau County and their operator, Suez, for beneficial occupancy and beneficial use, respectively. The new pumping station is owned by Nassau County.

While the primary objective of the project was diversion of flow from Barnes Avenue to address SSOs, another environmental benefit was diversion of a portion of the VOH wastewater from the Bay Park STP to the Cedar Creek WPCP. This diversion reduces the total volume of effluent discharged by the Bay Park STP outfall to Reynolds Channel. This in turn reduces nitrogen load to the channel. As indicated in the New York State Section 303(d) "List of Impaired/TMDL Waters," nitrogen discharged to the channel supports macroalgae growth in adjacent waters, significant amounts of which are pushed into the channel by tides, prevailing winds and currents *(NYSDEC 2018)*.

Steven Hearl, PE, LEED AP is Vice President and Department Manager of Collection and Conveyance Systems for H2M architects + engineers in Melville, New York. He may be contacted at shearl@h2m.com.

Reference

NYSDEC. 2018. "The Draft New York State 2018 Section 303(d) List of Impaired Waters Requiring a TMDL/Other Strategy." New York State Department of Environmental Conservation, pg. 30. Accessed July 24, 2019. *https://www.dec.ny.gov/docs/water_pdf/303dlistdraft18.pdf.*

“If It Ain’t Broke Don’t Fix It” Collection System Cleaning

by Jay Boyd

There is an old saying, “if it ain’t broke don’t fix it.” That folksy, simple statement bears quite a bit of truth. Why would we spend money on something that is functioning? For example, why would I spend a few thousand dollars replacing my hot-air heating unit when it works? We get warmth on-demand. Besides, we have other maintenance projects such the backyard fence. It’s nearing its end-of-life, so for a similar expense why not address that?

The heater is functional. I know that there are newer models with better technology making them more efficient, translating into lower use of fuel and heating costs. These new systems have multiyear warranties where mine has none. Plus, the new models run quietly while my heater is a little noisy.

So, asking the question again, is it “broke”? Fuel prices over time will rise and there is a prospect of pay-back with a newer unit. Should a breakdown occur with the old unit, there is a looming prospect of repair, perhaps even an emergency repair, so we have a standing liability. With this perspective, what looks like it “ain’t broke” may well be “broke” considering the higher fuel costs and an uncovered liability for repair. In this context, the heater is more important than the fence. It’s “broke.”

So why the story of the heater? We use many processes and day-to-day routines that get the desired results. Yet are these processes as efficient as they could, and should, be? Like the heater, just because they work and give us the desired effect, does it mean that there aren’t better alternatives with improved outcomes? Can we gain greater efficiency and lower operating costs? To answer this, we’ll look at the recommended best practice of rigorous cleaning of the collection system.

The Story of a Small City

The City of La Mesa is located just 12 miles east of San Diego, California. Called the Jewel of the Hills, between 1910 and 1915 its rolling hills and arid landscape made La Mesa a perfect backdrop for more than 100 Western films shot on-location.

CITY OF LA MESA JEWEL of the HILLS

Logo for the City of La Mesa, California.
City of La Mesa, California

Today, the city boasts a population of 57,000 residents. It has a quaint downtown village surrounded by residential and commercial areas, all fitting in a 9.1-square mile area where the city owns, operates and maintains its 153 miles of collection system and an additional 50-plus miles of storm system.

A Really Brief History of (Over)cleaning

The goal of federal and state regulators is to stop sanitary sewer overflows (SSOs). Like New York, California’s regulatory State Water Resources Control Board has high standards for compliance and reporting of overflows. Steep fines for noncompliance can be levied, placing high demands on all cities to assure that they comply.

La Mesa’s limited, seven-person maintenance staff is responsible for myriad duties in addition to collection system maintenance. They must address 100 high-frequency cleaning sites monthly ***(Photograph 1)***. This scheduled routine is done to stay ahead of any buildup caused by fats, oils and greases (FOG), roots, debris and sediment, all to avoid the threat of overflows. In effect, the city overcleans as a preventive measure. It’s working.

Photograph 1. Workers cleaning a collection system.
ADS Environmental Services

La Mesa is certainly not alone in their approach. High-frequency cleaning has been considered a “best practice” for decades and appears in many dozens of operations and maintenance (O&M) manuals. Here is just one example of a recommended process found in a USEPA collection systems Capacity, Management, Operation and Maintenance (CMOM) manual from 1999:

> “Scheduled cleaning is proactive in that cleaning is done on a preventive basis to remove material prior to a stoppage occurring. Preventive cleaning activities can be supplemented by additional cleaning on an as-needed basis in cases where predictive information such as previous history, inspection data, pipe age and material, slope, or other information indicates a need for more frequent cleaning.” *(USEPA 1999)*

In the most general sense, overflows are caused by the system’s capacity being challenged in some way. Blockages, where the flow is impeded, is one of them. Cleaning is recommended to keep pipes free of obstructions. How is it determined when to clean? History. This means that to be proactive and stay ahead of historic problems, utilities must overcompensate by overcleaning.

Figure 1 illustrates how overcleaning can affect SSO occurrence.

The City’s Challenge

La Mesa uses high-frequency cleaning and has achieved SSO reductions over the years. From this perspective, as the saying goes, “it ain’t broke.” Or is it? As mentioned, the city cleaned 100 sites monthly, resulting their small staff spending 80% of their time cleaning. Upon taking a closer look, this rigorous cleaning program created an underlying problem: “how do we keep up?” With vacations, sickness, staff turn-over and emergencies all impacting their schedule, keeping up is difficult. This perceived “best practice” may be unsustainable, and adding personnel was not an option. Yet, the city needed a solution to reduce pressure on their staff without any risk of increased SSOs.

Additionally, like so many other systems across the U.S., the La Mesa collection system had older pipes. The city was concerned that

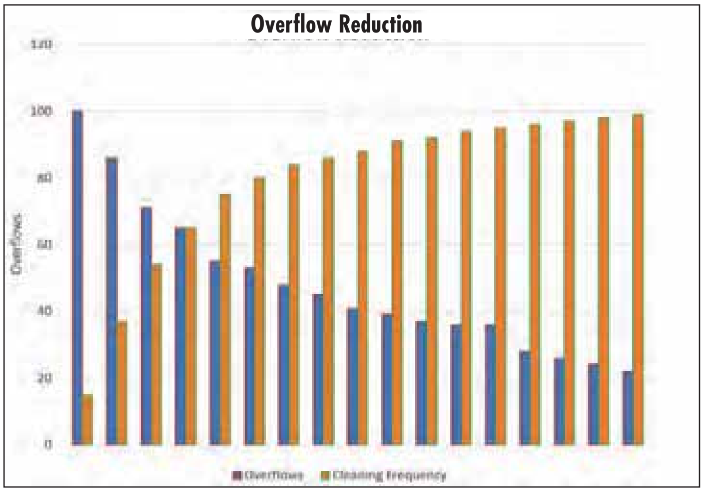

Figure 1. This graph is an amalgamation of multiple U.S. utilities' results. It shows that as cleaning frequency increases (orange), SSOs decrease (blue). Although individual results vary from utility to utility, they all demonstrate this inverse relationship. *ADS Environmental Services*

high-pressure spray from the frequent cleaning operation promoted accelerated wear on already marginal pipes. Cleaning was a necessity, but they needed to balance that against detrimental wear exacerbating pipe failure.

A New Vision

Recognizing that their current practices were "broke," they were determined to create a new process with three objectives:

1. Reduce demands on the operations team.
2. Reduce the threat of premature pipe wear, especially on older pipes.
3. Maintain and even improve SSO prevention.

The city realized that the main issue with their process was cleaning frequency. It was based on the site's history, and the cleaning schedule was set up accordingly. If the site had a history of many problems, it was cleaned with higher frequency than a site with a history of fewer problems.

Aside from when the site was cleaned by the field crew, the utility had no way of knowing the condition of the site between cleanings. In effect, they were blind to the real-time conditions of the site.

With this realization, the city called on a trusted supplier of monitoring equipment and services with whom they had previously done successful flow metering projects. They met and discussed the situation and their forward-looking vision. The city learned from the supplier that a growing cadre of utilities were investigating and implementing a new process that optimized cleaning. Using remote site monitoring, utilities gained ongoing visibility to sites previously being cleaned at high frequency. The monitors would continuously measure and communicate conditions to cloud-based software and could be viewed on desktops, tablets or smartphones ***(Figure 2)***. This software can detect when a blockage is developing, based on machine learning. The software provided the data and could alert the utility's staff when it was time to clean.

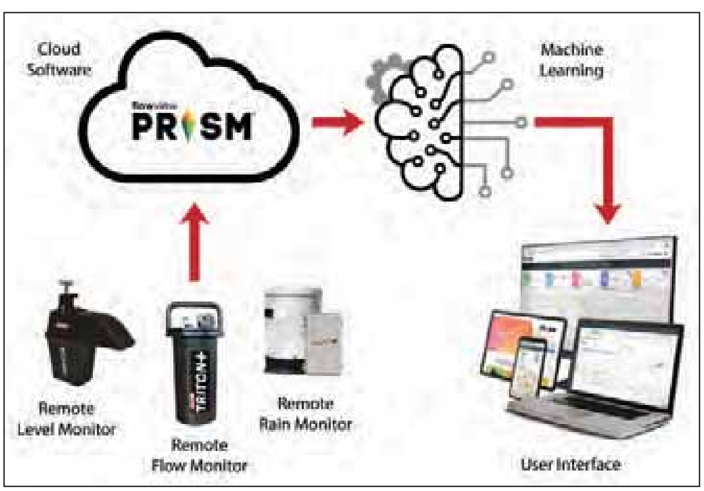

Figure 2. The remote monitors continuously measure and communicate conditions to cloud-based software. This software uses machine learning to recognize a developing blockage. The software alerts the users through interfaces when cleaning is necessary. *ADS Environmental Services*

In multiple studies conducted by the supplier with utility partners, it was shown that cleaning frequency was safely reduced by 67 to 93%. The city was quite interested in this approach. It had the potential to meet their objective for lower cleaning frequency while also decreasing risks from SSOs.

The Test and the Technology

The supplier and La Mesa agreed to establish a pilot. Ten high-frequency (e.g., monthly) sites were selected. The supplier provided a new-generation level-only monitor at each site. These new-generation level monitors were equipped with three sensors: an ultrasonic sensor, a pressure sensor and an alignment sensor.

The ultrasonic sensor was capable of precision measurement to a distance 20 feet from the sensor to an 8-inch invert below. It had five configurable alarms. Its low-flow alarm was valuable for detecting upstream blockages. As well, there were four high-level alarms to provide optimum redundancy and assurance against SSOs.

The pressure sensor was capable of monitoring fully 8 inches above the unit if submerged and could measure an overflow event. The third sensor monitored the remote unit's alignment. This was important to assure that the remote system was always monitoring invert levels and no other manhole surfaces, enabling acquisition of high-quality data and avoiding false alarms. In all cases, users could be notified by text message or email if an issue arose. Moreover, if the condition corrected itself, users would be notified.

In addition to the alignment sensor, these remote units used a stabilized mounting method to maintain a fixed position ***(Photograph 2)***. No sensor movement meant no errant measurements and, therefore, no false alarms.

The system was equipped with a new cellular communications technology called LTE-M. Unlike voice-based cellular, LTE-M signals could be transmitted from an antenna located inside the manhole, providing quality connectivity. This made installation fast and movement to another site easy. With the system software, users could view remote sites in real time through quick summary dashboards.

During the study, the greatest challenge was to break old habits of routine cleaning based on a rote schedule. Rather, the field team cleaned when the remote system indicated to do so. The team wanted to trust the system and be able to rely on data quality. This trust was essential for the success of the study. Earlier technologies had suspended the sensors from cables, which were susceptible to movement that created false alarms and eroded the user's trust in the system. To overcome this mistrust, the remote units in this study used a stabilized mounting method, fixing the ultrasonic sensor's alignment to the water. This reduced the chances for false alarms to help build confidence in the reliability of the system.

Results & Savings Opportunities

The results were tabulated monthly ***(Figure 3)***. The pilot period was four months. Previously, 10 sites would have been cleaned each

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Photograph 2 (top and bottom). Fully stabilized monitors enable high-quality data collection. The units are shown mounted above the invert in each instance. *ADS Environmental Services*

month under the old protocol and totaled 40 cleanings. ***Figure 4*** shows site conditions that do not indicate a need for cleaning. As shown in ***Figure 5*** and ***Figure 6***, two sites required cleaning in the first four months, a 95% reduction in cleanings.

The tabulated data indicates that monthly cleaning frequency could be reduced in all cases. Effectively, these sites were being overcleaned. Two of the sites might need quarterly cleaning driven by remote sight monitoring systems' feedback. Based on this data, changing the monthly schedule (12 times per year) to a quarterly schedule (4 times per year) would be a significant reduction in staff time spent on cleaning.

La Mesa would still maintain their annual full-system cleaning policy but would also realize significant time savings by reducing high-frequency cleaning. In turn, the operations maintenance team would be given back time to address other tasks and be better able to keep up with other maintenance demands.

In sum, this pilot demonstrated that the city's new vision would meet their three objectives:

1. Cleaning frequency and corresponding pressure on the field staff could be reduced.
2. Reduced cleaning of high-risk pipes enabled asset life extension.
3. Full-time site monitoring at these sites assured that SSOs would be mitigated.

Showing the Money

Upon completion of the study, the utility's management saw a clear opportunity to financially justify this new optimized cleaning process. They knew the true cost of cleaning with a comprehensive accounting for all factors, including but not limited to:

- Amortized cost of the truck.
- Annual insurance cost.
- Parts and labor for truck maintenance.
- Fuel usage.
- Burdened field labor costs.

Fully accounted, the cost per segment cleaned was $400. This meant that with every segment not cleaned there was a corresponding $400 savings. During the first four months, cleaning would have cost $16,000 ($400 times 40 sites). Instead, using the optimized cleaning process they cleaned twice, costing them $800 ($400 times two sites). This was a savings of $15,200.

They also knew that this savings would not simply be in the form of cash. It was a productivity savings. As stated previously, the city's personnel could not sustain their pace. If they were not to fall behind, they would have to add staff. Alternatively, they could opt to clean less and accept an increased risk of SSOs. The latter would not be acceptable because with that risk came the potential for substantial penalties. Fortunately, optimized cleaning brought a new alternative.

One other important factor to consider is that the rate of cleaning reductions throughout the course of one year would not be 95% but is anticipated to be something less. With 100 high-frequency sites we can assume that some of these would need to be cleaned multiple times but at a reduced frequency from the previous routine. With that in mind and using a very conservative estimate of a 50% total reduction across all sites, the cost of implementation could still be justified. For example, if there was a 50% reduction across the 100 high-frequency sites being cleaned 12 times annually, the result would be a total reduction of 600 cleanings. At $400 per cleaning, $240,000 in savings could be achieved. With this savings, the acquisition of the new-generation level monitors would have a payback of less than one year.

Getting Beyond Broke and Fixing It

Cleaning is an important and necessary requirement for operations and maintenance toward the end of lowering SSOs; it should not be eliminated. Yet, like we saw with the heater story, just because something works doesn't make it a "best practice." It may not look "broke," but it may not be the "best" either.

One of the essential tenants of all work practices is to seek continuous improvement, both in work processes and with ourselves. Much has changed in the past two-plus decades. Technology, once expensive and often highly complex, is now inexpensive and easy-to-use. It is this significant change that enables a new approach to cleaning.

To be clear, this study does not suggest that cleaning is no longer necessary. Instead, it suggests that the mechanism to determine cleaning frequency can, and should, change. Remote site monitors can more effectively determine the necessity to clean. It right-sizes frequency, telling you when to clean. With this change, we can realize some major benefits:

1. Reduction of time-pressure on operations to clean, with corresponding monetary savings.
2. Reduced pipe wear by lowering mechanical stress on high-risk pipes and thus extending the asset's life.

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Site Location	Jul-18		Aug-18		Sep-18		Oct-18		Nov-18		Dec-18	
	Clean?	*Type*	*Clean?*	*Type*	*Clean?*	*Type*	*Clean?*	*Type*	*Clean?*	*Type*	*Clean?*	*Type*
70thSt	No		No		No		No		26-Nov		No	
Colorado	No		No		No		No		11/26/2018		No	
EchoDr	No		No		9/17/2018	Grease	No		11/26/2018		No	
HorkinsonAve	No		No		No		No		11/26/2018		No	
JessieAve	No		No		9/11/2018	Grease/Roots	No		11/26/2018		No	
JuliettePl	No		No		No		No		11/26/2018		No	
LakeMurray	No		No		No		No		11/26/2018		No	
NeboDr	No		No		No		No		11/26/2018		No	
PanoramaDr	No		No		No		No		11/26/2018		No	
PineSt	No		No		No		No		11/26/2018		No	

Figure 3. Tabulated cleaning frequency results. Green cells in the chart indicated no cleaning was performed while red cells indicated cleaning did occur. *ADS Environmental Services*

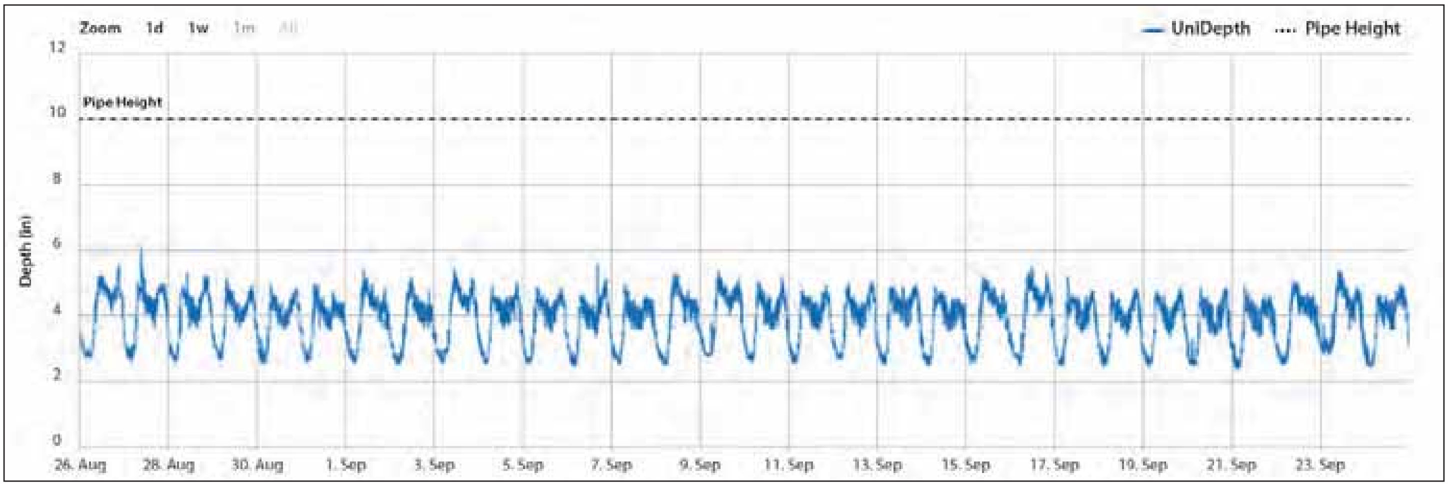

Figure 4. Continuous remote site data provides ongoing visibility. In this instance, a regular diurnal flow is evidenced. *ADS Environmental Services*

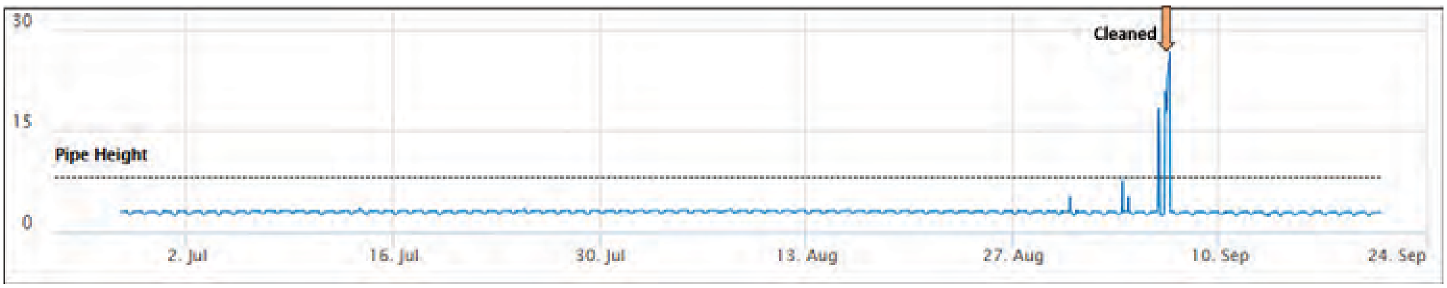

Figure 5. Remote site data at this location, for the period from early July to late September, indicated that cleaning was needed in early September when the depth increased significantly over the baseline measurements. The pipe height is about 8 inches. *ADS Environmental Services*

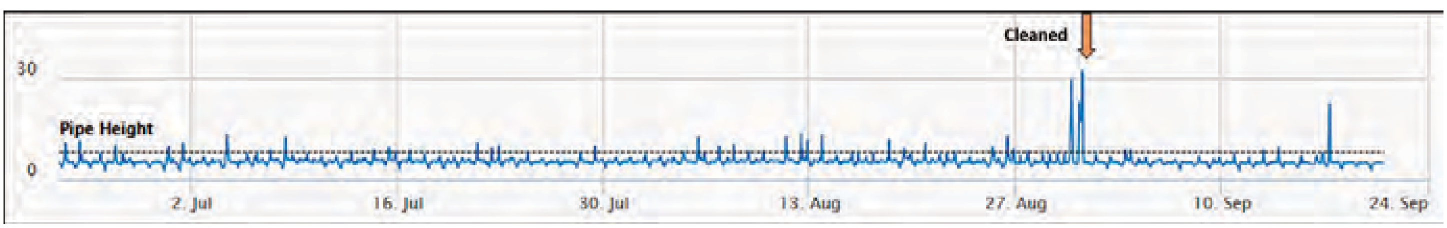

Figure 6. Remote site data at another location, for the period from early July to late September, indicated that cleaning was needed in early September when the depth increased significantly over the baseline measurements. *ADS Environmental Services*

3. Acquisition of continuous remote site monitoring to prevent SSOs where such protection previously was absent.

Reduced cleaning frequency brings some additional benefits. There's less time spent in the streets, reducing worker exposure to traffic while the public benefits from less traffic disruption. Fewer truck trips means lower carbon emissions. Finally, continuously acquired data can be used for better understanding of the collection system's capacity, its response to wet weather, and even contribute to model calibration.

