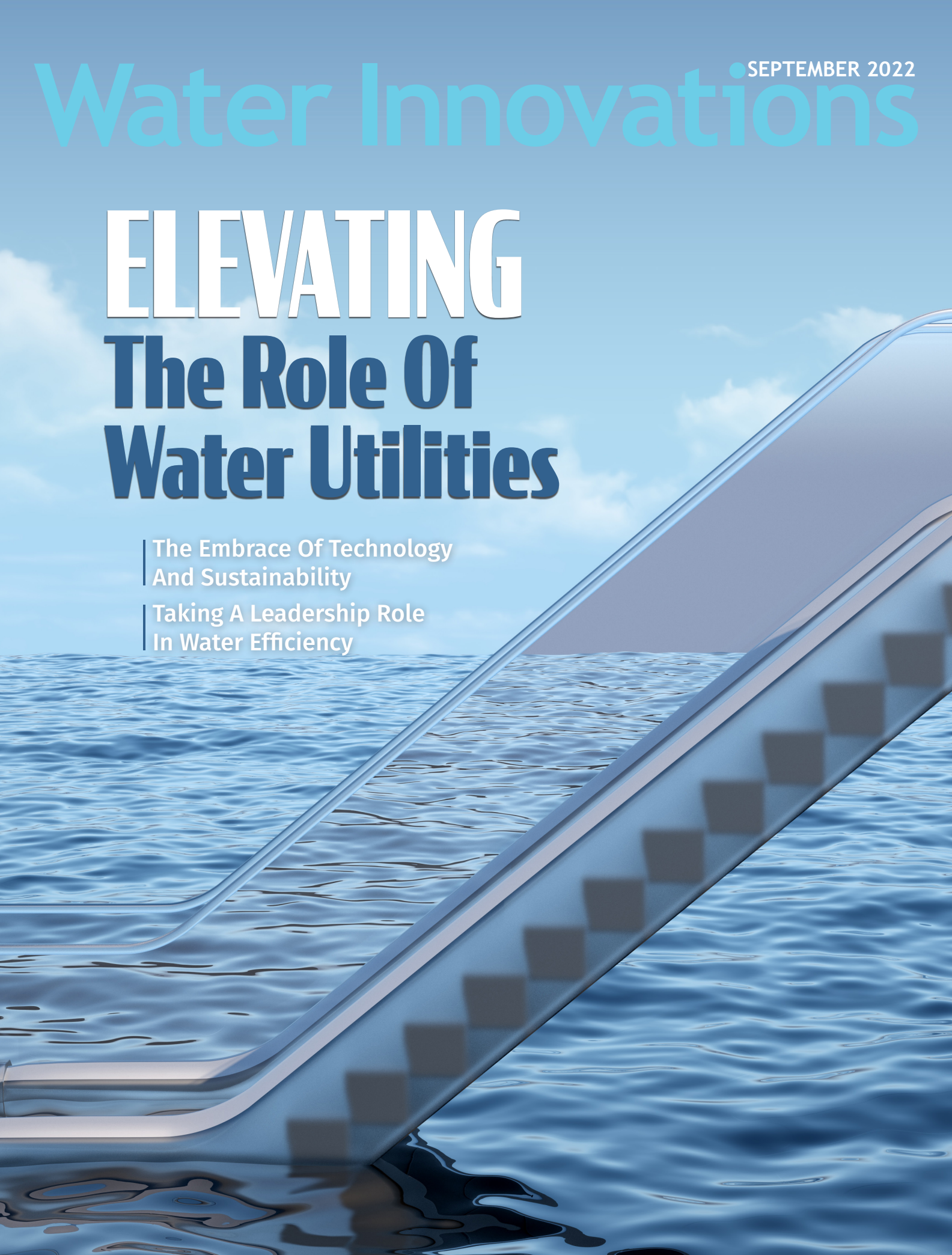
Water Innovations
SEPTEMBER 2022

ELEVATING The Role Of Water Utilities

- The Embrace Of Technology And Sustainability
- Taking A Leadership Role In Water Efficiency



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By Kevin Westerling
Chief Editor, editor@wateronline.com

All For One And One For All — **For Water's Sake**

Societal well-being is hugely dependent on a clean and available water supply, which is becoming increasingly dependent on community engagement and education.

