As this year continues to reveal many firsts and extraordinary situations for all Americans, I hope that you, your family, and your friends are safe and in good health. Like most of you reading this letter, I too did not expect this year to turn out the way it has to date.

After much consideration, discussion, and thought, the Governing Board has concluded that the 2020 State Conference that was to be held in Cincinnati will not take place this year. Though many factors were discussed, in the end, the number one factor was the health and safety of our membership and the professionals of the water industry.

When I started to gather my thoughts for this writing, I began to reflect on all of the wonderful experiences I have had at past conferences and the people I have had the honor and privilege to meet and be able to call my friends and associates. While this is not the way I expected my year as Chair to go, I realized there are many things to be grateful for.

I am grateful for the members of the board and members of committees and districts who have committed their time and efforts to this organization during these unprecedented times. I am proud to hear stories of professionals in our industry who have gone above and beyond the call of duty to provide the public with safe drinking water in a time of crisis. Members of our
profession have proven time and again that in times of great crisis we, the water industry professionals, are willing to go to extraordinary lengths to ensure the safety of colleagues while making sure the water never stops flowing.

Some examples include filtration plant staff living in trailers on-site, working long hours, and having to be away from their families for days at a time. Some working from home to properly social distance while homeschooling their children because the schools were closed. Some taking on duties and responsibilities outside of their job classification. All working selflessly to make sure they did their part.

It has been said that a person’s true character is revealed in times of crisis. What I have learned this year is the character of the professionals in the water industry is strong and resilient. While we do not control what happens, we do control how we respond. We responded by asking ourselves: How can we help? How can we use this time to get better? To grow? To be of service and use?

I want to thank everyone who has worked long hours and has never wavered in their commitment to service. I am proud to say I am a water professional, I’m proud to serve with the great men and women of this profession. I am proud to say that when history looks back on the year 2020, the men and women of the water industry will have proven this to be their “Finest Hour”.

New to AWWA’s tradition of celebrating accomplishments of our members, AWWA and AWWA’s Young Professional Committee is introducing the 5 Under 35—Outstanding Young Professional Award! This is the young professional member’s opportunity to be honored and recognized for demonstrating outstanding service to their Section or Association through leadership and active participation in AWWA YP programs. Nominations may be made by Section YP Committees (with Section Board approval), the Association YP Committee, or by professional staff of AWWA or its Sections. The individual must be under 35 years of age and an AWWA member at the time of the nomination and when the award is presented. Nominations for 2021 recipients are open now through October 1, 2020. Please find the application and more information on the www.awwa.org / Awards webpage.

After several years of volunteering in many positions and other facets for OAWWA, I am ending my latest volunteer position as your Ohio Director on May 31st. Under normal conditions, my tenure would have ended at ACE20 with some outgoing rituals. I will miss these and the interactions with my 2020 Director classmates. It is a bittersweet time.

From the beginning of my Director tenure, I have been blessed by working with and for the incredible Ohio Section and our committed board members. The respect I feel for you all is immense. Water Professionals are always on the job protecting their communities. Thank you for your sacrifice and dedication in keeping us healthy and safe; before, during and after this crisis.

Did you know? Volunteering doesn’t mean that you aren’t compensated, you are; either through contacts you make, or opportunities you find along the way. Having had an extremely fulfilling experience as a longtime volunteer for the Ohio Section, I would recommend to all to utilize your passion for water and volunteer at the District, State and Association level.

I have enjoyed working with the Ohio Section Governing Board and am appreciative of their commitment to Ohio and the Association. I want to thank the City of Dayton for allowing me this opportunity to volunteer. Thank you for the opportunity to support you as the Section Director. My passion for and commitment to the Ohio Section AWWA and the Association will remain.

If you have questions on the Association activities, please contact oawwa@assnoffices.com.

Let us work together for a better Ohio through better water.
VICE CHAIR: SAM JACOBS

Sam Jacob graduated with honors from Marion L. Steele High School in Amherst, Ohio, in 1999. He attended the University of Toledo and graduated in 2004 with a BS in Chemical Engineering and minors in Chemistry and Business. Sam graduated from the University of Toledo in 2005 with an MBA with a Management Focus.

While attending the University of Toledo, Sam performed co-ops with Lorain County Engineers, R.E. Warner, Associates and the Ohio EPA Northeast District Office. After graduating from college, he worked at Ross Environmental Services in Elyria, Ohio. He was hired by the City of Elyria as the Assistant Superintendent of the Water Plant.

Sam holds Class IV Water Supply and Class II Wastewater Treatment certificates, Chemical and Micro Lab Certification, and is a Registered Professional Engineer in Ohio. He has served as the Northeast District Secretary since 2012, and the Assistant Treasurer for the Ohio Section AWWA since 2015. He has taught water and wastewater classes for OTCO and is a member of the Technology Committee.

SECRETARY: GEORGE SENDREY

George Sendrey is a project manager at Environmental Design Group who specializes in water distribution systems and water treatment. He has a bachelor’s degree in biology from Mount Union and a bachelor’s degree in mechanical engineering from Cleveland State University. He currently lives in Brecksville with his wife, Jennifer, and their two kids, Matthew and Lauren. In his spare time, he enjoys playing golf and fishing as well as playing, coaching and watching soccer.

TREASURER: VALERIE MEYERS

Valerie A. Meyers is the Project Manager within the Water Division for the City of Warren. Prior to this position, she was the Operations Supervisor and Laboratory Supervisor at the Water Filtration Plant within the City where she has worked over the last fourteen years.

She graduated from Youngstown State University with a Bachelor of Science in Chemistry. She holds a Class IV Water Supply license, as well as Chemical and Microbiological Laboratory Certification as well.

She is active within AWWA and continues to serves on the Technical Programming Committee.

Valerie enjoys spending time with her entire family, including her two children, Olivia and Mason. She is currently finishing a six-year term as a Deacon at her church, First Presbyterian Church of Mineral Ridge.

AT-LARGE TRUSTEE: DARYL BOWLING

Daryl Bowling is a Water System Consultant for Suez Advanced Solutions. In this role, he works with many municipal utilities in Ohio. He has assisted many utilities in water tank projects. These projects include tank condition assessments, tank cleanings, tank paintings, and tank asset management. Daryl has also assisted other utilities in the area of water quality. One of the primary water quality areas is Trihalomethane Removal. These projects can consist of finding hydraulic methods for reducing water age to installing in-tank aeration systems to remove TTHMs.

Daryl has been very active in AWWA for the last 7 years. He started as a District assistant secretary/treasurer and worked his way to becoming the District Chair. Daryl has been on several committees during his tenure as well. Daryl is a graduate of Eastern Kentucky University and furthered his education in London, England. Daryl enjoys spending time with his family, including this two boys Austin and Logan, and his wife Janet.

NE DISTRICT TRUSTEE: DENITA BONHART

Denita R. Bonhart has 20 years of experience in city government. She joined the Cleveland Department of Public Utilities in 2009 serving as a project manager on the Director’s staff providing leadership to employee change management teams, the department’s reorganization efforts, developing and tracking key performance metrics as well as process improvement initiatives.

Currently Denita is a Business Process Analyst for Cleveland Division of Water learning all she can about the treatment and distribution of water which has led to her involvement with AWWA. Denita volunteered for the 2015 state conference in Cleveland and was a member of the local arrangements committee for the 2019 section conference. After attending the One Water Conference in 2018 in Columbus, Denita was recruited to chair the GAWWA Diversity Committee. Under Denita’s leadership the committee had a successful relaunch during 2019 and continue to seek out avenues throughout the Ohio section to provide new and emerging topics and exercises relevant to diversity, inclusion and equity.

Denita was born and raised in Memphis, TN. Her utility experience has come full circle as her favorite uncle retired from Memphis Light, Gas and Water. Denita lives in Cleveland where she enjoys exploring the city’s culture, attending CAVS games and supporting all things downtown. Denita is the proud mother of Joseph and Ashley Bonhart and grandma to Posh Spice, her seven year old daschund mix.
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Gorman-Rupp's Integrinex® Advanced controls with new FloSmart™ technology are the brains behind the management of your ReliaSource® lift station. FloSmart technology, featuring integrated architecture, is capable of recognizing when a pump is clogging and initiating a cleaning cycle without interfering with the operation of your pump station. For more information, call us at 419.755.1011 or visit GRpumps.com.

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ABSTRACT

Originally built in the 1920s, the Brilliant Water and Sewer District (BWSD) in Brilliant, Ohio was using two wells to serve a population of 2,100 people through 766 service connections. Faced with the need to increase its average production of potable water from 0.59 million gallons per day (MGD – or 2,233 m3/d) to 1.08 MGD (4,088 m3/d), BWSD sought to add waters from a new well to two existing wells, (Well No. 1 and Well 2 No. 2, that were installed in 1927 and 1945, respectively. BWSD could not operate both wells simultaneously.

Both existing wells were meeting the current primary drinking water standards as set by the U.S. Environmental Protection Agency (EPA) and Ohio EPA, however, adding the third well would trigger an Ohio EPA requirement that would apply to all three wells (Rule 3745-91-09 of the Ohio Administrative Code). Based on this requirement, the Ohio EPA refused BWSD's new well permit, requiring BWSD to build a new water treatment plant (WTP) to treat source waters from all three wells for manganese. BWSD contracted with W.E. Quicksall and Associates, Inc. of New Philadelphia, OH, to help it meet this requirement.

Vertical Pressure Filter System Meets Treatment Objectives for Brilliant Water and Sewer District

To address the water needs, the District and its engineering consultant, worked to design and build a new water treatment plant located the Labeille Street location. The new plant includes a three-vertical pressure treatment system designed for potable water production with features capable of meeting special water quality needs for the immediate 672 customers and those in the southern part of the county. The new plant has been operating since December 2019, in compliance with all safe drinking water regulations and will provide sufficient water for current and future development in BWSD’s service area for many years.

This paper will be a case study of BWSD’s WTP and its current operation using the WesTech Vertical Pressure Filter water treatment technology consisting of three (3) 11-foot diameter vessels which can produce a total of 750 gpm (1.08 MGD).

CONTENT

EXISTING FACILITIES

Brilliant Water and Sewer District obtains raw water from two 430 gpm wells. The Brilliant Water and Sewer District potable water treatment process consists of filtration, disinfection and phosphate addition. A population of 2100 people are served through 766 service connections. The plant has an average daily production of 0.59 MGD (190 gpm), and has a recorded maximum day of 0.71 MGD (430 gpm). The plant has an approved capacity of 0.72 MGD (430 gpm).

The existing water treatment system was built in the 1920’s and provides sequestration of iron and manganese with a phosphate addition along with disinfection using sodium hypochlorite. The current system includes two wells – Well No. 1 and Well No. 2, installed in 1927 and 1945, respectively. Only one well can be operated at a time. Well No. 1 was refurbished in 2015. Both Wells No. 1 and No. 2 meet existing primary drinking water standards as set by the U.S. EPA and Ohio EPA. To increase capacity to meet current capacity of 550 gpm and future
Vertical Pressure

demands of 750 gpm, a third well is required. The addition of a third well is triggering an additional treatment requirement by the Ohio EPA.

PROPOSED WELLFIELD AND PROPOSED WATER TREATMENT PLANT

The plans proposed to develop one new well and construct an iron and manganese removal water treatment plant with a capacity of 1.08 MGD (750 gpm) at the new treatment plant location. The plans also proposed raw water transmission lines to the new plant, a finished water transmission line to the existing storage tank. The dedicated finished line is used partially for contact time (CT) and new sanitary sewer lines discharging into the existing sanitary sewers.

Planning for the treatment plant began in 2015 when the water quality standards were not being met. It took approximately 2 years from the ground-breaking stages to completion of this project.

EQUIPMENT PROVIDED.

This project incorporates state-of-the-art water treatment technology involving downflow media vertical pressure filter system using a media coated with manganese dioxide. An oxidant is added prior to filtration for iron and manganese removal using sodium hypochlorite. Chlorine is added as a disinfection agent prior to the clearwell. There is also provisions to feed sodium hypochlorite to the high service pump discharge. pH adjustment is made prior to the clearwell using caustic soda and corrosion control.

The system is controlled with an Allen Bradley PLC and SCADA system providing real-time graphic visual displays and report generation.

Vertical Pressure Filters are an effective, inexpensive, and low-maintenance method of reducing many raw water constituents including, but not limited to, iron, manganese, turbidity, color, and or arsenic. Water is introduced to the top side of the vessel where it passes through a bed of filter media to remove unwanted particulate. The water then passes an underdrain plate with distribution nozzles for effluent discharge. Once the media fouls to a predetermined set-point, a backwash cycle is required to dislodge residual particulate for waste discharge.

Vertical Pressure Filter systems with automatic valves and controls reduce operator attention. Backwashing from in-service filters reduces the scope of supply by eliminating the need for backwash supply pumps, tanks, and valves.

For this project, the engineer selected three (3) ASME code vertical pressure filters with the following design criteria:

*The design backwash rate listed is based on a temperature of 25 °C. The actual backwash water rate must be adjusted 2% up or down for each degree Celsius difference above or below from design temperature; i.e., above 25 °C increase by 2%, below 25 °C decrease by 2%.

AUTOMATIC SIMULTANEOUS AIR-WATER BACKWASHING

Backwash can be initiated either manually or automatically using the electrically actuated valves. When in automatic mode, backwash can occur based upon reaching a terminal headloss across the bed or be scheduled to occur at a specific time, established by the operator.

Terminal headloss across the filter is monitored with both gages and a pressure switch as shown.
A control panel with Allen Bradley CompactLogix PLC operates the system through a Panel View Plus color touch screen.

This project included a simultaneous air and water backwash process, known as MULTIWASH® process which combines air and water simultaneously for the duration of the backwash. The simultaneous air and water wash provides a vigorous scouring action to clean the media while specially designed washtrough baffles are used to eliminate media loss as the loosened dirt is flushed from the media bed. The cleaning process prevents both chemical and biological fouling of the filter media and eliminates expensive chemical cleaning and frequent media replacement while reducing long-term operational costs and improving filtration efficiency.

**How It Works:**

Terminal Headloss: The backwash sequence starts at terminal headloss; the inlet and effluent flows are stopped and the backwash waste valve is opened.

MULTIWASH® System: Backwash water and air are started simultaneously when the cell water level reaches the washtroughs. Simultaneous air and water are continuously applied to the media while the backwash wastewater is overflowing the trough.

Air Purge: Once the MULTIWASH® backwash cycle is complete, the air is discontinued. The water continues to flow, purging the underdrain and media bed to remove entrapped air.

Return to Service: If required by the filter media, a reclarification step is performed to reclassify the media. The filter is then returned to service. If applicable, a filter to waste step is performed prior to returning to service.

The MULTIWASH® process is the most efficient, effective, and economical backwash cleaning method in the market. Other cleaning methods may not clean the media adequately and may require more energy and time to perform. These advantages make the MULTIWASH® process the best choice for any backwash cleaning system.

Aggressive air-water backwashing often can result in media loss. Inside a closed vessel, operators are not able to determine media depth without looking inside, usually removing the manway. Using media retaining baffles with the MULTIWASH® backwash process, media loss is minimized alleviating operators concerns. Minimizing media loss, enhances filter run time, and reduces costs both in replacing media and downtime during media replacement.

The figure shows a cut-away of the vertical pressure filter showing the baffled washtroughs in the top and the air distribution piping and air nozzles in the bottom. Waste during a backwash is collected and directed to the outside of the vessel by the piping below the washtrough.

The MULTIWASH® backwash process was originally developed for wastewater applications. Deep filter beds with large media provided long filter runs with good effluent quality. However, the large filter media bed required very high backwash rates and large volumes of water for proper backwashing. The addition of air to the backwash system increased the scouring action of the backwash, more effectively dislodging solids from the media. However, this extra energy could also lift the media out of the filter cell. This application pioneered the development of specially designed media retention baffles to eliminate media loss. All media, including sand, anthracite, GAC, and other specialty media is retained using MULTIWASH® baffles.

General Filter as inventors of the MULTIWASH® system (sustained simultaneous combined air and water backwash) in 1976 have sold 608 installations since then, with 251 of those installations being the low-profile design.

continued on next page
The media provided in each vessel includes the following configuration.

