MAY 2023

Water Innovations

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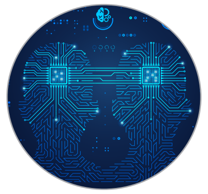

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FROM THE EDITOR

By Kevin Westerling
Chief Editor, editor@wateronline.com

When Almost Perfect Isn't Good Enough

Despite statistically astounding performance, water and wastewater utilities have almost no room for error due to the nature of public perception and the importance of their work.

Covering the water industry doesn't typically lend itself to splashy news items (puns aside), but over the years I've been witness to a few doozies — water stories big enough to gain mainstream exposure. It isn't what you hope for, but it does remind the public about the value of water. Unfortunately, those bad experiences can lead the same public to a negative perception of those who typically serve them the precious resource without issue (or credit).

From Toledo's drinking water shutdown back in 2014 due to toxic algal blooms, through Flint's years-long lead-contamination crisis, to Jackson, MS's current struggles because of failed infrastructure, regular folks are getting familiarized with the inner workings of municipal water systems, for better or worse.

Just recently, in March, I was receiving calls from family members (I'm "the water guy" to them) for advice around the chemical spill in the Delaware River that prompted Philadelphia water officials to issue warnings about the drinking water — actively urging bottled water use — until it was tested and cleared. It turned out to be somewhat of a false alarm in that the contaminated water never reached the intakes in large enough quantities, but there was a mini panic in the interim, including scenes of unrest among the throngs of people converging on stores for bottled water. There was also some mixed messaging from officials, who initially said to use bottled water after 2 p.m. on Sunday before stating that tap water was safe until 11:59 p.m. on Monday.

Further, one of the chemicals in question was butyl acrylate, which was also among the chemicals spilled in East Palestine, OH, only the month before, so the anxiety among consumers was understandable. Still, it was distressing to hear a South Philly resident say (via CNN): "I don't trust the city. They sound like they don't really know what they're talking about."

Scanning Twitter around that time, there was a bevy of mocking memes, including one that incredulously asked, "Who still drinks tap water anyway?"

As an advocate for the water industry, particularly the people who work tirelessly to keep our drinking water safe and our waterways clean, this lack of public trust — despite a historically impeccable track record — is upsetting. One can only hope that the intermittent attention (whenever there's a problem) helps fuel the necessary investments needed to update and improve our systems so that "upsets" are kept to a minimum.

To that end, this edition of *Water Innovations* highlights some very high-profile problems and, of course, solutions.

The ever-growing PFAS problem, which will soon mandate mitigation due to pending regulations, is the focus of our cover story — with a pathway to financial compensation. Finding and replacing lead service lines may be an even bigger issue, made much more manageable with predictive models and the guidance you'll find here.

The latest innovations are further explored with an article on enhancing digital twins with machine learning and a case study on the benefits of remote alarm notifications. And for the wastewater crowd, you'll find a roundup of treatment solutions for difficult-to-treat streams and a report on the expanding treatment chemicals market.

Hopefully, the thought leadership herein will keep you ahead of challenges and out of the news. Nobody's perfect — and your rare defeats may get more public attention than your overriding success — but we know your value is immeasurable, and we will continue to champion your efforts. ■

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PFAS Payback: How Utilities Can Hold Polluters Accountable

As the federal government ramps up the regulatory process for enforceable limits on PFAS in drinking water, estimated to cost billions annually, an environmental attorney details how utilities can hold polluters — instead of ratepayers — financially responsible.

By Ken Sansone

By now, you probably know that the U.S. EPA recently proposed maximum contaminant levels (MCLs) for two per- and polyfluoroalkyl substances (PFAS), PFOA and PFOS, at 4 parts per trillion (ppt), which is close to the level at which they can be reliably measured. Because, based on the limited testing conducted so far, PFAS is seemingly ubiquitous, this development will have a serious impact on water providers across the nation as they are required to test for, monitor, and remove these contaminants if they exceed the proposed MCLs.

We have yet to see a contaminant with such a combination of dangerous attributes as PFAS: Exposure at very low levels has been scientifically proven to be dangerous; environmental contamination is incredibly widespread, as PFAS chemicals have been used in so many different products for decades; and they do not break down naturally, earning the nickname "forever chemicals." This gives PFAS the potential to be the most expensive environmental catastrophe in history.

Unless the manufacturers responsible for this pollution are held accountable, utilities' ratepayers are likely to be the ones to bear the burden of billions of dollars needed to treat PFAS-contaminated water. SL Environmental Law Group (SL) is part of a legal team that has a successful track record of holding these polluters accountable and has gathered ample evidence that the manufacturers have been aware, for decades, of just how dangerous PFAS is.

As partner at SL, I represent more than 100 water providers in a multidistrict litigation (MDL) over PFAS exposure that has already grown to include more than 2,000 plaintiffs, and I anticipate that many more water providers will be joining this MDL in response to the EPA's proposed MCLs. After the MCLs take effect, systems that exceed these levels will either need to take the contaminated sources out of service and get water from elsewhere or implement treatment solutions, both of which usually come at a great expense. As a result, these water providers should be motivated to pursue litigation against the responsible manufacturers in an attempt to recover these response costs.

With the first water provider case in the MDL set to go to trial in June, here are some questions for utilities to consider about the MDL process and how to get involved.

How does multidistrict litigation work in the context of PFAS lawsuits?

- An MDL is a consolidation of many lawsuits from around the country involving similar claims by different plaintiffs against the same defendants. The whole purpose of the MDL is to consolidate the beginning stages of litigation while reserving each plaintiff's right to take its own case to trial, with lawyers of its own choosing. Although MDLs often result in what are called "global settlements" of the claims brought by most or all of the plaintiffs, it's always up to each individual plaintiff whether to enter into a settlement. If the plaintiff is not happy with what's being offered, it will have the chance to take its case out of the MDL, to federal court in its home state, and bring the case to trial there.
- As many municipalities and other water utilities across the U.S. filed lawsuits claiming that their water supplies have been contaminated with PFAS from aqueous film-forming foam (AFFF), either alone or in combination with other PFAS-containing products, they have had their cases grouped together before the same court in an MDL. The MDL was formed in December 2018 and is being heard in the U.S. District Court for the District of South Carolina. There are four categories of plaintiffs: water providers, property owners, personal injury plaintiffs, and the sovereigns (states, territories, and tribes). The water provider cases are one subset of approximately 2,500-plus cases pending in the MDL, but the court has selected the water provider cases to go first.

Why is this necessary and helpful for utilities?