In conclusion, the practice of cleaning to reduce SSOs isn't "broke" but the mechanism to determine frequency may be. Remote site monitoring brings a new opportunity to improve the cleaning process. The real challenge before us is recognize what is "broke" and then get to the task of fixing it.

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Reference

USEPA. 1999. *Collection Systems O&M Fact Sheet Sewer Cleaning and Inspection.* EPA 832-F-99-031. United States Environmental Protection Agency Office of Water. Washington, D.C. September 1999.

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Automating Collection System Data Analyses to Create Planning-Level Rehabilitation Recommendations

by John LaGorga and Tyler Pitts

Background and Introduction

The City of New Rochelle, the Town of Mamaroneck, the Village of Larchmont and the Village of Pelham Manor, herein known as the Consortium, own and maintain approximately 1.1 million linear feet of sanitary sewer encompassing three sewer districts within southeastern Westchester County, New York. As a result of a Consent Order between the New York State Department of Environmental Conservation (NYSDEC) and Westchester County, the Consortium was required to perform a Sanitary Sewer Evaluation Survey (SSES) to identify potential sources of infiltration and inflow (I&I).

Over a nine-month period, from October 2016 through August 2017, the Consortium performed sanitary sewer investigations consisting of pipe inspection with closed-circuit television (CCTV), manhole inspections, smoke testing and dye testing. The SSES data were analyzed and used to develop planning-level rehabilitation recommendations for a report due to the NYSDEC by May 2017. Approximately 1.1 million linear feet of CCTV sewer pipe inspection video and 7,000 manhole reports needed to be analyzed in a few months to meet the project's submission dates. As a result of this aggressive schedule, traditional methods of reviewing CCTV videos and reports and performing an alternatives analysis were not practical; as such, an automated analysis method was developed. Additionally, the inspection results were incorporated into the Consortium's existing Geographic Information System (GIS) databases.

In this article, the inspection and data analysis methodologies will be presented, along with the results of the planning-level sewer rehabilitation analysis. This automated SSES approach was used to quickly and efficiently develop planning-level sewer rehabilitation recommendations in a time frame that would meet the Consortium's and regulatory agency's requirements.

Data Collection

Sewer Pipe Inspection (CCTV)

Sewer pipe CCTV inspection data were collected using the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) procedures for sanitary sewer television inspection. Approximately 1.1 million linear feet of gravity sewer pipe (approximately 4,400 pipe sections) in the three sewer districts were inspected. Data for non-gravity pipe such as force mains were not collected.

During the inspections of sewer pipes, multiple measurements and observations were documented. Included in the data collection effort were pipe material, pipe diameter, infiltration type, defect type, severity, and locations of infiltration and defects. The observed defects included both infiltration defects (active leaks such as infiltration gushers) and structural defects (holes, cracks, fractures) of varying magnitude. Defects found in this inspection included, but were not limited to:

- Collapsed pipe.
- Broken or open hole in pipe.
- Cracks and fractures.
- Deformed pipe.

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- Mineral or grease deposits.
- Offset joints.
- Sags in pipes.
- Root penetrations.
- Break-in laterals.
- General infiltration associated with defects.

Additional data were collected during the inspection and stored in the PACP database as metadata. The inspection metadata included, but was not limited to:

- Time.
- Date.
- Weather.
- Location.
- Direction of survey.
- Upstream manhole.
- Downstream manhole.
- Pipe section reference number.

The metadata, specifically the pipe section reference number, allowed for the observations made during the inspection to be matched to the corresponding upstream and downstream manholes. ***Figure 1*** depicts an example sewer pipe inspection report that presents the data contained in the PACP databases. These reports were generated automatically using the PACP databases, similar to the analysis described in more detail in the Alternatives Analysis section of this article. Note that the type of defect and location are automatically populated on the report graphic.

Manhole Inspection

Similar to the sewer pipe inspections, manhole inspection data were collected using NASSCO standards Manhole Assessment and

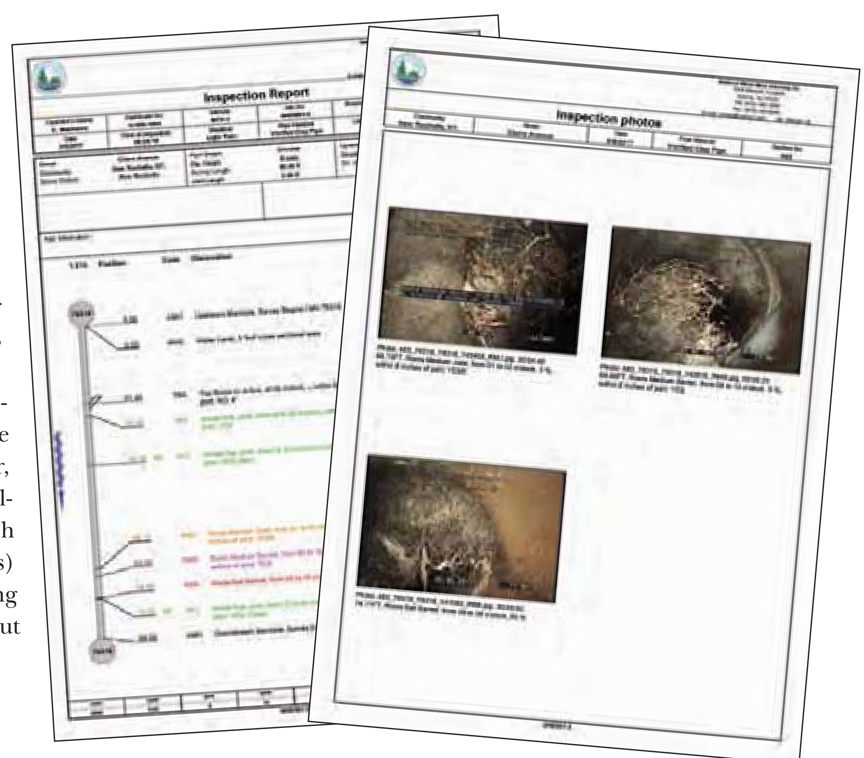

Figure 1. Example of a Sewer Pipe Inspection Report.
National Water Main Cleaning Company

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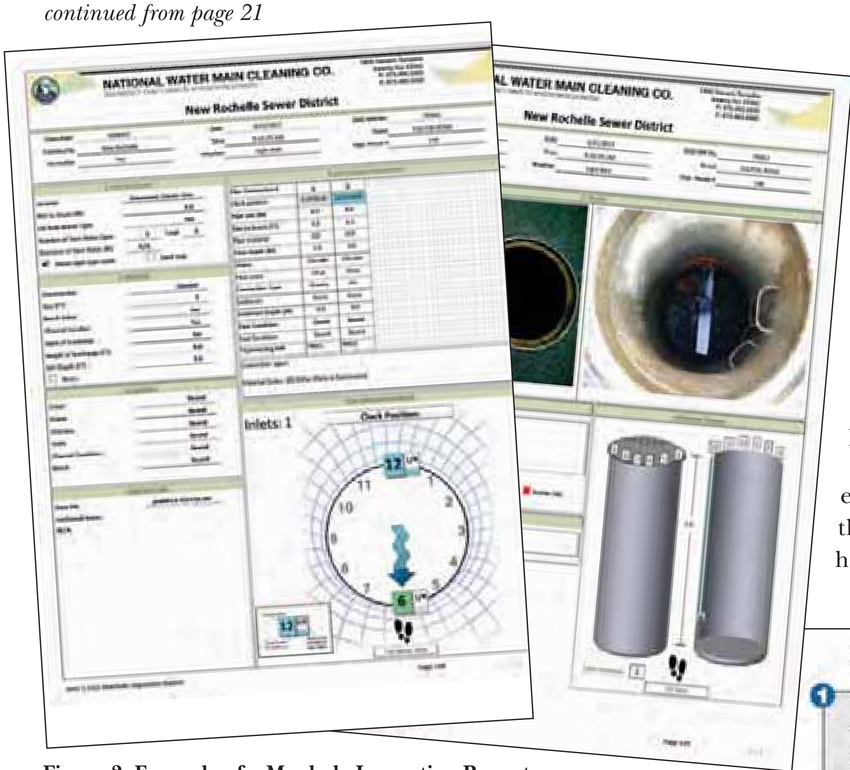

Figure 2. Example of a Manhole Inspection Report.
National Water Main Cleaning Company

Certification Program (MACP). Data collected during these inspections included condition data and metadata such as the following:

- Structural conditions for frame and cover, chimney, walls, and bench and channel.
- Location of infiltration defects.
- Incoming and outgoing pipes.
- Diameter.
- Material.
- Depth.
- Latitude and longitude.
- Manhole number.

Like the Sewer Pipe Inspection Report, the manhole inspection data were also automatically retrieved from the MACP database to create Manhole Inspection Reports ***(Figure 2)***. Note the automatically produced graphic on the lower right corner of the report that shows defect type and location.

Alternatives Analysis for Sewer Pipe Rehabilitation

Analysis Introduction

An automated alternatives analysis approach was used to generate planning-level sewer rehabilitation recommendations for this project. This analysis relied on the "codified" PACP database compiled following collection by each CCTV truck and manhole inspection unit. Such databases are typically Microsoft Access databases and are critical because they have a standard, consistent layout that lends itself to simple automation. This analysis approach aimed to generate preliminary rehabilitation recommendations based on the observed pipe conditions and Consortium-selected criteria. The Alternatives Analysis approach is depicted in ***Figure 3***.

This process is repeated for every pipe section within the PACP inspection databases.

Analysis Methodology

For this analysis, each defect was assigned a rehabilitation method. ***Table 1*** shows the rehabilitation method assigned to each type of observed defect within a pipe section. For example, a crack longitudinal was assigned the rehabilitation method of a cured in place pipe (CIPP) spot liner (i.e., 10-foot spot liner). Some defects, such as broken pipe, could be rehabilitated using different rehabilitation methods depending on severity. For these types of defects, the highest cost rehabilitation method applicable was selected. In the case of a broken pipe, for example, the rehabilitation method chosen was an open-cut point repair. This approach was taken so the final cost estimate would be conservatively high for planning purposes. Rehabilitation methods were based on industry standards and tailored to the Consortium's preferences for sewer rehabilitation.

As part of the analysis setup, the rehabilitation method for each type of defect was stored in a separate Excel file, allowing the rehabilitation method to be changed periodically without having to change the actual analysis code.

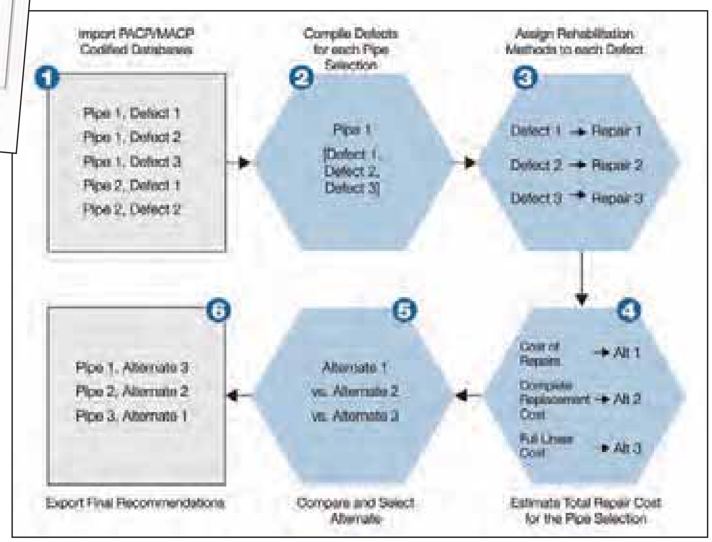

Figure 3. Flow chart outlining the major steps within the Alternatives Analysis.
GHD Consulting Services Inc.

Table 1. Associated Rehabilitation Methods for Each PACP Defect.

Defect	Defect PACP Code	Associated Rehabilitation Method
Deformed	D, DH, DV	Open-cut point repair
Joint Offset	JOL, JOM	Open-cut point repair
Cracks	CC, CL, CM, CS	CIPP spot liner
Fractures	FC, FH2, FL, FM, FS	CIPP spot liner
Joint Separated	JSL, JSM	CIPP spot liner
Tap Break-in	TBB, TBC	Lateral liner (top hat)
Deposits Attached	DAE, DAZ, DNZ, DAGS, DSC, DSZ	Joint grouting
Infiltration	ID, IS, IW, IG, IR	Joint grouting
Root Balls	RBB, RBC, RBJ, RBL	Joint grouting
Broken	B, BSV, BVV	Open-cut point repair
Hole	H, HSV, HVV	Open-cut point repair
Collapsed Pipe Sewer	XP	Open-cut point repair
Abandoned Survey	MSA	Sag or other – potential open-cut
Water Level Sag	MWLS	Sag or other – potential open-cut

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Table 2 presents probable costs for different rehabilitation methods based on pipe diameter. For certain methods, such as open-cut point repair, approximate depth was also factored into the probable rehabilitation cost. The probable rehabilitation costs were estimated based on a variety of past local bid prices and did not include legal, fiscal, engineering and project contingencies. Similar to the rehabilitation method by defect, the probable cost information was stored in a separate Excel file, allowing the cost data to be changed periodically without having to change the actual analysis code.

The alternatives analysis was developed to specify one of the following rehabilitation/replacement options for each pipe segment:

1. Full pipe replacement.
2. A full-length pipe liner, manhole to manhole. This option includes grouting active laterals and lateral lining break-in and intruding taps.
3. A combination of open-cut point repair(s) with a full-length pipe liner. For example, a pipe may have a short, collapsed section that cannot be lined, but the remainder of the pipe defects can be addressed by a full-length pipe liner. This option can also include grouting active laterals and lateral lining all break-in and intruding taps.
4. One or more open-cut point repair(s) and/or trenchless spot repairs to rehabilitate the entire pipe. This option can include open-cut point repairs, spot liners, joint grouting and lateral lining all break-in and intruding taps.
5. No rehabilitation necessary.

The recommended rehabilitation/replacement option was selected by comparing the estimated construction costs for each option as described below.

- A full-length pipe liner was recommended when the total cost for completing the trenchless spot repair(s) exceeded 33% of the cost for a full-length pipe liner. This criterion emphasizes lifecycle cost considerations; even though the full-length liner has a higher cost today, it has a much longer life expectancy and therefore a lower lifecycle cost.
- Certain defects, such as a collapsed pipe, can only be repaired using an open-cut point repair. However, if the cost of the trenchless spot repairs of the remaining defects exceeded 33% of the cost of the full-length pipe liner, the full-length pipe liner was recommended.
- If the cost of full replacement of the pipe was less than twice the cost of the next highest alternative, full replacement would be selected. This reflects a lower lifecycle cost of a new pipe section.

Once a rehabilitation option was selected or recommended, additional spot repairs were assessed as follows:

1. If the pipe rehabilitation recommendation called for a full-length liner, all active laterals in that section would receive lateral grouting. Active laterals in a pipe not receiving a full-length liner would not receive lateral grouting.
2. Every intruding tap and break-in tap required a top hat liner.
3. A pipe with one or more infiltration defects would receive joint grouting at every joint in the pipe section unless it was receiving a full-length liner or being completely replaced.

Because of the automated nature of this analysis, design criterion could be changed "on the fly," with collection system-wide recommendations being developed within minutes. Methodologies for selecting different rehabilitation approaches, costs, and repair method weights could all quickly be changed at the front end of the analysis, allowing for sets of recommendations to be developed over the course of minutes.

Planning-Level Recommendations and Design

Rehabilitation Analysis Results

The rehabilitation analysis was run for approximately 1.1 million linear feet of sanitary sewers throughout several delineated sewer basins within each Consortium community. This analysis identified approximately $53 million worth of pipe and manhole rehabilitation work throughout the sewer basins. Using the GIS geodatabase and output from the rehabilitation analysis, the rehabilitation work was distributed and organized by sewer basin. This laid the foundation for completing the sewer rehabilitation work using a comprehensive sewer basin approach, where both major and minor defects throughout an entire sewer basin are rehabilitated, minimizing the potential for I&I to migrate to minor defects that otherwise may not have been rehabilitated.

During the SSES inspections, pipe sections with severe defects (i.e., collapsed pipe) were automatically reported to the engineer

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Table 2. Probable Wastewater Pipe Rehabilitation Unit Cost Estimate (ENR = 10,700).