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
<th>Layer Depth</th>
<th>Effective Size</th>
<th>Uniformity Coefficient</th>
<th>Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthracite*</td>
<td>300 ft²</td>
<td>12 in</td>
<td>0.6-0.8 mm</td>
<td>≤ 1.6</td>
<td>1-ft Bags on Pallets</td>
</tr>
<tr>
<td>Manganese dioxide coated*</td>
<td>450 ft²</td>
<td>18 in</td>
<td>0.30-0.35 mm</td>
<td>≤ 1.6</td>
<td>1-ft Bags on Pallets</td>
</tr>
<tr>
<td>Torpedo sand</td>
<td>72 ft²</td>
<td>3 in</td>
<td>0.8-1.2 mm</td>
<td>≤ 1.7</td>
<td>1-ft Bags on Pallets</td>
</tr>
<tr>
<td>Gravel</td>
<td>288 ft²</td>
<td>12 in</td>
<td>1/4 in x 1/8 in - Next 3 in</td>
<td>1/2 in x 1/4 in - Next 3 in</td>
<td>1/2 in x 1/2 in - Next 3 in</td>
</tr>
</tbody>
</table>

*Media quantities will include sufficient volume for skimming typically 5% extra.

Managing waste water production in water treatment plants is of concern. Estimates used to evaluate waste piping were calculated as follows per the Ten State Standards. Only one vessel can be backwashed at a time.

The exterior is painted with one shop stripe coat of Tnemec N140-15BL tank white Pota-Pox®Plus primer applied with brush to all weld and hard to reach areas, followed by one shop coat of Tnemec N140-1255 beige Pota-Pox®Plus primer. Field finish to be applied by others.

Today, the new drinking water treatment plant provides a maximum/design capacity of 1.08 MGD to service its local customers and assorted businesses. The design capacity will also meet the community’s growth needs for the foreseeable future. The facilities provide capacity to treat up to 750 gallons per day running two or all three filters. Finished water is pumped to two tanks (183,000 gal owned by BWSD and 240,000 gal owned by Jefferson county) after being pumped from the two onsite clearwells (240,000 gal each). The total cost of the project was $3.6 million from the community with a zero percent interest loan from OEPA-WSRF and a $250,000 grant from ARC.

The City is conducting monthly sampling measurements and currently meets the required manganese removal consistently with this new water plant. They are currently getting non-detectable amount of iron and manganese.

**About the Authors**

**Rene Carson**, is an Application Engineer for WesTech Engineering, based out of Ames, IA. Rene joined WesTech in 2018 and has been engaged in the municipal water and wastewater market for 1.5 years. She can be reached at 515-268-8443 or rcarson@westech-inc.com.

**Richard R. (Rich) Ross, PE**, is the Regional Product Manager for WesTech Engineering, based out of northern New York. Rich joined Microfloc in 1992 and has been engaged in the municipal water and wastewater market for 25 years. He can be reached at 443-255-5973 or rross@westech-inc.com.

**Bret E. Norton, PE**, is a Senior Design Engineer at W.E. Quicksall, Inc and Associates based in New Philadelphia, OH. Bret has been in the water and wastewater market for 31 years. He can be reached at (330) 339-6676 ext. 317 or ben@wequicksall.com.
Elyria Solids Handling Project “Makes the Cake”

By Carl M. Steifried, PE Senior Project Manager, Burgess & Niple

Although thickened solids were being trucked off-site to the City's wastewater treatment plant, concerns about rising trucking costs, volume restrictions, and disposal options needed to be addressed in the CIP. New solids thickening and dewatering facilities will eliminate hauling to the WWTP and allow the City to have dewatered sludge cake picked up and taken directly to an approved landfill.

CIP Planning Process

The CIP creates a roadmap that provides the path to rehabilitation, renovation, repair, and replacement of existing and outdated facilities based on their condition, performance, O&M costs, and reliability. A recommended plan of improvements was developed with each project being scored, ranked, and then prioritized based on need, costs, and benefits.

Using the results of treatability studies conducted by the City, B&N completed the study in two phases; Phase I included preparation of a Preliminary Design Report (PDR), which addressed chemical optimization of aluminum chlorohydrate (ACH), potassium permanganate, zinc orthophosphate, and powder-activated carbon. The PDR also evaluated modifications/additions to the rapid mix, flocculation and settling basins to maximize the rated plant capacity and improve water quality through chemical and process optimization. The report included preliminary designs of the improvements, cost estimates, and a schedule for implementation of the recommended improvements in Phase II.

Phase II included preparation of construction plans and specifications to construct a...
Utility Highlight / CITY OF ELYRIA

250,000-gallon sludge thickener tank and a sludge dewatering building to house a 100-GPM centrifuge and two 20 CY sludge containers. The results of the pilot studies during preliminary design were used to size sludge dewatering equipment and sizing of the sludge thickener. The Solids Handling Facilities were bid in early 2016.

Existing Conditions

The Ohio Environmental Protection Agency (OEPA) Approved Rated Capacity for the City of Elyria Water Treatment Plant is currently 22.0 MGD. An overview of the plant is provided to familiarize the reader with the water treatment processes used to treat the raw water drawn from Lake Erie.

Mechanically Cleaned Screens: Two mechanically cleaned screens are located at the lower level of the pump house. The newer screen is 8 feet wide with 3/8-inch openings and is rated for 30.0 MGD.

Raw Water Low Service Pumps: Four raw water pumps that were installed prior to a 1967 plant upgrade when two new pumps (Nos. 6 and 8) were installed. Recently new electric motors and VFD controls were installed. Maximum pumping capacity is 27.8 MGD with a volume of 12,400 gallons.

Pumps are as follows:

- No. 8 – 11.0 MGD or 7,640 GPM
- No. 7 – Future
- No. 4 – 7.0 MGD or 4,861 GPM
- No. 2 – 7.8 MGD or 5,417 GPM
- No. 1, 5, and 6 – 6.5 MGD or 4,514 GPM

Rapid Mixing: At the Elyria WTP, rapid mixing is accomplished in two chambers, each 10 feet, 4 inches square and have a 15.5-foot sidewater depth (SWD) with a volume of 12,400 gallons.

Lime, Alum, Powdered Activated Carbon (PAC), and Fluoride were being fed in the raw water channel upstream of the rapid mix chambers and prior to flocculation. Overfeeding the chemicals resulted from the various chemicals being fed at the same location. Modifications were recommended to improve chemical mixing by reconfiguring the rapid mix basin and reducing the detention time from 140 seconds to the recommended 30 seconds.

Flocculators: Horizontal shaft paddle mixers provide 32 minutes of detention time at the design average daily flow of 22.0 MGD. The flocculators are 66 feet long, 16 feet wide and have a SWD of 15.5 feet. Rated capacity for this process is 23.5 MGD with all four units online and a 30-minute detention time as required by TSS.

Sedimentation Basins: There are four below grade sedimentation basins. Two of the basins are 39 feet wide by 195 feet long, and two are 41.5 feet wide by 260 feet long. Sidewater depth in all four basins is approximately 13 feet and 15.5 feet respectively. Detention time through the settling basins, under Average Daily Flow (ADF) conditions with all tanks in operation is 4 hours and meets TSS for sedimentation. Each tank has two sludge hoppers approximately 20 feet wide with a minimum of two sludge draw-off points. A low dividing wall separates the two sludge collection zones.

Sedimentation Basins:

- No. 8 – 11.0 MGD or 7,640 GPM
- No. 7 – Future
- No. 4 – 7.0 MGD or 4,861 GPM
- No. 2 – 7.8 MGD or 5,417 GPM
- No. 1, 5, and 6 – 6.5 MGD or 4,514 GPM

Flocculators:

- Horizontal shaft paddle mixers
- 32 minutes of detention time
- 22.0 MGD
- 15.5-foot sidewater depth
- 66 feet long, 16 feet wide
- 15.5 feet SWD
- 23.5 MGD for all four units
- 30-minute detention time required by TSS

Sedimentation Basins:

- Four basins
- Two 39 feet wide by 195 feet long
- Two 41.5 feet wide by 260 feet long
- Sidewater depth: 13 feet, 15.5 feet
- 4 hours detention time
- Two sludge hoppers 20 feet wide
- Low dividing wall

The location of Sedimentation Basins Nos. 1 and 2 in relationship to the Flocculators and the difference in geometry between the four tanks result in challenges to equalize the flow and solids loading among the four Sedimentation Basins.

Filters: The Filter Building houses 10 mixed media filters with porous tile underdrains, providing a total filter area of approximately 7,208 SF. With all ten filters in service, the capacity is 20.7 MGD at a filtration rate of 2.0 GPM/square foot. With the largest filter out of service, the rated capacity at 2.0 GPM/square foot is 18.7 MGD. Pilot tests are planned to run the filter at higher surface loading rates for OEPA approval.

Backwash Pumps: Backwash water will be drawn from directly from the clearwell. A new backwash pump rated for 12,950 GPM has been provided in the new High Service Pump Building.

Attenuation Basins: Two Attenuation Basins provide a combined capacity of 164,000 gallons. is currently limited to two backwash volumes per day or approximately 188,000 GPD (1.6% of the current 12 MGD ADF). The City was interested in increasing this to the 10% maximum allowed by the OEPA backwash water recycle rule.

Recycling settled supernate flows from the Attenuation Basin back to the Raw Water Pump Station (RWPS) via an existing 12-inch gravity drain line. Backwash water can be pumped to continued on next page
the City of Lorain sewer in an emergency. Settled solids are pumped to the Head House Sludge Storage Tanks for disposal.

**High Service Pumps:** A new High Service Pump facility with a rated capacity of 33.0 MGD was constructed in 2015. The new building will house four new high service pumps to be rated as follows:

- **Pump No. 1:** 5,500 GPM (8.0 MGD)
- **Pump No. 2 and 4:** 10,500 GPM (15.0 MGD)
- **Pump No. 3:** 6,950 GPM (10.0 MGD)

**Clearwells:** There are three clearwells with a total capacity of 3.2 MG. One clearwell has a capacity of 1.2 MG and the other two hold 1.0 MG each. The clearwells can be operated in series or parallel.

**Solids Storage Tanks:** Two sludge storage tanks were housed in the Head House Building at the Elyria WTP. The four-story building housed the original concrete backwash water reservoir on 4th floor of the building. Two 61,300-gallon sludge storage tanks, each 20’ x 20’ x 11’ side water depth (SWD) were designed to receive settled solids that were pumped from the sedimentation basins. Three sludge transfer pumps are in the basement piping gallery. Thickened sludge is drawn from the hopper and pumped to a 5,500-gallon sludge tanker trucks. Sludge containing 3-4% solids was being hauled off-site to the Elyria WWTP, where it is combined with their WWTP sludge prior to dewatering and disposal. A telescoping valve is provided in each tank to decant from 3,000 to 15,000 gpd (1 to 5 feet) of clear supernate to the City sewer.

**Basis of Design Report**

The Basis of Design Report (BDR) included the findings, conclusions, and recommendations to upgrade the existing Rapid Mix, Flocculation, Sedimentation, and Attenuation Basins, and construct new Sludge Thickening and Dewatering facilities. The BDR included improvements needed to increase the rated capacity of the plant from 22 MGD to 29 MGD by making modifications to the Rapid Mix Tank, Flocculation Basins, Sedimentation Basins, and Attenuation Basin. This article focuses on the design and construction of a sludge thickener and centrifuge to dewater solids and produce a sludge cake that could be directly transported to a landfill for final disposal.

Solids from the Sedimentation and Attenuation Basins would be sent directly to a new Sludge Thickener adequately sized to handle 30 days of thickened solids. A new centrifuge would be provided to dewater 100 GPM of 4% thickened sludge. Spiral screw conveyors would be used to transfer sludge cake to one of two 15 CY dumpsters housed inside a new masonry Solids Handling Building. The lower level serves as a pipe gallery with pumps to draw thickened sludge from the new thickener sludge hopper and feed it to a new centrifuge.

Decant from the dewatering operation would be returned to the Raw Water PS or sent to the City sewer in case of an emergency. Harmful Algal Bloom (HAB) event that would prohibit recycling the flow. Solids for the Attenuation Basin would be thickened and then pumped to the new Thickener. The existing Sludge Storage Tanks (SST) provide additional storage capacity and can be used to allow for unloading and storing trucked-in sludge from other facilities. Piping is provided for emergency filling of tanker trucks for off-site disposal in the event of an extended outage of the centrifuge.

**Sludge Dewatering Pilot Tests**

A pilot test of the sludge dewatering equipment would be conducted to establish design parameters for sizing the new centrifuge system. A Request for Proposals was issued, soliciting vendors interested prequalifying their dewatering equipment to participate in a 4-day demonstration using ACH sludge pumped from the existing sedimentation basins to the existing sludge thickener tanks.

The bid form required the listing equipment cost, estimated annual operating costs, and associated costs for spare parts, extended warranty cost, and annual maintenance contract. A total life cycle cost evaluation formula was provided to establish the equivalent annual cost for each bidder.

Each vendor was provided with the designated trial runs to be performed over a 3-day demonstration period. Test results with feed rates, solids concentrations, machine speed, cake moisture, capture rate, polymer dosage, and power consumption were reported. Each vendor could run trials using polymers besides the two anionic and cationic polymers specified. Each vendor submitted a priced proposal for their equipment showing capital and O&M costs. Costs for spare parts and an extended warranty were also provided.

Three vendors successfully met the minimum performance levels needed to be deemed a “qualified bidder.” The City raised concerns about their potential risks of pre-purchasing the equipment. The RFP was cancelled, and the project proceeded as a conventional design.

### A. Centrifuge Parameters

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<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Number of Centrifuges</td>
<td>One</td>
</tr>
<tr>
<td>B. Minimum Solids Capture Rate</td>
<td>97.5%</td>
</tr>
<tr>
<td>C. Maximum Polymer Usage:</td>
<td>35 pounds (active) per ton dry solids</td>
</tr>
<tr>
<td>D. Maximum Capacity of Solids Handling:</td>
<td>1,000 lbs./hr. (dry solids)</td>
</tr>
<tr>
<td>E. Maximum Operating Cycle:</td>
<td>4 days per week, 7 hours per day</td>
</tr>
<tr>
<td>B. Sludge Type</td>
<td>ACH potable water settled solids</td>
</tr>
</tbody>
</table>

### B. Sludge Type

- **A. Sludge Solids Content in Feed:** 2.5 to 4.0% dry solids
- **B. Throughput Solids:** 1,000 lbs./hour (dry solids)
- **C. Maximum Hydraulic Loading Rate:** 100 gallons per minute (GPM)
- **D. Minimum Solids in Cake Discharge:** 25% Dry Solids @2% Feed
Utility Highlight / CITY OF ELYRIA

Design Phase

Selecting Site Location. During design, three alternate locations on the plant site were considered. One location was too far removed from the sedimentation basins. The second location was eliminated due to clearances from overhead power lines that would have required relocation of the main 69 KV feed to the plant. The third site provided a central location but was bounded on the west by a 7-story high, 90-year-old, masonry H.S. Pump Building, a plant stormwater outfall sewer located 10-feet off the building, and the 54’” raw water main that wraps around the north and east sides of the proposed new facilities.

Records indicated a pre-1900 clearwell and filter building in the vicinity of the proposed site. Soil borings did not encounter any old foundations, but drilled caissons were needed to support the south wall of the Solids Handling Building (SHB). To protect the existing 54” raw water main and the Old High Service PS foundations, soldier beams and lagging were used to protect the adjacent structures. The drilled caissons were also used to retain the existing driveway for sludge hauling trucks.

New Solids Handling Building. A new masonry building was constructed to house the centrifuge sludge pumps, sludge dewatering equipment, conveying equipment, polymer feed equipment, two 15 CY sludge containers, and electrical control panels. The architecture reflects the style of the nearby old and new High Service Pump Buildings, as well as the Head House, and Chemical Building. Insulated cavity walls, window units, and precast concrete roof deck protect against cold winds off the lake. A Pump Gallery is provided beneath the first floor of the building to house the sludge pumps, solids grinder, decant/centrate pumps, piping, and flow control valves.

New Sludge Thickener. The final design included constructing a 230,000-gallon sludge thickener that is 48 feet in diameter, with an 18-foot SWD, and a concrete deck spanning the width of the tank. The 48-foot diameter octagonal-shaped tank eliminates the need for large corners fillets. Vertical pickets are attached to the rake arms to aid in solids compaction and convey the sludge to a 5-foot deep center sump. Settled solids are concentrated from approximately 2.5% solids to 4% - 6% solids, prior to being pumped to the centrifuge for dewatering. An optical sludge blanket meter detects the interface between the clear supernatant and thickened sludge. Three 8-inch pipes are used to decant supernate into a separate decant/centrate pump clearwell.