Across the board, we have learned a lot over these past few years about the value of effective communication — sometimes the hard way, by doing it wrong (see COVID confusion, social media "news" feeds, political idealogues/demagogues, etc.). To elicit public support and action, you must first garner the trust that comes through honest motives and information. But as data accumulate and information is updated, guidance can change. Thus, it's also very important to be nimble with your messaging. Honesty doesn't mean you have to be right, but you do have to be forthright. If delivered in good faith, your message is received with goodwill.

The water industry, too, has had a difficult time lately. Old pipes need repairing, lead pipes need replacing, PFAS is proliferating, source water is receding, floods are increasing, and the labor force is retiring. And that's just the tip of the iceberg.

Remedying these issues will take coordination, cooperation, and (of course) money. Our water and wastewater utilities, as capable as they are, do not work in a vacuum. Administrative and operational duties are handled exceptionally well — so smoothly as to go unnoticed — but public attention and support are needed to solve society's shared water issues. It is our job to remind consumers of the minor miracle that happens every time they turn on the tap, to educate them on the work that goes into it, and to foster respect and admiration for the process and the product so that they support efforts to maintain a clean, sustainable, and equitable water supply.

This year at WEFTEC, the Water Environment Federation enlisted Shama Hyder, an award-winning brand strategist, global speaker, and bestselling author, to provide the keynote address at the WEFTEC Opening General Session. The invitation to speak in front of the largest annual gathering of water and wastewater professionals in North America confirms the importance of communication to meet industry goals.

"The water sector is grappling with issues that are challenging to communicate about, such as rate increases, PFAS, and biosolids," said WEF President Jamie Eichenberger, adding that it's imperative for water utilities and companies to engage frequently and effectively with stakeholders.

Hyder is the founder and CEO of Zen Media and has been called the "Millennial Master of the Universe" by FastCompany.com. Considering her age and expertise, she is uniquely qualified to address the challenge of replacing baby boomer workers in the wake of the ongoing "silver tsunami" of retirees.

"There is a critical need to build a workforce that is younger, more diverse, and with new skills," noted Eichenberger. "As a millennial, Shama will provide perspective on how the water sector can use branding and marketing to attract the generation to work in the sector."

And, naturally, Hyder leans into digital resources, which are integral to improving nearly all utility operations. Those in attendance at WEFTEC (Oct. 8-12 in New Orleans) are sure to gather plenty of information and inspiration from Hyder, fellow presenters, exhibitors, and attendees to help solve our pressing and mounting water challenges.

Water Online can also help in that regard. This edition of *Water Innovations* features articles on technology and sustainability adoption trends, the importance of utility leadership for continued water security, the use of AI-enabled pipeline asset management and IoT sensors to reduce water waste, as well as introductions to new wastewater-treatment and risk-management techniques.

To borrow the phrase from our national infrastructure initiative, we can Build Back Better — but only through shared commitment, collaboration, and trusted communication. Let's get moving, together. ■

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Surveying The U.S. Water Sector's Embrace Of Technology And Sustainability

Ten years since first arriving on the scene, Black & Veatch's latest annual survey of the water sector reveals a changing set of circumstances, challenges, and potential solutions.

By Mike Orth

Just a decade ago, Black & Veatch's first annual assessment of the U.S. water industry showed a sector grappling with the lingering fallout of the financial crisis. Upgrades to infrastructure well past its prime fell victim to funding deemed grossly inadequate. "Sustainability" held the promise of significant benefits, even if a unified definition proved elusive. Data's vast potential in managing and optimizing assets was on the industry's radar, though actually seeing it in practice was another story.

Ten years since, Black & Veatch's 2022 Water Report — based on expert analyses of a survey of more than 300 stakeholders in America's water, wastewater, and stormwater sectors — magnifies how many of those takeaways remain — and how so many things have grown more complex.