Rehabilitation Task Description	Unit	Probable Costs per Pipe Diameter (Dollars) 6	8	10	12	15	18
CIPP short liner-point repair	Each	3,000	3,450	3,900	4,500	5,700	6,000
Joint grouting	Each	25	27	29	31	37	39
Lateral liner (top hat)	Each	3,000	3,000	3,000	3,000	3,000	3,000
Lateral grouting	Each	600	600	600	600	700	700
CIPP full-length liner	Feet	50	50	53	71	94	118
Open-cut point repair (0'-6' depth)	Each	8,000	9,000	9,000	12,000	15,000	16,000
Open-cut point repair (6'-12' depth)	Each	14,400	16,200	16,200	21,600	27,000	29,000
Open-cut point repair (12'-16' depth)	Each	17,600	19,800	19,800	26,400	33,000	36,000
Open-cut point repair (+16' depth)	Each	20,800	23,400	23,400	31,200	39,000	42,000
Full-length replacement (0'-6' depth)	Feet	250	250	250	280	300	320
Full-length replacement (6'-12' depth)	Feet	313	313	313	350	375	395
Full-length replacement (12'-16' depth)	Feet	375	375	375	420	450	475
Full-length replacement (+16' depth)	Feet	475	475	475	532	570	590

Notes:
- Open-cut point repair cost is based on 15-foot length..
- Open-cut replacement cost based on complete pipe replacement (approximately 200 feet)
- Open-cut replacement and open-cut point repair costs based on non-NYSDOT roads.
- Trench replacement only; no milling and pavement of road.

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and Consortium. These pipe sections were reviewed in detail so that design of emergency repairs could be completed immediately. Otherwise, a relatively small percentage of inspection videos and reports were reviewed to develop the planning-level recommendations. Developing the planning-level recommendations was largely completed through the automated process depicted in ***Figure 3***.

Flow Monitoring and Basin Ranking

As part of the SSES efforts, flow monitoring of each delineated sewer basin was performed. The flow monitoring data were used in conjunction with the planning-level rehabilitation recommendations to identify sewer basins that provided the lowest dollar per estimated I&I removal rate. These rates were developed for each sewer basin by dividing the comprehensive planning-level rehabilitation probable cost by the estimated I&I that could be removed by using said comprehensive rehabilitation approaches. By using this method, the first phase of rehabilitation work could be focused on the sewer basins with the most cost-effective I&I removal rate.

Design Effort

Using the planning-level rehabilitation recommendations and after identifying basins with the most cost-effective I&I removal rate, approximately $7.3 million of work was selected for the first phase of rehabilitation and design effort. This work would be done on a sewer-basin level, meaning that each selected sewer basin would be addressed using a comprehensive approach. Using such an approach, the maximum potential I&I removal rate could be achieved.

After rehabilitation work was identified using the analysis result, each pipe section and manhole was reviewed in detail to develop the final design recommendations. This effort included review of CCTV video and manhole inspection reports. During the review, external factors not considered during the planning-level recommendation analysis, such as location and volume of traffic, were now taken into account. This review process ultimately led to the development of final design recommendations on a basin-by-basin basis.

The final design recommendations were developed into two sets of contract documents, one for open-cut and one for trenchless rehabilitation, which were advertised for bidding. The lowest quantified bids for both contracts totaled approximately $7.2 million, less than 2% different from the results of the automated planning-level recommendation analysis.

GIS Integration

In conjunction with the development of final design recommendations, the sewer assets with condition information were mapped using the provided GIS geodatabases for each of the communities. These GIS geodatabases were furthered developed by using GIS tools to map the location of each observed defect along each pipe section, as well as to link the inspection reports and videos to each asset. The final geodatabases were provided to the Consortium along with an external hard drive containing each municipality's inspection data. ***Figure 4*** depicts a portion of a GIS map showing some sections of pipe and the location of defects along the length of each pipe.

Conclusion

By using the codified databases and automated data analyses discussed in this article, $53 million worth of planning-level rehabilitation recommendations were quickly and efficiently developed based on Consortium-set criteria. The planning-level results were further used to recommend approximately $7.3 million worth of sewer rehabilitation work, allowing for the design effort to be focused on sewer basins with the highest I&I removal per dollar spent. Using this approach, the planning-level recommendations were developed into bidding documents and construction rehabilitation work valued at $7.2 million.

Acknowledgements

Special thanks to Charles Strome III, James Moran and Alexander Oliveira from the City of New Rochelle; Stephen Altieri and Robert Wasp, Town of Mamaroneck; Justin Datino and Rick Vetere, Village of Larchmont; and John Pierpont, Village of Pelham Manor.

Figure 4. GIS map displaying observed CCTV condition points mapped along sanitary sewer pipe sections.

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A Public Solution to Private Property Infiltration and Inflow

by Beth Pfalzer and Angela M. Horton

Wipes, grease, low lying vents draining yards, improper sump pump and downspout connections. What do all of these have in common? They are all items from private properties that may cause or contribute to sanitary sewer overflows (SSOs) and basement backups. Public sewer systems exist to service private properties, yet system operators everywhere struggle to mitigate the adverse impacts private properties have on their infrastructure.

Many sewer utilities have developed public education programs identifying the problems associated with nonflushable and flushable-labeled products such as wipes, or to address fats, oils and grease (FOG) discharges. Wipes and FOG are introduced into the system by an action of the resident and there is a specific behavior that can be easily changed to address it. But tackling private property infiltration and inflow (I&I) sources such as low-lying vents, sump pumps or downspouts discharging to the sanitary sewer system (***Figure 1)*** present a different type of challenge.

The Erie County Department of Environment and Planning, Division of Sewerage Management (DSM) has a multipronged approach to address the challenges associated with private property I&I, including education, a developer lateral replacement program and a private property inspection program. Of these three methods, the DSM's private property inspection program has been the most impactful.

Inspection Program Organization and Authority

The DSM has a robust I&I identification program. While the major component of the DSM's program consists of traditional sanitary sewer evaluation survey (SSES) methods such as flow monitoring, smoke testing, dye testing, manhole inspections, and other activities within the public sewer system, a key component of the program also includes inspections on private property. As part of the DSM's I&I program, private property interior and exterior inspections are completed to identify problems such as improper connections and deficiencies.

The DSM is comprised of seven sewer districts, each with its own Board of Managers. Each of the seven sewer districts is split into smaller evaluation areas called mini-systems (MS). An MS in an Erie County Sewer District (ECSD) typically consists of a sewered area in which all flows are conveyed through a single point, allowing for assessment of the magnitude of I&I in the upstream system. In the various sewer districts, an MS is chosen for evaluation based on flow monitoring results showing high wet-weather peaks, areas with a concentration of private property owner complaints, operational history at pumping stations with high wet-well alarms, and/or those areas with other wet weather issues or concerns.

The ECSDs operate under the *Rules and Regulations for Erie County Sewer Districts (Rules and Regulations),* which were first adopted by the Erie County Legislature in December 1971. The Rules and Regulations serve as the ECSD "sewer use ordinance" and include key provisions that allow the DSM to inspect properties that are served by the sanitary sewer, issue notices of violations, hold enforcement hearings and issue penalties (i.e., premium assessments or fines).

The DSM performs on average approximately 2,700 private property inspections per year. Property information is retrieved from Erie County's real property database using a geographic information system (GIS) map, and a list of addresses for all parcels in an MS is generated. The DSM does not pick and choose which properties to inspect, but rather takes an areawide approach.

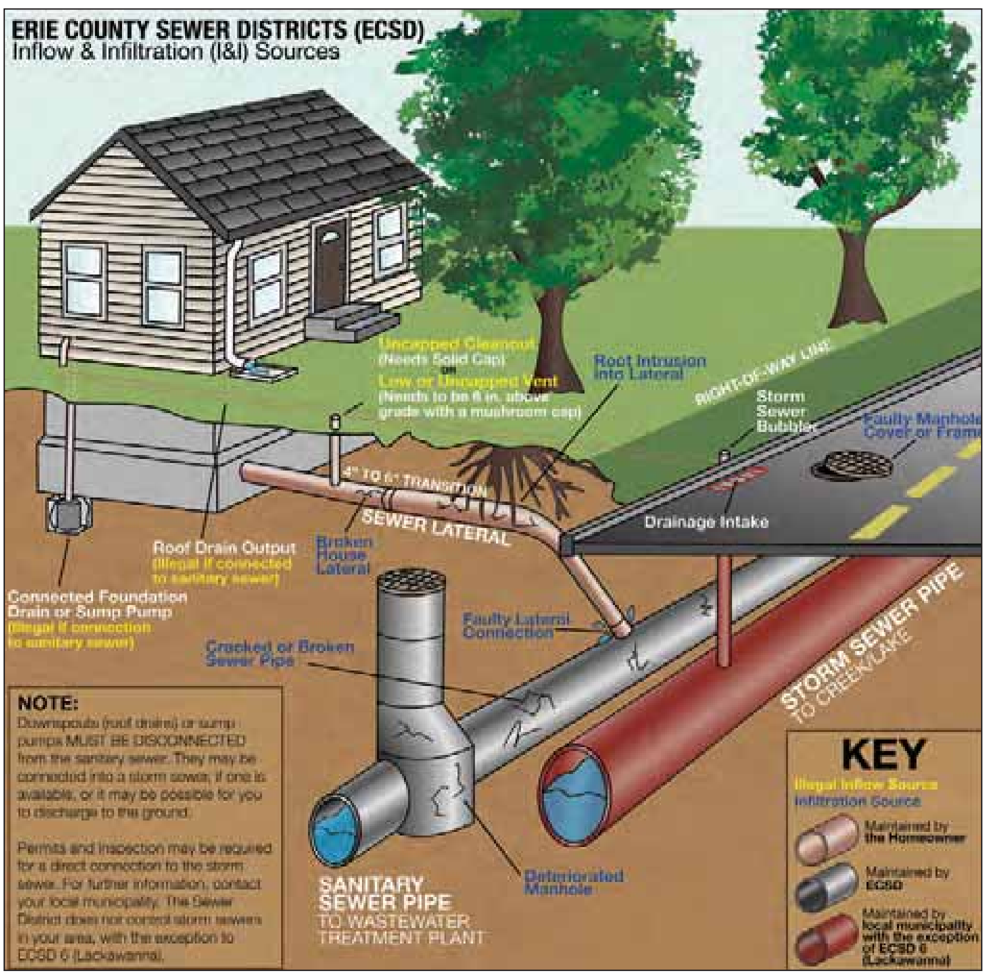

Figure 1. Examples of the I&I sources associated with a private residential property.

Angela M. Horton and Jacqueline Vujec

How the Program Works

Using the address list generated from the county's real property database and GIS, letters are sent to property owners requesting that they schedule an inspection. The letters include information regarding why the inspection is being conducted, educating the recipient what I&I sources are, what the inspection will entail, and cite the authority in which the ECSDs must complete the inspection pursuant to the Rules and Regulations. These letters further advise property owners that failure to allow staff to inspect the property is a violation of the Rules and Regulations

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and if noncompliant could be referred to an enforcement hearing and subject to a premium assessment or fine.

On-Site Inspections

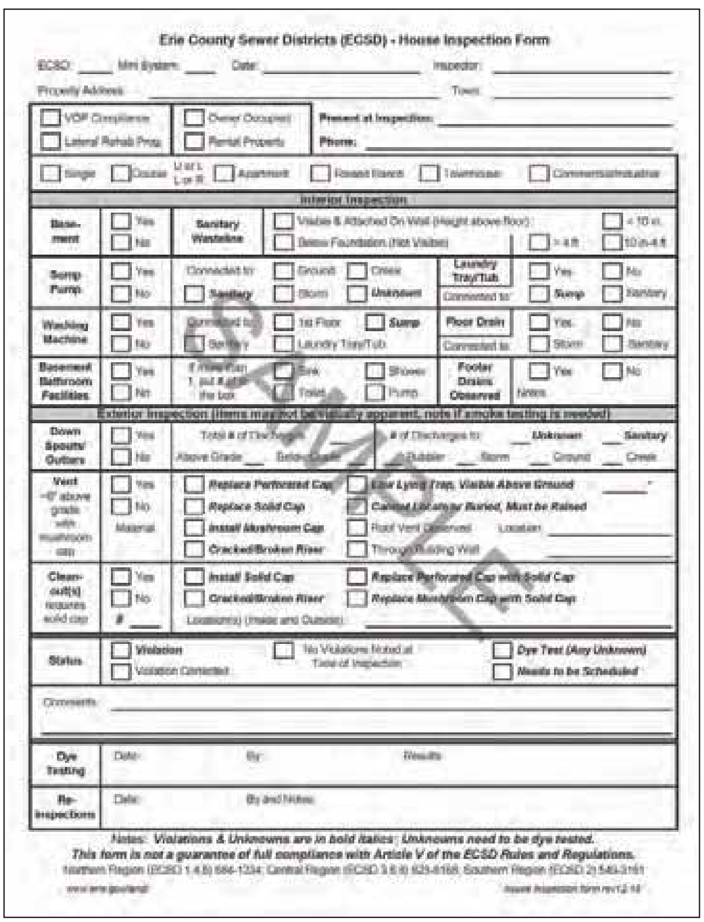
After residents contact the ECSD offices in response to the inspection request, a specific appointment time is set and an ECSD employee will meet the resident at their property. The ECSD employee is to arrive on time, in a county vehicle and uniform, and is to present their county identification card. As noted in the inspection request letter, only the below-grade areas of the structure and the exterior of the home will be observed during the visit. The interior portion of the inspection can include:

- The location of where the plumbing exits the home, above or below the basement floor.
- Sump pump discharges, which may need to be dye tested to properly confirm.
- Footing drain discharges, if observed.
- Floor drain discharges.
- Any below-grade plumbing connections such as basement bathrooms.

The exterior portion of the inspection includes:

- Noting low-lying vent risers.
- Finding improper caps or open riser pipes for the vent or clean out.
- Identifying roof downspout discharges, which may need to be dye tested to properly confirm.

The ECSD inspector uses a standard form ***(Figure 2)*** that details the items to be viewed to foster consistency in the actual inspection and for the proper population of inspection databases.



Erie County Sewer Districts (ECSD) - House Inspection Form

ECSD: ____ Mini System: ____ Date: ____ Inspector: ____

Property Address: ____ Town: ____

Present at Inspection: ____

Phone: ____

Interior Inspection

Exterior Inspection (items may not be visually apparent, note if smoke testing is needed)

Status: Violation; Violation Corrected; No Violations Noted at Time of Inspection; Dye Test (Any Unknown); Needs to be Scheduled

Comments: ____

Dye Testing: Date: By: Results:

Re-Inspections: Date: By and Notes:

Notes: Violations & Unknowns are in bold italics; Unknowns need to be dye tested.

This form is not a guarantee of full compliance with Article V of the ECSD Rules and Regulations.

Figure 2. An example of an ECSD house inspection form. *Angela M. Horton*

Violations

The primary violations identified, such as sump pump connections to the private lateral, roof leaders connected to the sanitary sewer system, and low-lying vents or improper vent or cleanout caps, require relatively low-cost corrections to bring the property into compliance. The ECSDs have not focused their private property program on lateral deficiencies or footer drains, as the fixes to address those potential I&I sources would cost property owners thousands of dollars.

Proper caps for the vent and cleanout reduce the potential for I&I. *Angela M. Horton*

Sump pump and downspout connections below grade may be connected to the sanitary sewer system and should be dye tested to verify where they discharge, as improper connections can expose the property owner to the risk of sewage backup into the home. *Angela M. Horton*

From year to year, the number of violations identified and corrected will vary. In some areas, the age of the housing stock is such that numerous violations will be identified because the structures were constructed before modern plumbing standards were instituted. In other areas, it will be sporadic violations scattered throughout the MS. In 2018, approximately 450 violations were identified and subsequently fixed through the private property inspection program.

If a violation is noted during the inspection or through follow-up

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dye testing, the property owner is sent a notice formally identifying the violation and stating that the owner has 90 days to correct. Once a violation is corrected, another inspection is scheduled to confirm that the cited issue has been addressed. If the violation is not corrected within this timeframe, up to three more reminder letters are sent in 30-day increments. As a last resort, should the violation remain after these repeated attempts, the property owner will be referred to that district's Board of Managers with the recommendation to schedule an enforcement hearing.

Enforcement Hearings

Approximately every year and a half the DSM holds an enforcement hearing for noncompliant properties. A letter is sent advising the property owner they have been referred to the hearing, the items that will be considered during the hearing, the authority in which the hearing is being held, and that if they are found compliant before that date, the hearing will be canceled. By the time a hearing is held, there has been significant outreach by the ECSDs besides the letters, including personally visiting homes and knocking on doors to communicate the need to address the noncompliance. Fortunately, most property owners comply with the program and only a handful of individuals require this step in the process.

During the hearing, the DSM will present information to the hearing officer and the resident may do the same. The hearing officer will issue his or her findings, which are subsequently submitted to each of the ECSD Boards. The ECSD Boards have the authority to levy premium assessments or fines in response to violations of the Rules and Regulations. In limited instances the ECSD Boards have exercised that authority when presented with a private property inspection program violation. The property owners are then given 30 days to comply, after which they will begin accruing premium assessments. While violators may be subject to a premium assessment or fine, the goal is compliance and penalties are a last resort.

Lessons Learned

The private property inspection program is by no means a perfect process. The DSM started the program in ECSD No. 6 (City of Lackawanna) in the 1980s and has over time learned a great deal to improve the program's management and procedures.

Property Access

One of the largest challenges is that some property owners are resistant to having the government enter their private property. There have been instances where residents have sent complaint letters to elected officials stating that they refuse to allow an inspection for various reasons. The DSM's private property inspection program was the topic of discussion during a local talk radio show a few years ago, with people questioning if it violates their constitutional rights.

Throughout the years, a greater level of effort has been spent on educating property owners regarding the purpose of the program, the limited nature of the inspections, and the benefits of compliance. Oftentimes residents are reassured when it is explained that the ECSDs are like a utility such as their gas, electric or phone/internet service provider that may need to enter properties on a limited basis. It is also important that county employees who interact with property owners demonstrate a level of professionalism by being polite, presenting proper county identification and wearing appropriate attire. For those situations where residents simply refuse to allow an inspection, sometimes the most effective method is for an ECSD supervisor to meet face to face with the person, which oftentimes assuages concerns or mitigates the situation.

Program Management

Management of the program has also improved throughout time. Inaccurate recordkeeping, inconsistent data, staff not following up on items such as dye testing, and the like, have all been issues encountered over the years. The DSM has implemented standardized forms, analyzes information in GIS, and overall is providing better oversight and review of the data to address these problems. The DSM is investigating mobile technologies to further the efficiency and effectiveness of the data management.

Public Education

Recently, ECSD inspectors have begun noting when homes have below-grade facilities such as floor drains, basement toilets, sinks and showers tied into the sanitary sewer system. The DSM now sends letters to property owners informing them that, although these facilities are not a violation of the Rules and Regulations, there are nonetheless risks associated with having these types of below-grade connections that are not otherwise protected. Many property owners are unaware that these facilities provide a pathway for a basement backup. This has become a good public education opportunity regarding the risks.

End Goal

The DSM believes addressing private property I&I is a critical part of managing the ECSDs. Significant effort is put into this program to decrease wet-weather flows, alleviate operational problems and mitigate customer complaints. Many property owners are unaware of I&I sources connected to their sanitary facilities. They do not understand how this I&I can contribute to backups and SSOs, as well as generally impact the ability of the sewer service provider to continue its job of protecting public health and the environment.

Educating the public takes proactive measures on our part and is our best defense in remediating I&I sources. It is important to teach members of the public that their choices, such as not flushing wipes down the toilet or not putting grease down the drain, make a difference. Raising their low-lying vent, eliminating the roof downspout connected to their lateral, and other I&I corrections are all measures residents can take to alleviate the overall stress on the sanitary sewer system.