Decant/Centrate Pumps. Two 200 GPM Decant/Centrate pumps return the centrate from the centrifuge and the supernate decanted from the thickener back to the RWPS clearwell. Each Decant Pump has motor-operated valves and controls the startup and cleaning operations with Operator Interface Terminal (OIT) monitors. Solids concentration. A PLC-based control panel can be adjusted to produce the optimal sludge cake solids concentration. A PLC-based control panel with Operator Interface Terminal (OIT) monitors and controls the startup and cleaning operations of the centrifuge, the sludge feed pumps, polymer feed system, and conveyor system.

Sludge Cake Spiral Screw Conveyors. Four spiral screw conveyors direct the sludge cake

continued on next page
Utility Highlight / CITY OF ELYRIA

vertically, then overhead to discharge into one of two 15 CY dumpsters. A pivoting conveyor slowly moves back-and-forth in an arc to continuously fill a container. When full, the conveyor reverses direction and starts to fill the second dumpster.

At design flow, the centrifuge will operate 14 hours per week and process a maximum of 1,000 lbs./hour of dry solids 25%-35% sludge cake, requiring approximately 7 hours to fill a 15 CY dumpster to its maximum 40,000 pound allowable hauling weight.

Attenuation Basin for Settling of Filter
Backwash Water: Two Attenuation Basins, each 20’ W x 55” L x 10.5’ SWD, providing storage and settling for 90,700 gallons of backwash water. The plant typically backwashes two filters per day that average 75,000-90,000 gallons per backwash. Once an Attenuation Basin is full, the solids can settle out are pumped to the new Sludge Thicker.

Supernate is returned to the RWPS clearwell by a gravity drain or pumped by the new 1,050 GPM pump decant pump P-3 through an existing 12-inch force main. Settled backwash solids are pumped to the new sludge thickener for dewatering.

An 8-inch flow control valve and magnetic flow meter are used to regulate the recycle flow to less than 10 percent of plant actual flow allowed by Ten State Standards. Pump P-3 can be throttled to recycle 540,000 GPD or 340 GPM of backwash water from six of the 12 filters. If all 12 filters were backwashed, Pump P-3 is designed to recycle 1.08 MGD or 770 GPM to the RWPS, which is within DEPA’s maximum allowable return rate to the RWPS clearwell at current ADF.

Figure 1 provides a schematic flow diagram of sludge lines and the various discharges from Decant Pumps P-1, P-2, and P-3 to sewers and manholes that are connected to the City sewer. All sanitary flow will be recorded with the existing meter in MH D and sampled at Sample MH C.

Figure 1 Schematic Process Flow Diagram

SCADA

New PLC-based control panels are provided in the Attenuation Building to control the new recycle pump, sludge pumps, levels, flows, and control valves. In the Head House, a new PLC panel controls two new sludge transfer pumps for the truck fill operation, new grinder, and levels in the Sludge Storage Tanks.

In the Solids Handling Building, a new PLC panel controls the sludge thicker drive, sludge pumps, centrate pumps, grinder, conveyors and polymer feed systems. The new Centrifuge Control Panel is fully integrated with the plant SCADA system. Twenty-three motor operated flow control valves are provided to direct flows from the settling basins, Head House, and Attenuation Basins to the Thickener. Magnetic flow meters measure flow rates and recorded and totalized using the plant SCADA system.

Construction Issues

While drilling of the caissons, the abandoned masonry walls and concrete filter bottom slab and roof of the clearwell were encountered. The new building was shifted southward by one foot to construct the caissons. Old walls were demolished and the clearwell was filled with low strength concrete.

As excavation proceeded for the thickener, the 5 KV electrical feed from the main plant substation to the old high service pump building was encountered and had to be relocated between the sheet piling and the 54” water main. New ductbank for the 5 KV electrical cables, 480-volt power, and 120 and control wiring were run between the existing substation and HSPS. Wiring was swapped over during several scheduled outages, and then the old ductbank and wiring were demolished.

Construction Cost

The $5 million improvement project took 20 months to complete and has been in full operation for over two years.

Acknowledgements

The author would like to thank the City of Elyria’s Samuel F. Jacob, Superintendent, Samuel W. Jacob, Assistant Superintendent, John Schneider, P.E., City Engineer and the plant staff for their involvement in the planning, design, and construction phases of the Solids Handling Facilities Improvement Project.
This February, four members of the Ohio Section Young Professionals Committee attended the annual WEF/AWWA Young Professionals Summit in Anaheim, California. The event allowed us to engage and interact with more than 200 American Water Works Association and Water Environment Federation young professionals (prior to the COVID outbreak) over the three-day event.

The program started off with a bus load of the early-arriving, energetic young professionals spending their Sunday morning giving back to the community during a beach clean-up of nearby Junipero beach. As a reward for their hard work, the group had the opportunity to nerd-out on a private tour of “the world’s largest water purification system for indirect potable reuse” at Orange County Water District’s Groundwater Replenishment System.

The following days, the collaboration and education on the water industry continued, including the AWWA YP Leadership Training and full day WEF/AWWA YP Summit. The AWWA YP Leadership Training marked a milestone for the Ohio Section, as it was the first time the committee was asked to present during the Section Sharing portion of the day. Pooja Chari and her fellow AWWA YP Committee members had taken note of how much growth the Ohio Committee has had in the last 5-6 years, thanks to former chairs Sierra McCreary, Mike Giangiordano, and Tyler York, who helped take the committee from 3 people to 15 people with representation throughout the state and many new initiatives.

During the AWWA YP Leadership Training, Randall Berkley, Committee Chair, and Sarah Hayes, Fresh Idea Chair and newly appointed Chair Elect, spoke to this growth and provided lesson learned on the committee structure and successful events for other Section leaders to take that back to their sections. July Laszakovits, 2020 Fresh Ideas winner and new YP Committee University Liaison for the Ohio State University, found this day particularly enjoyable, noting how much she learned about the mission of AWWA and what the YP Committee is striving for – to engage the community and water professionals under 35.

The last day of the Summit was a leadership training day where participants got the opportunity to practice their leadership techniques and even improvisational business skills. We were fortunate to learn from an experienced panel including Erin “Pink” Mosley, Tom Kunetz, Rogue Water, and Dianna Crilley. A great way to hear more about the YP Summit is to listen to the Water in Real Life podcast episode number 93 where several attendees and speakers discuss their experiences.

Finally, a special thank you to AWWA Ohio Section Leadership and members for their continuous support and engagement. Your investment in Ohio’s young professionals is an investment in the industry today and Ohio’s future.

For any young professional interested in attending next year’s YP Summit in Atlanta, GA or getting more involved in their district chapter, contact your district YP representative listed on the Ohio AWWA website.

Thanks to former chairs Sierra McCreary, Mike Giangiordano, and Tyler York, who helped take the committee from 3 people to 15 people with representation throughout the state and many new initiatives.

Are you a YP looking to become more involved or grow your network?

We encourage you to reach out to one of our YP committee members or join our mailing list to learn about the many exciting things happening for 2020!

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Sarah Hayes, Fresh Ideas; Stantec, Columbus, OH sarah.hayes@stantec.com
INCLUSION IN THE WORKPLACE IS A SIGNIFICANT GOAL FOR MANY ORGANIZATIONS, BUT CAN ALSO BE A DIFFICULT ONE TO ACHIEVE. At times, unconscious biases impact our ability to be truly inclusive. Unconscious bias, or implicit bias, refers to a bias that we are unaware of, and which happens outside of our control. They are the underlying attitudes and stereotypes that people unconsciously attribute to another person or group of people that affect how they understand and engage with a person or group. These biases happens automatically and is triggered by our brain making quick judgments and assessments of people and situations, influenced by our background, cultural environment, and personal experiences.

With the onset of COVID-19, there have been many reports of xenophobia and biases toward individuals of Asian descent, opposing protests about the best course of action regarding the economy and finger-pointing of blame. Stress, anxiety, fear, feelings about our lack of ability to find a cure or treatment, grief about losing our personal and professional routines can trigger biases during a crisis. The following is an excerpt from a 2020 Deloitte employee newsletter (www.deloitte.com/COVID-19) providing some strategy checks to help us manage our personal and professional routines can trigger biases during a crisis.

Unconscious biases to watch out for in times of crisis

Affinity bias: The unconscious tendency to get along with others who are like us. It is easy to socialize and spend time with others who are not different.

Strategy Check: Seek to work with those outside of your “go-to” circles. Challenge yourself to engage at least once a week with someone whose culture or background is different from yours. Make mental notes of similarities you share so that you can differentiate between attributes that may cloud your judgment rather than their unique qualities. What is the best that can happen? You can gain a new appreciation for an associate.

Confirmation bias: The inclination to only consider information that confirms a particular point of view. Many of us are working from home, which can make it easy to dismiss others points of view on conference calls and webinars. We can easily withdraw from the conversation unless our ideas are the focus of the team meeting or we can unconsciously steer the conversation to exclude the ideas of others.

Strategy Check: Seek to actively listen and take notes while others are sharing their ideas. You may find that something they say may actually enhance your view point.

Personality error bias: The judgment that a person’s behavior is core to their personality, without considering external factors.

Strategy Check: This requires you to be the better person. We are all facing the same crisis whether is it a pandemic or other life factors such as grief, disappointment, anxiety or stress. Be cognizant that others may exhibit behavior that is the product of circumstances and not who they are as a person. Give them the benefit of the doubt.

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Savina Phillips
Savina Phillips is Vice-Chair of the OAWWA Diversity & Inclusion Committee and has been an integral part of the committee’s relaunch. As a new member to AWWA, Savina has embraced the association and is excited to develop diversity and inclusion activities beyond the traditional view point. She believes without diverse resources and inclusion of different viewpoints, the greatest solutions may easily be left uncovered. Savina is an Assistant Manager of Marketing at Cleveland Department of Public Utilities and a native of Akron, OH. Her marketing experience was very valuable when developing the committee’s new brand. The visualization of the many color variations connected by ridged puzzle lines, is Savina’s idea of diversity and inclusion, different pieces working together for a common goal. If you stopped by the booth at the 2019 Ohio Section Conference held in Cleveland, saw the diversity and inclusion logo, or received any D&I promotional material you saw Savina’s aesthetic design. You may have even seen her welcoming smile. During the 2019 Conference Savina was an irreplaceable member of the local planning committee and put the “fresh” into the Fresh Water Mixer. She enjoys traveling, spending time with her family, and looks forward to continuing to developing diversity and inclusion practices that will further aid the section and each of us as individuals.

Sapna Mulki
Sapna Mulki is Principal of Water Savvy Solutions in Columbus, OH. Sapna works with public and private water and wastewater utilities and nonprofits to develop strategic public water education and outreach programs. Sapna regularly speaks about the techniques of effective public communication to ensure project success and behavior change. She is also an advocate for diversity, inclusion, and belonging in the workplace and provides strategic implementation on the same. She believes that Diversity is being invited to the dance and Inclusion mean being invited to plan and participate in the dance. Sapna has been a welcomed addition to the OAWWA Diversity & Inclusion Committee. She is developing articles and presentations that we are excited to share with you in the future. You may have met her at the committee booth at the 2019 Section Conference or welcoming you to the Fresh Water Mixer.

continued on next page
UPDATE: OAWWA Diversity & Inclusion Committee

CHALLENGE

Looking at the word cloud let us know which word or phrase (or suggest one that is not included) resonates the best when you think of Diversity & Inclusion. Email your responses to our committee chair, Denita R. Bonhart at denita_bonhart@clevelandwater.com. Insert “choose to include” in the subject line. All submissions will be entered into a drawing to win a D&I Swag Bag and because one is such a lonely number, the committee will award four prizes.

I ❤️ DIVERSITY
Swag Bag!

Committee Members
Denita R. Bonhart, Chair
Cleveland Water
denita_bonhart@clevelandwater.com
NE DISTRICT
Savina Phillips, Vice-Chair
Cleveland Water
Said Abi-Aki
Cleveland Water
Juan Elliott
Cleveland Water
Angela M. Jones
Northeast Ohio Regional Sewer District
NW DISTRICT
Mark A. Riley
City of Toledo Division of Water Distribution
SE DISTRICT
Sapna Mulki
Water Savvy Solutions
SW DISTRICT
Kathleen Stephens-Bryant
Greater Cincinnati Water Works
Trish Harrison
Greater Cincinnati Water Works
Christopher M. Weber
Clear Consulting, Inc.

IMPORTANCE OF DIVERSITY & INCLUSION

Gender Diverse companies in the top quartile for diversity are 15% more likely to financially outperform those in the bottom quartile for gender diversity.1
Ethnically Diverse companies in the top quartile for diversity are 35% more likely to financially outperform those in the bottom quartile for ethnic diversity.3

46% of AWWA members have reported their ethnicity.

AWWA BOARD MEMBERS
43%
Believe that AWWA values diversity.2

AWWA MEMBERSHIP
75%
Believe it is very important to emphasize diversity and inclusion in our policies, actions and practices.2

19%
OF BOARD MEMBERS ARE FEMALE 2

19%
OF ASSOCIATION SENIOR MANAGEMENT STAFF ARE FEMALE 2

46%
87%
Believe diversity is important to extremely important for the future growth of the organization.2

92% of US population growth in the last decade has been ‘minorities’.3

New Water Well Planning: Don’t Fear the Boreholes

Stuart Smith, RG, CGWP, Ground Water Science

Water well construction is a process reaching back into prehistory.

Ground water and the process of siting and constructing water wells is saddled with a certain amount of mysterious thinking, and we’re sorry to say that our experience in Ohio is that there is not much interest in or knowledge of improvements in methods that enhance results. You who are the exception know who you are, bless you.

OK, smart-aleck ground-water guy, what do we need to know?

All well construction is site-specific — the need for knowledge is the key to success.

It is the nature of our practice that we work in a variety of settings. So maybe it is more self-evident to us than others that drilling boreholes in the sand and gravel in the Miami River Valley is distinct from the dolomites of the Lake Erie shoreline, sandstone in northeast Ohio, or in my case, granite in Tanzania. However, you do see people trying to impose features learned one place on tasks in another.

So, the first rule of water well construction is to understand the challenges and constraints of the hydrogeologic setting where the water well is needed. As consultants, it is also incumbent on us to educate the client on these as well. What can the client reasonably expect? What are the risks and challenges, such as risks of contamination from activities in the area? What water quality is to be expected, and therefore water treatment needed?

Geology and what to expect: Ohio is a surprisingly varied place hydrogeologically (the science and description of ground-water resources). If you need a certain, large amount of water, it pays to locate where that kind of water is available. Even where the water can be available on the average, it may or may not be available on any one parcel.

Consider any landscape you see on the surface: A river may have ponds, rapids, narrow, steep valleys, all of which affect the energy of water flowing through it. The same processes, plus maybe a coral reef or a muddy bottom forming in the occasional marine bay, or a mile-high glacier, happened in Ohio in the past, and forms the geology you see now driving along or the aquifers below our feet. So, it is not all the same, not even over any given 40 acres.

Figure 1

Water quality and what to expect: We have had both water systems managers and engineers inform us what water quality they expect the contractors and us to give them. Once again, we are accessing a natural system that has its own rules. Here there may be a radioactive shale pocket that ruins our good mood.
after finding 500 gal/min of low-hardness water. There might be the buried mastodon carcass or woody patch that supports high manganese in a gravel bed. One part of the carbonate may have higher fluoride or strontium than another. Arsenic can occur in some settings. In general, we can have a pretty good idea what to expect, but variety and surprises happen.

Information before designing and drilling. While Ohio is thoroughly perforated and the state maintains extensive drilling log records, a particular location may still be poorly known. It is literally the case that rock can be encountered at 15 ft on one side of a road and 300 ft on the other side. In the same area, some very nice pockets of sand and gravel (recharged from rock) can be easy to miss. Recognizing this, it is important to do as much preliminary work as possible, because the available budget is inevitably limited. More local geologic and water quality information would improve results.

There are several ways to approach this:

1. Pick a spot, option it from the landowner, drill a production well, hope for the best, and accept what you get. The spot may be known from existing wells, map and photo searches, or be near a utility connection, or available at the right price.

2. Conduct test drilling over a possible water well site to find the most promising geology in which to site a water well. This involves conducting borehole drilling over the potential site to collect samples and develop cross sections in order to pick the best likely well construction locations. So yes, this is drilling without actually constructing a well, for information. The drilling, and sometimes construction of a test-pumping well, is more simple than final well construction. Preferred sites may be converted to a production well and monitoring wells. Methods depend on geology, available drilling tools, cost, schedule, and margin of error accepted.