An MDL generally has a lot of advantages:

- If early cases in the MDL are resolved in favor of the plaintiffs, it often results in a domino effect of settlements for the remaining cases, which can be resolved without requiring lengthy discovery and pretrial litigation processes. In fact, water providers that file in the MDL now are not subject to depositions or other burdensome discovery demands, but need only to complete a brief "fact sheet" that summarizes their PFAS impacts. Typically, the presiding judge tries to steer the parties toward an agreeable resolution with a national settlement. Unlike a class action settlement, an MDL settlement is not binding on any party without its agreement to participate; if a case is not settled during an MDL, it is sent back to the plaintiff's home court for trial.
- Of the water systems involved in the MDL, three bellwethers were chosen as test cases. Bellwether trials are used to work through common legal and factual issues that apply to the majority of the other similarly situated cases. If the test cases receive favorable results, the larger pool of plaintiffs can proceed more efficiently, often creating a domino effect of settlements or court judgments.
- Given the progress that has already been made, this MDL may provide water providers their best chance of recovering

> **While the costs for cleaning up PFAS can be high, taking legal action doesn't have to cost money up front.**

the costs of PFAS cleanup, and doing so quickly. There is still time to file a claim and join this MDL. It is a streamlined legal process, and if water providers choose a law firm that works on contingency, fees are only paid if their case receives a successful outcome.

The public's understanding of the dangers and prevalence of PFAS is expanding as the mainstream media continues to ramp up coverage. Organizations suing these polluters are demonstrating to the public a responsible approach for covering the costs associated with the cleanup rather than asking their ratepayers to foot the bill.

What does it mean for the utility's customers?

If the water systems are able to recover the cleanup costs through litigation, they will not be forced to raise their rates to build and run the water treatment plants. As a result, their ratepayers (i.e., the public) won't have to shoulder the burden caused by the PFAS polluters.

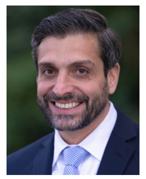
How are liability and the share of culpability determined?

Almost all PFAS compounds entered the environment due to the actions of a small group of manufacturers, led by 3M and DuPont. In fact, 3M was the only manufacturer of PFOS in the United States and the principal manufacturer of PFOA as well (until DuPont began making PFOA in the early 2000s). Though these manufacturers supplied PFAS compounds to other smaller manufacturers that incorporated them into other products, many of them did so without knowing the risks of releasing PFAS into the environment. As a result, 3M and DuPont have been named as the defendants in virtually all lawsuits over PFAS contamination filed by water suppliers, which have not typically named local businesses that used or released PFAS.

How can utilities get involved in multidistrict litigation, what would be required of them, and are there specific timelines to adhere to?

- Additional plaintiffs can still join the MDL, which is likely one of the faster routes for a utility to try to obtain compensation if it has been impacted by PFAS from AFFF. Proceedings in the MDL have been underway for water providers for three years, so plaintiffs who join now effectively get the benefit of that earlier work and face a shorter time until potential resolution of their cases.
- While the costs for cleaning up PFAS can be high, taking legal action doesn't have to cost money up front. Some law firms, including SL Environmental Law Group, work on a contingency basis — meaning that the firms advance the costs of litigation and are paid only if there is a successful outcome.
- In order to file a lawsuit as part of the AFFF MDL, water systems should hire a law firm experienced in handling these kinds of cases, which will be able to draft a complaint to get the lawsuit filed. Because just a small group of manufacturers are responsible for PFAS, a lengthy investigation is typically not necessary before filing the case.
- The statute of limitations is a time limit that applies to every legal claim. Outside of special circumstances, claims brought after the statute of limitations has run out cannot be brought to court, no matter how valid or valuable they are. The time to bring a lawsuit varies from state to state, but can be as short as two years, and what triggers the clock can also vary from state to state. Water providers that have detected PFAS in their supplies, at any level, should consult with experienced legal counsel at the first opportunity to evaluate the potential impact of the statute of limitations on their claims.
- Better yet, water providers can simply file a claim promptly to avoid or at least minimize any statute of limitations problems — even if their PFAS detections are below the MCL and they do not anticipate any remediation costs. This protects the system in the event that the MCLs for PFAS change (as they are likely to do, following the EPA's recent announcement of new draft MCLs for several PFAS compounds) or the levels of PFAS in the system's supplies increase. ■

About The Author



Ken Sansone is a partner at SL Environmental Law Group PC, where he exclusively represents water suppliers and other public agencies in contamination lawsuits, including claims over PFAS, 1,2,3-trichloropropane (TCP), and perchlorate. Prior to joining SL, Ken was assistant attorney general for New Hampshire. He has more than 20 years of experience handling complex civil and criminal cases in federal and state trial and appellate courts. He received his law degree from New York University and his undergraduate degree, magna cum laude, from Duke University.

Houston, We Have A Solution: Enhancing The Water Digital Twin Using Machine Learning

How artificial intelligence is assisting the digital twin to benefit Houston's water utilities and citizens.

By Charlie He and Wen Zhao

The city of Houston and water authorities in the region have embarked on a multi-year project to construct a major expansion to the Northeast Water Purification Plant (NEWPP). This project will increase capacity from 80 MGD to 400 MGD. Using Carollo's Blue Plan-it® Decision Support System, a digital-twin type of operation model was developed for the NEWPP to assist the engineers, managers, and operators to virtually experiment with their facility to support operational decisions (Figure 1).

Calibrated using full-scale, pilot-scale, and bench testing data, our digital twin can track flow and mass balance, estimate solids production and chemical usage, simulate truck traffic associated with chemical and solids hauling, and assess power consumption. With several mechanistic-based water treatment analytics integrated, it can be used to assess concentration-time (CT) and predict disinfection byproduct (DBP) formation for the plant's multi-disinfectant systems, including ozone, chlorine dioxide, chlorine, and chloramine. It can simulate the impacts of chemical additions on water quality, tracking 15 corrosion and stability indices using standard algorithms similar to those used by the RTW model, Water Pro model, EPA WTP Model, etc.

However, one challenging area of the water treatment modeling is how to estimate settled water turbidity and total organic carbon (TOC) when a combination of coagulation/flocculation chemicals (aluminum chloralhydrate [ACH], coagulant aid, floc aid, etc.) is added. No accurate mechanism model is available to simulate the performance of the flocculation and sedimentation process. Empirical models are often limited in their capabilities and accuracy, as shown in Figure 2.

In the past, the plant staff relied on daily jar testing to determine the removal rate of turbidity and TOC under a given chemical dosing scheme. In recent years, zeta potential measurements were introduced, which seemed to have better correlation with chemical dosages. But it is still insufficient to support the development and calibration of a reliable and universally applicable model. A flexible operation support module is desired for the user to: 1) determine the settled water quality based on raw turbidity and TOC along with coagulant and polymer doses; 2) determine the chemical doses based on raw turbidity and TOC as well as the target settled water quality; and 3) determine the coagulant and polymers doses based on raw water quality and a zeta potential target.

In recent years, advanced data analytics and machine learning technologies have gained increased popularity in the water industry. Using common computational libraries, users can leverage machine learning to identify patterns of data and generate statistical models without explicit instructions. Fully integrated into the Blue Plan-it Digital Twin models, several machine learning coding methods, such as random forest regressor or K-neighbors regressor, can now be easily applied to supplement our conventional water analytics.