Just as the industry's infrastructure continues to age, so are its workers, increasingly exiting into retirement with their skills and institutional knowledge, posing formidable staffing challenges in a historically tight job market. The embrace of data in decision-making — vital in enabling utilities to do more with less in this age of "digital water" — is recognized for its potential but still lags in adoption. Cybersecurity, climate change, and decarbonization — unmentioned in the 2012 report — have emerged as pressures the industry can't ignore. Concerns about evolving regulations are deepening.

Despite all of that, there's opportunity and optimism. Funding through the American Rescue Plan Act of 2021 (ARPA) and the $1.2-trillion Infrastructure Investment and Jobs Act (IIJA) is a generational opportunity to invest in long-overdue water projects. The downside: Many utilities — insistent that they'll pursue some of that infusion — aren't quite sure how to go after it.

In this complicated world of water, old ways of thinking are giving way, albeit relatively slowly, to what's new and possible in addressing chronic pain points in 2022 — the 50th anniversary of the Clean Water Act — and beyond.

The Vexing Complexities Of Aging

Ten years ago, survey respondents declared aging water and sewer infrastructure as the industry's foremost concern. That hasn't changed; nearly two-thirds — 63% — still put it atop the list, but it is down nearly 12 percentage points from a year ago.

Over time, workforce-related issues have ascended in the rankings, with the challenge of hiring qualified staff — not included as a survey option in 2012 and ranked No. 14 in 2017 — now spiking to No. 2. The industry's aging workforce jumped three spots to No. 4 over the past decade, just behind increasing or

From your perspective, what are the most challenging issues facing the water, wastewater, and stormwater industry today?

Source: Black & Veatch

	Rank	
	2022	2012
Aging water and wastewater infrastructure	1st	1st
Hiring of qualified staff	2nd	—
Increasing/expanding regulation	3rd	5th
Aging workforce	4th	7th
Funding or availability of capital	5th	3rd
Justifying CIPs and/or rate requirements	6th	—
Managing capital costs	7th	2nd
Water conservation	8th	11th
System resilience	9th	—
Managing operational costs	10th	4th/7th*
Treatment technology	13th	6th
Information technology	14th	9th

— A dash indicates the answer wasn't included in 2012

* Managing energy costs and Chemical cost asked in 2021

Which efforts are your utility practicing to enhance sustainability? *(Select all that apply)*

Source: Black & Veatch

71.6% **Proactive replacing of infrastructure**

60.2% Asset management program

40.9% Water conservation initiatives

28.4% Green energy

28.4% Analytics and dashboards to empower operation discussions

25.0% Industrial and commercial implementation of water reuse

23.9% Nutrient removal

20.5% High-quality wastewater as part of water supply portfolio

19.3% New user rate structures

15.9% New personnel training approaches

8.0% New financial modes

4.5% Stormwater as part of the water supply portfolio

expanding regulations — an issue that ranked fifth in 2012.

Given the exodus of older skilled workers, utilities more than ever are looking to fill the void through automation, outsourcing, and an ever-thinning pool of recruits who enjoy more career options and greater leverage for various reasons. Fewer people generally seek out water utility work, and the pursuit of their talents has devolved into a bidding war in which utilities — especially smaller ones — often can't compete, given their tight finances.

Data: A Path To Resilience, Sustainability

With growing awareness of everything that data can do, going digital can help water utilities reap greater efficiency and resilience through actionable information to evaluate and optimize asset performance, along the way alerting them of potentially looming failures.

Yet only seven in 10 respondents say they're collecting "lots of data," though slightly more than one-quarter believe they are leveraging it effectively. Those who aren't are missing out, given that harnessing data — and artificial intelligence technologies — offers rewards ranging from a holistic view of the water system to enhanced efforts to track consumption, drive efficiencies, save energy, and prioritize investment dollars, heightening resilience and sustainability.

Since its absence in Black & Veatch's 2012 water report, sustainability isn't merely a buzzword. Some 72% of survey respondents now say their enterprise has sustainability goals and the means to measure them, up roughly 7 percentage points from last year. Slightly more than half say separately they've adopted sustainability goals, independent of community or regulatory pressures.