3. There is an entire field known as geophysics, involving electrical, magnetic, sonic, seismic, and even gravity ways of developing a picture of the subsurface without drilling. Employing these techniques is especially useful on totally unknown properties where drilling may not be feasible. In the oil and gas field, no move is made without thorough geophysical surveys. You may be surprised that in our Tanzania work (in a developing country), geophysical surveys MUST be conducted before drilling starts. The results back up the rule. Surveys help to narrow borehole locations to the most likely to be productive. Variations on surface geophysics designed to be lowered in the borehole help to refine the picture of the borehole provided by logging drilling cuttings. Here, a further set

---

In general, we can have a pretty good idea what to expect, but variety and surprises happen.
New Water Well Planning: Don’t Fear the Boreholes

of signals, such as gamma detectors, help to detect fine features, or radioactively hot spots to avoid (for water) or seek out (for oil). Note that none of this is water witching or dowsing, which are folklore.

4. A combination of steps 1 to 3: a) using log, map, and aerial photo study to narrow possible sites, b) geophysics to refine a test drilling study (where, what methods, to what depth), and c) drill boreholes in the refined locations to collect geologic samples to design a final well. Part c) may include a test well to collect water samples and estimate capacity.

Yes, this is all information without production. However, it refines what a water well can be, and makes it the best that it can be: location, design, and materials. In poorly known sites, these steps allow “hold” points where work can be halted with less money spent if results are poor. We’ve seen large, deep, expensive wells drilled without prior subsurface exploration, resulting in 300-ft shale wells or even 1500-ft million-dollar wells in swelling clay, both entirely unproductive.

The type of geophysics and test drilling matter. Geophysical methods are specific to the likely geology. The methods we employ to find water-bearing fractures in Tanzania are different than those finding a good sand and gravel target in an Ohio glacial river outwash or fractures in Ohio carbonates. They also need to be employed and analysed by qualified geophysicists. We’re proper qualified hydrogeologists, but sub the geophysics to the experts. Figure 2

Our old friend cable tool drilling is an excellent exploratory method in addition to its value in clean and accurate sand-and-gravel well completions and well rehabilitation. The drawback is that it is slow. If you have a season or years to explore, this is a good choice (and a rig nearby if you have pump problems). Figure 3

Mud rotary is literally quick and dirty wherever it is used, although a good water well completion method in expert hands. Air rotary drilling is difficult to beat for exploratory drilling in both sandstone and carbonate aquifers, again if managed well. If drilling is too fast or bits are dull, cuttings can be difficult to interpret. Figure 4.

Hollow stem auger methods are very useful in clay, sand, gravel sequences. They drill these rather rapidly and can be equipped with drive tube tools that provide a core for inspection. Direct push (Geoprobe) methods likewise provide a core, and have many applications, such as investigating water quality problems around wastewater basins or ground water contamination.

Rotary sonic (Rotasonic) works in many lithologies including hard rock. Similar to vibratory pile drivers, they vibrate a pipe into the ground and yield a very useful core, in a plastic sleeve no less. Rotasonic is relatively fast, and is available from several vendors in Ohio. So, if you need to site that well this month, this is the way to go. Figure 5, Figure 6.

Or you can guess and hope for the best, or go on a hunch. It’s your project.

Managing expectations

Managing water well construction, as we do, requires preparation for variety in geologic conditions, contractors, rules, and even supply trains. This means not just possibly choosing among various methods, but also carefully thinking through the logistics of the project to be sure that everything needed is accessible, and not 500 miles or 1000 km away. Usually this is the responsibility of the drilling contractor, but project management should keep those on the checklist.

However, even when meticulous care is taken, unforeseen challenges can arise in the form of 1) insufficient quality of materials and 2) unexpected site conditions.

Dealing with “the need for speed”

Tighter budgets and expensive rotary rigs can cause troubling increases in demands for speed from well contractors and sales engineers. This impulse to “push it” most especially affects time devoted to well development and cutting corners on well sealing. Even in straight air drilling, the tendency to push it causes clogging of small fractures and pore spaces with fine cuttings, air locking of aquifer zones, and crooked, corkscrewed boreholes. Time is needed for well development. A number of techniques have been developed to speed up development or redevelopment, but this essential part of well construction still takes time.

continued on next page
New Water Well Planning: Don’t Fear the Boreholes

The role of standards and specifications... and the expert inspector

Perhaps disdained by some as “the paperwork” by “armchair busybodies,” the two versions of “the rule books” each play a key role in managing the above-referenced challenges.

Standards and standard practices serve as the sector’s written memory of what works. They have various purposes, but define what is right: Casing types and wall thicknesses, metal and plastic standards, material quality that is in contact with liquid, concentrations and weights of fluids. Such standards and standard practices (usually developed by professionals by consensus) help to set the tone, and allow everyone to be “all on one page.” States, nations and local jurisdictions also have enforceable rules, which may rely on standards. Where these exist, they must be followed. Our practice is to follow the more stringent path: standard or rule as the case may be.

In a history note, early in its history (1973-1975), the U.S. EPA sponsored a process that gathered and sorted through quality water well construction practices across the USA. Managed by the veteran U.S. Public Health Service experts who became EPA authorities on water well construction (much expertise lost when they retired), well contractors and hydrogeologists mobilized by the National Water Well Association (now National Ground Water Association) gathered good practices and standards.

These standards have remained the basis for standards in the present day, for example as codified by ASTM, the AWWA (such as Standard A100) and the NGWA's own standards for water well construction (ANSI/NGWA 01-07). The resulting Manual of Water Well Construction Practices (revised in the late 1990s) remains in circulation.

State rules. Different states have different approaches. West Virginia has rudimentary construction rules but strictly governs well contractor qualifications. Ohio has laughably limited rules on qualifications, but has detailed well construction rules. These rules have a demonstrable effect on good well construction. One rule, the 300 ft isolation rule (strictly enforced) rather puzzles us. We have researched this, and there is no definite objective reason for it. Neighboring states with similar geology have different isolation distances. In some geology (cavernous karst), 300 ft is not likely to be enough. In some deep settings with adequate protection from the surface, 50 ft may be enough. We’d like to see a 3-D and geologically based isolation distance. But those are the rules.

The specification is written to protect the client and set standards for the contractor, as well as a level field for bidding. The casing shall be this … Development at ____ for ___ hours… Sometimes details such as “the rig shall not be squirting oil everywhere” or “repairs made on the contractor’s time.” Clients and often civil engineers usually do not know well construction, and over 99 % of it disappears into the subsurface. Sometimes, specifications are antiquated, wrong for the geologic setting, or just ignorantly impractical, and these should be refreshed with every new well project.

Who designs and defines the project? As in most places, engineers usually have overall water project management primacy in Ohio, and we know that the well we are working on is often a small part of a larger project, such as a new water treatment plant. As such, engineers want to have the well and its systems (power, piping, controls) defined as early as possible, without changes from estimated costs. This is entirely understandable, but the earth beneath defines what the well can be.

We note, with full respect for the rigor and scope of engineering expertise, that many civils lack familiarity with hydrogeology and water well design. This is where having an actual credentialed hydrogeologist in the loop is very useful, to make that well all it can be – but also understanding the constraints. We do not have geologist licensing in Ohio, so selecting such a person usually comes by assessing qualifications, and also having a level of trust in them. We also recommend having someone familiar with the local hydrogeology, rather than a staff geologist from the San Diego office on board to check off that box in the specifications.

Well contractors also have an abundance of practical and technical knowledge of hydrogeology and well construction, and should be considered as more than mere machine operators. They also like to control the well construction process, and certainly know it well most of the time. Contractors are not interchangeable, and each company has strengths and weaknesses. An experienced hydrogeologist is very helpful in assessing capabilities, and helping to choose the right one for this specific situation. Finally, qualified hydrogeologists are the experts on water well testing and its interpretation to define and benchmark performance. Then you know what the wells can produce, now and for the future.

We also recommend having someone familiar with the local hydrogeology, rather than a staff geologist from the San Diego... continued on next page
Finally, where possible, we recommend having an expert in the water well construction process serving as an inspector for the customer on the work and to document it. There is no intended knock on qualified well contractors here, but the inspector represents the client such as the utility. Well construction always involves unknowns and decision making at the site. Sometimes unfortunate things happen, and quickly besides. Also, the product disappears deep into the ground. The qualified inspector (typically a qualified hydrogeologist) also interpret how the specs apply in real time and conditions.

New challenges in old territories

Hydrocarbons: Resource competition, for instance, can cause changes in existing ground-water use development practices. We have long experience with coal and quarrying aggregates and rock (even defining modern groundwater law), but new possibilities emerge. For example, coal seam gas development in eastern Australia, where the coal beds are interbedded with aquifers, presents new potential challenges to ground-water users there. So far, in the case of Queensland, at least in our experience, everyone is being really responsible and watching the situation closely. However, in the spirit of watchfulness, professional and citizen-led monitoring programs are essential to water resource protection. We’ll always need good water, but maybe not gas. We’ll see how that develops in Ohio as coal is increasingly left in the ground, but value must be extracted for return on investment in reserves.

Under our feet around our Appalachian Plateau office in eastern Ohio is the Utica shale play and its cousin, the Marcellus, mostly in Pennsylvania. Evaluating and responding to water impacts from this oil and gas development of unprecedented scale is difficult. Further to the west is development of the much shallower – and close to aquifer formation – Devonian hydrocarbons. U.S. oil and gas development literally began in this region in the 1850s, so it is perforated with over 150 years’ worth of wells and pipelines, most developed long before modern regulatory rules by operators intent on maximizing profit results. Additionally, some aquifers are dirty and with high iron and sulfide, and in Pennsylvania, there are no private water well construction rules. Methane in parts of the Utica lands has been shown to be coming from coal, and not so much from the new “fracked” wells, but more extensive studies are underway to better define what is happening. How do you sort out the cause of a local problem? And what about brine hauling and the fate of radioactive drilling cuttings? Answering such questions requires analysis that just is not getting done at the Ohio state level, and local water utilities have little say in the location of oil and gas facilities in Ohio. While we find modern oil and gas companies to be far more responsible than in the past, we also have to remember that they are under pressure to perform, and also that water is irreplaceable.

Irrigation: While an issue in the U.S. west for a long time, irrigation is more recently a factor in parts of Ohio. The management of irrigation wells is very limited in Ohio, and has the capacity to alter aquifer characteristics and flow fields in aquifers such as those in far northwestern Ohio. Recently, awareness of nitrate and phosphorus, and even plastics and PFAS/PFOS contamination of ground water and streams has been trending. Regional cooperation, for example through local Soil and Water Conservation Districts, is needed.

Geothermal: Another subtle challenge to groundwater resources is low-temperature (heat pump based) geothermal. Geothermal heating and cooling are valuable parts of the push toward energy conservation and conversion to renewable power sources. However, a geothermal system for a commercial structure can involve dozens to hundreds of boreholes into or through aquifers. It is necessary to seal these boreholes properly, but contractors make their money by the foot or meter. A steady diet of geothermal work can affect contractor attitudes toward well construction, with less patience for the slow, careful nature of municipal water well construction done right. The knowledgeable and people-savvy on-site inspector armed with standards and specifications is more valuable than ever.

Preparing for water well projects (a checklist for client representatives):

1. Understand the local hydrogeologic setting.
2. Strive for optimal water well construction sites via the practice of geology and geophysics.
3. Pre-qualify well contractors and understand their capabilities (in Ohio, there is no effective licensing).

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4. Get to know (and respect) local rules and procedures and work with clients and engineers to help them understand the needs, how the process works, and realistic budgets.

5. Write good, practical construction specifications.

6. Enforce these through the contracting process, site inspection and documentation with appropriate flexibility.

7. Obtain permits, well site approval when a site is chosen, in general keep the government folks in the loop – Make sure well contractors keep you in the loop (and not after the fact).

8. Know who owns and controls the well site – Make sure it is the intended party free and clear of encumbrance, and security is assured.

9. Document the results for the client and reporting to regulatory agencies. Archive copies as they all lose them.

Further reading:


Ohio Administrative Code (OAC) Section 3745 Section 9, Water Well Standards http://codes.ohio.gov/oac/3745-9

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A seminar program on hydrogeology (which can be customized to location), drilling and water well construction, testing, and ongoing asset management (up to 6 contact hours, but also shorter segments) is available from Ground Water Science.

Author: Stuart Smith, RG, CGWP, is a hydrogeologist with some decades of experience and partner with Allen Comeskey, CPG, in Smith-Comeskey Ground Water Science LLC, providing hydrogeologic services in municipal ground water supply, well problem solving and wellfield asset management planning. Stuart is also partner in Ground+Water Tanzania, Ltd., a hydrogeology, well drilling and water construction company operating in Tanzania.

Figures and captions
Fig. 1. Some aquifer settings found in Ohio. Many municipal wellfields are located in our extensive sand-and-gravel aquifers, but sandstone (north-central to northeast Ohio) and carbonate rock (west and northwest) often provide very high yields. Clay-rich till (lower right) often protects from human influence.

Fig. 2. Geophysicist and crew running a surface resistivity survey in central Tanzania (Ground+Water Tanzania Ltd. Photo). Similar surveys can be run to assist ground water exploration in Ohio.

Figure 3. Setting a well screen with a cable tool drilling rig.

Figure 4. Test drilling with an air rotary drilling system, geologist inspecting drill cuttings.

Figure 5. Features of a quality well performance test.

Figure 6. Ground water quality testing and sampling. Dear lab people: When you design your instructions and the procedures you want us, remember that it may be after a sleep-deprived night and 30 F.

Figure 7. Geologist logging and inspection. A geologist on site working for the client is a big asset in assuring quality of data and installation.
Management and Condition Assessment on a shoestring budget

Jefferson Regional Water Authority (JRWA) is a water utility in Montgomery County, OH that has a staff of 6 employees and 7 board members. JRWA has an all hands-on deck approach to their work and all employees play critical roles in their metering, repairs, billing and system upgrade work. When Ohio Senate Bill 2 was passed in 2017 requiring all water utilities in the state of Ohio to have a written asset management plan JRWA knew that performing all of this work internally would be tough to fit into their already overburdened schedule. Paying for an expensive asset management plan was also not an option for the utility. JRWA contacted several firms and ultimately selected RA consultants to begin the process of creating a gap analysis to determine what elements of an asset management plan JRWA already had in place versus what they would need to develop. JRWA did not want a prepackaged asset management plan as they are a unique utility and wanted their plan to be customized for them. Another unique desire of JRWA was they wanted to cash flow all future work and not take on any additional debt. They were fearful that any rate increase proposal would fail due to the financial condition of their town and their rate payers.

The EPA defines an asset management plan as "a written document that demonstrates the managerial, technical, and financial capability of a public water system, a discipline for managing the life cycle of infrastructure assets to achieve a defined level of service at the least cost and risk to the utility".

RA began the process by creating a detailed list of everything that is needed for an EPA approved asset management plan and what each item on the list demonstrated whether it be a managerial, a technical, or a financial capability.

With a very limited budget JRWA and RA decided that any items JRWA could perform internally they would, and anything that was better suited for external resources would be handled by RA.

The largest pain points for JRWA were online maps, asset life projections, listing the assets in order of most critical to update to least based on an asset condition weighting system, and creating financial projections for the entire utility factoring in this new information and information from historical P&L statements. JRWA does not employ an in-house accountant so financial projections for more than a year out were not routine business practices.

One of the very first items on the asset management plan requirements list was a map including the location and names of major assets. JRWA did not have digitized maps of their assets at this point in time so RA Consultants was called to action.
Management and Condition Assessment on a shoestring budget

RA took JRWA’s 248 hard copy engineering plans and georeferenced them to real world coordinates using GIS software. Once the drawings were georeferenced, RA digitized the water mains, and other data available on the drawings, including air valves, service lines, etc. RA survey crews then field verified that the georeferenced data matched real work placement.

RA then setup and configured Jefferson Regional Water Authority’s ArcGIS Online account to enable the use of the ESRI ArcGIS Collector Application for the field employees. This process allowed the use of a smartphone or tablet to collect and update information in the field. Some features of ArcGIS Online include the ability to collect and update data in the field, log your current location, and put the data you capture to work so you can make more informed and timely decisions.

The Jefferson Regional Water Authority is now able to use maps anywhere to ground-truth data, make observations, and respond to events. The ArcGIS Collector Application will improve the efficiency of the field workforce and the accuracy of the city’s GIS.