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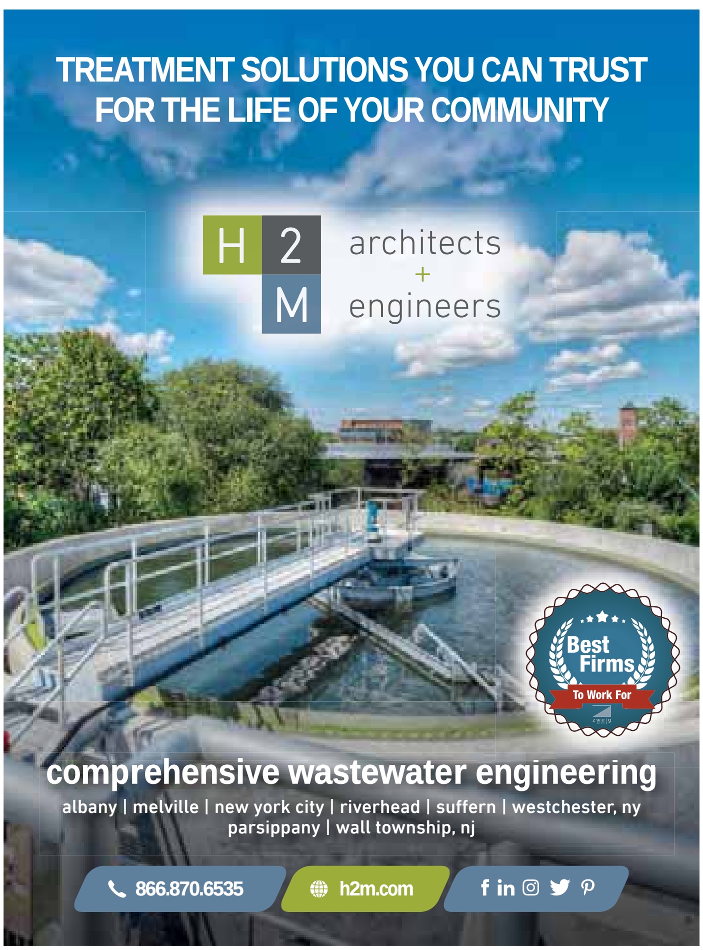
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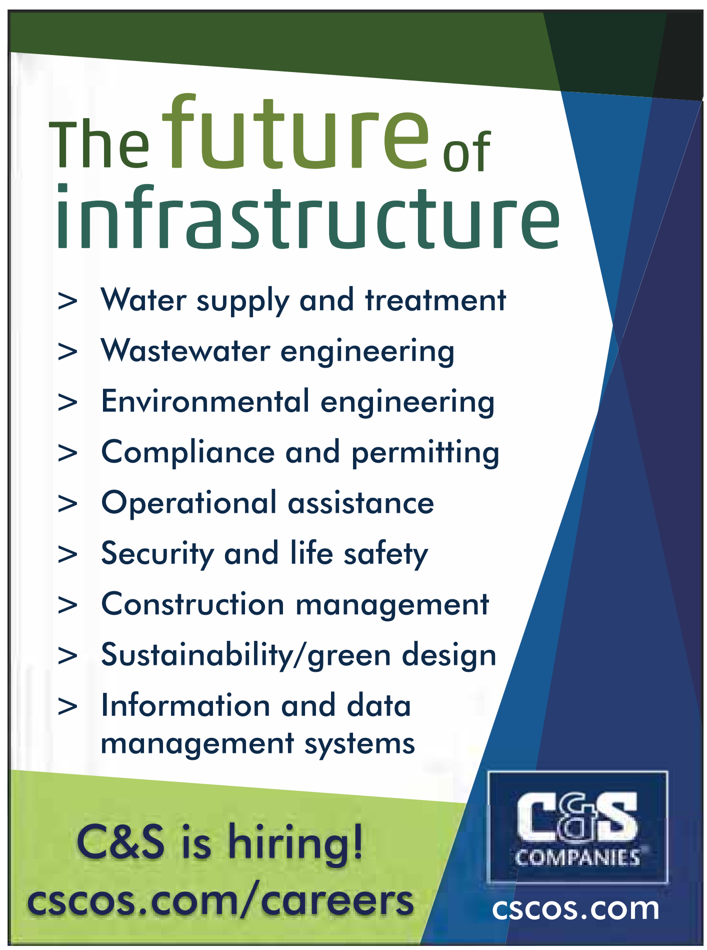
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Wet-Weather Infrastructure: Smart Analysis and TOTEX Planning Equal Savings and Resilience

by Nick Anderson and Melissa Carter

The Narragansett Bay Commission's CSO Abatement Program protects local waterways, such as the Woonasquatucket River, from sewer overflows. *Stantec*

There's a phrase we use in the world of data analytics: today we are data-rich and knowledge-poor. The rise of real-time data has put more information than ever at our fingertips, but without proper analysis and context, this data boom does not deliver much value.

Municipalities can address this challenge in their approaches to water infrastructure design and engineering to make data work smarter and harder and deliver real value. Using advanced hydraulic models, it's possible to translate extensive data into a holistic story of the overall outcomes of a project.

The goal? To increase understanding and confidence, drive efficiency and achieve actual cost savings.

Setting a Plan, and Checking It Twice

Ongoing work on one of the largest combined sewer overflow (CSO) projects in the Northeastern U.S. serves as a prime example of the great potential for advanced data analysis when applied to hydraulic modeling in optimizing project solutions.

Over the past 20 years, the Narragansett Bay Commission (NBC) in Rhode Island, which operates wastewater collection and treatment facilities for 10 member communities, has been leading a three-phase program to address CSO volumes and resulting environmental impacts. Program goals include:

- A reduction of annual CSO volumes by 98% with no more than four overflows per year.
- An 80% decrease in shellfish bed closures.
- A 98% reduction in fecal coliform loading.

The main component in Phase I (under construction from 2001 to 2008) involved the installation of the Providence Tunnel, a 16,284-foot-long rock storage tunnel with an inside diameter of 26 feet, located approximately 270 feet below grade. This phase also involved the addition of a tunnel pump station, drop shafts and a consolidation of conduits. Phase II (under construction from 2011 to 2015) added CSO interceptors to connect additional outfalls to the Providence Tunnel, several sewer-separation projects, and the addition of a wetland storage facility. The plan for Phase III involved a second, deep rock CSO storage tunnel nearly 13,000 feet long and 28 feet in diameter with an estimated capital cost of $815 million.

Before kicking off the third and final phase, NBC selected Stantec to revisit the original Phase III plan to identify possible opportunities to optimize the existing approach and consider new tactics that may further benefit CSO control goals. The first task was to make sure what was proposed more than 20 years ago would still meet the regulatory goals of storing runoff from a three-month storm and controlling to a level of no more than four CSO overflows in a typical year.

However, while the engineering approach proved solid, the original analysis for this project was 20 years out of date from a technological standpoint. Since computing power was limited at the time, teams had no choice but to make broad assumptions about hydraulic modeling. Recent technological advances presented an opportunity to take a deeper dive into the system performance.

By harnessing the power of advanced analytics in conjunction with hydraulic models and total expenditure (TOTEX) planning, which considers capital and operational expenditures, there was a real chance to "sweat the system" to optimize the project. This work was done while ensuring the new approach still met the original CSO control criteria without introducing any additional risk.

The result? A detailed model with smart analytics that have helped establish a road map for solution optimization at an estimated $60 million reduction in capital costs.

Building a Smart Model for Smarter Solutions

Using an adaptive management strategy, as much data as possible was initially collected, in many cases more than what is typical for the early stages of a design project, with the intent of using the power of data for project refinement as the hydraulic model becomes more informed. Very few municipalities have a backlog of data, so getting as much data as early as possible, using continuous metering and flow assessment, created the means to gain confidence in the design at a much earlier stage, with smaller refinements to follow.

By taking a TOTEX approach, the focus shifted to analyzing the overall system-wide CSO control outcome, rather than a single output of a project with set locations and sizes based on a total amount of rainfall to capture or convey. In this vein, it was important to examine standard operating procedures such as the long-term environmental impacts, the costs, the impact on future maintenance and ownership.

This strategy informed the approach for building the hydraulic model, including the mapping of all wastewater infrastructure with the digital terrain model and model confidence supported using long-term rainfall and sewer flow data. Stochastically generated rainfall events were then used to evaluate system performance and overflow exceedance over time, rather than the traditional approach focused on retention of volume for selected rainfall events. Combined, these data helped provide a better understanding of the system to determine flow trends into sewers, available capacity, and general water movement within the system ***(Figure 1)***.

By continuously running the model, collecting NBC's SCADA

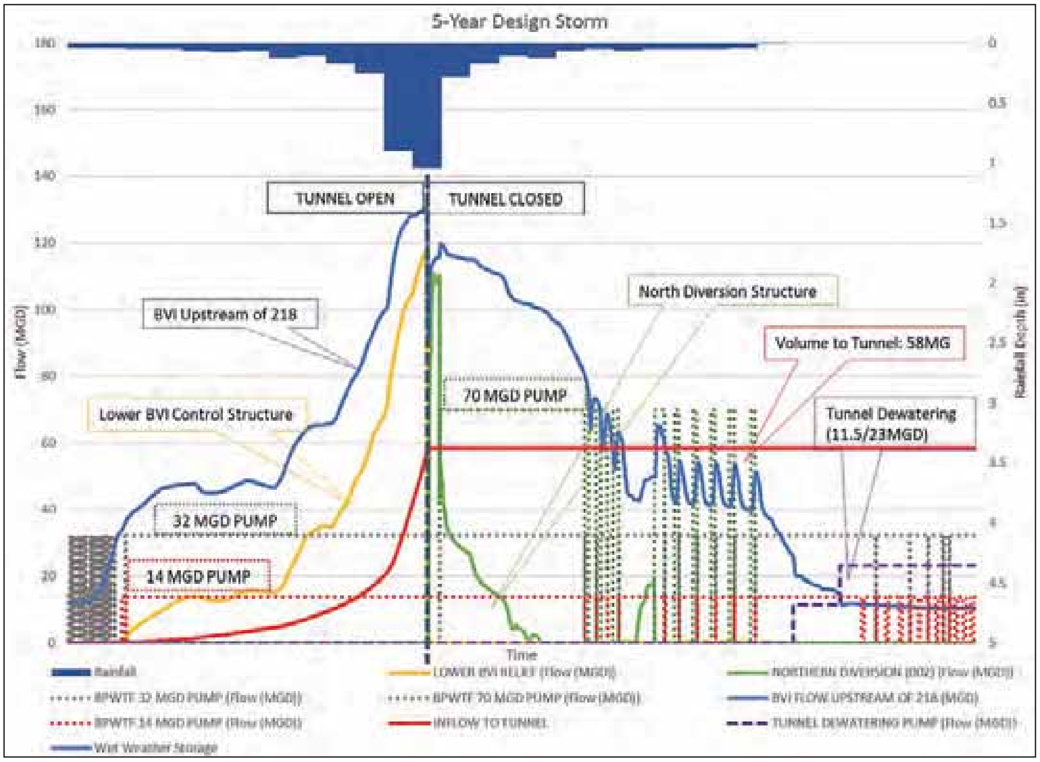

Figure 1. Using a hydraulic model to understand both the magnitude of flows and the timing is critical. Individually, these data points represent simple flow conditions, but collectively they represent a complex matrix of interactions that must be understood and managed to create a successful outcome. *Stantec*

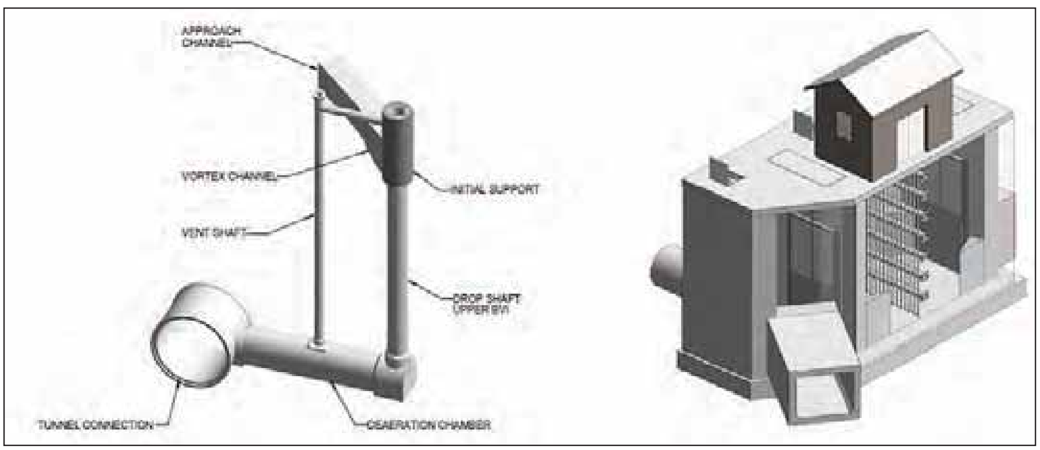

Figure 2. Using flow control structures in conjunction with real-time controls enable the existing system capacity to be maximized before flows are diverted to the tunnel; these structures are the cornerstone of the solution optimization. *Stantec*

data and, in some cases, adding additional flow meters over the course of five years on this project, the model has become increasingly accurate and reliable. This allows the design team to have more confidence in the model as a design tool and rely less on conservative design assumptions. In seeing these data year over year, trends and changes have been identified, ensuring that the designed system will stand up to the rigors of rainfall and system response changes as they occur via real-time control of facilities. This can accommodate adaptation for future impacts as well, such as long-term climate change.

One of the keys to the optimization of the CSO control plan was the opportunity to better use the existing system to manage flows, allowing construction of new facilities to be minimized. The model was used to determine the optimum timing for NBC to open and close gates to fill the tunnel and allow the existing system to maximize storage 'sweated' without exceeding the level of overflow control required.

In the original plan, several new interceptors had been proposed to help direct flows to the tunnel. With the optimization strategy to maximize utilization of the existing system, the focus turned to determining whether aspects of the existing system capacity could be further leveraged through minor upgrades to relieve bottlenecks and get flow to the tunnel more efficiently. In other words, the key was making sure the system was able to push flows into the tunnel more efficiently based on flow depth during wet weather events to create the capacity needed in the existing interceptors; this in turn reduced system backups and overflows in upstream sewers during peak flow conditions. This would then allow flows in the upstream sewers to flow freely throughout the larger storm events, ultimately reducing the need to build new infrastructure to add capacity.

This became the biggest single saving in the optimization strategy ***(Figure 2)***. The reevaluation plan was amended to include this optimized design, which was accepted by the Rhode Island Department of Environmental Management in 2017.

Analytics tools like this enable engineers to make earlier informed decisions to optimize capital solutions. In making the data and model work harder, NBC's CSO control solution has been set up for success against the rigors of future climate change, while ensuring it is being used most effectively and meeting project goals.

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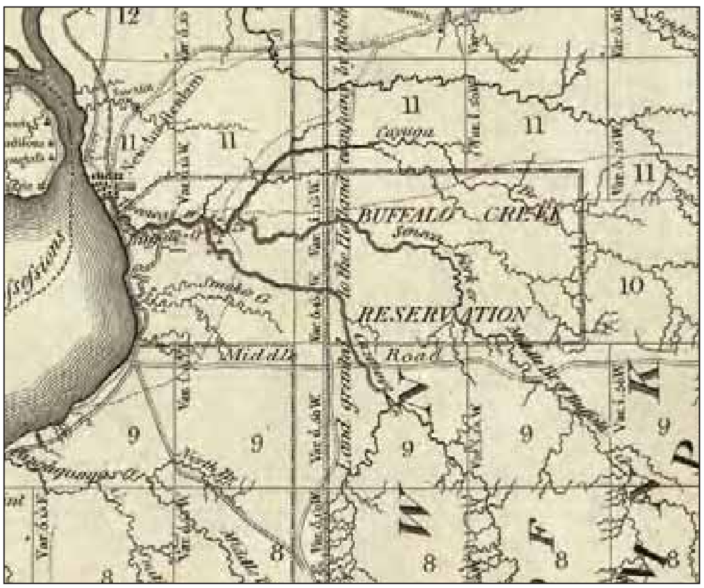
Buffalo's Sewers: The History of the Queen City from Below

by Rosaleen B. Nogle

Buffalo and the Erie Canal

On Oct. 25, 1825, the opening of the Erie Canal linked the Atlantic Ocean to Lake Erie and New York City to the Village of Buffalo, New York *(History Central n.d.)*. This forever changed the destinies of the tiny frontier settlements of Black Rock, Buffalo, Cold Spring and the Buffalo Creek Reservation. Within a few short decades the reservation had been dissolved and the remaining communities were incorporated into the City of Buffalo. What had been sparsely populated, remote frontier communities suddenly became the hub for western expansion and raw material transport from the interior to the coastal cities. As a result, Buffalo experienced a population explosion. Businesses sprang up to serve the needs of pioneers heading west, the sailors working along the canals and Great Lakes, and the infrastructure that transferred the grain, lumber and other goods from the lake ships to the smaller canal pack boats.



Detail view of the "Map of the Morris's Purchase or West Geneseo in the State of New York," by Joseph & B. Ellicott, dated 1804, showing the Buffalo, New York, area. (Cartography Associates 2000)

David Rumsey Historical Map Collection

Unfortunately, much of this early development was haphazard at best. Housing, commerce and industry all co-existed alongside one another. There were no sewers, much less a water resource recovery facility. Rather, early settlers made use of backyard latrines and cesspools. Drinking water was obtained either from the open waterways or from wells. When rain or snow melt runoff struck the early city, sewage from latrines and cesspools was flushed into the drinking water sources, causing waves of cholera and typhoid.

Buffalo's First Sewer Systems

As the city developed from mostly open marshlands to buildings and impervious streets, the need for sewers was recognized, primarily for stormwater control and only incidentally for sewage management. These first sewers were laid by private citizens to protect their own assets. As such, the sewers were installed to simply take flows from local streets into the nearest waterway. At the same time, the canal network was expanded to provide direct water access for industry and power for early mills.

These earliest sewers were generally of poor construction and were purportedly collapsing within a few years of their construction, though in at least one case they survive to this day. By the late 1840s, it had become apparent that if Buffalo was going to continue to expand, the city would need to take public ownership of the sewer system. A series of large sewers were planned to drain the major right of ways, which had suffered from flooding, impassible roads and stagnant standing water *(Steele 1866, p. 1)*. Unfortunately, before these sewers could be constructed another cholera epidemic hit the port city.

The 1849 cholera epidemic was responsible for as many as 877 deaths and 3,555 nonfatal cases. Although these values were the official count, actual counts may have been higher *(Cotter and Patrick 1918, p. 43)*. Seventeen percent of these deaths were confined to just three small neighborhoods, the Hydraulics, the Flats and the French Block *(Cotter and Patrick 1918, p. 48)*. The Hydraulics was a neighborhood surrounded by the fetid Hydraulic and Hamburg canals and the Mill Race to the north of the Buffalo River. The population of the Hydraulics neighborhood worked in the mills driven by the Mill Race and would dispose of refuse in the same stagnant canals that fed the wells that they drew their drinking water from.

Map of The City of Buffalo, Charles Magnus lithograph, New York, circa 1850, (hand colored map on a letter sheet). Modern digital addition denotes the locations of the following: red lines are trunk sewers; yellow lines are side sewers; light blue lines are natural waterways; dark blue lines are completed canals; gray lines are canals under construction.

Charles Magnus (base map)/Rosaleen Nogle (digital addition)

The Flats was a neighborhood on the banks of the Buffalo River where it spilled into Lake Erie. Similar to the Hydraulics, it was surrounded by fetid canals and the heavily polluted Buffalo River and Erie Harbor. Residents of the Flats drew their water from wells under the direct influence of surface waters polluted by sewage and all manner of other refuse.

The French Block was a small neighborhood located half a mile inland from the Erie Canal. But as a locally low spot, it was where stormwater, the sewage from overflowing cesspools, and pollution littering upstream streets would collect after storms *(Cotter and Patrick 1918, p. 48)*. This in turn would leach into the drinking water wells.