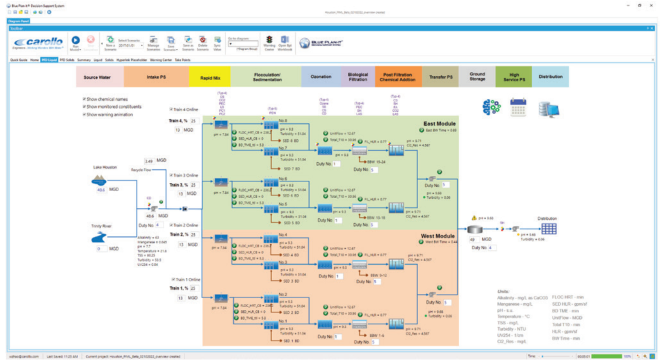


Figure 1. Integrated with the latest machine learning and artificial intelligence analytics, Carollo's Blue Plan-it WTP Operations Simulator helps water treatment plant managers and operators increase productivity and reduce operational costs.

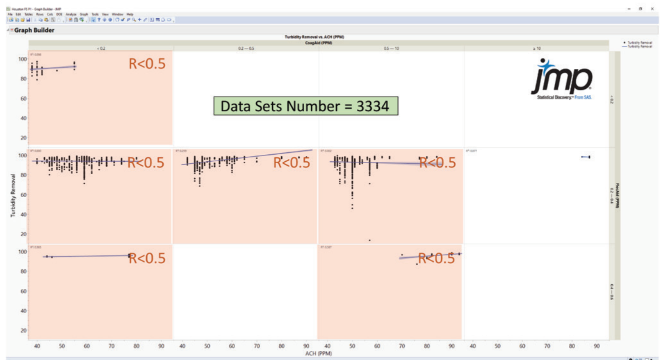


Figure 2. A multizone correlation analysis of the historical data demonstrated that the chemical dosages have poor correlation with settled water turbidity and TOC removal, with coefficient of determination (R2) value of less than 0.5.

Can We Trust It? The Accuracy Of The Machine Learning Model

Four years of full-scale and jar test data for NEWPP were used for machine learning, with 80% of the data (2,666 data points) used to train the model and 20% of the data (644 data points) used to test the model accuracy. The data included, but are not limited to, raw water TOC, turbidity, and zeta potential; settled water TOC, turbidity, and zeta potential; ACH dosage; flocculation aid dosage; coagulant aid dosage; time; and temperature. The machine learning algorithm can be used in three simulation modes: 1) chemical calculator mode to predict chemical dosages; 2) removal rate mode to predict the settled water TOC and turbidity; and 3) zeta potential mode to predict the amount of chemicals needed to achieve a target zeta potential. When compared using the 20% testing data, the machine learning model accurately predicts settled water quality and chemical dosages with R2 range from 0.93 to 0.99, significantly better than conventionally fitted empirical models (Figure 3).

Once the accuracy of the model was successfully demonstrated, the machine learning module was integrated into the latest version of the NEWPP operations simulators. This innovation was well received by plant managers and operators. It is being actively used for training, troubleshooting, and O&M planning. The plant is collecting additional data day by day, which will be used to retrain the machine learning model. It is expected that the model's accuracy will continue to improve over time.

What Else Can We Do With It? Other Applications Of Machine Learning In Water Treatment

Instead of considering it as a black box, machine learning, when applied correctly, has been proven useful. It is a particularly good solution when no known mechanisms or correlation are available to predict results and when adjustment of multiple factors (in the case above, dosages of multiple chemicals) ends up with multiple results (e.g., TOC, turbidity, zeta potential, etc.). The next reasonable step to improve the NEWPP digital twin is to apply machine learning to model granular media filtration process. It is expected that this will improve the current empirical ways for estimating filtered water quality, filter backwash frequency, and unit filter run volume (UFRV). This will result in more accurate simulation of disinfectant decay and DBP formation using a hybrid data-driven mechanistic model.

Machine learning applications in the water industry can be even more useful than what has been demonstrated above. It can also be used for modeling adsorption process performance to predict media replacement frequency for TOC or per- and polyfluoroalkyl substances (PFAS) removal; membrane process modeling to predict membrane backwash, maintenance wash, and clean-in-place (CIP) frequencies; and model predictive control of wastewater biological treatment.

Additionally, it can also be used to supplement the distribution system water quality modeling. Utilities often have years of data on chlorine residuals, trihalomethanes (THMs), and haloacetic acids (HAAs) in the distribution system. Other data are also relevant, including water quality from each source in the system (bromide, UV254, pH, temperature, dissolved organic carbon [DOC], etc.), chlorine dosage at each injection point, and information required to estimate water age and source contribution in the entire distribution system.

A machine learning model, which constantly receives and processes real time data and frequently gets retrained in an automated manner, could be instrumental to cope with such complexity and enhance the dynamic nature of the distribution system operation. Often the issue is not lack of data, but lack of an established approach to turn the data into knowledge. To cope with this challenge, Carollo is working with utilities to establish a data pipeline for accumulating data semi- or fully-automatically from various sources (SCADA, lab information management systems [LIMS], data loggers, United States Geological Survey [USGS] website, etc.) to feed the digital twin. A strong data processing module is also being integrated into Blue Plan-it to scrub, downsize, resample, and process the raw information into useful data that can feed the model. ■

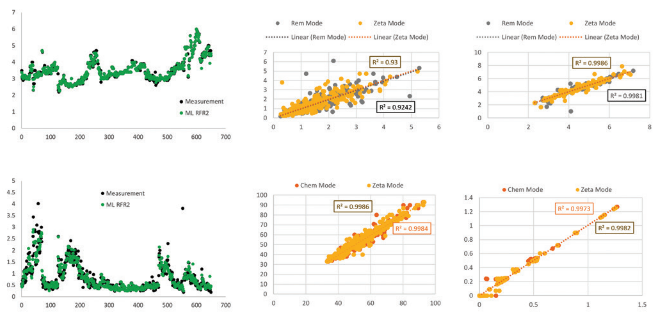


Figure 3. Machine learning model predicts settled water TOC and turbidity, ACH doses, and coagulant aid doses accurately. (Measured data in black; machine learning predictions in green.)

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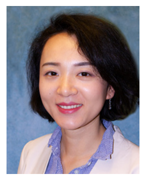

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Roundup On High-Strength Wastewater:

Treatment Challenges And Solutions

Wastewater is by nature a nuisance, but there are especially difficult varieties, covered herein, that can cripple onsite systems if not understood and handled properly.

By Stephanie Beadle

High-strength wastewater is commonly overlooked when implementing onsite or decentralized wastewater treatment. Many wastewater sources are viewed as similar to residential sources and lumped into the "domestic strength" waste category, only to find that there is much higher than anticipated organic loading and insufficient pretreatment prior to discharge.

While the definition of high-strength waste (HSW) varies among agencies and publications, the consensus is that wastewater is high strength when biochemical oxygen demand (BOD); total suspended solids (TSS); fats, oils, and greases (FOGs); and nitrogen are higher than typical domestic wastewater. Typically, high-strength wastewater results from industrial or commercial sources. These sources are often variable, with fluctuating concentrations and higher potential for co-contaminants that may impact treatment effectiveness.