Being limited by JRWA’s available technology and budget RA decided that the rest of the work could be done in Excel and not in a proprietary software or sophisticated business system that JRWA would need to purchase and pay to maintain on a recurring basis. RA listed all JRWA’s assets that were deemed critical and had JRWA do an inspection of each asset. It was crucial that JRWA used the same criteria for each asset and not just do a visual inspection. Using the information JRWA provided (the installation date, rehab date, historical maintenance records, and expected useful life information from each asset) RA was able to develop estimates for the remaining useful life of each asset and provide a recommended replacement or rehabilitation date. RA and JRWA then worked on cost estimates to rehab or replace each asset and to develop maintenance costs associated with caring for these assets. JRWA also provided a capital improvement list of items that were already in their plans.

Using all this new information the asset management plan was starting to come together, and it was time to develop the financial projections. RA was able to lay out the capital by year that JRWA would need to save in order to cash flow all rehab and replacement projects. We also had a list of assets that were not being maintained at a level that would allow for the longest useful life, so we knew we had to increase operating budgets to account for that. RA then laid out a year by year projection of JRWA’s financials with everything that we learned from this exercise and forecasted the impact on JRWA’s cash balance if no rate increases were implemented.

After reviewing this calculation JRWA changed their thoughts on a proposed rate increase. With the proposed budget increases for enhanced asset maintenance and savings for capital improvements JRWA could have ran out of cash in as little as 3 years without factoring in a catastrophic event.

With the updated financial forecast RA was able to show the impacts of varying rate increases over multiple years versus one massive rate increase that would put a large financial burden on the customers of the utility. The EPA recommends staggering rate increases over multiple years and this is what was proposed to JRWA.

Rate increases are tough for any utility and are usually met with opposition and extensive debate. While cautious to present the proposed rate increases to the board, RA and JRWA staff knew that all of the information gathered during the asset management plan process made a compelling and vital case. Ultimately the proposed rate increases were accepted by all board members and passed!

Fortunately, JRWA had a strong cash position coming into this exercise so even though staggering the rate increases would lower their cash reserves initially the future looks very bright. JRWA will be in a strong enough position financially to handle any unplanned events and will be able to invest in operating and maintenance activities that will renew and prolong the life of their assets which is exactly the goal of the Asset Management Plan requirement.

Key Characteristics of an Asset Management Plan

- **Managerial**
- **Technical**
- **Financial**

FINANCIAL

TECHNICAL

MANAGERIAL

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1. Ohio EPA COVID-19 Responses – DDAGW Website Creation

As a precautionary response to COVID-19, on March 23, Ohio EPA Central Office and district offices temporarily closed. Ohio EPA staff members all began working from home. Staff, having limited access to their telephones, were reached by email (firstname.lastname@epa.ohio.gov) and began to use remote services to ingest plans, permit applications, etc., electronically.

To assist public water systems during these unsure times, a website was posted by Ohio EPA – Division of Drinking and Ground Waters (https://epa.ohio.gov/ddagw/covid19). This webpage contains a multitude of in-depth tools, guidance, and information for public water systems, including a questionnaire that can be filled out by entities and submitted to Ohio EPA for direct assistance. There are multiple Quick Links on the site that lead to guidance on this situation from organizations such as the Centers for Disease Control and Prevention, American Water Works, U.S. EPA, ASDWA, Ohio EPA, etc. There are also tabs for Operations, Operators, Public Systems, Laboratories, Monitoring, and Engineering – more specific to the Division’s normal guidance and functions. The Operations tab contains information regarding operator staffing requirements, Ohio public water system operator guidance, designating essential employees, required public water system monitoring, and additional information regarding operations. The Operators tab contains information specifically for operators of public water systems, and the Public Systems tab contains guidance and essential documents for those public water systems. The Laboratories tab contains information regarding the Ohio EPA laboratory certification program and how these activities will be conducted during the pandemic. The Monitoring tab contains a list of laboratory collection services still operating during this time. It also includes information regarding 2019 Consumer Confidence Report draft reviews and submittals. The Engineering tab includes information regarding plan submittals (how to do so electronically) and fee updates.

During this time, distribution system monitoring has been a question and concern for some public water systems. In response to these issues, Ohio EPA DDAGW has created recommendations on how to address distribution system monitoring requirements and sampling, which can be found on the website at https://www.epa.ohio.gov/ddagw/covid19#187665330-operations. This specific link also contains information regarding operator staffing information and recommendations.

Updates from Ohio EPA have been maintained and posted regularly on this website, and throughout the pandemic it has been recommended that entities and consumers check the site on a regular basis. Please feel free to reach out to the Ohio EPA with any questions that you may have by calling (614)-644-2752, or send an email if you are trying to contact a certain staff member.


In response to Governor DeWine’s COVID-19 State of Emergency Declaration and ODH Director Acton’s Stay at Home Order (Order), nonessential Ohio businesses closed to the public beginning April 7, 2020. Many noncommunity water systems provide drinking water to businesses impacted by the Order and stopped operating as a result.

Returning a noncommunity water system to normal operations after the Order ends won’t be as simple as unlocking the doors and turning on the lights. Most noncommunity water systems operate year-round, with at least some usage most days. Long-term closures are unusual for many water systems and pose unique hazards to public health and water quality regarding operator staffing information and recommendations. When buildings close or become vacant for extended periods of time, the stagnation of water within plumbing can lead to deterioration in water quality, including loss of disinfectant residual, microbial growth, the accumulation of sediments and metals, and increased disinfection byproduct formation.

Fortunately, long-term closures aren’t completely unknown in the world of public water systems. The Revised Total Coliform Rule (RTCR), effective April 1, 2016, requires a seasonal public water system to take specific actions before opening to the public at the beginning of their operating season. The Simplified Start-Up Checklist For Fully-Pressurized Seasonal Systems can be used as a guide when preparing to return a closed noncommunity water system to service.

(continued on next page)
Preparing to Return to Normal Operations

At a minimum, the following actions should be taken by public water systems as they prepare to open:

- **Inspect system components to ensure they are in good condition.**
  
  - Well: The well cap fits securely to the tap of the well casing and the bolts are present and tight. The screen in the down-turned vent is intact. The casing is structural sound (without holes or cracks).
  
  - **Pressure tank:**
    The tank is not leaking. The air bladder has not failed. To determine if the air bladder has failed in a metal pressure, rap a knuckle on the side of the tank. The bottom half of the tank should sound dull when you tap it. The top half should sound hollow. In fiberglass tanks (or if the metal tank sounds the same, top and bottom), unscrew the cap from the Schrader valve (fitting where air can be added) and very briefly press down on the stem in the valve. If the bladder has failed, water will spit from the valve.
  
  - **Any other tanks:** The tank is not leaking. Access hatches are secured. Overflow and vent screens are intact.
  
  - **Treatment equipment:** Equipment does not appear damaged. Chemical injection points have been cleaned. Necessary chemicals are on hand, NSF-approved, and not expired.

- **Distribution lines/plumbing:** All visible lines, plumbing, fixtures, and drains appear intact. Critical valves operate as needed. Valves are in the appropriate open or closed position.

- **Make any Repairs Necessary.**

- **Disinfection of the well and distribution system is strongly encouraged if repairs are necessary.**

- **Flush the System.**

  - Ohio EPA’s detailed instructions for flushing premise plumbing may be useful [https://epa.ohio.gov/ddagw/covid19/#18766534-consumers]. Noncommunity water systems that consist of multiple buildings should flush distribution mains first; if possible, and then flush each building individually, beginning with the building closest to the treatment plant and proceeding outward.

- **If the water system’s well water is high in iron, sulfur, or other contaminants, particulates may accumulate in the well.** Pumping the well to waste (if possible) may reduce the particulates that enter the treatment equipment and distribution system.

- **Disinfection:**
  
  - Although not required, owners and operators may decide to disinfect the water system before opening to the public. Instructions for well and distribution system disinfection are available at [https://epa.ohio.gov/Portals/20/documents/rules/rtcr/DisinfectingWellandDistributionSystem.pdf]. Any time a public water system well is disinfected, two total coliform negative (safe) special purpose samples, collected at least 30 minutes apart, must be obtained from the well before returning it to service (Ohio Administrative Code (OAC) 3745-9-08[D]).

- **Total Coliform Sampling:**

  - Before re-opening and serving water to the public, all public water systems that stopped operating due to the COVID emergency must collect at least one total coliform negative (safe) special purpose sample from a routine location listed in their total coliform sample siting plan.

**Sampling after Returning to Normal Operations**

Returning to normal operations also means returning to the routine of collecting the compliance samples required by the water system’s monitoring schedule. Entry point samples may be collected at any time after the water system returns to normal operations. Normal operating conditions are the operational and treatment processes routinely used by a public water system which are representative of the practices under which water is typically delivered to consumers [OAC 3745-81-01(N)(2)].

However, additional care must be taken to ensure compliance samples collected from distribution system locations are collected under normal operating conditions. This is because the concentrations of these contaminants – such as lead and copper, disinfection byproducts, and total coliform – are affected by the operation of the distribution system. So that the quality of the water served to consumers can be accurately assessed through compliance sampling, the rules that detail the monitoring requirements for these contaminants include special sampling requirements.

Total coliform samples, for example, must be representative of water throughout the distribution system [OAC Rule 3745-81-50(B)]. This means a public water system that does not have an approved disinfection treatment system may not add disinfectant to any part of the system prior to collecting a total coliform compliance sample [OAC 3745-81-01(N)(2)]. While disinfecting before sampling may result in total coliform negative samples, it is not representative of the water served to the public during the rest of the monitoring period and may mask an ongoing bacteriological contamination issue.

Similarly, the lead and copper rules require first-draw samples that have stood motionless in the plumbing system . . . for at least six hours [OAC Rule 3745-81-86(B)(2)]. Because lead and copper usually enter drinking water through corrosion of plumbing materials, their concentrations increase as water remains in contact with the lead- or copper-containing components. Because people do not always run their taps before consuming water, the six-hour stagnation period is intended to mimic the average age of (continued on next page)
water after a decreased use period, such as overnight or a workday.

Concentrations of disinfection byproducts (DBPs) are also sensitive to water age and increase over time as disinfectants react with the organic matter in the water. So that DBP compliance samples are representative of the water customers are consuming, these samples must be collected under normal operating conditions [OAC Rule 3745-81-24(C)(5)]. Flushing the distribution system just prior to collecting DBP samples is not be considered normal operating conditions [OAC 3745-81-01(N)(2)].

Neither the period the noncommunity water system was not operating, nor immediately after flushing before returning to service after the Order ends, Ohio EPA established the following timeframes for distribution system timeframes for distribution system return to service after the Order ends, met for noncommunity water systems maintenance period. To define when system was not operating, nor operating conditions. To define when normal operating conditions have been met for noncommunity water systems returning to service after the Order ends, the system deactivates. If you have questions, please contact your Ohio EPA district office representative for assistance.

3. Asset Management and Reporting Metrics Data

In 2018, Ohio EPA adopted Ohio Administrative Code (OAC) Rules 3745-87-01 through 3745-87-05, which require every public water system to develop a written asset management program. The purpose of the asset management program is to demonstrate the managerial, technical, and financial capability of the public water system. An effective asset management program will help water systems to achieve the longest useful life of each asset at the lowest cost, while delivering the expected level of service.

As part of asset management, all public water systems are required to track and annually document asset management metrics in accordance with OAC Rule 3745-87-05. Metrics are performance measures that allow public water systems to gauge the status of their water system. All public water systems will be required to report their metrics data to Ohio EPA each year. Ohio EPA is currently developing a new online tool, called the Drinking Water Online Portal (DROP), which will allow water systems to submit metrics data electronically. Metrics data must be submitted electronically through DROP. Hard copies and other forms of electronic submission will not be accepted.

DROP will be available from August 1 to November 15 this year for public water systems to submit metrics data for 2019. Each public water system will need to identify a Metrics Submitter, who will need a valid email address, in order to create a DROP account. For 2020, public water systems must estimate any metrics data that was not collected during 2019. The water system will be able to indicate in DROP if the data is actual or an estimate.

All public water systems must have an asset management program and record metrics data. The asset management templates for noncommunity and community systems can be found at https://epa.ohio.gov/ddagw/pws/assetmanagement.

Metrics Data for Noncommunity Water Systems

Transient noncommunity (TNC) and non-transient noncommunity (NTNCS) public water systems must track and report the following metrics data:

- Documentation of instances when the water system’s pressure dropped below 20 psi.
  - If the water system’s pressure drops below 20 psi, it is considered a disruption of service. The PWS must keep record of each disruption of service event and the total number of events must be reported in DROP.
- Number of days unable to serve water
  - Noncommunity PWSs must record each day when they are unable to serve water during regular business hours due to an emergency in the water system (e.g., equipment failure, power outage). This does not include scheduled downtime for repairs (e.g., planned maintenance), and it does not include the off-season if the facility operates seasonally. The total number of days when the water system was unable to serve water must be reported.
- Repair, rehabilitation or replacement tasks per year (Emergency vs. Planned)
  - The PWS must record and report the number of water system repair, rehabilitation, and replacement tasks each year. The PWS must track planned tasks and emergency tasks separately. The total number of each task must be reported.
- Reserve funds
  - Noncommunity PWSs must report the amount of reserve funds on hand or available for immediate use by the water system (e.g. reserve fund balance). It is recommended to have enough on hand to replace the most critical water system asset in the event of failure. If no funds are set aside, report $0.

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For further instruction on noncommunity metrics, please see Ohio EPA's fact sheet on Noncommunity Asset Management Metrics.

Metrics Data for Community Water Systems

Community public water systems are required to report a different set of metrics. These metrics are based on calculations. Therefore, community public water systems must report the raw metrics data into DROP that will be used to automatically calculate the metrics data.

4. Cyanobacteria and Ozone Treatment - The Village of Put-In-Bay Highlight

The Village of Put-In-Bay uses Lake Erie as a surface water supply with treatment of its drinking water thru a multi tech filtration system. There are only 311 service connections, but the population swells to over 20,000 during the tourist season. The treatment has proved efficient for the removal of turbidity but would not be effective in the removal of microcystins. Cyanobacteria (Blue Green Algae) in addition to producing toxins, can pose other treatment challenges for public water systems, including taste and odor and shortened filter run times. The Village of Put-In-Bay piloted an ozone system in the summer of 2017 and 2018. The ozone system proved effective in the destruction of toxins taste and odor and extended filter run times.

The Village Administration changed at the end of 2018 as did the water superintendent. The 2019 HAB season was quickly approaching and expedited action was required to install the treatment prior to HAB season. The Village Administration worked very closely with its engineer and Ohio EPA (legal, engineering, administration, and the division of environmental and financial assistance) to meet the construction deadline of July 1, 2019.

Bids were advertised and opened Jan. 31, 2019. The awarded total project cost was $2,099,282.22. Final revised detailed plans were issued for the ozone system on Feb. 26, 2019, which included an ozone generation system. The WSRLA loan was awarded March 28, 2019.

Ozone equipment was delivered to the Island in May and June of 2019. The final Ohio EPA construction inspection was completed on July 24, 2019, just in time for HAB season. In addition to the ozone installation the Village constructed a new water laboratory and a large break wall to protect the water plant from high lake levels. The coordination of the expedited project required extra effort from all the stakeholders. In the end, the Village of Put-In-Bay is better equipped to produce safe drinking water year-round.

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Demystifying Intelligent Water:
Realizing the value of change with advanced asset management

Kevin Slaven – Asset Management Lead, Arcadis
Eric Bindler – Research Director (Digital Water), Bluefield Research

Introduction
Like their counterparts in other parts of the country, Ohio’s water and wastewater utilities face an array of pressures and pain points, including deteriorating infrastructure assets, an aging workforce, the need for high-in-demand skillsets, and changing social and cultural dynamics. Further challenges — diverging demands in cities and rural areas, depleting aquifers, emerging contaminants, escalating extreme weather disruptions, and expanding affordability gaps — continue to mount.

With the odds seemingly stacked against utilities, it’s no wonder the people leading them are looking to modernize their game plans. Achieving today’s goals while preparing for tomorrow’s challenges means reimagining how utilities manage their assets — the pipes, people, and everything in between. Technology for monitoring, managing, and predicting asset health and performance is giving rise to a new paradigm of digitally enabled asset management. Data-informed decisions around operations, maintenance, and capital investment across multiple time horizons empowers utility leaders to optimize scarce financial and staff resources, service levels, and value for customers.

Adoption of advanced asset management remains limited to a relatively small group of innovative, tech-savvy utilities. More widespread acceptance could help narrow U.S. utilities’ funding gap by as much as $62.4 billion over the next decade by eliminating $27.5 billion from capital investment burden (CAPEX) and $34.9 billion in unnecessary operating costs (OPEX). In Ohio, adoption of advanced asset management tools and frameworks could save water and wastewater utilities as much as $1.0 billion in CAPEX and $1.3 billion in OPEX between 2019 and 2030, equating to $2.3 billion in cumulative total expenditure (TOTEX) savings over the next decade.