While it was several decades before germ theory would be accepted as the cause of the high prevalence of cholera in these particular neighborhoods, the prevailing miasma theory provided an impetus to embark on public sewer building projects that had been rejected in 1848 due to the expense *(Steele 1866, p. 11)*. The new municipal

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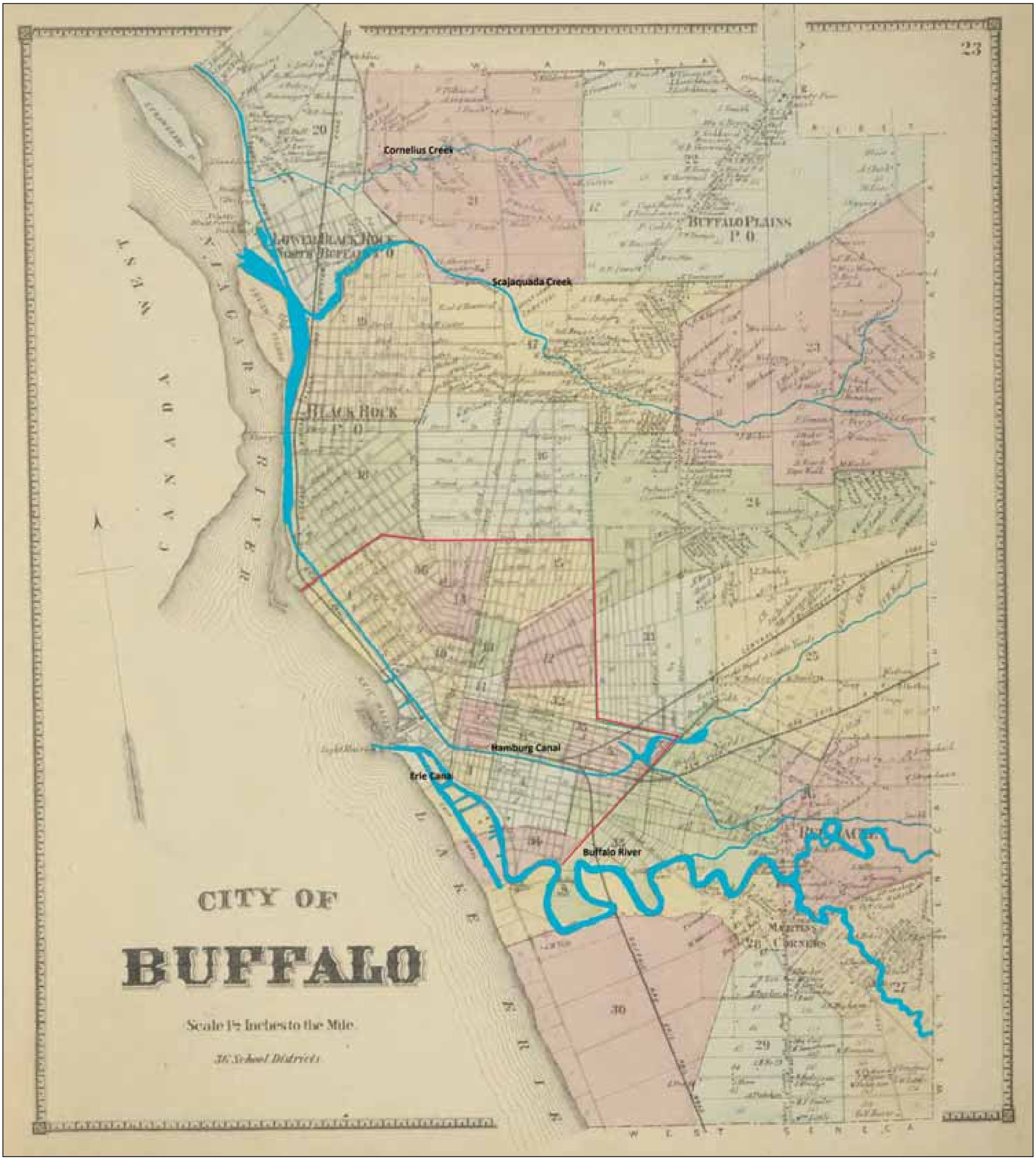
sewer system was built using state of the art technologies to provide wastewater disposal to the entire fledgling city. This in turn meant that by the time of the Civil War, "outhouses … which become so great a nuisance as population becomes dense, have nearly disappeared from the center of the city." *(Steele 1866, p. 14)*. The system was, however, less than perfect. In 1866 it was already becoming clear that the system would need to be upgraded and expanded due to a lack of catch basins, manholes and gas traps both within the public system and private plumbing *(Steele 1866, p. 14)*.

A Growing City, An Expanding Sewer System

Following the Civil War, the city expanded dramatically, showing no signs of stopping. By 1880, Buffalo city government was committed to a plan to vastly expand its system to ensure that the entire city would have sewer service. As part of this expansion, wastewater treatment was considered, but rejected on the basis that if most



1866 Map of City of Buffalo with modern digital modifications showing the 1850 border in red and waterways highlighted in blue.

New York City Library (base map)/Rosaleen Nogle (digital addition) of the wastewater could be conveyed to the Niagara River, then "… there is an end of it. Nature will provide that it never appears again to trouble your neighbors." *(City of Buffalo Common Council 1880).*

At this time separation of the storm and sanitary sewer systems was considered, but also rejected. It was argued that to construct a combined system, which could carry both storm and sanitary flows, would require "no appreciable increase in their dimensions" as compared to a strictly stormwater system *(City of Buffalo Common Council 1880*). To create a "double system" would require duplication of efforts, which was deemed impractical for a city the size of Buffalo *(City of Buffalo Common Council 1880).*

Having decided against wastewater treatment and separate sewer systems, Buffalo embarked on a major project of installing sewers throughout much of the modern limits of the city over the next two decades. Smaller (12"-24") sewers were connected by large trunk sewers, which also drained marshy former creeks. These trunk sewers discharged into the large waterways: the Niagara and Buffalo Rivers; the Scajaquada Creek; and the Black Rock Canal.

The largest of the trunk sewers, the Swan Trunk, only incidentally carried sewage to the Niagara River from inland sewers; its primary purpose was to flush out the Hamburg Canal and Wilkenson Slip through a system of automatic flushing gates. During wet weather, these gates would close, and the capacity of the Swan Trunk would be used for carrying combined sewage to the Niagara River *(Waring 1884).* During dry weather, the gates would open to allow the higher elevation of the Buffalo River and Lake Erie to flush the Hamburg Canal and Wilkenson Slip through the Swan Trunk into the Niagara River *(Kane Jr. 1923).*

During this period the former Mill Race, which had lost its purpose as an energy source for the Hydraulics, had become a public nuisance and was converted into a sewer. The project of converting the Mill Race into a sewer was the first of several similar projects that would mark much of the sewer construction between 1900 and 1929. Over this period, the Ohio and Hamburg canals, among others, were converted into sewers. Often this involved reusing portions of the existing canal structures to form the sewers, though the cross-sections of the sewers were significantly smaller than the canals that they replaced. This effort to bury heavily polluted waterways reached its culmination with the conversion of Scajaquada Creek into the Scajaquada Drain from Main Street across the entire east side of the city to the city line *(Kane Jr. 1923).* While these efforts did much to eliminate the hazard that untreated wastewater posed to the city, they did nothing for communities downstream.

Pouring the concrete on the roof of the drain.
Image source: private collection (Kane Jr. 1923)

Buffalo's Wastewater Wreaks Havoc Downstream

Despite the reassurance of the 1880 report regarding the capacity of the Niagara River to absorb and eliminate any hazards posed by the wastewater pollution by the City of Buffalo, by 1918 it had become clear that Buffalo's wastewater was imperiling downstream communities. Despite the treaty to protect boundary waters that was signed a decade before, the International Joint Commission of the United States and Canada found that "in the Detroit and Niagara Rivers conditions exist which imperil the health and welfare of the citizens of both countries in direct contravention of the treaty." *(International Joint Commission 1918, p. 51).* Further, the report concluded definitively that, "the sewage of Buffalo is polluting to a serious extent the available water supplies of the two Tonawandas [the cities of North Tonawanda and Tonawanda] and the city of Niagara Falls, New York." *(International Joint Commission 1918, p. 21).*

Further, this pollution was not just a hypothetical danger or nuisance, but a very real threat to the health and well-being of downstream communities. While cholera had faded from the scene, typhoid was still rampant during this period. The discharge of raw sewage by the city of Buffalo into the Niagara River was contributing to illnesses and deaths from this disease in downstream

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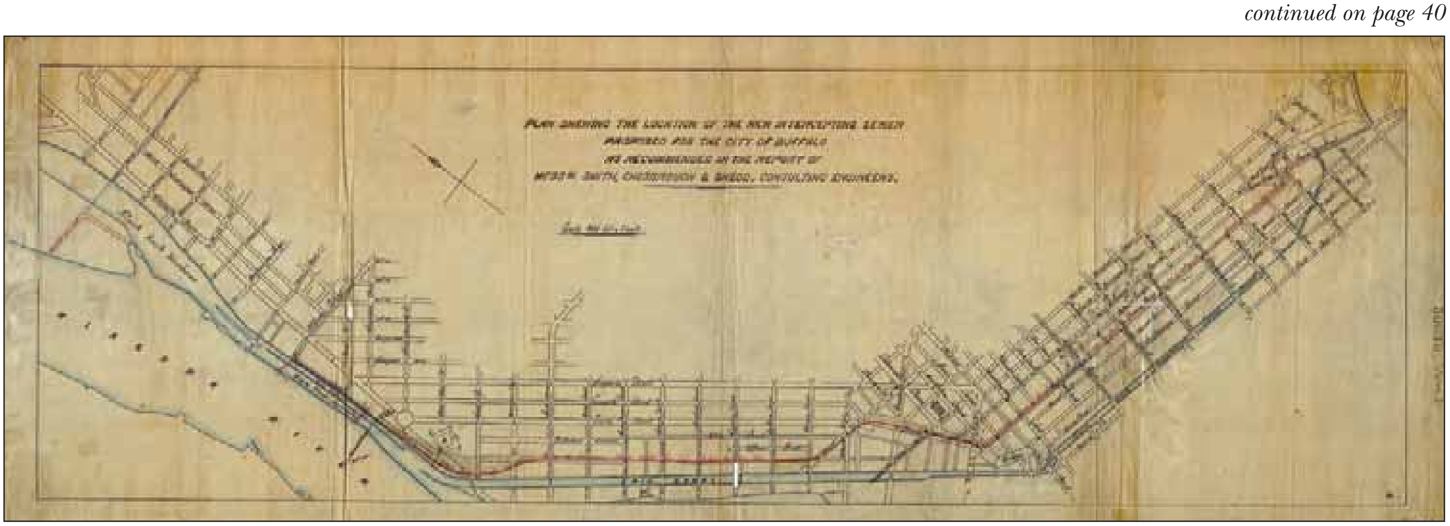

"Plan Shewing the Location of the New Intercepting Sewer Proposed for the City of Buffalo as Recommended in the Report of Messrs Smith, Chesbrough & Shedd, Consulting Engineers." Stamped Jan. 6, 1882, by the City Engineers Office of Buffalo, New York.
Smith, Chesbrough, & Shedd, Consulting Engineers

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communities. "In 1907 the City of Niagara Falls, New York, had a typhoid death rate of 222.4 per 100,000 population, and the average for the last 10 years is 130. This is the heaviest typhoid death toll recorded anywhere in the civilized world and does not include the death rate among visitors who contract the disease there." *(Canadian Public Health Association 1912)*. Not only was there a very real threat to human health, but there was also an aesthetic concern due to "1/100,000 of the water of the east channel of Niagara River consists of actual excrementitious matter from the human and animal population of Buffalo." *(Benedict 1903)*.

By April 1929, the City of Buffalo was well on its way to designing a new system for the treatment of wastewater and conveying wastewater to those proposed treatment facilities *(Buffalo Courier Express 1929)*. These efforts culminated in the May 1930 "Report to George F. Fisk, Commissioner of Public Works, upon A Comprehensive Plan for Sewerage for Buffalo, New York, Summary Report from George B. Gasciogne, Consulting Engineer," a comprehensive basis of design document for the construction of facilities to alleviate the issue. Unfortunately, the October 1929 stock market crash heralded the complete economic devastation of the Great Depression of the 1930s. With its finances ravaged by the loss of its tax base and a spike in unemployed citizens looking to the government for support, the city put any further plans for sewage treatment on hold.

Buffalo Sewer Authority Created

With no further actions being taken by the city's government, in 1935 the New York State Health Department stepped in, issuing a mandate to ameliorate the public health disaster resulting from the city of Buffalo's discharge of raw sewage to the Niagara River. It was beyond the bonding capacity of the city's government to absorb the enormous cost of this undertaking, so a few months later the New York State Legislature founded the Buffalo Sewer Authority (BSA) as a separate legal entity with the mandate to "provide an effectual and advantageous means for relieving the Niagara River, Buffalo River and Lake Erie from pollution by the sewage and waste of the city and relieving the city from inadequate sanitary and stormwater drainage and for the sanitary disposal or treatment of the sewage thereof." *(State of New York 1935)*.

In addition to reconsidering the previous logic of relying purely on disinfection for treatment, the new BSA also reconsidered the logic of maintaining the combined sewer system. After some analysis it was determined that:

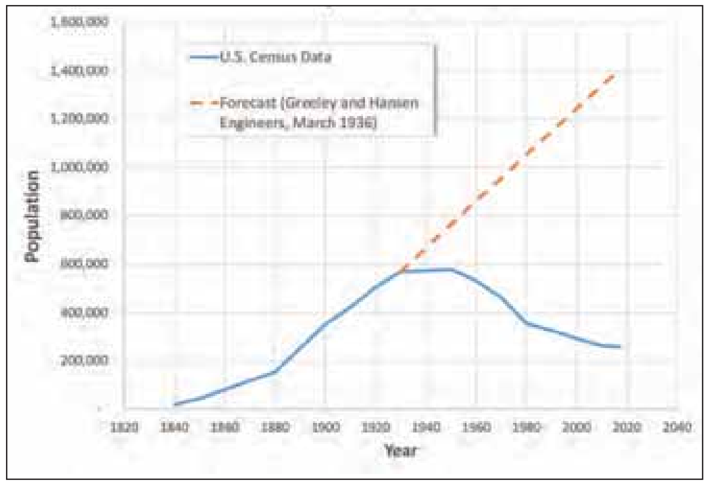
> *Reconstruction of the sewerage system on the separate plan was impractical from a financial standpoint and, in any event, the scope of the project. Accordingly, the interceptors were designed based on diverting 2 ¾ to 3 times the dry weather flow of sewage, such diversion being predicated upon a population of 1,100,000 forecast for 1985* (Hansen 1938).

By June 1938, the $15,000,000 project of constructing a new treatment facility and the vast network of intercepting sewers had been substantially completed *(Hansen 1938)*. During dry weather, the wastewater from the city of Buffalo was conveyed in its entirety to the new treatment facility on Bird Island in the Niagara River for screening, primary treatment and disinfection. During wet weather, however, this system still allowed for the relief of excess flows through a system of combined sewage overflows through weirs to the preexisting combined sewage outfalls.

Ostensibly the provision of combined sewer overflows should have prevented flooding even during extreme wet weather events. As soon as the original project was completed, however, the BSA commissioned the firm of Greeley and Hansen, which had designed the Bird Island Treatment Facility and interceptor sewer system, to "establish the locations in the city where existing sewers are inadequate, and to determine the degree of inadequacy, and the proper means for filling the deficiencies, including preliminary designs and cost estimates for all feasible alternative arrangements of relief sewers." *(Greeley and Hansen Consulting Engineers 1941)*. A summary report of findings was submitted to the BSA in February 1941. Some preliminary progress was made in the ensuing months in remediating these deficiencies; however, the necessary funding, materials, and labor for this project quickly dried up following the bombing of Pearl Harbor, Dec. 7, 1941.

Postwar: Revisiting Sewer Infrastructure

Once World War II ended, the BSA again embarked on the mission of eliminating flooding within the city. The city faced an ever evolving and worsening situation on several fronts:

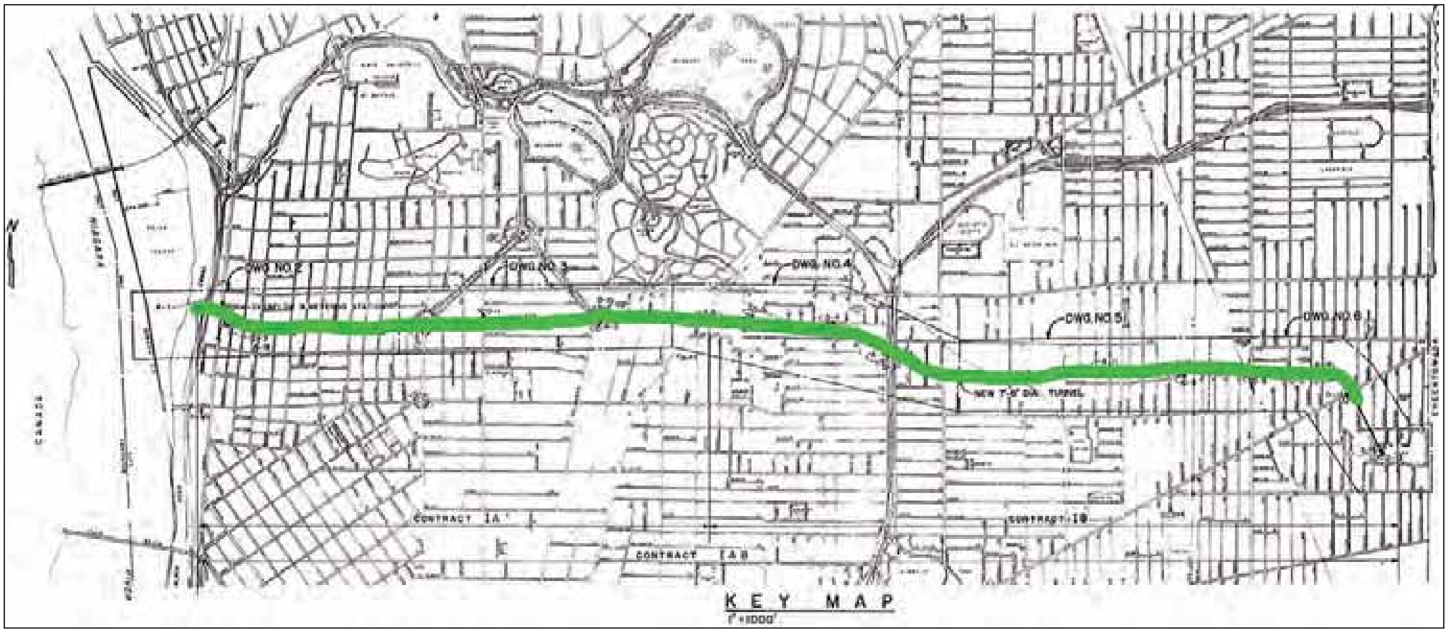


Forecast versus actual population of Buffalo, New York. Data compiled from the U.S. Census; 1936 forecast from Greeley Hansen (Greeley Hansen 1936) *Rosaleen Nogle*

- As the returning war veterans moved into new suburban developments in the surrounding communities, the population of the city began a slow and steady decline that has persisted for the decades, destabilizing the tax base.
- Several of the suburban communities were built on higher ground than the city itself. As agricultural and forested land was turned into suburban developments, the stormwater that had once been absorbed into the groundwater table was drained into the city across streets and through sewers and waterways.
- At the same time, new highways were being constructed in and through the city of Buffalo. One of these highways, the Kensington Expressway (NY-33) was constructed as a below-grade highway along what was the tree-lined Humboldt Parkway. To accommodate this new highway, the Bird-Ferry trunk was severed, and flows were rerouted from the east side of Buffalo.