Nearly two-thirds cast sustainability as a critical strategic focus in the water sector, though one-third say sustainability "sounds good" but isn't a priority. Seven in 10 from utilities that serve more than 500,000 customers deem sustainability a priority, compared with 58% of those who serve fewer than that population threshold.

Approaches to greater sustainability vary, with proactive replacement of infrastructure leading the way at 72%, ahead of asset management programs (60%) and water conservation initiatives (41%). As decarbonization gains momentum across all utilities, nearly 30% of water sector respondents say they're adopting initiatives involving green energy, with an identical number using analytics and dashboards to empower operational discussion.

Welcomed Funding From Uncle Sam

Inadequate funding and the numbing price tag of languishing infrastructure upgrades have been years-long headwinds for the industry, where four in 10 respondents believe funding for capital projects will not be enough over the next five to 10 years. By a two-to-one margin over their bigger counterparts, utilities with fewer than 500,000 customers think that will be the case. Overall, one-third say funding will be sufficient, while 16% believe it will merely meet the requirement.

Feeding into state revolving funds (SRFs) as part of partnership between states and the U.S. government, tens of billions of dollars from the IIJA over the next five years will go to critical water investments, including projects involving drinking water and sewers. Billions more are bound for cities and counties under the ARPA.

Fifty-eight percent of respondents say they're pursuing ARPA funds, with one-third intending to chase IIJA money earmarked for water infrastructure and resiliency efforts. Yet when pressed as to why their organizations haven't taken advantage of funding mechanisms, the top cited reasons were that they were administratively too burdensome (37%), the programs were too restrictive (27%), and there was a lack of awareness about them (21%).

Asked separately whether they're accelerating capital projects because of new state or federal funding sources, just one-third of respondents said they "might or might not" — the top reaction. One-quarter reported "probably yes," with one in five "probably not."

Clearly, the IIJA represents more of a lifeline to the water industry — not a panacea, given that more long-term investment will be essential to address decades of underinvestment. But in a sector rife with challenges — from eliminating contaminants from drinking water to thwarting cybercriminals, to mitigating climate change's effects — it's another positive step forward. ■

About The Author

Mike Orth is president of Black & Veatch's governments and environment business.

Utilities And Water Efficiency: Taking A Leadership Role

By Lynda DiMenna

Water is an essential resource, and utility customers' lives count on a reliable flow of it coming out of their tap. In order to protect natural resources, a utility must be responsible and manage water wisely, while still operating at a level that supports all the needs of customers. The first step is talking about water efficiency.

While images of vast oceans and torrential rains might imply an abundance of water, the fresh water needed for human and animal consumption, agriculture, and other parts of life is quite limited. According to the U.S. Bureau of Reclamation,[1] even though water covers about 71% of the Earth's surface, only 3% of it is fresh water and 2.5% of that is unavailable for human use. The scant 0.5% remaining results in a challenging situation, and that's not taking issues such as overuse, pollution, and drought into consideration. Without an adequate focus on water conservation, we could risk diminishing this limited resource even further, with consequences such as rising costs, reduced food supply, health hazards, and environmental impacts.

To help ensure access to clean water, and the water sources that we depend on to provide it, we must first acknowledge the threats against them.

As water utilities, we are in a unique position to make an impact. We connect the water source to our customers' taps. This allows for a significant reach and influence on water efficiency in our country and an important responsibility to be a steward, advocate, and leader for the conservation of one of Earth's most essential resources.

Utilities Should Protect Water

It's a common misconception that, in reference to water conservation and efficiency, we mean doing with less or sacrificing. In reality, we know that it is actually about helping make sure there is enough safe, clean water at any given time to meet our needs. Water efficiency means being more productive, reliable, and affordable. It means better water availability, better water service, and supporting jobs and growth — at lower cost, with less disruption, restriction, waste, and pollution. It means using improved technologies and practices that deliver equal or better service with less water. It saves consumers money, protects the environment, and enhances the economy.