What’s driving the demand for change?
The shift toward advanced asset management practices in the water and wastewater utility sector is being driven by four key trends.

First, the investment gap is growing. Total public and private capital investment in U.S. water and wastewater infrastructure reached an estimated $36.6 billion in 2018, less than a third of the $119.0 billion in annual investment the American Society of Civil Engineers (ASCE) projected would be necessary by 2018. This $82.3 billion investment gap is the highest it’s ever been after two decades of steady growth, increasing nearly sevenfold since 2000, when the gap was $11.9 billion. The ASCE...
2017 Infrastructure Report Card scored America’s Water Infrastructure as a D grade. ASCE estimates that there are 240,000 water main breaks per year wasting over two trillion gallons of treated drinking water. In addition, according to AWWA, an estimated one trillion-dollar investment is needed to meet the 25-year demand projections on America’s water infrastructure. ASCE predicts that Ohio alone will need an investment of $13.41 and $14.58 billion in water and wastewater infrastructure over the next 20 years.

Second, affordability issues continue to challenge utilities and their customers. Average U.S. monthly water and sewer rates increased 31% in real terms since 2012, more than double the growth in median household income between 2012 and 2018.1,2 Despite rate increases, utility revenues are still falling short, with only 21% of U.S. utilities able to fully cover the cost of providing services.3 If these trends continue, 36% of households will not be able to afford water within the next five years.4

Third, institutional knowledge is leaving. An estimated 10.6% of water sector workers will retire or transfer each year between 2016 and 2026, with some utilities expecting as much as half of their staff to retire in the next five to 10 years.5 This will drain utilities of the institutional knowledge that veteran system operators have built up over decades. Not to mention, competition to attract and retain the next generation of leaders is heating up.

Fourth, regulations are slow to evolve. While utilities in countries like the United Kingdom, Australia, and Canada must adhere to robust asset management planning and reporting requirements, the U.S. regulatory climate is much different — some states are enacting rules around asset management with ties to funding and/or operating permits, but the process is slow, and may only address one utility service (water or sewer). For example, Ohio Administrative Code (OAC) 3745-87 requires that all public water systems in Ohio must demonstrate the technical, managerial, and financial capability of their system by implementing an asset management program (AMP). The intent of Ohio’s AMP is to provide public water systems with guidance on how to better manage their water systems to meet safe drinking water requirements. Currently, Ohio’s AMP requirements are applicable only to drinking water systems, and there are no planned asset management requirements for sewer systems. While these individual policies help raise asset management awareness, a comprehensive regulatory framework like the one found in the U.K. is nowhere on the horizon in Ohio or the U.S. more broadly. Rather, utilities can look beyond the regulations to focus on the lessons learned from three decades of asset management maturity in the U.K.: 1) Include more than just physical assets. 2) Leverage data and technology. 3) Take a total expenditure (TOTEX) perspective.

Advanced asset management surpasses traditional limits

Traditional asset management’s greatest limitations are that it doesn’t consider all the assets and spend that a utility manages, nor does it leverage the power of advanced technology, such as artificial intelligence and predictive analytics, to do so. Embracing a new Intelligent Water framework — which combines advanced digital technologies with skilled workforces and innovative workplace cultures — can help push utilities into new forward-looking territory where advanced asset management becomes business as usual, all while addressing critical affordability, workforce, and regulatory challenges.

The first limitation of traditional asset management continued on next page
Demystifying Intelligent Water: Realizing the value of change with advanced asset management

approaches is that they are focused strictly on physical infrastructure — they don’t look past the pipes, plants, and equipment, which hampers utilities’ abilities to leverage their entire cache of strengths, and leaves opportunities to maximize resources or create cost savings unexplored.

Advanced asset management, meanwhile, takes a total asset focus, recognizing the substantial value that utility workers create for their organizations, customers, and communities. The advanced asset management paradigm prioritizes investments not just in treatment and conveyance infrastructure, but also in people, skills, and safety, and leverages the experience and institutional knowledge of veteran utility operators for long-term asset management planning. This expanded view leads to a better understanding of how to apply strengths to prioritized risks before infrastructure fails instead of after.

The second limitation of traditional asset management frameworks is that they fail to capture and share data effectively and rely too heavily on historical data and industry standards rather than real-time information on asset health and performance. Disparate datasets on utility assets are housed across multiple platforms and databases (GIS, CMMIS, SCADA, hydraulic models), and many organizations struggle to break down these data silos. Meanwhile, the differing standards that different utility departments — finance, engineering, planning, or operations — apply to asset identification, valuation, and lifecycle planning make collaboration difficult. Reflecting these diverging, siloed approaches to asset valuation, most U.S. utilities have not yet incorporated systematic measurements of risk into their asset management planning workflows, with many relying solely on asset age when prioritizing capital replacements.

Advanced asset management approaches instead emphasize openness and integration, bringing together data from multiple sources and silos in order to optimize asset operations, maintenance, and investment decisions. In addition, advanced asset management relies on real-time data on asset health and operations — for example, from remote meters, sensors, and other Internet-of-Things (IoT) devices — rather than static snapshots of historical data alone, and leverages advanced analytics to immediately detect deviations in asset condition, predict future asset failures, analyze what-if scenarios, and prescribe optimal maintenance or replacement interventions.

As more and more vendors come to market with new solutions for collecting, analyzing, and learning from real-time water and wastewater asset data, utilities are under increasing pressure to have clear frameworks in place for the management, integration, and use of disparate asset data streams. Leveraging these new solutions also requires harnessing new skillsets to complement the financial, engineering, and operations and maintenance resources central to traditional asset management. Anticipated demand for software developers and information security analysts in the water sector will grow more than 25% from 2016 to 2026, more than double the growth rate continued on next page
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of more conventional roles such as pump operators and environmental engineers.6 Water utilities will face significant competition from other industries for these in-demand digital skillsets, increasing pressure to create workplace cultures conducive to digital growth and innovation.

The third and final limitation of traditional assessment management paradigms is that they prioritize upfront CAPEX considerations without accounting for the OPEX costs associated with operating and maintaining an asset over its full lifecycle. This creates an untenable scenario where maintenance is predominantly reactive (i.e., in response to asset faults or failures) or preventive (i.e., on a static, time-based schedule, determined by historical data or standard industry assumptions about the mean time between failures for a specific asset type).

This traditional approach is failing for four main reasons. First, U.S. water and wastewater infrastructure is deteriorating faster than utilities can rehabilitate or replace it, with the estimated average age of U.S. water pipes reaching 45 years. For example, one small Ohio utility’s break rate has approached 90 breaks per 100 miles of pipe, which is over four times the 2018 AWWA Utility Benchmark for Water Distribution System Integrity of 19.4 breaks per 100 miles of pipe for a combined utility. Second, water sector maintenance costs reached an all-time high of $50.2 billion above capital in 2017,7 with utilities increasingly forced to operate in a more reactive mode, exacerbating affordability challenges.

Third, investments in physical infrastructure renewal and replacement often take a replace-in-kind approach to sizing and capacity needs while population, wet weather intensity, and water usage trends continue to shift, with indoor water consumption falling and U.S. population growth slowing. Finally, environmental shocks and stressors (e.g., droughts, wildfires, extreme weather events) strain utilities’ assets and budgets, and prevent utility workforces from focusing on programmatic asset replacement and renewal. The 2010s saw an average of $12 billion disasters each year, up from only three such events per year in the 1980s.8 Recently, southwest Ohio had an extreme weather with winds reaching up to 140 MPH. Officials issued 36 tornado warnings, one flash flood warning and recorded multiple reports of golf ball-sized hail. This event caused the City of Dayton water system to lose pressure after the 15 tornadoes cut power to both treatment plants and pumping stations. The loss of pressure in the system prompted a boil advisory that lasted for four days.

Advanced asset management, by contrast, takes a more expansive view of asset costs, optimizing TOTEX over the lifecycle of an asset rather than upfront CAPEX alone. TOTEX, which was introduced by U.K. water industry regulator Ofwat in 2013, equates to the sum of CAPEX and OPEX. It encourages utilities to make more

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holistic asset management and investment decisions that maximize value over an infrastructure asset’s full operating life. For large-scale assets such as water and wastewater treatment facilities, for example, OPEX costs (such as operations and maintenance labor, supplies, and energy) can account for 75% to 85% of total lifecycle costs.9 Optimizing these day-to-day operating costs creates significant long-term savings.

TOTEX optimization requires a shift in maintenance philosophy from reactive or preventive maintenance modes to predictive or prescriptive approaches that prioritize real-time asset condition. Condition-based or reliability-centered maintenance approaches generate OPEX savings (as both labor and asset performance are optimized) and CAPEX savings (as asset life is prolonged, and replacement expenditures are deferred), driving down overall TOTEX.

Though uptake of advanced, digitally enabled asset management tools and frameworks is still limited among U.S. utilities, the results from early adopters are promising. For example, digital asset investment planning and risk analysis tools have allowed utilities to reduce annual CAPEX by as much as 20%. Using a median estimate of 11.3% in CAPEX avoidance, these platforms could help utilities to save a total of $27.5 billion in CAPEX between 2019 and 2030. Meanwhile, early adopters of advanced asset management practices have seen OPEX savings of as much as 30% of annual maintenance, chemicals and labor costs, and as much as 50% of annual energy and contract services costs. Using these figures, advanced asset management could save U.S. utilities a total of $34.9 billion from 2019 to 2030.1

Altogether, advanced asset management practices stand to help U.S. water and wastewater utilities save as much as $62.4 billion in TOTEX costs between 2019 and 2030, with annual savings increasing from $1.3 billion in 2019 to $9.8 billion by 2030 — or 6% of total projected utility expenditure nationwide by the end of the decade. In particular, adoption of advanced asset management tools and frameworks could save Ohio’s water and wastewater utilities as much as $1.0 billion in CAPEX and $1.3 billion in OPEX between 2019 and 2030, equating to $2.3 billion in cumulative TOTEX savings over the next decade.1

Improving the journey

In order to meet the challenges of the coming decades, utility leaders will need to move away from siloed, traditional asset management philosophies to more holistic understandings of (and transparent communication regarding) their assets, data, workflows, and priorities.

These guidelines can support effective change, but it takes action to realize value. Investing in new ways of working and advanced technology is essential to creating a sustainable water future. Together, they can empower the workforce to overcome affordability and resilience challenges, seize optimization opportunities and foster thriving communities.

Change doesn’t need to be instant or revolutionary to be worthwhile. Evolving in increments can help organizations fine tune their strategies using lessons learned along the way. For utilities looking to begin their

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journeys, here are the critical first steps to take and tools that can help.

1) Know who you are and where you’re at

Create or update your strategic plan: When implementing an advanced asset management program, a key measure of success is whether it helps the utility achieve its strategic goals and objectives. Alignment between the program and the plan provides a line of sight for employees to understand how the higher-level strategy fits into the day-to-day activities required to execute it.

A strategic plan should identify internal and external strengths, weaknesses, opportunities, and threats to the organization. Key examples of internal and external factors include rate constraints, workforce skillsets, regulatory requirements, data availability, customer expectations, and resistance to change.

Conduct a formal assessment on asset management maturity. The Water Environment Research Foundation, which is now the Water Research Foundation (WRF), developed an asset management knowledge base focused on utility members’ needs, called SIMPLE. WRF members can access the framework and decision support tools such as the WRF Strategic Asset Management GAP analysis, developed specifically for the water sector. The analysis assesses practice levels for seven core quality elements of asset management: processes and practices, information systems, data and knowledge, commercial tactics (service delivery), people issues, organizational issues, and asset management planning.

Another useful benchmarking tool is based on the International Standards Organization (ISO) 55000 series of asset management standards. This series describes the elements of a management system for asset management, including Leadership, Planning, Support, Operation, Performance Evaluation, and Improvement. The Institute of Asset Management provides a self-assessment tool based upon these standards.

2) Understand your workforce and the role people play

Foster a culture of innovation: One of the disciplines of the Utility Innovation Framework is maximizing workforce engagement, which allows utilities to create an agile environment that encourages new ideas and adopts new concepts. In turn, these new ideas can accelerate growth and support of advanced asset management programs.

Creating and maintaining a culture of innovation can be a challenge. More than 100 utilities have used the Innovation Environment Self-Assessment Survey to benchmark their innovation environments. When combined with fact-based validation, it provides a clear understanding of where to begin.

Employ change management best practices: It is estimated that 70% of change programs fail, mostly due to employee resistance.10 It is crucial to put people at the center of the change to ensure the solution is utilized long-term. Change management is not simply a task to be completed near the end of the project or program. It must be consistently addressed throughout the entire process to ensure acceptance and adoption. Many successful change management models can be applied, including the ADKAR model by Prosci, which defines five tangible outcomes that people need to achieve for lasting change: awareness, desire, knowledge, ability, and reinforcement.

Key elements of change management for an asset management program include creating and communicating an overall mission and vision, defining roles and responsibilities, documenting a communications plan, providing training, and measuring progress on a routine basis.

3) Weave resiliency into asset management, and vice versa

Recognize synergies in planning processes: Both resiliency and asset management planning require identifying the assets most critical to the water system, or those that have the highest consequence of failure. Doing this thoroughly once can be used for both. Asset management best practices evaluate asset performance against all potential failure modes including mortality (from natural causes), capacity, efficiency, and level of service to determine risk and drive CAPEX or OPEX needs. Resiliency planning, meanwhile, requires an evaluation of assets against external threats from malevolent actions and natural causes which can also be viewed as performance failure modes for an asset.

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Evaluating all the performance failures together and identifying the most likely to occur first provides a comprehensive look at the timing of potential CAPEX and OPEX needs, and a potential for savings. A perspective which combines resiliency and advanced asset management frameworks is especially critical for Ohio’s water and wastewater utilities, given their heightened exposure to climate-related threats and extreme weather events such as polar vortexes, tornadoes, and flooding.


Sources:


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Manganese is a common, naturally occurring mineral found in rocks, soil, groundwater and surface water. Manganese is an essential mineral, and the majority of manganese exposure for most people comes from the food that we eat. However, where the manganese level in the drinking water is elevated, the overall intake of manganese can be too high and health effects including adverse neurological effects have been shown.

The US EPA has long ago developed a health advisory level (HAL) for manganese at 0.3 mg/L, which was intended to be protective of a lifetime of exposure to manganese below this level. Further, the US EPA also recommends that infants up to 6 months of age not be ingesting water with levels exceeding 0.3 mg/L more than 10 days in a year. Still, there is not currently a US EPA or Ohio EPA primary standard to require reduction of manganese below this level. Current US EPA (and Ohio EPA) Secondary Maximum Contaminant Levels (SMCLs) allow for manganese levels in drinking water at a concentration of 0.05 mg/L or below as an aesthetic concern only. The US EPA has long set this level as a secondary level due to noticeable staining and taste complaints above this level.

Ohio EPA had followed US EPAs guidance on manganese and had only a secondary standard for manganese. As a “secondary standard”, it was not readily enforced, and Ohio EPA had allowed sequestration which only improved the visual appearance and helped keep manganese in solution. While US EPA still has a health advisory value of 0.3 mg/L, Health Canada has recently instituted a health-based guideline value of 0.12 mg/L and an aesthetic objective of 0.02 mg/L – one of the lowest limits in the world. Due to recent attention on manganese, current Ohio EPA policy has now disallowed sequestration and communities with elevated manganese are now forced to provide manganese removal as if there were a federal (or state) standard at 0.05 mg/L.

With this new policy by Ohio EPA to require the reduction of manganese in drinking water supplies, many utilities are being forced to provide filtration for the first time or otherwise make expensive filtration improvements. This new Ohio EPA policy has begun impacting small to medium-sized water utilities – especially in eastern Ohio groundwater systems, where the groundwater Mn levels are often above even the health advisory levels. The Ohio EPA's Ambient Ground Water Quality Monitoring Program (AGWQMP) has shown significantly higher manganese in eastern Ohio – especially with sandstone and sand and gravel aquifers, and significantly when underlain by the Pennsylvanian-Aged bedrock. Figure 1 shows the relatively higher levels of Mn in eastern Ohio. Figure 2 further illustrates that the highest levels appear to be within areas of Pennsylvanian Aged bedrock.
Most well-run iron and manganese removal (filtration) plants have been able to remove manganese to some extent. However, depending on filtration media type, chemical feed (aeration, pre-chlorination, pre-permanganate), pH, raw Mn levels, and other factors, significant improvements may still be required to keep Mn below the newly required levels. When utilities are considering alternatives to remove manganese, many opt for conservative “10 state standards” designs involving permanganate and/or chlorine addition, long detention times (30 minutes), and synthetic greensand (as natural greensand is no longer available). However, there are also alternative high rate / catalytic medias that can significantly remove iron and manganese to low levels with little to no detention time, and even no feeding of permanganate. Further, some of these medias can perform at filtration rates much higher than conventional groundwater filtration – resulting in far lower overall capital costs.