Overall, these changes resulted in the construction of many new storm relief sewers (oversized combined sewers constructed with additional holding capacity for stormwater) and separate storm sewers.

In 1966, the BSA, in consultation with the state of New York, expanded the Bird Island Treatment Facility to add secondary treatment *(Buffalo Sewer Authority n.d.)*. With this addition, a tunnel was bored across the city to intercept combined sewer overflows



Scajaquada Tunnel Interceptor, Drawing No. 1 (1982). *Leonard S. Wegman Co, Inc.*

that had formerly been discharged into the Scajaquada Drain and reroute them into the interceptor sewers for treatment at Bird Island. This tunnel also serves as a conduit for the conveyance of wastewater from the Town of Cheektowaga to the treatment facility.

From 1981 to 2014 the BSA embarked on a continuous project of constructing separate storm sewers, raising and altering weirs, installing back water gates and capping combined sewer overflows with the purpose of reducing the number of combined sewer outfalls. On March 18, 2014, the United States Environmental Protection Agency and New York State Department of Environmental Conservation approved the BSA's Combined Sewer Overflow Long Term Control Plan. Since then, the BSA has made major progress in implementing this plan. In these first five years, the BSA has concentrated its efforts on:

- Installing green infrastructure to restore the ability of natural systems to absorb rainwater.
- Using Smart Sewer technology to use the full capacity of a collection system sized for 1,100,000 people, with the city's current population at a quarter of that.
- Optimizing the existing system.

Eventually, the BSA will also need to construct more traditional gray infrastructure projects, but with these innovative technologies, the Buffalo Sewer Authority has been able to reduce the size, cost and need for these facilities.

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References

Benedict, A.L. 1903. "Original Communications: Local Conditions of Geography and Population, as Bearing on Water Supply and Sewerage of Buffalo." *Buffalo Medical Journal* Volume XLII-LVIII (No. 12): 869-875.

Buffalo Courier Express. 1929. "Fisk Tackles Giant Task of Revamping City Sewers: Sifts Problems in North, South Buffalo Areas." April 14.

Buffalo Sewer Authority. n.d. "The History of Buffalo Sewer." *https://buffalosewer.org/history/.*

Canadian Public Health Association. 1912. "Pollution of the Great Lakes." *The Public Health Journal* (Canadian Public Health Association) Vol. 3 (No. 10): 569-570.

Cartography Associates. 2000. "Map of Morris's Purchase or West Geneseo in the State of New York. Ellicott, Joseph & B. 1804." David Rumsey Historical Map Collection. Accessed Sept. 17, 2019. *http://www.davidrumsey.com/maps718.html.*

City of Buffalo Common Council. 1880. "Minutes No. 29: Special Session." *Corporation Proceedings 1880-1881.* Buffalo, New York, July 29.

Cotter, John V., and Larry L. Patrick. 1918. "Disease and Ethnicity in an Urban Environment." *Annals of the Association of American Geographers* Vol. 71 (No. 1): pp. 40-49.

Greeley and Hansen Consulting Engineers. 1941. "Comprehensive Plan for Relief Sewers Summary Report." February 1941, pg. 1.

Greeley Hansen. 1936. "Table 1. Past and Estimated Future Population of Buffalo, March 1936, U.S. Census." *Buffalo Sewer Authority General Plan for Collecting and Treating the Sewage of Buffalo Progress Report No. 2.* Buffalo Sewer Authority.

Hansen, Paul. 1938. "$15,000,000 Buffalo Project Protects International Waters." *Municipal Sanitation* (R.H. Donnelley) Volume 9:433-434.

History Central. n.d. "1825 Erie Canal Opened." History Central. © 1996-2018 *History Central.* All Rights Reserved. *https://www.historycentral.com/Ant/Eirie.html.*

International Joint Commission. 1918. *Final Report of the International Joint Commission on the Pollution of Boundary Waters.* Washington, D.C.: Government Printing Office.

Kane Jr., Patrick. 1923. "Buffalo, New York, is Doing Away with Public Nuisance Through the Construction of an Underground Drain." *The American City* magazine, February. *https://www.wnyheritage.org/content/scajaquada_drian_project_-_1920s/index.html.*

State of New York. 1935. "Article 5: Public Utility Authorities, Title 8: Buffalo Sewer Authority Section 1176." *The Laws of New York, Consolidated Laws Public Authorities.*

Steele, Oliver G. 1866. "Buffalo City Sewerage and Sanitary Science, a paper read before the Historical Society Club, Jan. 3, 1866." Buffalo, New York: Buffalo Historical Society; U.S. National Library of Medicine. *http://resource.nlm.nih.gov/9605680.*

Waring, George E. 1884. *The Buffalo Trunk Sewer in Course of Construction.* American Society of Civil Engineers.

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Buffalo Sewer Authority Rain Check 2.0, Citywide Green Infrastructure

by David A. Barnes, Kevin Meindl and Oluwole McFoy

Introduction

The Buffalo Sewer Authority (BSA) is moving forward to meet the Green Infrastructure (GI) commitments of their Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP). The LTCP was approved by state and federal regulatory agencies in 2014 and included implementing GI strategies for runoff control for impervious surfaces. BSA committed to GI as a practical solution to support traditional gray infrastructure projects and help reduce CSOs into local waterways.

New CSO abatement alternatives were developed and evaluated for comparison to the updated Preferred Alternative from the 2004 LTCP. The new alternatives included innovative and/or emerging technologies such as real-time control and GI. BSA provided additional detail on their GI program by developing a Green Infrastructure Master Plan which includes further refinement of GI impervious surface control targets in critical areas of the collection system. This included analysis at the more localized Sewer Patrol Point (SPP) level, to identify where the system would most benefit from GI technologies. The SPP-level GI allocation provides a more refined and cost-effective approach for BSA to work toward a 1,315-acre total GI program effort.

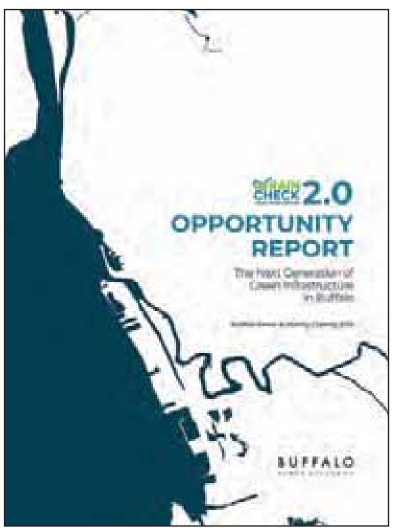
BSA remains committed to evaluating opportunities to maximize the use of additional cost-effective GI approaches. The target acreage is a minimum program commitment. Any additional GI acreage proposed, in conjunction with the optimization of gray projects, would be in addition to the 1,315-acre goal. This approach allows BSA to adaptively manage the GI program to incorporate lessons learned in each implementation program and take advantage of land use and infrastructure investments projected for each period to deliver the maximum public benefits to the City of Buffalo at the lowest cost.

Background

Officially launched by BSA in 2015, the Rain Check GI program has involved local, state and national water protection partners to plan and implement GI to reduce the frequency and impact of sewer overflows into local waterways.

Rain Check 1.0 was the first generation of GI implementation in the City of Buffalo. This initiative included tackling the parts of the built environment that create the most runoff from stormwater, such as streets, parking lots and roofs. Projects included:

- Green streets along key transportation corridors with planted areas to collect and infiltrate stormwater and improve pedestrian safety.
- Green parking lots that collect and absorb stormwater.
- Demolitions and vacant lot restorations that created neighborhood green spaces to absorb stormwater.



Rain Check 1.0 Benchmark Report
Buffalo Sewer Authority

- Rain barrels and downspout disconnections that enable homeowners to keep stormwater out of the system.

Rain Check 2.0 is a comprehensive, strategic plan that investigates GI projects within six priority sewer basins to reduce the stormwater runoff from approximately 500 acres of impervious surfaces. Community education and engagement are critical to the success of the program.

The Rain Check 2.0 work included the following major components:

- *Benchmark 1.0 Report* to document Phase 1 GI efforts.
- Rain Check 2.0 *Communication and Education* efforts including a new website, online tour and engagement materials.
- A *Technical Advisory Committee* (TAC) to provide guidance on technical and implementation challenges.
- Local *Government Engagement Meetings* to identify opportunities for collaboration.
- *Private Engagement Meetings* to identify partnerships for implementing GI projects.
- A *Stormwater Tree Analysis* and TAC to identify planting opportunities and crediting.
- *Retrofit Reconnaissance Inventory* including a desktop screening analysis to identify possible sites. Field investigations were then performed to determine feasible sites.
- *Rain Check 2.0 Opportunity Report and Equity Analysis.*

Rain Check 2.0 summarizes the preliminary effort to identify opportunities for GI on sites within the priority CSO basins ***(Figure 1)*** and includes recommendations for how GI can be

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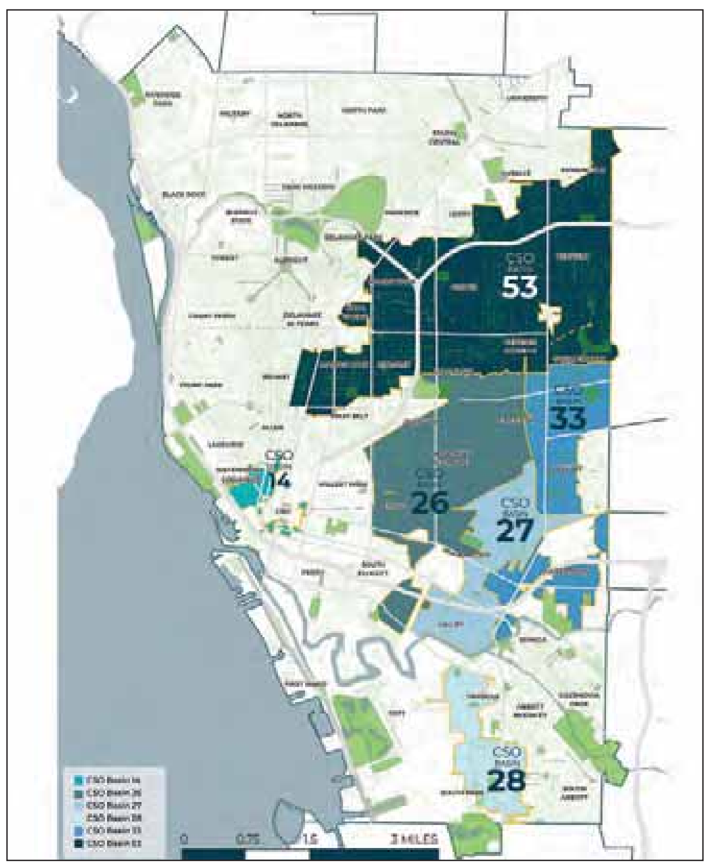

Figure 1. Map showing the six Rain Check 2.0 priority CSO basins.
Buffalo Sewer Authority/Arcadis


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deployed throughout the City of Buffalo.

The *Rain Check 2.0 Opportunity Report* describes efforts undertaken by BSA and identifies the need to create communities of action for implementation. Rain Check 2.0 includes a tool kit of GI technologies that can be deployed in Buffalo and identifies various strategies for structuring GI to maximize stormwater, environmental, equity and economic benefits.

Inclusive Outreach and Public Engagement

Public GI planning and projects can create venues for residents, community-based organizations, and other stakeholders to connect to and shape local decision-making processes. Robust outreach and engagement can provide mutual benefits to both BSA and community members by deepening understanding of community priorities; increasing legitimacy and support for public plans and projects; cultivating resident and community stewardship of projects; and improving government/community relations. Additionally, GI projects can initiate and facilitate community visioning in disinvested neighborhoods to help distribute these benefits to parts of the city that need it most. Outreach and engagement materials were developed to promote the benefits of GI ***(Figure 2)***.

CSO Basin Site Selection

BSA evaluated each of the priority CSO basins through the lenses of equity, environmental systems and site analysis. The opportunities identified in each CSO basin are an effort to balance these three priorities based on the specific conditions in the basin. For example, commercial properties and parking lots comprise much of the impervious area in the priority CSO basins. They are therefore some of the largest contributors of stormwater to the combined sewer system. Retrofitting these properties with GI will be critical to effectively manage the stormwater challenge. Institutions, such as schools and churches, may be smaller contributors of stormwater, but investments in GI on those properties may better support achieving equity goals, such as workforce development and neighborhood revitalization, than developments on private property alone. Improvements to corridors, including green streets and tree planting, address high levels of impervious surfaces and provide benefits such as reducing the urban heat island effect and increasing walkability of neighborhoods.

Based on this analysis, the *Rain Check 2.0 Opportunity Report* identifies types of GI opportunity sites. The opportunity sites were grouped by category, the key categories being corridors, commercial properties, parking lots, institutions, parks and vacant lots. These opportunity sites were identified in each CSO basin based on:

- Equity considerations citywide and within each CSO basin.
- Analysis of how GI would impact and improve environmental systems.
- Site analysis to determine the best opportunities to retrofit GI based on the highest impervious area and the highest feasibility.

Site Analysis

The total area in the six priority CSO basins is 6,827 acres. The target is the removal of 569 acres of impervious cover using GI. To understand the potential for managing large areas of impervious surface, detailed site analyses within the priority CSO basins were performed. These analyses involved two components:

1) A thorough desktop analysis utilizing advanced GIS and remote sensing techniques.
2) Detailed on-the-ground field surveys.

The initial desktop analysis identified potential parcels, property owners and land use. This included key community partners and property owners, such as Public Schools, Parks, Buffalo Urban Renewal Agency, Buffalo Urban Development Corporation, Buffalo

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Figure 2. Green infrastructure education and engagement materials. *Buffalo Sewer Authority/Arcadis*

Municipal Housing Authority, and religious centers. These community partners can act as catalysts for engagement and implementation. The analysis concluded that a significant portion of the impervious reduction targets could be achieved working with these partners.

BSA then conducted field surveys of properties identified through the desktop analysis. The objectives of the field surveys were to:

- Narrow the list of potential parcels to include only those where GI retrofits were feasible.
- Identify the impervious surface drainage area that could be captured on each site.
- Delineate areas within each site appropriate for GI.
- Propose potential GI solutions appropriate to each site.
- Identify implementation challenges at each site, such as parking and utility conflicts.

For each priority CSO basin, the *Rain Check 2.0 Opportunity Report* includes a map showing all the parcels surveyed, the drainage areas and possible GI location. A detailed description of different GI practices was developed.

Since many GI practices include plants, ensuring that possible GI sites have enough sun to grow plants is an important consideration. Therefore, the field surveys included an assessment of shading at each possible GI location. These finding are summarized for each CSO basin. An on-site evaluation was also made regarding how visible the potential GI practice would be from the public right of way. Visibility is important to the community and as a way for BSA to determine if there are any issues with a GI installation.

Site Field Evaluations

Several digital data collection and analysis applications were used to enhance project delivery and support production of the *Rain Check 2.0 Opportunity Report,* released in May 2019. Retrofit Reconnaissance Investigation (RRI) forms, developed by the Center for Watershed Protection and modified by BSA, were completed for over 400 private properties across the six priority sewer basins. Field data collection was conducted using Collector for ArcGIS, a mobile data collection app, to delineate drainage patterns and identify potential retrofit areas efficiently between office and field staff. Survey123, a form-centric data collection app, was used to complete the modified RRI form for each of the assessed areas. More than 10,000 data points were collected during the field investigations. These were summarized in Microsoft Power BI, a business analytics service, to build a library of information for future planning, engagement and implementation efforts ***(Figure 3)***. The team automated collected data into a series of site summary forms using ArcGIS Pro. Specifically, the map series functionality of ArcGIS Pro allows the team to produce hundreds of site layouts by iterating collected data over a series of mapping extents, from a single index layer.

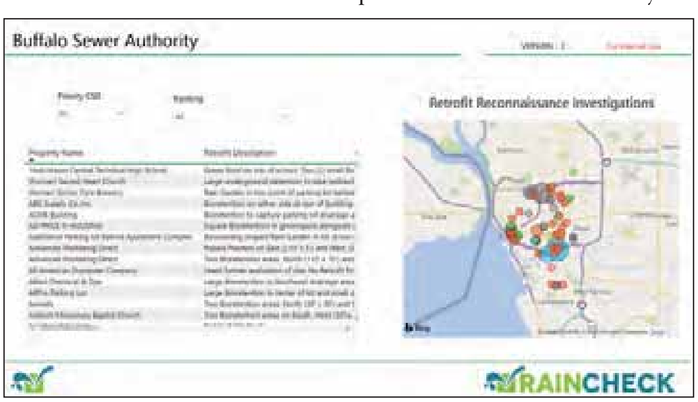

Figure 3. Microsoft Power BI output example. *Buffalo Sewer Authority/Arcadis*

An analysis of citywide tree canopy cover was also conducted to inform appropriate decision makers of current gaps in the urban forest to help prioritize future tree plantings at a higher level of accuracy. A custom workflow was built using Model Builder for ArcGIS to automate the processing of over 7 gigabytes of LiDAR data. The output of this workflow was further analyzed using standard geoprocessing tools to provide more focused insights.

The results of the field reconnaissance are summarized in ***Table 1.***

Table 1. RRI Field Results for Each CSO Area.

CSO	Target Reduction (Acres)	RRI Impervious Area (Acres)	Feasible Reduction (Acres)	Number of Sites Investigated	% Feasible vs Target
14	12.9	87	78	65	604%
26	63.6	244	115	96	179%
27	72.8	320	156	45	214%
28	27.4	68	58	38	211%
33	94	231	180	86	191%
53	298.9	560	485	133	162%

Opportunity Sites

Opportunity Sites were identified for each CSO basin. Workshops were held to review all field data and to discuss each CSO basin's characteristics, including:

- Tree canopy.
- Urban character.
- Equity considerations.
- Potential partners.
- Key neighborhood groups.
- Key corridors.
- Opportunities for clusters or networks.

Corridors

In several CSO basins, corridor GI is critical to meeting the stormwater goal. The predominance of large corridors allows for the organization of GI into larger networked system, increasing the overall potential effectiveness in the basin. For example, the Scajaquada Creek corridor also presents the opportunity to incorporate water history into GI and make underground infrastructure visible. Adding a park would provide an opportunity for both GI and neighborhood connectivity.

Sites

The sites inventoried for GI retrofits typically focused on businesses and large institutional campuses as well as community partner institutions. These sites are organized along many key corridors or grouped in industrial or commercial areas.

Clusters and Networks

Combining feasible retrofit sites, important institutional sites, and corridors reveals the existence of key clusters. The presence of community institutions provides the opportunity to have a programmatic focus, such as workforce development, community health or economic development.