Common HSW Sources

Some of the most common HSW sources are convenience stores, food establishments (anything with a commercial kitchen), wineries and breweries, campgrounds and RV parks, hospitals, nursing homes, and laundromats. Another potential source of HSW can occur when the organic loading of a typical domestic-strength wastewater source deviates from standard assumptions. These can include septic tank operational issues and a reduction in dilution with the use of low-flow water fixtures.

HSW Treatment Design Challenges

While there are a variety of high-strength wastewater sources, there is one step that should come first when designing for any of them: characterization of the influent waste stream. It should be made clear that a single sample will most likely not be representative of the fluctuations in mass loading that commonly occur with HSW sources. When possible, it is helpful to have multiple samples to better characterize variability in the waste stream. It is important to characterize both organic loading in the form of BOD/TSS, but also co-contaminants that may interfere with BOD/TSS treatment. The following are common constituents and conditions that may be encountered when dealing with HSW.

Fats, Oils, and Grease

FOGs often go hand-in-hand with sources of HSW. The most common source of fats are animal fats from cooking and associated cleanup. Fats are typically the most sensitive to temperature when compared to oils and greases but are more easily treated via biological processes. Oils are most commonly vegetable-based cooking oils or soaps and remain in liquid form within the typical temperature range of wastewater. Biological treatment processes are less effective for oils when compared to fats. Lastly, greases in wastewater are petroleum-based and are frequently a result of beauty and cleaning products such as lotions, detergents, and hair products entering the system.

The most effective pretreatment technology for FOGs are grease interceptors immediately following wastewater collection. The grease trap is highly effective on fats, as they are more easily solidified and separated from the waste stream via a grease trap. An effluent filter on the grease trap can further address FOGs; however, it can lead to increased maintenance and inconvenience if the FOG concentration is such that the filter fouls quickly and requires frequent replacement. In some more severe cases, the best option is to separate the FOGs at the source and haul them offsite to be treated separately.

Temperature

While warmer wastewater is preferable to promote biological processes (ideally between 77° and 95°F), some commercial applications may introduce hot wastewater (most commonly those with high-heat dishwashers or washing machines). For HSW sources with higher effluent temperatures (above 80°F), it may be beneficial to utilize either a holding tank prior to a grease interceptor or a larger volume grease interceptor in the design to add residence time to promote cooling and mixing with cooler wastewater introduced between washing cycles. This will help promote fat solidification within the grease interceptor prior to the septic tank.

Alkalinity and pH

Cleaning products and food waste can impact pH in HSW. Wastewater with a pH outside of the preferred range (6–9) can prohibit biological activity. Heavy use of cleaning products containing bleach can raise the pH outside of the ideal treatment range. Conversely, food service locations like coffee shops or wineries can contribute wastewater below the ideal treatment range. In addition to inhibition of biological treatment, lower pH can also make phosphorus precipitate more soluble and may increase total phosphorus in system effluent.

Wastewater from breweries contains brewing and fermentation byproducts. Breweries are designed with drains throughout the facility to catch rinse water from every stage of the brewing process.

While dilution and flow equalization can provide some buffering for spikes or drops in pH, the best way to combat wastewater pH outside of the preferred operational range is to incorporate pH adjustment into pretreatment via chemical feed.

Cleaning products and food residues can contain bicarbonates and carbonates, which can directly reduce alkalinity in wastewater. Alkalinity directly impacts the nitrification/denitrification process. Treatment systems with effluent nitrogen limits may require alkalinity adjustment via chemical feed to maximize total nitrogen reduction within the treatment system.

Flow Rate

Fluctuations in flow rate can easily impact the mass loading rate into a treatment system. Almost all sources of wastewater have variability in flow throughout the day, but in HSW sources in particular, operational cycles can greatly impact wastewater flow rate and mass loading. Providing a flow equalization (EQ) tank along with timed dosing to better control treatment system loading and control potential spikes in both flow and BOD concentrations is the best way to manage these fluctuations. Flow EQ tanks must provide sufficient volume to handle peak flow rates, and flow EQ pumps also need to be sized to provide a preferred average flow to dose the treatment system.

Quaternary Ammonia

Commonly found in disinfectants, surfactants, dryer sheets, and fabric softeners, quaternary ammonium compounds (QACs) are found in both domestic and high-strength wastewater. Many QACs are prolific and can have a biocidal effect throughout the wastewater treatment system. Anaerobic conditions like those found in a septic tank provide poor biodegradation; however, aerobic conditions do increase biodegradability of QACs. QACs can be especially biocidal to nitrifying bacteria and should be monitored closely for treatment systems requiring nitrification. The best way to mitigate QACs is to eliminate them at the source or limit use and increase tankage to allow dilution within the system.

BOD/TSS/Nitrogen

Once co-contaminants and wastewater quality that may impact biological treatment have been addressed, the primary contaminants can be more easily treated. Following a grease trap and septic tank, BOD and TSS are reduced, but the bulk of the BOD/TSS reduction for HSW applications will occur under aerobic conditions. The biological treatment system should be sized to accommodate the average mass loading and should also be able to handle surges in mass loading that may occur. HSW treatment systems typically require larger footprints and higher airflow for aerobic treatment. Some systems incorporate recirculation of partially treated wastewater to reduce the overall system footprint. Common biological treatment system technologies used include biofilm media-based options like moving bed bioreactors or fixed bed bioreactors, as well as a variety of activated sludge processes.

While the flow EQ tank will prevent flow surges into the biological treatment system, there may still be operational variability at the source that could increase BOD/TSS or nitrogen concentrations entering the treatment system. BOD/TSS addressed with aerobic treatment and nitrogen will require both aerobic and anoxic phases to address total nitrogen in system effluent.

Importance Of System Start-Up, Maintenance, And Monitoring

It is especially important to use treatment system start-up as an opportunity to further characterize the waste stream and to ensure that sufficient treatment occurs before system effluent is released. All monitoring equipment should be tested to prevent reading errors once the system is operational.

Depending on state requirements and the complexity of the wastewater treatment system, a licensed operator may be required. With or without a licensed operator, a regular operation and maintenance schedule is crucial for system upkeep when dealing with HSW. Regular monitoring and system adjustments can prevent potential contaminant breakthroughs and identify necessary treatment system adjustments that may be required if the HSW source has changed significantly.

Understanding The Wastewater Source

The biggest mistake when selecting pretreatment technologies for onsite wastewater treatment is to make general assumptions about the wastewater quality. Many HSW sources come as a surprise after a system has already been designed and installed due to lack of characterization. As with almost any design application, the more data available, the more appropriate and accommodating the final product will be.