While utilities in western Ohio still can have relatively high levels of manganese in their ground or even surface water, it is typically less problematic than in eastern Ohio. Further, since the carbonate aquifers in western Ohio produce much harder water than in eastern Ohio, many utilities have already provided softening. A secondary benefit is that softening can also significantly reduce the manganese levels in water. Lime softening (high pH precipitates Mn), ion exchange (Mn not removed in the filters is exchanged/removed similar to calcium and magnesium in the ion exchange vessels), and membranes (physically excludes Mn due to pore size) all typically provide enough manganese removal to be within even the secondary standard of 0.05 mg/L. There are advantages and disadvantages of each of the methods of water softening which are summarized later in this text.

As many utilities will be required to make capital improvements to meet these “new” requirements, decisions must be made on the extent of these improvements. Many utilities will be required to increase water rates significantly, and there may be some customer push back – especially in areas that do not already soften their water. The incremental capital cost of adding softening as part of the improvements for manganese reduction is smaller than one might think (in many cases), especially if softening will be providing some of the manganese removal.

As the operational cost of softening at the municipal level is far less expensive than ion exchange softening in individual homes by individual homeowners with the purchase of salt, much of any potential rate increase could be more easily justified by the utility. It is estimated that salt costs alone for a home water softener cost the homeowner $10 - $25 per month or more. Softening on a municipal scale would likely cost less than $3 per month in additional operational costs.

Using a very conservative (low) monthly savings (say $7 per month) and 1,000 customers – would yield enough overall savings for the utility to capitalize an additional $2.8 million, which would likely far exceed the incremental cost of adding softening (based on 3%, 20-year financing) for a plant serving this population. Of course, there are some customers who do not have or want soft water and/or do not want to pay for others to have softer water. This is understood and the author takes no stand on the issue. Transparency, and public communication/education is key for any community faced with similar challenges.
If the utility ultimately decides that it could make sense to start softening, or wishes to evaluate this, a comparison of some of the softening technologies is shown below in Table 1 and a summary comparison that follows.

### Table 1 – Advantages and Advantages of Various Softening Technologies

<table>
<thead>
<tr>
<th>Treatment Technique</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
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</table>
| **Ion Exchange**    | 1. Lower Capital Cost  
2. Small footprint  
3. Removes Manganese not removed in filtration. | 1. Adds TDS to receiving stream — Potential TDS Compliance Issues  
2. Operational Cost — Salt Costs are Significant  
3. Adds Significant Sodium to Water |
| **Lime Softening**  | 1. No TDS Compliance Issues  
2. Relatively Stable Cost Over Time  
3. Reduces TDS in Finished Water and Lime Sulfate  
4. Removes (precipitates) Manganese and Iron. | 1. Significant lime handling / delivery is required  
2. Lime Disposal Required and Costly  
3. Most Expensive Capital Cost except for larger plants |
| **Reverse Osmosis / Nanofiltration Membranes** | 1. Minimum Capital Cost  
2. Less Chemical / Material Delivery Than Lime Softening  
3. Removes Dissolved Manganese (Stabilized MS (Mn) Must be Removed in bios  
4. Lower Chemical Costs  
5. Highest Water Quality  
2. Higher Power Costs  
3. Potential concentrate disposal issues  
4. Potentially Unfamiliar Treatment / Operator Comfort |

### Ion Exchange Softening (IX): Strong acid cationic ion exchange (most common) typically utilizes a polystyrene resin which is regenerated with salt (bulk sodium chloride) to exchange for other ions in the water. When in operation, the resin “beads” readily exchange (trade) the sodium ion inside with an ion in the raw water. There are differences in ion selectivity in some resins but in general the calcium and magnesium (hardness causing ions) are exchanged with sodium (adding sodium to the water). Iron and manganese can also be exchanged but will decrease resin life and could plug the resin bed if the iron / manganese is in the oxidized forms. IX can be completed in an enclosed pressure vessel or open “filter” beds. In addition to adding sodium to the finished water, this method of softening adds the most dissolved solids (primarily sodium and chloride) to the ultimate receiving stream. IX systems have been trending downward in favor of membrane softening for many utilities due to high salt costs, water quality, and the environmental impacts of such a high amount of salt sent to the receiving stream. For a typical Ohio groundwater, the amount of salt discharged to the receiving stream (through a WWTP or directly to the stream) can be as high or higher than 7,000 pounds of salt per million gallons. Not only is this a significant amount of salt going into Ohio streams, the cost of the salt would be approximately $420 per million gallons (based on $120 per ton). However, these systems are easy to operate and can be automated.

### Lime Softening: The Lime softening process adds lime (calcium oxide) - or sometimes lime and soda ash to raise the pH significantly high enough to drop out the calcium and magnesium ion as a precipitate — thus softening the water. Iron and manganese are also significantly removed. Most of the large (10+ mgd) plants that soften utilize lime softening. For new installations, the cost of constructing a lime softening (or its variations) is often higher than both IX and membrane softening. This coupled with the ever-increasing cost of lime sludge disposal (especially with surface waters that potentially have algal toxins within this sludge), has caused many utilities to forego lime softening in favor of membrane softening.

### Membrane Softening: Nanofiltration or reverse osmosis softening (RO) involves pumping water through a series of spiral wound membranes under relatively high pressure (70 psi – 125 psi). Due to the small pore size of the membranes, the hardness-causing ions (calcium and magnesium) as well as many other ions are removed. The selection of membrane will depend on the ion that is intended to be removed. For instance, while membrane softening is targeting calcium and magnesium ions (relatively large size ions), a looser membrane can be used than if nitrates, sodium, or other ion is also needing removal. Membranes in Ohio waters have been used to...
## Terry Lewis Huber • 1956-2020

Terry Lewis Huber, 64, passed away April 8, 2020 at his home surrounded by his loving family after a courageous battle with cancer. He was born May 15, 1955, in Lima. On May 22, 1982 he married the love of his life, Cheryl Kay Anspach, and she survives in Lima. Terry graduated from Bluffton High School in 1973 and attended The Ohio State University. Terry recently retired from the City of Lima where he spent nearly 41 years working at the Water Supply & Treatment Plant, of which he spent 25 years as the plant supervisor. He held a Class IV water supply operator's license and taught basic and advanced water operator classes through the Operator Training Committee of Ohio. Terry was a 32-year member of the American Water Works Association (AWWA), receiving the Ohio Section AWWA Operator’s Meritorious Service Award for continuous compliance with all public health standards in the water treatment system, training of water treatment personnel, and support of the Ohio Section AWWA. In addition to his water career, he was a member of Rockport United Methodist Church (RUMC) where he had served as a liturgist, a lay leader, and many other roles. He enjoyed playing and watching sports (especially Ohio State football), attending his kids and grandkids’ events, and running the family business, Huber Farms, that he co-owned with his twin brother Larry. Terry was a devoted husband, father, and papa who always made time for his family. He is remembered as a loving, caring, generous, and soft-spoken man. He enjoyed traveling, especially his trips to Hawaii, the Smokies, and various mission trips throughout the United States. Terry will be greatly missed in our Ohio water community and we ask that you keep Larry Huber, a Past Chair of the Ohio Section AWWA Governing Board, and their family in your thoughts.

## Jake Meinerding named Principal

### FOR IMMEDIATE RELEASE

JONES & HENRY ENGINEERS ANNOUNCES JAKE MEINERDING, P.E., PROMOTED TO PRINCIPAL OF FIRM, CINCINNATI, OHIO

Jones & Henry Engineers, Corporate Headquarters, Toledo, Ohio / March 31, 2020

Jones & Henry Engineers is excited to share, our Cincinnati Office Director and Project Manager, Jake Meinerding, has been named a Principal of the firm. From our Cincinnati, Ohio office, we continue to grow our team to support the Southern part of Ohio, Northern Kentucky, and Southern Indiana.

Brad Lowery, P.E. and President of the firm shared, “Mr. Meinerding’s exceptional dedication to the firm, and our commitment to the water, wastewater and infrastructure world, has taught me the importance of this field and how we can truly benefit society.”

Jake has been a valuable employee for over twelve years following his graduation from Ohio Northern University. At Ohio Northern, he gained his degree in Civil Engineering and the foundation was laid for his technical knowledge and understanding of the problem-solving required in being a professional engineer.

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As he began his career in the water/wastewater treatment and infrastructure world, he sought to further enhance his skills and knowledge and took on the challenge of obtaining his Master’s Degree in Environmental Engineering from the University of Cincinnati.

Brad Lowery, P.E. and President of the firm shared, “Mr. Meinerding’s exceptional dedication to the firm and our clients made making him our newest Principal an easy choice.” He has been intricately involved in studies, designs, and construction projects and was recently the lead designer and project manager for his hometown of St. Marys’ new water treatment plant, which is currently under construction.

Jake shared he is, “looking forward to working with utilities and municipalities and our team at Jones & Henry for the rest of my career.”

Jake notes, “I could not be more proud to be part of the future of Jones & Henry Engineers and our commitment to the water, wastewater, and infrastructure world. I look forward to my new role here and the unique opportunities it will bring.”

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INTRODUCTION

This article provides information necessary for those water systems using chloramines as a secondary disinfectant and presents detailed information related to nitrification in water distribution systems. Several water treatment plants began using chloramines to meet the Stage 2 Disinfectants/Disinfection Byproducts Rule for total trihalomethanes (TTHM’s) in the late 1990’s and early 2000’s. Some of these systems may have switched to chloramines without fully understanding nitrification, its causes, and how to control nitrification in their distribution system. This series of articles is meant for water systems that either produce chloramines at their water treatment plant or for distribution systems that purchase drinking water that contains chloramines. Consecutive water systems, those that purchase water from a wholesaler, can be especially vulnerable to nitrification since they may not have chemical capabilities themselves to combat a nitrification event. This article is one in a series of three articles explaining nitrification and its causes, distribution system monitoring and response plans, and control measures to prevent nitrification events.

Water systems using chloramines for secondary disinfection are encouraged to maintain available reference materials related to nitrification in water distribution systems in their library. American Water Works Association (AWWA) currently has a manual of water supply practice for nitrification in their reference literature. Figure 1 illustrates the most current version (Second Edition) of M56 - Nitrification Prevention and Control in Drinking Water.

CHLORAMINES

Chloramines are formed by the reaction between free chlorine residual and ammonia. In most water treatment plants, chlorine is applied first to produce free chlorine residual to meet CT requirements for disinfection in clearwell storage. Once the CT requirements are met, an ammonia source is added to the water to convert the free chlorine to monochloramine shown in the reaction below.

\[ HOCl + NH_3 \leftrightarrow NH_2Cl + H_2O \]

Chlorine to nitrogen ratios generally are maintained at 4.5 to 5.0 to minimize free ammonia residual in the water and to produce only monochloramine. Often water pH also is maintained at 8.3 or greater to increase the reaction rate during the conversion. Increased pH also tends to stabilize chloramine residual in the distribution system. Water systems typically avoid feeding too much or too little ammonia so that dichloramines and trichloramines are not produced in the reaction.

NITRIFICATION IN WATER DISTRIBUTION SYSTEMS

Nitrification in distribution systems is a microbiological process where reduced nitrogen compounds (usually ammonia) are sequentially oxidized to nitrite and then possibly to nitrate. Nitrification can be problematic for water systems using chloramines for residual maintenance and THM control. Biofilms are always present in distribution systems at relatively low levels and usually are controlled by maintaining the proper residual concentrations. However, specific species of bacteria in the biofilms can grow and reproduce quickly if excess free ammonia is present in the water. These bacteria are generally responsible for nitrification events by reducing chloramine residuals and by releasing ammonia into the water from chloramine residuals.

There are two primary reasons that chloramine residuals decline over time in distribution systems. One reason is due to chloramine demand-causing substances present in the water. Both organic and inorganic materials commonly found in the water can react with chloramines reducing their residual concentration and releasing free ammonia. A second reason is natural chloramine decay based on water pH, water temperature, and water residence time (water age) in the system.

Excess free ammonia can be present in water from several sources. Customary sources for excess free ammonia in chloraminated water include improper chlorine to nitrogen ratios during treatment, autodecomposition of chloramines, increased chloramine demand by elevated organic content (NOM, TOC, etc.), release of ammonia from chemical reactions in the system, presence of nitrite ion in the water, and decomposition from biofilms. Many of these reactions in distribution systems release free ammonia from the chloramine residual present and increase biofilm activity.

Incomplete nitrification involves typical release of ammonia from monochloramines and development of nitrite ion in the water. Both activities significantly decrease chloramine residuals due to an increase in demand. Complete nitrification involves oxidation of nitrite in to nitrate by biological activity.

Nitrification in distribution systems is a two-step microbiological process. Nitrosomonas bacteria use ammonia to produce nitrite ion. Nitrite is then consumed...
by Nitrobacter or Nitrospiras bacteria producing nitrate ion. These activities result in decreasing chloramine residuals as well as increase chloramine demand in either portions of the system or in the entire distribution system. Generally, nitrification occurrence begins with increasing water temperatures (greater than 15°C) and in the highest water age areas and where free ammonia is present. Hydrant flushing often spreads the biofilm bacteria into other areas of the system making nitrification worse. The quickest means of determining whether residual decline is from autodecomposition or from nitrification is to monitor nitrile levels in the distribution system. Generally, background nitrite content in most distribution systems will be about 0.02 mg/L to 0.03 mg/L. If residual decline does not have corresponding nitrite increase above 0.03 mg/L, then the most likely cause of declining residuals is autodecomposition from high water age and elevated water temperatures.

Nitrosomonas bacteria presence will increase nitrite content in the water as nitrification occurs. If nitrile levels in the system increase above 0.03 mg/L, then the most likely cause of declining residuals is autodecomposition from high water age and elevated water temperatures. Is also common during nitrification events to observe decreasing water pH levels and cause of declining residuals is nitrification. Changes in water quality often can lead to other operating problems and/or regulatory non-compliance issues.

Chloramine Decay

After they are formed, chloramines generally follow two specific reaction mechanisms - demand reactions and decay reactions. Residual decay in distribution systems follows a first order reaction from the classic Chick-Watson equation. Predictions of either free chlorine decay or chloramine decay can be made by modeling decay reactions over time. The residual decay reaction is shown below.

\[
C_t = C_0 e^{-kt}
\]

Where \(C_t\) = Chloramine residual in mg/L at time \(t\)

\(C_0\) = initial chloramine residual in mg/L

\(k\) = decay coefficient

\(t\) = residence time in days

The site-specific decay coefficient for water systems is based on water quality and is estimated from experimental data. Coefficients also can be adjusted from specific pipe sizes, flow velocities, water temperature, corrosion byproducts, and biofilms developed in water systems where the resulting coefficient accounts for multiple decay responses. Once an estimated decay coefficient is identified, residual decay over time can be calculated to predict a residual concentration at a specific water residence time or water age in the distribution system. Figure 2 illustrates a typical residual decay model for a system using chloramines.

Figure 3 demonstrates the impacts of water pH on chloramine residual. Lower pH values tend to increase chloramine decay, while maintaining elevated water pH levels in distribution systems results in more persistent residual concentrations.

Figure 2 - Typical Residual Decay Model

| k = 0.011 |
|---|---|---|---|---|---|---|---|---|
| Temp. °C | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
| mg/L | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 |
| 2.0 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 |
| 2.5 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 |
| 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.8 |
| 3.5 | 3.9 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 |

Figure 3 - Impact of Water pH on Chloramine Decay

continued on next page
Nitrification In Water Distribution Systems (Part 1 of 3)

Figure 4 shows the effects of water temperature on chloramine decay. Lower water temperature tends to reduce residual decay, while elevated water temperatures increase residual decay in water systems. Elevated water temperature, especially in the southern states, is likely the major contribution to residual decay in water distribution systems making residual maintenance exceedingly difficult. Chloramination is commonly used in elevated water temperature conditions due to its residual persistence in water versus free chlorine residual.