Opportunity Report

The final deliverable is the *Rain Check 2.0 Green Infrastructure Opportunity Report and Equity Analysis.* The document describes the

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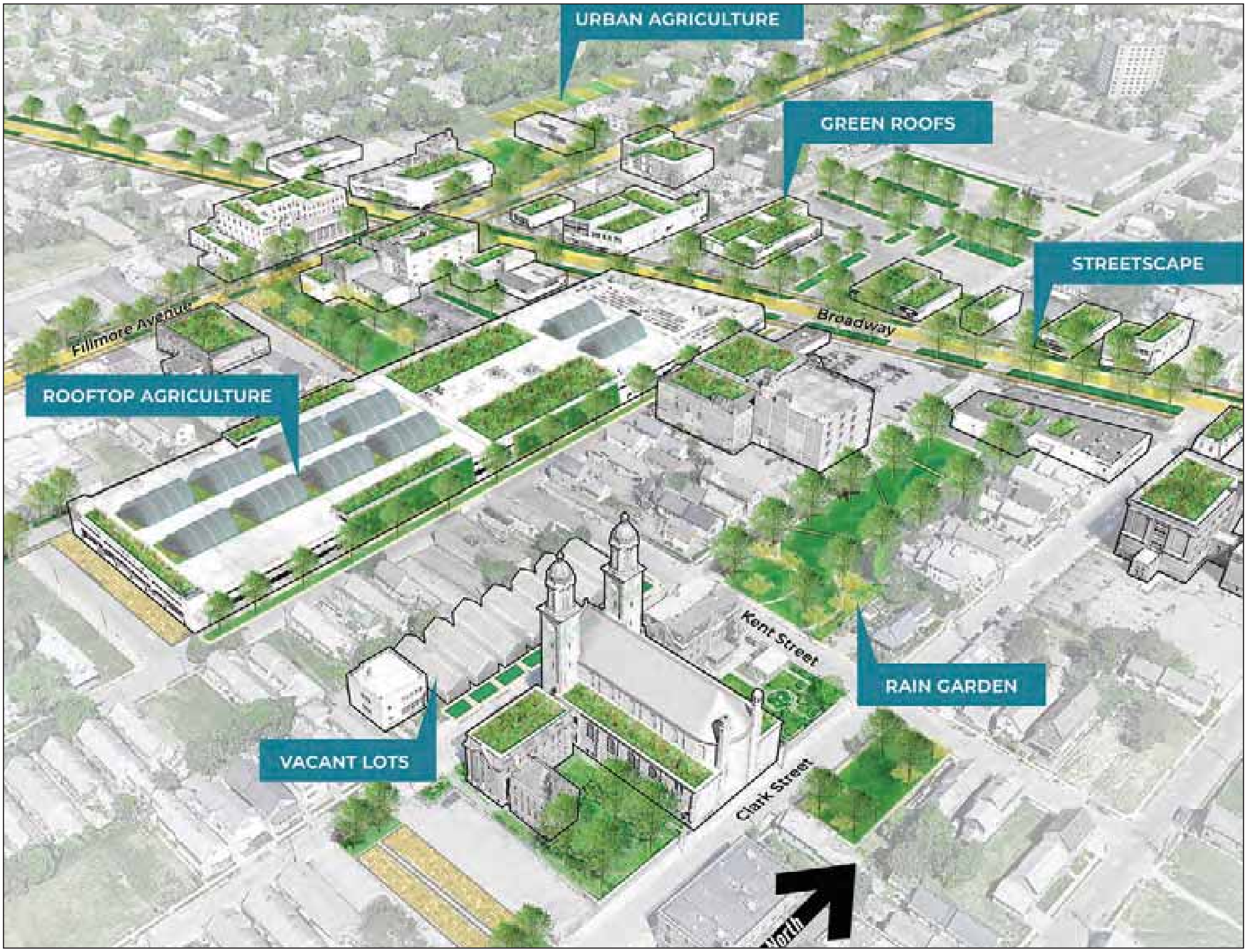

Figure 4. Potential GI for one neighborhood. *Buffalo Sewer Authority/Arcadis*

Figure 5. Location summary forms for stakeholder engagement meetings. *Buffalo Sewer Authority/Arcadis*

Buffalo Rain Check 2.0 Green Infrastructure efforts undertaken by BSA. The document was completed in spring 2019 and highlights opportunities in each priority sewer basin to meet CSO compliance requirements. The report includes green stormwater solutions located on both public and private property throughout the city to better manage stormwater, improve the health of waterways, and enhance and beautify the public land ***(Figure 4)***.

As a benchmark report, the document synthesizes some of BSA's research and outlines future initiatives. As a tool to facilitate future investment in GI, the document provides a unified framework and strategies to support planning and decision making. As an opportunity analysis, the document identifies potential partners and community benefits to engage stakeholders and property owners in planning and funding of GI projects across the City of Buffalo.

Successful GI requires a supportive culture in Buffalo that advocates for its implementation and maintenance. Rain Check 2.0 includes a robust strategy of engagement ***(Figure 5)*** and a balancing of priorities to ensure that stormwater goals are met and that the implementation of GI is informed by consideration of equity and the broader environmental context.

The work of Rain Check 2.0 confirmed that BSA can meet or exceed its stormwater goals in the priority CSO basins by employing GI. Meeting the goals requires investments in GI on both publicly owned and privately-owned properties. Ongoing planning and outreach to identify partners, engage stakeholders, and build trust and shared values is critical to success. *The Opportunity Report* is a first step in that larger planning effort.

The next steps in achieving BSA's stormwater goals include continuing communications and education, advancing private stakeholder engagement and developing the GI implementation program.

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The reports cited in this article are available on the Rain Check Clean Water Buffalo website *https://raincheckbuffalo.org/*.

A bioretention cell, or rain garden, installed as part of Buffalo Sewer's CSO 060 Green Infrastructure Project. *Buffalo Sewer Authority*

Achieving 21st Century Results with Legacy Infrastructure

by Kristina Macro and Maria Krug Comuniello

In the early 20th century, Buffalo, New York, was the eighth largest city in the United States with a booming economy and steady population growth. With expectations of continued prosperity, a massive sewer system was built to accommodate up to 750,000 people. However, planners did not anticipate the suburbanization and decline in industry that would lead to Buffalo losing half of its population.

Today, Buffalo Sewer Authority (BSA) serves a population of 259,000. Even with its seemingly oversized sewer system, Buffalo experiences 2 to 3 billion gallons of combined sewer overflow (CSO) annually, and now has an administrative agreement with the state of New York to correct this problem. While developing their 20-year Long-Term Control Plan to reduce overflow events and improve water quality, BSA realized it could leverage its underutilized, existing assets instead of relying entirely on new construction. What were once oversized pipes are now “smart sewers” that form the basis of a citywide plan to minimize overflows by retrofitting and optimizing the operational behavior of its legacy sewer system.

Inline Storage Opportunities

BSA discovered that, as a result of the population decrease and the associated decreased load in the collection system, the large, shallow pipes in the system potentially had millions of gallons of unused storage capacity. An evaluation of BSA’s hydraulic model of the collection system found that eight major trunk lines were more than half empty during the peaks of the largest expected storm events. These underutilized pipes provide a cost-effective opportunity for inline storage to reduce overflows. Inline storage (ILS) takes advantage of the extra capacity in the pipe to store combined sewage in the trunk line during the peak of storm events, slowly releasing flow after the storm when the downstream system has capacity to convey flow to the water resource recovery facility (WRRF). Real time control (RTC) systems maximize the benefits of inline storage for any given storm, ensuring an optimal storage and release rate based on current conditions in the system.

BSA’s team identified up to 16 sites for inline storage and optimal conveyance throughout the city. The initial return on investment of this citywide program was expected to reduce BSA’s annual overflow volume by 15 to 20%, or over 350 million gallons. Based on the modeled outcome of the RTC program as well as green infrastructure projects for uniform rainfall typical year simulations, BSA was able to negotiate $145 million out of their Long-Term Control Plan.

RTC sites chosen for inline storage consist of chambers constructed with mechanical gates that close during wet-weather events to store flow within the existing pipe, freeing up capacity in other areas of the system ***(Figures 1*** and ***2)***. In active storage mode, the gates modulate to maintain a target flowrate out of the structure, allowing continuous dewatering without causing an overflow downstream. After the storm, the gates return to dry weather mode and open completely, allowing unrestricted flow through the pipe ***(Figure 3)***. Additionally, the ILS structures are constructed with an emergency relief weir. Should an issue arise with the gates, flow can be conveyed over the weir to the WRRF. This ensures that the hydraulic grade line will not exceed safe levels and mitigates the risk of basement backups upstream.

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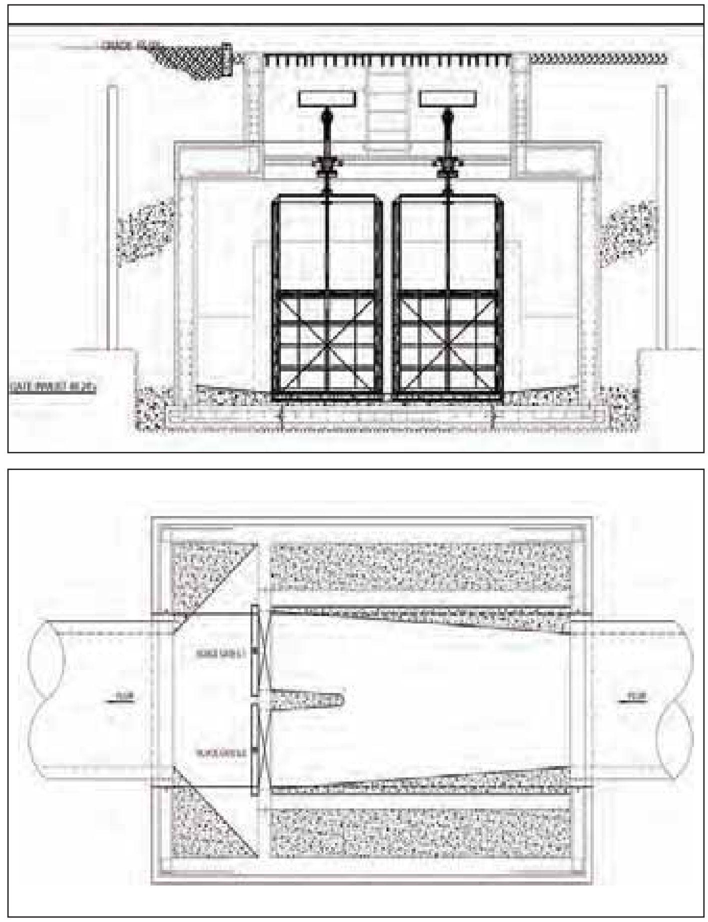

Figure 1. Configurations of in-line storage structures. *GHD*

Figure 2. Construction of the Bird RTC chamber. *GHD*

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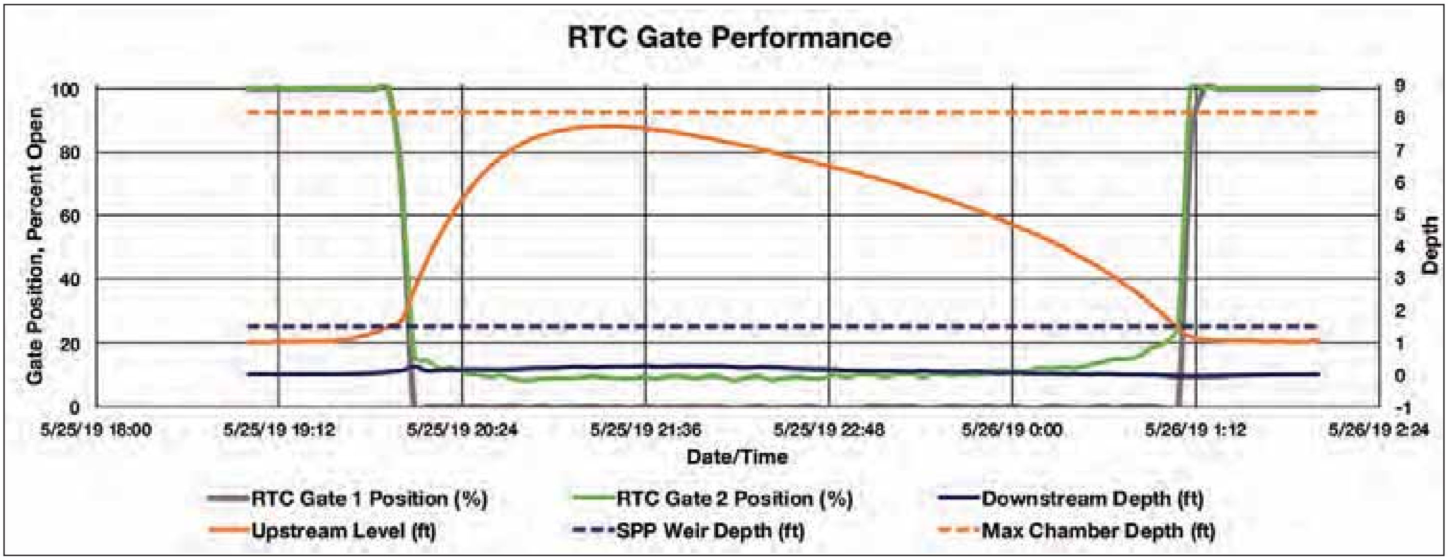

Figure 3. Example performance of RTC gates. *Arcadis and EmNet*

Intercepting Overflow Pipes

Another control strategy used was RTC interception of overflow pipes. These overflow pipes discharge combined stormwater and wastewater directly into local waterways. In this situation, a new diversion pipe connects the overflow line to an existing interceptor pipe, which conveys flow to the WRRF. Similar to the gate modulation in an ILS structure, valves are installed on the diversion pipe and modulated to store flow upstream or send it to the interceptor when there is capacity. Flow that would have otherwise overflowed can then be conveyed back to the collection system and treated.

Figure 4. Map of RTC site locations throughout Buffalo. White indicates sites in service, green indicates completed sites undergoing post-construction tuning, purple indicates sites in construction, and blue indicates sites in design. *Arcadis and EmNet*

For both inline storage and RTC interception, the gates and valves are triggered by level monitoring equipment and modulated based on control logic coded within programmable logic controllers installed at each site.

RTC and Adaptive Management

BSA builds and commissions these RTC sites on an adaptive management basis. Sites are identified by performing a broad assessment of the collection system, considering factors such as pipe diameter, utilization during wet weather events, available ground cover, location of side sewer connections, and existing conduit slope. Operation of the collection system improves as each site comes online, so any potential new sites are evaluated for impact beyond that provided by the operational sites.

There are currently four operational sites, two sites under construction, and four sites entering design ***(Figure 4)***. The first two inline storage sites, commonly referred to as the Bird Avenue RTC (Bird) and the Lang Avenue RTC (Lang) sites, were commissioned in early 2016. The Smith Street RTC site was commissioned in 2018 and utilizes outfall storage to increase flows to interceptors downstream that are underutilized during storm events. Since July 2018, when BSA began tracking key performance indicators for the Smith Street site, these three sites alone have captured over 400 million gallons of combined sewer overflow.

Most recently, BSA implemented coordinated control of RTC sites, so that sites communicate with each other to signal when wet weather is happening and find where capacity exists in the system. This approach utilizes individual inline storage sites more efficiently to enable higher systemwide overflow volume capture. As the first example of this concept, the Hazelwood RTC site was constructed upstream of the Lang RTC site ***(Figure 5)***. While most ILS sites operate based only on local level sensor readings, the Hazelwood site also receives level sensor data from the Lang site. Because Hazelwood can receive communication from Lang, the two sites can coordinate during storm events to optimize usage of each. The storage at Lang is utilized first, and the Hazelwood site serves as a secondary source of storage when the Lang site is almost full. In

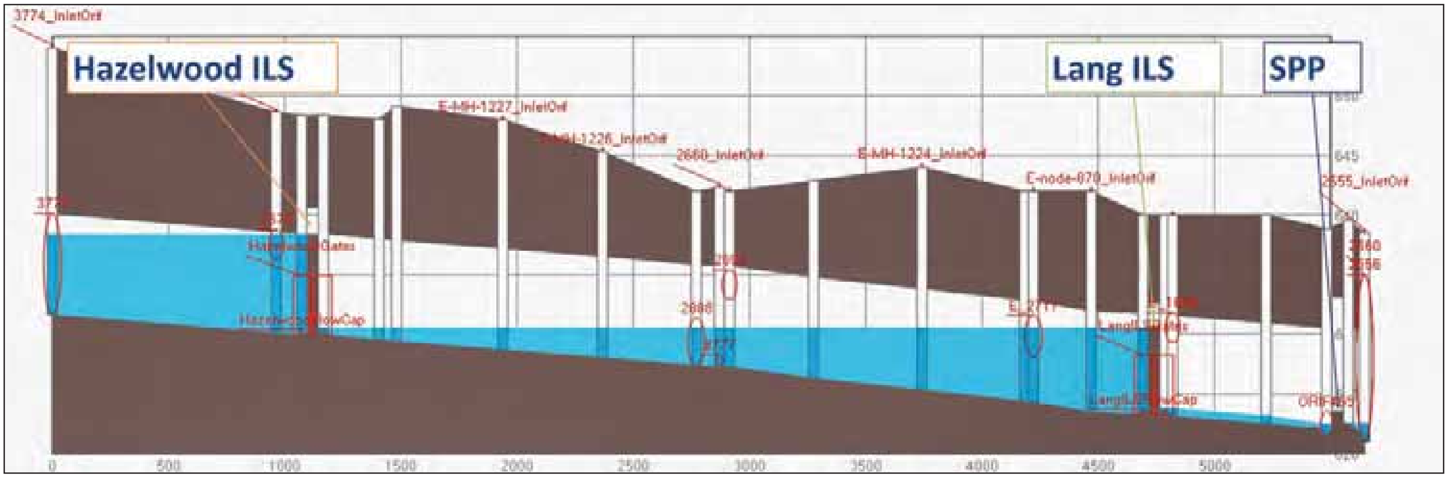

Figure 5. Schematic of the Hazelwood and Lang inline storage sites. Storage at the Lang site will be utilized first, and the Hazelwood site provides additional storage upstream. Both sites coordinate to regulate the flow released downstream to the sewer patrol point (SPP), which regulates the combined sewer overflow. *EmNet*

this way, the Hazelwood site can store additional volume that would have previously overflowed. The addition of the Hazelwood site with coordinated control is expected to provide an additional 60% reduction in overflow volume at the downstream sewer patrol point compared to Lang operating independently.

The sites in construction, North Bailey and Hertel at Deer, use inline storage to minimize overflows. North Bailey is in the same sewer district as Lang and Hazelwood. It will work with those sites to reduce overflows into Scajaquada Creek, a high priority waterbody for water quality improvements. Hertel at Deer is the largest ILS chamber constructed to date, with four 5-foot by 5-foot gates storing flow in two large barrels upstream.

The Next Steps

Building on the success of the operational RTC sites, the next round of sites in design are expanding the concept of coordinated control and will specifically target global benefits:

- The primary objective of the new Broadway Oak and Babcock Pump Station sites are to use storage upstream in the system to make room for additional downstream flow to reach the WRRF. Babcock Pump Station is a unique RTC opportunity for BSA because it involves changing pump station operations instead of building new infrastructure. Since the cost of converting the station to an RTC site will be much less than installing a new ILS chamber, BSA will be able to complete long-awaited station upgrades as a part of the program.
- A new RTC site upstream of the existing Smith Street RTC site (Smith Eagle) will utilize the same coordinated control concept as Lang and Hazelwood to provide additional storage in the Smith Street Drain and further reduce CSO events and overflow volume. These two sites will work together to ensure optimal usage of the storage volume and capacity in the interceptor.
- The Mill Race site will apply the RTC interception strategy to prevent overflows from occurring while there is still capacity in the system.

The impressive performance of the real-time control strategies implemented thus far demonstrates how BSA can take advantage of existing capacity to minimize CSOs, saving tens of millions of dollars in prevented construction of new storage facilities. As BSA expands the network of RTC sites and coordination between them, there will be increased opportunities to manage the urban watershed and optimize the use of existing assets. These sites can work together to take advantage of the temporal and spatial distribution of rainfall across the city, providing storage capacity to the areas of the sewer system that need it most during each unique storm event.

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More Than Just Regulators and Pump Stations: Collections Operations at the Front Line of CSOs and Climate Resiliency

by Frank Loncar

Introduction

In the wastewater industry, the New York City Department of Environmental Protection's (DEP) Collections Operations are synonymous with regulators and pump stations; DEP has managed these structures for over a century. However, few know the vital role Collections Operations plays in DEP's solutions for combined sewer overflow (CSO) control. For more than 10 years, all new CSO facilities that have been incorporated into DEP's Collections Operations utilize a diverse range of technologies. Moreover, Collections Operations is playing an increasingly significant role in climate change and infrastructure resiliency in the New York City landscape.