Conclusion

Wastewater engineers are increasingly faced with complex HSW challenges. Careful consideration at the start of the design phase of the inputs to the system in design, flow rate fluctuations based on usage, how the system will be operated, maintained, and monitored, and any potential need for pretreatment will result in a HSW treatment system design that will provide efficient and effective treatment for the long haul. ■

About The Author

Stephanie Beadle, PE, is a wastewater engineer with Infiltrator Water Technologies. She is a professional engineer with 10 years of environmental remediation and process engineering experience. She joined Infiltrator's technical services team in 2022. Stephanie holds a B.S. in environmental engineering from Johns Hopkins University and an M.S. in environmental science and engineering from the Colorado School of Mines. Stephanie is a process design engineer for Infiltrator's advanced wastewater treatment products, including the ECOPOD and ENVIRO-AIRE product lines. Stephanie can be reached at sbeadle@infiltratorwater.com.

How To Evaluate *Predictive Models For Lead Service Line* Inventory And Replacement

Get an accurate service line material prediction for Lead and Copper Rule (LCR) compliance by avoiding modeling pitfalls.

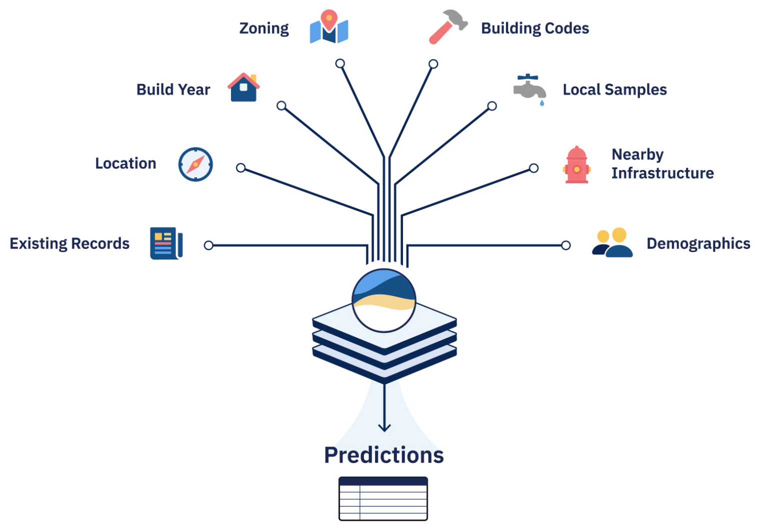
By Jared Webb and Dunrie Greiling

The U.S. EPA has included predictive modeling as a service line material investigation method. The approach sounds straightforward: Use the information you know to make predictions about what you don't yet know. Utilities can then use those predictions to prioritize lines for excavation and replacement.

If you are not a trained data scientist, how do you pick an approach? This article will cover what predictive modeling is and give you questions to ask to help you choose wisely.

What Is Predictive Modeling For Lead Service Lines?

Utilities do not have complete or even accurate service line materials records. In the absence of comprehensive records, utilities have turned to data science to predict unknown service line materials. They can then use those predictions to prioritize lines for excavation and replacement.



> **Reminder: A model's hit rate is just one of many indicators of success.**

A predictive model uses known information to predict what is unknown: service line materials, in this case.

A model can use many inputs, including the utility's historical records and information about the local built environment such as build year, zoning, location, demographics, information on nearby infrastructure like fire hydrants, and local water samples.

The process is iterative: Where lead is and is not found guides the model to make better predictions.

Question The Data

How Do Models Handle Biased Data?

Biases can emerge when certain types of homes or neighborhoods occur too often or not at all in the records used for prediction. For example, if most historical records are for a particular neighborhood within the city, the model will likely perform well in that neighborhood, but be less accurate for other city neighborhoods.

These biases can come from:

- ease of access
- inspecting only where you expect to find lead
- recent work in the area
- residents' participation.

We have seen that historically disadvantaged communities tend to be in older, more urban areas where construction and reconstruction records are scant compared to newer, more suburban areas.

With statistical prediction, it's "garbage in, garbage out." In short, a model that has been trained on biased data will provide inaccurate, biased results. While sophisticated techniques to debias data exist, the best and most straightforward approach is to collect representative data (e.g., data from across the city chosen randomly rather than by convenience) to feed the model.

If your modeling approach does not include obtaining or ensuring representative data, that's a red flag.

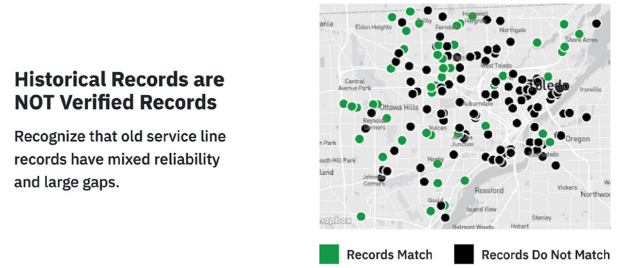
Does The Model Accept Historical Records As Truth?

Unfortunately, the paper records that utilities have often do not reflect the reality of what's in the ground. Although tap cards and other records may have been accurate when they were created, they have not been consistently updated after the fact.

Inspections show that many of our utilities' historical records are inaccurate. (The record does not match the material in the ground or home.)

If the model or modeling team trusts these records without verifying their reliability, the model will make inaccurate predictions from these records.

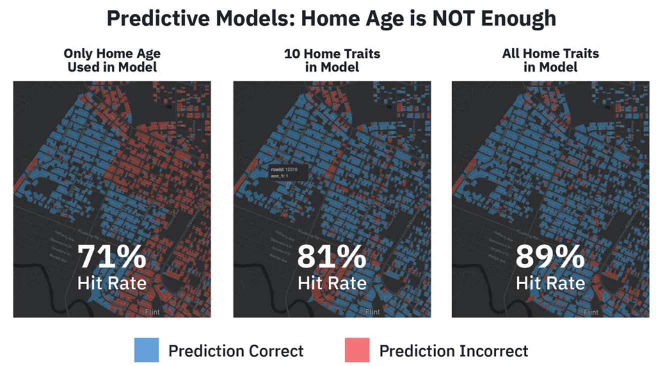
Ask how the predictive model will treat historical records. Be wary if they are accepted uncritically as truth.



What Data Does The Model Use Beyond Historical Records?

Some water utilities and engineering consultants make predictions about service line materials using only home age or home age and building codes. However, home age and other inputs — including verified service line material records; zoning; building codes; location and timing of infrastructure updates (e.g., water main and hydrant replacements); and census data about demographics — predict more accurately than home age alone. While no single feature is necessarily predictive, it's important to see who is living in affected areas so that utilities can incorporate environmental justice into their planning, funding, and communications.

Ask whether the model uses information beyond the historical records brought by the utility. If not, red flag.



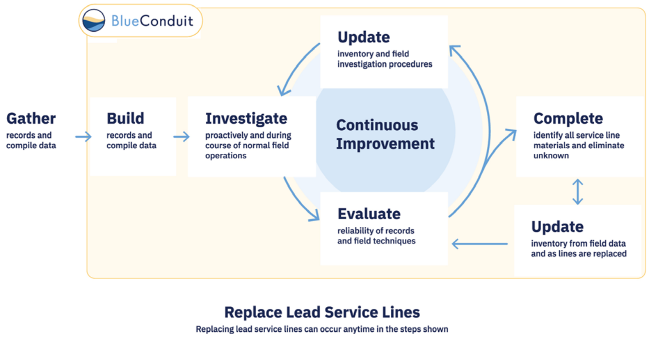
How Does The Modeling Process Incorporate New Information?