Figure 4 - Effect of Water Temperature on Chloramine Decay

Chloramines and Consecutive Water Systems

Consecutive water systems often do not operate and maintain a water treatment facility. Consequently, these systems must rely on the water wholesaler (supplier of the purchased water) to produce enough chloramine residual for the consecutive water system operations. Maintaining chloramine residuals in consecutive water systems can be difficult depending on water quality and temperature, the initial chloramine concentration in the purchased water, and water residence time in the wholesale system as well as in the consecutive system. Use of booster chloramination equipment in consecutive water systems is not common and decay of chloramine residuals often reduces residual levels below desirable concentrations. Similar issues exist if the consecutive systems experiences nitrification where little to no water quality adjustments can be made to reduce nitrification occurrences. In most cases, consecutive systems must rely on assistance from the wholesaler if nitrification occurs in the distribution system. Recent experience using simple chemical treatment has shown promise for consecutive systems that aids in preventing nitrification. More information related to this chemical feed is disclosed in Part 3 - stay tuned.

Improper Chlorine to Nitrogen Ratios

Maintaining proper chlorine to nitrogen ratios in treatment applications is critical to minimize free ammonia residual in chloraminated water. Too much ammonia feed increases the free ammonia residual and can significantly reduce chloramine residuals in the distribution system by increased chloramine decay. Too little ammonia fails to convert all the free chlorine to monochloramine resulting in a mixture of different residuals that can increase taste and odor issues. Water chemistry generally dictates the most effective ratio of chlorine and ammonia that maximizes monochloramine formation and minimizes free ammonia in the water. Chemistry dictates that chlorine to nitrogen ratios be maintained between about 4.5 to 5.0 for proper monochloramine conversion. Maintaining water pH levels during chloramination at 8.3 or greater increases the reaction rate during chemical treatment. Any free ammonia residual remaining after monochloramine conversion should be no more than 0.05 mg/L. Excess ammonia in the water generally results in the reaction shown below and increases nitrite ion presence.

$$NH_3 + O_2 \rightarrow NO_2^- + 3H^+ + 2e^-$$

Autodecomposition of Monochloramines

Figure 3 illustrated the decomposition of monochloramine due to pH differences. Low pH levels tend to increase decomposition of residuals much faster than higher pH levels. At pH greater than 8.3, autodecomposition is significantly reduced maintaining higher chloramine residuals. Figure 4 demonstrated the impact of water temperature on decomposition of monochloramines. Elevated water temperature tends to increase decomposition of chloramines in water. Changes in pH, temperature, or residence time can result in autodecomposition of chloramines, which is simply chloramine residual acting on itself as shown below.

The reaction releases ammonia from chloramines and produces an acid that consumes water alkalinity and reduces pH levels. Changes in water quality from chloramine decay reactions can result in problematic system concerns as well as regulatory issues.

$$4NH_2Cl + 3H_2O \rightarrow 3NH_3 + NO_3^- + 5HCl$$

continued on next page
Increasing Chloramine Demands

Several water quality changes can increase chloramine demand in distribution systems that ultimately reduce residual concentrations. Increases on organic content (NOM, TOC, DO, biofilm growth, etc.) will increase the demand for chloramine oxidation in the customary chemical reactions and release ammonia from the residual levels present. Especially for surface water systems, natural organic matter leaving the treatment plant should not increase seasonally by more than about 0.5 mg/L as TOC. Elevated TOC content will impose a significant oxidation demand and initiate a decline in residual concentrations. Biofilm growth due to the presence of free ammonia and elevated water temperatures usually cannot be controlled by chloramines once the populations reach a site-specific level in the system. Primarily increases in inorganic content (like nitrite ion or bromide ion) can initiate nitrification reactions, but also produce a significant chloramine demand. The presence of inorganics in water further increases nitrification reactions releasing free ammonia from existing chloramine residuals. The typical chemical reaction associated with oxidation of organics and release of ammonia is shown below. The reaction byproducts alter water quality and may lead to regulatory concerns.

\[ C_6H_7O_2N + NH_2Cl + H_2O \rightarrow CO_2 + NH_4^+ + HCO_3^- + Cl^- \]

System Chemical Reactions

Reactions at the interior pipe surface with scales, inhibitor films, or corrosion byproducts can release ammonia thereby adding food for biofilm growth. The customary chemical reaction at the pipe surface is shown below. Ammonia release adds additional nutrients for microbial growth. Acid formation generally consumes alkalinity and reduces water pH levels. These water quality changes can impact quality deterioration leading to potential concerns and regulatory issues.

\[ 3NH_2Cl \rightarrow N_2 + NH_3 + 3HCl \]

Presence of Nitrite Ion

Nitrite ion in water creates a chloramine demand that releases additional ammonia from existing residuals according to the chemical reaction shown below. Ammonia release adds additional nutrients for microbial growth. Acid formation generally consumes alkalinity and reduces water pH levels. Nitrite formation generally perpetuates the nitrification reactions. These water quality changes can impact quality deterioration leading to potential concerns and regulatory issues.

\[ NH_2Cl + NO_2^- + H_2O \rightarrow NH_3 + NO_2^- + HCl \]

Residual Decline from Biofilms

Typical distribution system biofilms contain a few different bacterial species. Three general species; however, are contributors to nitrification in water and chloramine residual decline. Nitrosomonas species are ammonia oxidizing bacteria (AOB) that use free ammonia for food and metabolism producing nitrite ion (NO_2^-). Ammonia may be in provided excess during chloramination or may be released in the system from chloramine residual reactions. The production of nitrite ion further reacts with chloramines to release ammonia and to create residual decline. Water pH levels between about 7 and 8 are optimal for Nitrosomonas growth along with water temperatures between 25°C and 35°C. Figure 5 demonstrates the effect of pH on Nitrosomonas. Once Nitrosomonas populations increase they become resistant to chloramine disinfection. The increase in nitrite from these bacteria triggers that incomplete nitrification is occurring.

Figure 5 - Effect of pH on Nitrosomonas (Grady and Lim 1980)

Nitrobacter species and Nitrospira species are nitrite oxidizing bacteria (NOB) that use nitrite ion for food and metabolism producing nitrate ion (NO_3^-). Nitrite ion may be available from decay or demand chemical reactions or from Nitrosomonas activity. Research information states that increases in nitrate up to about 1 mg/L are possible during nitrification events. Water pH levels between about 7.5 and 8 are optimal for
Nitrobacter or Nitrospira growth along with water temperatures between 25°C and 35°C. Figure 6 illustrates the effect of pH on Nitrobacter. Once Nitrobacter/Nitrospira populations increase they become resistant to chloramine disinfection. An increase in nitrate from these bacteria triggers that complete nitrification is occurring.

Figure 6 - Effect of pH on Nitrobacter (Grady and Lim 1980)

Biofilms in Distribution Systems

Biofilms in water distribution systems usually are comprised on non-coliform bacteria that are always present in the water system. Although high populations of these bacteria generally are controlled by effective chloramine residual levels, certain conditions can accelerate biofilm growth changing the active biota at the interior pipe surfaces. It is well documented that once biofilm populations increase, chloramines are no longer effective at controlling their growth. In these cases, it often is necessary to use a different disinfect residual for a temporary period to rid the system of these invasion biofilms. It also is important to mitigate nitrification quickly once it occurs to prevent potential disease from opportunistic bacteria such as Legionella.

Phosphates and Nitrifying Bacteria

It is common practices in water treatment to add phosphates in treatment for corrosion control treatment and to reduce lead solubility. Some studies suggest that greater than 5 µg/L of phosphate in the water may contribute to increased growth of nitrifying bacteria in distribution systems. The contradiction in regulatory needs for lead and copper compliance using phosphates and the potential to inhibit growth of non-coliform bacteria by limiting phosphate in the water can be problematic. Lead and copper compliance is a regulatory requirement. Inhibiting nitrification in distribution systems is an operating necessity to reduce residual decline. Little specific data is presented in the literature stating that a phosphate level greater than 5 µg/L by itself created a nitrification event. Quite the contrary - the primary cause of nitrification is stated in numerous references as release of ammonia from chloramines that provide a food source for nitrifying bacteria. Historical evidence from water systems using chloramines demonstrates that nitrifying bacteria are commonly controlled using proper residual maintenance in the distribution system. Nitrification events occur when the necessary residuals are not maintained at levels high enough to inhibit nitrifying bacteria growth and enough ammonia is present to exacerbate their growth.

NITRIFICATION CONCERNS IN DRINKING WATER

Several water quality concerns and regulatory compliance concerns can evolve during nitrification events. Among these concerns are potential diseases from other pathogenic bacteria, maintenance of chloramine residuals, lower water pH and changes in water stability or increased corrosion, lower water alkalinity and potential corrosion control issues, significant increases in biofilm populations and heterotrophic plate counts (HPC), potential increases in lead solubility, potential increases in DBP formations, increases in nitrate concentrations, and microbial resistance to chloramine residuals. Some of these concerns are associated with potential impacts to regulatory requirements.

Care must be taken to avoid long nitrification periods since opportunistic bacteria can grow and potentially cause disease in water consumers. Legionella is an opportunistic bacteria as well as certain coliform bacteria. Declining residuals and poor residual maintenance can lead to significant growth in disease-causing bacteria either in specific locations or system-wide. The National Research Council stated (2006) that the most important problem exacerbated by both nitrification and by long retention times is loss of disinfectant residuals. Lost residuals or poor residual maintenance can promote regrowth of bacteria within distribution systems that may include Legionella as well as other organisms. Possible violations in the Total Coliform Rule might be experienced if nitrification events are not mitigated relatively quickly.

Nitrification often results in sharp decline in chloramine residuals in water systems. It is not uncommon to experience residual levels that fall below 1.0 mg/L as combined chlorine. Many states have minimum disinfectant residuals regulated in their drinking
Nitrification in Water Distribution Systems

Water always rules and USEPA also require at least 1.0 mg/L combined chlorine be present in the system. Chloramine residuals less than 1.0 mg/L can lead to bacteria regrowth as well as result in violations of the minimum disinfect residual levels afforded in regulatory requirements.

Nitrification often results in reduced water pH and alkalinity concentrations due to the acid byproduct formations from numerous chemical reactions (already disclosed). Water pH decreases to up to about 1.5 pH units and alkalinity reductions more than 35 mg/L have been recorded in water system nitrification events depending on the water’s initial buffering capacity. Under these conditions, water stability maintenance is compromised and corrosion of water piping and plumbing materials likely could occur. Corrosion reactions highly likely could increase lead solubility, copper solubility, and solubility of other pipe materials, (i.e., iron, cadmium, zinc, chromium) by great amounts. Increased metals uptake in water systems could lead to undesirable water color at a minimum, could cause failure to maintain water quality parameters in the system, and might result violations of the Lead and Copper Rule.

Due to the declining residuals during nitrification, it is not uncommon for significant growth of biofilms to occur in the distribution system. Biofilm growth further reduces disinfectant residuals and releases more ammonia into the system exacerbating biofilm development. It is well documented that once biofilms reach certain elevated populations, chloramine residual is no longer effective to control their growth. Other disinfectants (like free chlorine) that could be used to mitigate biofilm growth and rid the system of increased nitrite levels, often result in increased disinfection byproducts formations and could lead to violations of the Stage 1 and Stage 2 D/DBP Rules.

One should understand with this information that nitrification events are serious distribution system issues that need to be verified and mitigated soon after their discovery. Failure to do so compromises system water quality, can result in water-borne diseases, and might result in regulatory noncompliance.

Stay tuned for Part 2 and Part 3 in upcoming articles.
Water storage tanks are vital and valuable pieces of infrastructure in municipal water distribution systems. Not only do these tanks play an essential role in serving the community, they also represent a significant financial investment.

While properly maintained and protected steel tanks can have an expected lifespan of more than 100 years, keeping them in fit-for-purpose condition for the long-term poses challenges. Many utilities lack the resources to plan and conduct regular maintenance, while there are financial risks of running to failure assets that are critical to serving the community.

Without proper asset management, these tanks can experience serious issues. Problems such as corrosion as well as contamination from animals or debris may result in customer complaints, municipal regulatory compliance violations, or cause costly water distribution service disruptions. And the cost of replacing a tank can be double the cost of a maintenance program.

Asset management programs offer a solution

Asset management programs for water storage tanks provide a solution for utilities, extending the service life of these tanks while reducing maintenance costs and offering numerous other benefits. Asset management is a relatively simple approach in which a municipality enters into a multi-year agreement with a qualified organization or professional to rehabilitate and maintain its water assets. After the initial rehabilitation, the municipality transfers the responsibility for annual inspection and maintenance of the asset to the organization, which assumes all maintenance risk for a set annual cost. Funds are accrued annually to cover the cost of future rehabilitations.

For example, the SUEZ Tank Asset Management Program is a turnkey solution that addresses all the needs associated with a potable water storage tank from safety and structure to sanitation, security and coatings, so no potential issue is overlooked.

This program guarantees that the routine inspection and maintenance of a water storage tank never falls behind, improving the long-term performance and reliability of the system while enhancing water quality. It also ensures that the tank is fully compliant with all applicable safety and sanitary regulations. This preventative maintenance approach also supports GASB 34 compliance, which can significantly lower depreciation costs.

Steps in tank asset management

The first step in SUEZ’s program is restoration of the tank to its like-new condition. This starts with a condition assessment by a National Association of Corrosion Engineers (NACE).
certified inspector in five areas: safety, security, sanitary, coatings and structural. Using this information, SUEZ then creates a custom program for the tank and restores the asset.

Once the tank is in fit-for-purpose condition and compliant with all applicable safety and sanitary regulations, SUEZ takes full responsibility of the long-term maintenance of the asset. Performing annual condition assessments, periodic interior cleanings/disinfections, and on-going preventative maintenance of the tank eliminates the need for emergency repair funds and extends the life of the asset almost indefinitely. There is a lifetime warranty on all coatings and repairs while the tank is on the program so the utility can enjoy complete peace of mind.

The program also provides cost certainty, with consistent annual fees instead of unplanned expenditures. It makes budgeting easier as initial repair costs can be spread out over a few years if needed, and all future interior and exterior renovation costs are included. The utility knows exactly what they are going to pay every year, so through the budget process they can assess what funds are available for the myriad of other projects that happen in a water distribution system.

**Tank asset management in action**

Since 2017, the City of Youngstown, Ohio has been taking advantage of the SUEZ asset management program to repair and maintain its water storage tanks. Located in northeastern Ohio, midway between Cleveland and Pittsburgh, the city and its surrounding metro area are home to half a million people. In the heart of the Rust Belt, Youngstown has continued to redefine itself since the decline of the U.S. steel industry in the 1970s. The city prides itself on an entrepreneurial tradition and created the Youngstown Business Incubator, a program that offers resources for entrepreneurs.

The city buys water from the nearby Mahoning Valley Sanitary District (MVSD) and distributes it to 150,000 customers in the city and neighboring areas, making it one of the five largest systems in northeast Ohio. The city system has seven water tanks, ranging in size from 500,000 to 2.2 million gallons. Two of them date back to 1926, while others are between 40-50 years old.

In 2017, an inspection showed that four out of the seven water tanks were in need of exterior and interior renovation work in the near future. Four of the tanks had visible rust and corrosion, and some were experiencing steel failure. Roof rafters in two of the tanks were corroded and were experiencing steel loss resulting from previous renovations not being done correctly and lack of inspection.

SUEZ renovated four of the tanks in the first three years, replacing the entire roof on one tank because of rafter corrosion. The other three tanks will be renovated over the next few years.

The company also installed mixers in all seven tanks as a preventative measure for improved water quality. This technology, which was not available when the tanks were installed, offers many benefits in terms of water quality. The systems prevent stratification of temperatures at different levels of water, allowing the water to stay mixed in a homogenous state so that disinfectant and chlorine levels are the same from top to bottom. Mixers also help prevent ice formation in the winter.

In addition to guaranteeing the initial renovation, SUEZ also provides yearly inspection services, ensuring the tanks remain in like-new condition until the next scheduled renovation under the asset management program.

“Prior to the asset management program, we relied on our staff to do inspections, which is a safety concern. Now SUEZ takes all responsibility,” said Eugene J. Leson Jr., Chief Engineer, of the Youngstown, Ohio Water Department.

The city is very pleased with the result. By transferring responsibility for upgrading and maintaining the tanks to SUEZ, the City of Youngstown is now able to focus on maintaining other parts of its water distribution system. And they very much prefer having a single point of contact for all their tank management needs.

“Having SUEZ as a resource is very reassuring, knowing that with one phone call, all tank-related inspections, repairs, renovations, questions or issues will be taken care of properly,” said Leson.

Daniel Frum is Water Systems Consultant for SUEZ Advanced Solutions. Based in Ohio, he can be reached at daniel.frum@suez.com. For more information about SUEZ Asset Management Programs, visit www.suez-na.com.
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