History of New York City's Regulators, Interceptors and Pump Stations

DEP's Collections Operations personnel manage 497 regulators, 152 miles of intercepting sewers, and 96 pumping stations. All this infrastructure is fed through more than 7,500 miles of sewer pipes that comprise the local collection system under all city streets in the five boroughs of New York City. Many of these facilities are as old as, or older than, the treatment plants they serve. A closer look at the history of sewerage and wastewater treatment in New York City illuminates the reasons the city built these extensive facilities over time.

More than 150 years ago, the city's managers realized that proper sanitation was necessary to protect the health of a proliferating urban population. Studies in the early 1800s revealed that New York City's disease rates were higher than those of other major developed cities like London and Paris. Many New York City residents in the 19th century lived in deplorable conditions in dense tenements that did not have plumbing. The city's streets had drainage channels that routed rainwater, along with human and animal wastes, onto the streets. As scientists and health professionals began to draw the connection between management of human waste and disease transmission, engineers took action to design sewers to collect and carry away wastewater from the crowded streets to local waterbodies by gravity. This system of getting waste away from where people lived and into the waterways seemed to work fine … for a time.

As the city developed, more sewers were constructed throughout the city to collect and convey waste directly from homes and businesses, as well as rainwater from the streets, creating a vast network of what we now call "combined sewers." More than 65% of sewers in the city were originally designed as combined sewers, while in newer areas the city constructed a system of separate sanitary and storm sewers.

As the population continued to grow, New York City developed water and sewer systems along with it, still primarily designed to convey wastes to local waters. Finally, scientists and public health advocates identified the fact that untreated waste in the city's harbor at ever-increasing volumes created increasingly unhealthy water conditions, thus continuously growing the threat to public health. The city's planners and engineers eventually engaged the actual treatment of sewage to improve water quality, and the first wastewater treatment plant was commissioned in 1892 in Coney Island. The overall master plan included the construction of treatment plants throughout the city, near waterways, and prioritizing public exposure at bathing beaches, resulting in the scheme of the 14 plants constructed between the late 1890s up to 1989.

How did New York City convey collected combined sewage to these new treatment plants? The city constructed "intercepting sewers" that basically intercepted the existing old sewers near their respective outfalls, which were routed directly to the waterways, and diverted that flow to the new treatment plants. In total, the city installed 152 miles of large intercepting sewers and included combined sewer regulators designed to convey up to two times dry weather flow from incoming sewers to the treatment plants, while diverting excess volume to an outfall structure as a system relief point. This excess volume from the outfall structure is known as a combined sewer overflow (CSO). While the basic design and purpose of regulators has not changed much, the new regulators were built to include tide gates that acted as a check valve on the outfall to prevent tidal water from coming back into the system ***(Figure 1)***.

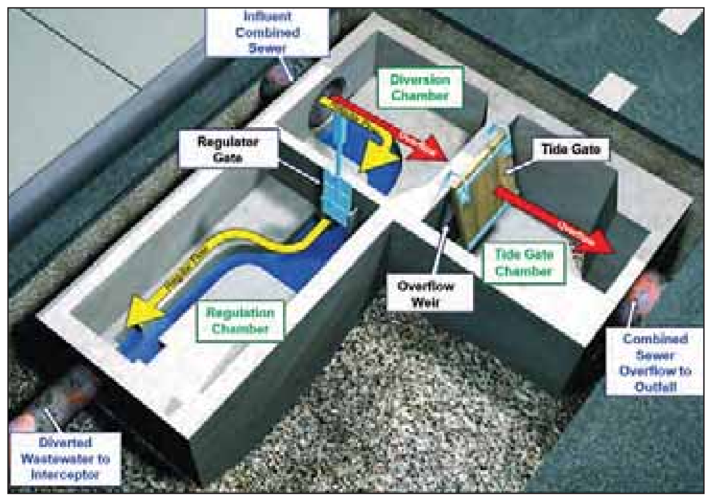

Figure 1. Diagram of combined sewer regulator. The tide gate acts as a check valve on the outfall to prevent tidal water from coming into the system. *NYC DEP image*

Photograph 1. Collections Sewage Treatment Worker operating truck-mounted crane to exercise a tide gate. *D. Poloyac, NYC DEP*

Today, Collections Operations crews maintain 497 combined sewer regulators throughout the city ***(Photograph 1)***.

Originally, New York City's system could rely on conveying flows by gravity. But as new developments sprouted throughout the city, pumping stations were needed to route flows to the plants. At the same time, the city's network of highways and roads was growing. Some of those roadways (e.g., FDR Drive and the Brooklyn Queens Expressway) also required pumping stations to convey stormwater from low-lying areas. Many of those stormwater pumping stations were operated originally by the highway departments but were eventually turned over to DEP's Collections Operations. Today, DEP operates 96 pumping stations, which vary in size from as small as 20,000 gallons per day of dry flow to as high as 80 million gallons per day (mgd), with some treatment plant influent pumping stations hitting 400 mgd. The city's future developments and growth may further increase the number of pump stations needed ***(Photographs 2*** and ***3)***.

Photograph 2. Collections Sewage Treatment Worker checking a submersible pump before installation. *D. Poloyac, NYC DEP*

To operate and maintain all these structures throughout the city, the Collections Operations division was formed within the DEP's Bureau of Wastewater Treatment. The group is divided to Collections Facilities North and Collections Facilities South, with around 145 staff. The division operates out of five crew quarters citywide, seven days a week, 365 days a year. The mobile crews monitor over 220 sites on a 24/7 basis utilizing the Citywide Collection Facilities Supervisory Control and Data Acquisition (SCADA) System. Currently, every pumping station is visited once daily, and each regulator is inspected a minimum of once per month ***(Photograph 4)***. The Collections Operations division also responds to alarms at all hours from the SCADA system.

Photograph 3. Collections Sewage Treatment Worker maintaining a main sewage pump. *D. Poloyac, NYC DEP*

Photograph 4. Senior Sewage Treatment Worker Victor Basdeo inspecting a regulator in the Bronx. *L. McWilliams, NYC DEP*

Photograph 5. DEP Collections crew "vactoring" a chamber. *L. McWilliams, NYC DEP*

The mobile crews utilize specialized trucks for repair and maintenance of regulators and pumping stations, including pump station trucks, regulator trucks, backup trucks, flusher trucks and Vactor trucks ***(Photograph 5)***.

Collections Operations Begins CSO Operations

The city's first major project designed to control and reduce CSO from regulators was the Spring Creek CSO Detention Tank, constructed in 1968. That facility was near the 26th Ward Wastewater Resource Recovery Facility (WRRF) and became a facility auxiliary to that plant. As future facilities were planned, there was a need to identify a group that could manage the different facilities coming online. Collections Operations became the primary manager and maintenance group responsible for new CSO facilities. In fall 2007, the Flushing Bay CSO Detention Facility, with 28.2 million gallons of tank storage and 15 million gallons of inline storage, went into operation as part of Collections Facilities North. Within a few years, additional CSO retention facilities were placed into service at Paerdegat Basin (20 million gallons of tank storage and 30 million gallons of inline storage) and Alley Creek (6 million gallons of facility storage). These new CSO facilities provided screening, retention and pumpback of CSO.

About 10 years ago, Collections Operations began to run aeration facilities that were installed within impaired waterways. These

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facilities encompass large blowers that provide increased oxygen and destratification of the nearby waterways in Shellbank Basin and Newtown Creek. DEP currently operates three aeration facilities that function during the summer months.

More recently, DEP began modifying some key regulators to improve CSO and floatables capture. Modifications to the regulators include weirs that are bent to increase storage; horizontal screens to capture CSO floatables; and underflow baffles that reduce CSO floatables. At two locations in the Bronx, Collections Operations maintains a netting system for the capture of floatables, helping to reduce trash and other debris that find their way into the city's waterbodies. DEP also modified the Avenue V Pump Station to a capacity of 80 mgd to convey additional wet-weather flows to the plant and to reduce CSO to Coney Island Creek.

The city's Long-Term Control Plans identify appropriate CSO controls necessary to achieve waterbody-specific water quality standards consistent with the Clean Water Act, including detention tanks, storage tunnels, pump station expansions, regulator modifications and disinfection facilities. These new facilities further expand the vital role that Collections Operations plays in protecting the city's residents and waterways.

Collections Operations' New Role in Climate Resiliency

Collections Operations' pumping stations are typically located in the lowest-lying areas, where gravity was insufficient to naturally convey sewage flows. Therefore, many of those pumping stations lie within the coastal storm flood zone and are threatened by rising sea levels. During Superstorm Sandy, DEP's Collections Operations division mobilized a major emergency response force and will take an even greater role for future storms. During the superstorm, 42 pumping stations suffered damage, mostly due to floodwater inundation. Collections Operations was the first responder responsible for restoration of this vital infrastructure. The crews have an extensive list of mobile equipment utilized for emergency response including portable pumping systems, portable force mains and portable generators. The crews used this equipment to restore pumping at flood-damaged stations and to provide electrical power when the electrical utility was unavailable.

The city is committed to improving the resiliency of vulnerable pumping stations, WRRFs and CSO facilities. Some measures have been implemented quickly at pumping stations as interim flood control measures. These interim systems included portable dams that are set in place before an impending coastal storm. Another common approach is the installation of flood planks to protect vulnerable doorways, windows and ventilation openings. Collections Operations maintains a system of planks and deployable dams for up to 31 pumping stations and one crew-quarters, which will be installed upon activation of the emergency coastal storm plan.

DEP continues to prioritize the installation of permanent resiliency measures at 14 pumping stations. These measures include the construction of permanent floodwalls, raised electrical equipment, facilities for portable generators and pumps, and flood planks and tanks that are deployed before a storm. Collections Operations is prepared and will be working hard to protect infrastructure before the next major storm.

Collections Operations to Play a Vital Role in Protecting Lower Manhattan

In 2018, New York City Mayor Bill de Blasio announced a plan to protect lower Manhattan from future coastal storms. Superstorm Sandy caused major damage in lower Manhattan, with floodwaters reaching residential and financial districts, the electrical power plant at 14th Street, and the 400 mgd Manhattan Pump Station, which is not a part of Collections Operations. The new projects will build a system of berms and walls to provide a flood barrier from 23rd Street to the southern tip of Manhattan. Those systems will be designed to hold back floodwaters from New York Harbor on the "wet" side of the flood walls, while still allowing dry and wet flows on the protected "dry" side of the flood walls to be conveyed to a pumping station and ultimately to the Newtown Creek WRRF in Brooklyn. Collections Operations will be tasked with maintaining and operating the equipment that will be added to the collection system for these projects.

So, the next time you see a Collections Operations truck on the roadway, remember they are helping to fight CSOs and protect New York City from threats posed by future coastal storms and climate change!

Frank Loncar, P.E., is the Director of Collections & Resource Recovery Operations for the Bureau of Wastewater Treatment in the New York City Department of Environmental Protection. He may be reached at floncar@dep.nyc.gov.

Succession Planning: A Case Study in Watertown, New York

by R. Mark Crandall and Angel French

Succession planning is ensuring that the proper personnel are in key positions for the future, to allow the facility to efficiently operate independent of employees with long-term "tribal" knowledge. Tribal knowledge is defined as unwritten information that is not commonly known by others in an organization but is necessary to provide quality goods or services *(ISixSigma, n.d.)*.

In 2015, at the City of Watertown Pollution Control Facility in Watertown, New York, we had projected a loss of 128 years of experience due to scheduled employee retirements by the end of 2017 and predicted the loss of another 110 years by end of 2023. From 2014 to the present, 178 years of experience have retired from our facility. Meanwhile, 53 percent of our current staff have less than five years' experience in the wastewater industry. Loss of experience is not unique to our facility; we needed to be proactive planning toward the future.

A cake to celebrate a recent retirement from the City of Watertown Pollution Control Facility. *R. Mark Crandall*

Our Facility

The City of Watertown Pollution Control Facility is a 16 million-gallon-per-day, 4A water resource recovery facility serving approximately 65,000 people. The facility has two influent streams: one from the City of Watertown; and the other from Fort Drum with surrounding communities. These two influent streams combine in the primary treatment tank, which then is diverted between

Aerial image of the City of Watertown Pollution Control Facility. *New York State GIS Clearinghouse orthoimage* two separate processes of extended air aeration tank and high-rate trickling filters.

Qualification Booklet

Loss of experience and knowledge at our facility due to scheduled employee retirements is a crisis. How are we going to replace all the lost knowledge? To answer this, senior staff came together to produce a qualification booklet (PQS) to standardize training for trainees.

New employees go through an initial safety training and immunization process. Sponsors are assigned to familiarize them with the plant as well as the qualification structure for the first few months. The trainee is rotated between the three major areas in the plant: operations, laboratory and maintenance. New employees are also given a qualification binder on their first day of hire. The binder contains the qualification booklet as well as other information about the facility.

The qualification booklet includes all areas of the plant: pretreatment, laboratory, operations and maintenance. Each area is to be signed off weekly by the respective senior staff in each area. Before going to the required schools for their license, trainees are expected to:

- Be able to explain the purpose of each piece of equipment and demonstrate their capability operating the equipment.
- Understand the flow path of water and ability to draw a one-line diagram of the water flow through the plant at the end of the qualification booklet.
- Read and understand all emergency procedures, Standard Operating Procedures (SOPs), and *Operation of Wastewater Treatment Plants Volume I&II* CSU Sacramento.

The qualification booklet is to be signed by the Chief Operator as a final signature validating that the trainee has the basic knowledge to be a wastewater operator at our facility.

Skills Alignment

During the initial interviews, prospective operators are asked about their prior experiences and what direction they want to take their career. Based on this information, junior personnel are aligned with senior operators. Throughout the qualification process, senior staff observe the strengths and weaknesses of the trainees to determine where the trainees would benefit the most in the organization. The trainees' first six months are customized toward building up their weaknesses.

Staff Organization

Our organization chart has been realigned to accommodate the change in staffing at the facility. Treatment plant positions are:

- One Chief Operator.
- One Process Worker 3 (Senior Operator).
- One Laboratory Technician.
- One Maintenance Supervisor.
- One Pretreatment Laboratory Technician.
- Two Process Worker 2s.
- Nine Process Worker 1s (four of which are still in operator trainee status).

Process Worker 1 (operators) work rotating shifts 24 hours a day, swapping time between laboratory, operations and maintenance. The Process Worker 2 position is trained to be a backup to one or two of the four division leaders of the plant. Currently both Process

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The components of the PQS booklet and the required reading materials for trainees. *Angel French*

Trainees learning to install new pumps. Pictured from left to right: Todd Nottell, Jay Slate, Chad Putnam and Chris McMahon. *R. Mark Crandall*

Staff receive management training in eight four-hour sessions for two months. *R. Mark Crandall*

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New employees receive training in fire extinguisher operation. Pictured from left to right: Michael Keefe, Seth Foster, Chris Kingsbury, instructor Cameron DeForest. *R. Mark Crandall*

A few of the new trainees at the plant. From left to right, Seth Foster, Derek Martin and Jay Slate. *R. Mark Crandall*

Worker 2s are aligned to replace the Pretreatment Laboratory Technician and the Maintenance Supervisor, who are set to retire later this year.

Leadership Training

Most of the staff at the facility have had little or no leadership or management training. We have obtained a grant to receive management training from an outside source. This management training was also extended to other divisions within the City's Water Department, including Administration, Water Filtration and Water Distribution. Training consists of eight four-hour sessions for two months. Leadership training will occupy 32 hours for multiple employees, and it will strengthen the crew's abilities as a whole. Trainees will know the difference between a Supervisor and a Leader. Supervisors get a job done; leaders empower employees to complete a job and do it well.

Additionally, junior personnel are assigned to a safety program to enhance leadership abilities. The trainee becomes the subject matter expert in the topic of their safety program. Each program leader is responsible for maintaining the records and the safety equipment associated with the program, training other employees, and ensuring the program is current with regulatory requirements.

Licensed Operators

Once a trainee is a licensed 2A operator, their training is tailored to their individual career path. Operators receive the identical training, but if they are interested in maintenance, they are afforded opportunities to tackle maintenance projects. Likewise, if they are more geared toward laboratory, they are awarded training and hands-on experience within the laboratory field.

We recommend that all our operators obtain a 4A license. By sending potential 4A operators to the required schools, the city will gain better trained personnel with enhanced understanding of wastewater treatment. In addition, employees will have the necessary qualifications to replace staff who are absent, whether they go on vacation for a short time or retire permanently. Investing in the personnel on-site allows us to maintain a minimum specific knowledge of the treatment plant's process.

Succession Plan

The transfer of knowledge and skills from one employee to another is crucial for the growth of personnel within our profession. We believe that senior staff should strive to train their junior staff as eventual replacements. The goal is to be able to fill a position with a qualified candidate before the retiree walks out the door for the final time.

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Reference

ISixSigma. n.d. Tribal Knowledge. Accessed April 20, 2019. *https://www.isixsigma.com/dictionary/tribal-knowledge/.*

Operator Quiz Fall 2019 – Potluck

The following questions are designed for trainees as they prepare to take the ABC wastewater operator test. It is also designed for existing operators to test their knowledge. Each issue of *Clear Waters* will have more questions from a different section of wastewater treatment. Good luck!

1. What is the typical removal efficiency of settleable solids in a primary clarifier?
   a. 10 to 15%.
   b. 20 to 50%.
   c. 40 to 60%.
   d. 95 to 99%.

2. Which of the following is associated with thick billows of white sudsy foam in the aeration tank?
   a. Old sludge.
   b. Low F/M ratio.
   c. High F/M ratio.
   d. High MLSS concentration.

3. What impact does the injection of chlorine gas have on the pH of wastewater?
   a. Increases pH.
   b. Decreases pH.
   c. Does not affect pH.
   d. Fluctuates the pH.

4. Which gas is the most abundant in a properly operating anaerobic digester?
   a. Hydrogen sulfide.
   b. Nitrogen.
   c. Carbon dioxide.
   d. Methane.

5. The formula for calculating the volume of a rectangular wet well is:
   a. V=L x W x C.
   b. V=W x A x P.
   c. V=W x L x H.
   d. V=W x H x D.

6. Check valves are used on the discharge side of centrifugal pumps to:
   a. Equalize the pressure on both sides of the impeller.
   b. Prevent water in the suction line from flowing back into the reservoir.
   c. Prevent water in the discharge line from flowing back.
   d. Regulate the rate of water flow through the discharge pipe.

7. A lantern ring is a:
   a. Metal ring for lowering an explosive-gas detector into manholes and wet wells.
   b. Shaft coupling that has been completely worn through in spots or that has "daylighted."
   c. Spacer ring in a pump packing gland to improve seal water distribution.
   d. Type of coupling for joining pipes that will not be covered or put in the dark for at least 5 days.

8. Hydrogen sulfide is a toxic gas that smells like _______. At high concentrations of hydrogen sulfide, however, the sense of smell is deadened, and no odor is detected.
   a. Dead fish
   b. Fuel gas
   c. Rotten cabbage
   d. Rotten eggs

9. A pH of 6.0 is:
   a. Acid.
   b. Alkaline.
   c. Neutral.
   d. Basic.

10. The flushing water pressure in a water-lubricated wastewater pump should be ___________ the pump discharge pressure.
    a. 10 psi less than.
    b. Equal to.
    c. 5 psi more than.
    d. 5 psi less than.

Answers on page 62.

For those who have questions concerning operator certification requirements and scheduling, please contact Tanya May Jennings at 315-422-7811 ext. 4, tmj@nywea.org, or visit www.nywea.org.

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Answers from page 61: 1D, 2C, 3B, 4D, 5C, 6C, 7C, 8D, 9A, 10C