A statistical model that is run once but is trained on representative data will work well. A model that is updated with new information will show continuous improvement.

As new data from inspections and replacements are gathered, the model will adapt to that data and make more informed predictions to locate lead service lines in the area.

Beware the "one and done" approach. Ask how often the model outputs will update.

Inventory Lifecycle



How Do You Define Success?

We have heard results described this way: "We dug only where the model predicted a high probability of lead and had a great hit rate." That is…frustrating. We want to get all of the lead out of the ground, not just the "high probability" lead.

One way to measure a predictive model is by its precision or hit rate. Is there lead where it predicts lead?

Reminder: A model's hit rate is just one of many indicators of success.

Another way to measure a model is recall. Recall measures how much lead a predictive model is able to locate out of all the lead in the ground.

It's a trade-off — models with better recall may have poorer hit rates.

The full recall of a model is only calculable once every service line has been inspected. However, with a representative sample of service line materials, a model's recall can be estimated with high confidence.

Be wary of sky-high hit rates without other success metrics or context. Ask about recall as well as hit rate.

Compared To What?

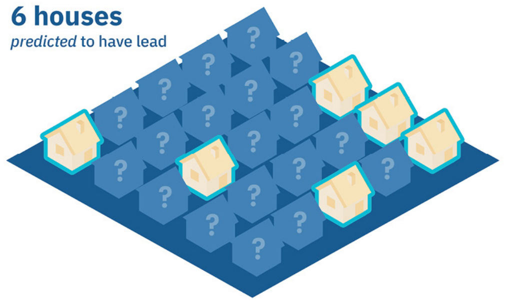
An easy way to make a model look smart is to compare it against something less so. A red flag is when the comparison for the model is random guessing. "Our model did better than a computer picking random addresses to test for lead."

It is doubtful any utility would replace service lines via random guessing. They would use something more intelligent than that, such as "Go in order from oldest to newest home within this time range" or another approach informed by their experience.

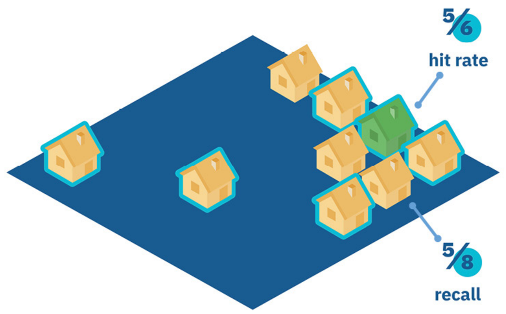
Ask what success is evaluated against, and be wary if it is compared to a strategy that you wouldn't use yourself.

See blueconduit.com/resources/ for more about our model, its predictions, and outcomes. ■

Prediction



Verified



BlueConduit's Experience In Predictive Modeling

About The Authors

Jared Webb is BlueConduit's chief data scientist. His responsibilities include processing and analyzing customers' data, managing relationships with technical service partners, and producing output of machine learning results. He has been a member of Dr. Schwartz's and Dr. Abernethy's team since 2016 and has served as chief data scientist since the formation of BlueConduit. Jared received his undergraduate and masters in applied mathematics from Brigham Young University, where he focused on the mathematical foundations of machine learning models.

Dunrie Greiling is BlueConduit's chief product officer. She combines her training in science (biology PhD, University of Michigan) with her two decades of experience in tech startups. Prior to joining BlueConduit, she worked in science-based software and device companies in many roles — as an employee, as a consultant, and as an advisor and entrepreneur-in-residence.

Forward-Thinking Utility Knows The Value Of Advanced Technology

Renewable Water Resources looks to remote alarm notification software to improve efficiency and avert problems.

By Cody P. Bann

Greenville County, SC, encompasses an area of approximately 795 square miles with a population of over 500,000. The water and wastewater infrastructure servicing the county is intricate and robust, including more than 350 miles of pipe that connect the community and provide for future growth and development.

For almost 100 years, Renewable Water Resources (ReWa) has been responsible for the county's water and wastewater infrastructure and manages eight water resource recovery facilities (WRRFs). This oversight includes purifying more than 40 million gallons of water per day from homes, businesses, and industries. ReWa also operates 83 pump stations and nine water treatment facilities. Each facility contains a self-sufficient water treatment process with onsite power generation and sometimes thousands of gauges, flow meters, and storage tanks, depending on the facility size.

Since 2002, ReWa has relied on AVEVA's System Platform supervisory control and data acquisition (SCADA) system integrated with WIN-911 remote alarm notification software to monitor the system and alert the team about any abnormal operating conditions. This involved a complicated process of the SCADA system calling a mobile phone; from there, operators would stop work to answer the call, then input a unique identification number, and then enter an acknowledgement. This process could take up to one minute. While this doesn't seem very long, this is critical time lost during possible emergencies. Additionally, since these alarm notifications were transmitted via cell phones, if the operator was in a part of the facility without good cell service, the call might break up and the entire identification input process would have to be repeated.

Upgrading Technology

In 2020 ReWa, WIN-911, and MR Systems, the systems integrator company ReWa partners with to implement technology, identified opportunities to improve the WRRF's alarming systems by deploying a streamlined, technologically advanced mobile solution. Tony Jones, ReWa business analyst, reached out to Edward Noyes, application engineer with MR Systems. Jones worked closely with Noyes, who listened to Jones' concerns and designed a system that met ReWa's high security requirements, improved the ease and efficiency with which operators can monitor and action SCADA alarms, and deployed a proactive monitoring system to notify ReWa technology personnel in the event of a system issue.

The resulting mobile app enables efficient plant operations by giving operators the ability to monitor and act on SCADA alarms via mobile devices with redundant voice and text callouts as needed. Additionally, it complements ReWa's mission of supporting wastewater treatment through the use of innovative solutions that promote operational efficiency and reinforce the core values of safety and unity.

"While we've only been using the mobile app for six months, the team has quickly adapted to working with the more efficient and robust system. They no longer waste time punching in identification codes or depending on intermittent cell service to acknowledge an alarm," commented Jones.

Faster response times are critical since many alarms involve lost power. In these situations, every minute counts to get an alarm message to the team, which could mean the difference between restarting the generator or experiencing an overflow.

AVEVA interface

Secure Monitoring

The types of alarms that are monitored include critical functions — pumps, UV disinfecting systems, generators, and utility power — that can stop a process and result in a sewer overflow or discharged untreated water. To ensure the systems' integrities aren't compromised, it's critical to use the most secure architecture possible. To that end, Noyes and the MR Systems team implemented intercomponent encryption in conjunction with a custom-built proactive monitoring system that detects whether WIN-911 and AVEVA are communicating and notifies designated personnel of any issues. Additionally, the app's integration with the SCADA system offers ReWa another layer of security.

Making A Difference

This proactive and perpetual monitoring routinely averts problems. However, in the event that any of the equipment is not operating properly, interactive alerts are sent to the ReWa team via the mobile app, phone call, email, or text. One such instance occurred when the team received an alarm related to a power outage at one of the WRRFs.

A newly installed generator did not automatically start during a power failure, and WIN-911 alerted the technology staff, who then began a dialogue with the operations team via the mobile app's chat feature. Because of this early and real-time intervention, ReWa assessed the problem and determined that the generator wasn't properly wired, avoiding additional problems that an extended power loss would have caused.

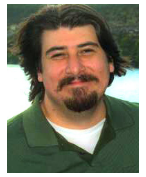
"Prior to this upgrade, ReWa functioned in a reactive mode and waited until the WIN-911 software notified the operations team there was an issue. Now, we have completely changed this mindset and become more efficient. The IT team knows there is a system problem long before the operations team," added Jones.

The Future

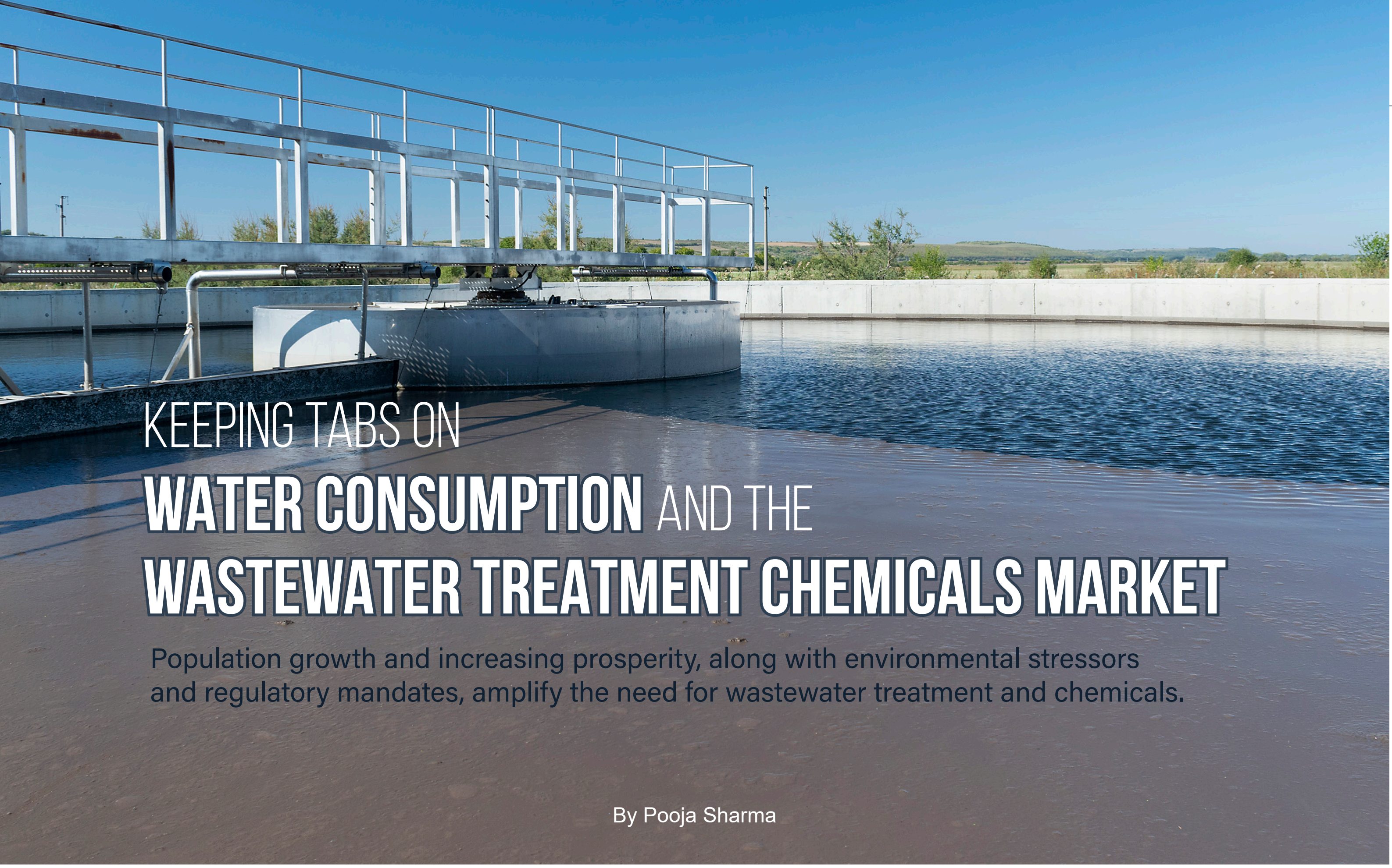
Named a Utility of the Future by the National Association of Clean Water Agencies (NACWA), ReWa is committed to enhancing the area's quality of life through the quality of its waterways. Using advanced technology such as the AVEVA System Platform and WIN-911 mobile app helps the team keep that commitment.

"This is a journey, and as a forward-thinking early adopter, ReWa continues to explore technology that allows us to improve infrastructure and operating efficiencies," said Jones. ■

About The Author



Cody P. Bann is director of engineering at Austin, TX-based WIN-911 and may be reached at cody.bann@win911.com. The company helps protect over 19,000 facilities in 85 countries by delivering critical machine alarms via smartphone or tablet app, voice (VoIP and analog), text, email, and in-plant announcer, reducing operator response times, system downtime, and maintenance costs. For more information, visit www.win911.com/.



KEEPING TABS ON WATER CONSUMPTION AND THE WASTEWATER TREATMENT CHEMICALS MARKET

Population growth and increasing prosperity, along with environmental stressors and regulatory mandates, amplify the need for wastewater treatment and chemicals.

By Pooja Sharma

The world has witnessed a steady rise in the volume of wastewater in recent years, given explosive population growth, healthy economic growth, ascending income levels, and consistent improvements in the water supply. It is no surprise that economic progress and GDP growth have led to an increase in water consumption, which itself is tied to changing food consumption patterns that put pressure on the agricultural and meat industries.

According to People for the Ethical Treatment of Animals (PETA):

- An average meat-eater consumes an estimated 15,000 liters of water per day, with a single steak equivalent to 50 bathtubs of water.
- Animals raised for food produce more than 10 times the waste generated by the entire human population, most of which runs off into waterways.
- Eliminating meat lowers water use by almost 60%.

Daunting estimates associated with the evolving dietary landscape point toward an anticipated surge in water consumption levels and call for a paradigm shift focused on adopting a proactive approach and introducing efficient wastewater management solutions, especially in developing economies.

Therefore, governments in several countries are implementing measures to gain more benefits from wastewater than just abating pollution, which will drive growth of the wastewater treatment chemicals market[1] over the next few years.

How can sewage treatment boost the global wastewater treatment chemicals market?

- 51% of Irish sewage is treated in accordance with EU environmental standards — a far cry from the average of 90% in the EU.
- A project to eliminate raw sewage flowing into seas and rivers from 32 towns and villages began or is scheduled to begin by 2024.
- Irish Water has committed to improving treatment at 27 priority areas but has no clear plan for improving river, lake, and coastal water quality.

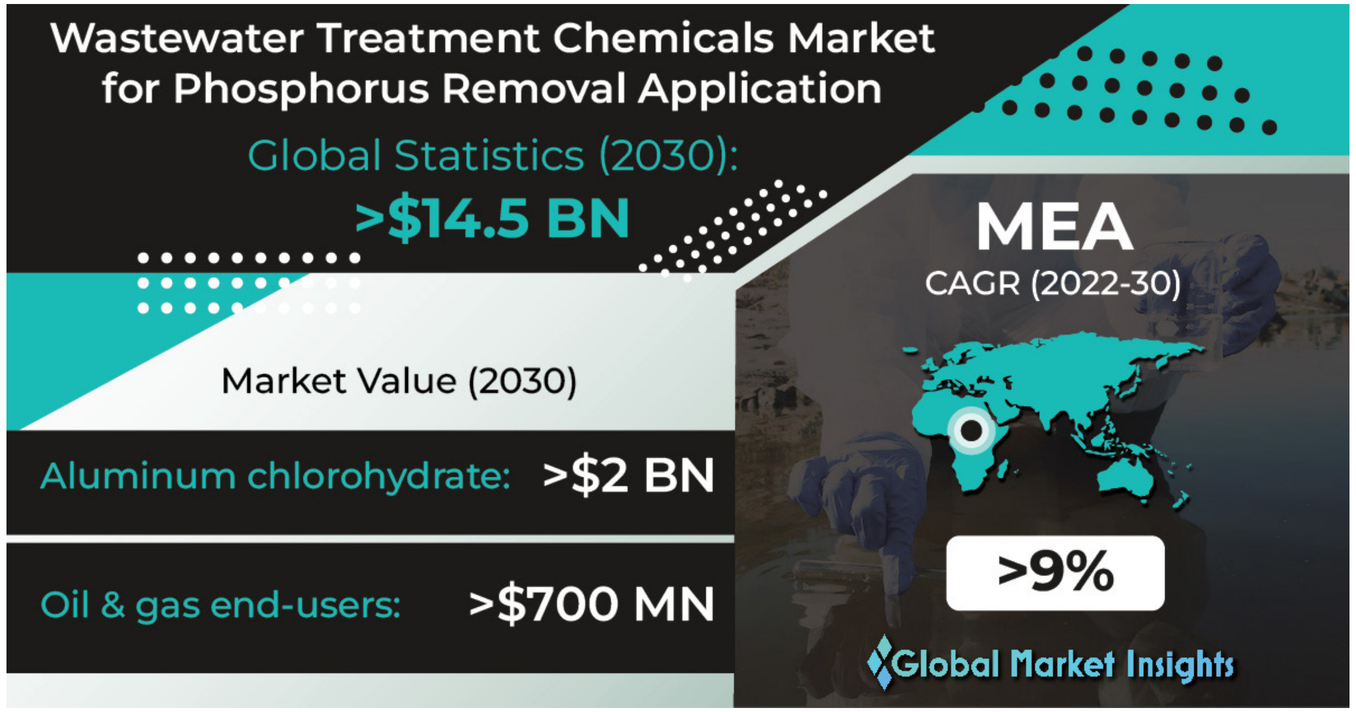
(From Urban Waste Water Treatment in 2021, EPA (Ireland), 2022)[2]

Despite the widespread concern about sewage in urban areas, these estimates also illustrate wastewater's potential as a resource, as sewage is composed of merely 1% solid waste and more than 99% freshwater, which after treatment can again be used across numerous industry verticals.

Thus, local and national authorities worldwide are focusing on using efficient waste-management technologies to enhance their sewage treatment capabilities in response to the multifold growth of sewage in cities and urban areas and the escalating water crisis.

To cite an instance, in February 2022, the Delhi Jal Board submitted a report to the Union Jal Shakti Ministry stating its willingness to boost its sewage treatment capacity by 130 MGD by December 2022. The city struggles with high levels of pollution in the Yamuna River caused by untreated wastewater from slum clusters and unauthorized residential societies, as well as poorly treated wastewater discharge from wastewater treatment facilities.

The move aimed to enable the city to treat 95% of its 707 MGD of wastewater, thereby propelling the demand for wastewater treatment chemicals such as aluminum sulfate, aluminum chlorohydrate, poly aluminum chloride, sodium aluminate, ferric sulfate, ferric chloride, ferrous chloride, ferrous sulfate, etc.



Stringent regulatory mandates to mitigate accelerating climate change will present new growth opportunities for the wastewater treatment chemicals' market size.

Climate change has severely disrupted weather patterns and resulted in unpredictable water availability, extreme weather events, contaminated water supplies, and exacerbated water scarcity. Such impacts can drastically affect the quantity and quality of water that an individual needs to survive.

To minimize these impacts and lay the foundation of a sustainable economy, regulatory authorities worldwide have introduced several reforms and stringent mandates. For instance, the Clean Water Act implemented by the U.S. EPA in 1972 has a set of strict effluent limitation guidelines (ELGs) that determine the maximum levels of contaminants that can be present in discharge water or industrial wastewater.

Industries that do not meet these standards are by law required to leverage more efficient water treatment technologies to lower the level of contamination to within the acceptable limits before discharge. Such initiatives and norms are poised to bring positive changes in the waste management scenario and therefore will strengthen the wastewater treatment chemicals market outlook through the ensuing years.

Worsening water stress is paving the way for future growth.

Clean water is one of the essential life-supporting elements, yet billions of people across the globe lack access to it. Despite the consistent efforts and initiatives undertaken by aid groups and governments to help people living in water-stressed regions, the problems are projected to get worse in the coming years.

This apart, conflicts over environmental crimes and natural resources have further intensified the issue. UN estimates suggest that a significant share of internal conflicts that took place over recent decades are associated with natural resources. Since the exploitation of natural resources leads to loss of livelihood, environmental damage, unequal distribution of benefits, and elevates the risk of violent conflict, the need to manage them sustainably and transparently is of utmost importance.

These concerns have accentuated the efforts undertaken by global policymakers to bring forth agendas focused on sustainable development, which, in consequence, may drive lucrative gains to the wastewater treatment chemicals industry. ■

References

1. https://www.gminsights.com/industry-analysis/wastewater-treatment-chemicals-market-for-phosphorus-removal-application
2. https://www.epa.ie/publications/monitoring--assessment/waste-water/urban-waste-water-treatment-in-2021.php

About The Author

Pursuing her professional career as a content writer for over two years now, Pooja Sharma has a post-graduate degree in English literature. The articles she writes are a balanced blend of her ever-growing love of language and the technical expertise that she has gained over the years.