To help ensure access to clean water, and the water sources that we depend on, we must first acknowledge the threats against them. And one of the most critical is water use itself. When it comes to water, we have all that we will ever get. While using water doesn't ultimately remove it from the cycle, it does redistribute it and impact the amount that is readily available for use. So, by implementing efficiencies in operations and in the lives of customers, we can help reduce water waste.

Utilities Should Educate Customers About Water

Despite increased efforts toward awareness of water scarcity, the average American continues to use anywhere between 80 to 100 gallons[2] of water per day, which adds up to roughly 29,000 to 36,500 gallons per American per year.

With this in mind, there is significant power in utilities educating customers. In fact, research[3] has shown that public education programs can assist in helping reach the goals of a water utility's conservation strategy, and even help increase consumer participation in programs that utilities may be implementing. With education also comes wiser water usage decisions from customers.

By expanding access to educational materials to the greater public and supporting continued research in water conservation, utilities can contribute to greater education and public awareness efforts.

American Water, for example, is committed to educating consumers about the value of water, using it wisely, and conserving this precious resource for generations to come. The company has a long-standing partnership with the U.S. EPA's WaterSense program to help its efforts. Environmental leadership is a core value aligned with performance metrics for American Water employees.

Customer education can include the creation and distribution of various tool kits for customers, with resources on the importance of water efficiency and conservation, how they can make small changes to conserve water in their daily lives, and what your organization is doing to address these issues. Utilities might also consider developing print or online reminders of the value of water and wise water use. For example, American Water has released informational content for Fix a Leak Week, Earth Day, and summer high water use, among others, to engage with customers about water efficiency. By including access to educational programs and webinars, or the contact information of someone at the organization, customers have an additional resource if they're interested in learning more. In addition, many water utilities partner with external experts to develop customer educational sessions aimed at indoor/outdoor wise water use, discovering leaks, and other efficiency initiatives.

This advocacy can spread beyond a utility's immediate customer base. By expanding access to educational materials to the greater public and supporting continued research in water conservation, utilities can contribute to greater education and public awareness efforts.

Utilities Should Be Leaders In Water Conservation

When it comes to conservation, we need to lead by example. Water and wastewater professionals also need to make a commitment to water efficiency throughout existing facilities. By evaluating all water use practices and the efficiency of treatment systems overall, we can practice what we preach. Further measures can include putting an emphasis on efficiency and implementing new technologies to accurately meter, and to monitor and track, water consumption data to help identify any consumption that might indicate an increase in water usage. For example, one of American Water's environmental goals is a commitment to meeting customers' water needs while simultaneously saving 15% in water delivered per customer, by 2035, compared to a 2015 baseline. American Water has already accomplished a 5% reduction in water delivered per customer.

According to the American Water Works Association[4] (AWWA), utilities should use comprehensive, integrated resources to make full use of conserved water in supply planning and participate in regional coordination and integration efforts. It is critical to view conserved water as a source of water that provides multiple benefits such as growth, environmental flows, and expanded economic uses. In some cases, water conservation is the least expensive option for a new source of supply, and utilities should also consider working with other agencies to adopt and implement efficient and wise water-use practices and land-use policies. For example, American Water contributed to a 2019 Water Research Foundation report[5] that found that by diversifying supply portfolios through measures such as incorporating alternative and para-supply strategies, water utilities can reduce the pressure on traditional sources and even increase supply availability for environmental use.

The time to take a stand is now. According to the EPA,[6] at least 40 states in the U.S. anticipate water shortages by 2024. As water utilities, we have a responsibility to use our influence and be a proponent for, and practitioner of, water efficiency across the board. ■

References:

1. https://www.usbr.gov/mp/arwec/water-facts-ww-water-sup.html
2. https://www.energy.gov/energysaver/articles/conserving-water-one-drop-time
3. https://www.allianceforwaterefficiency.org/resources/outreach
4. https://www.awwa.org/Policy-Advocacy/AWWA-Policy-Statements/Water-Use-Efficiency
5. https://www.waterrf.org/research/projects/anticipating-trade-offs-using-alternative-water-supplies
6. https://www.epa.gov/greeningepa/water-conservation-epa

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Lynda DiMenna serves as vice president and chief environmental and safety officer for American Water. In her current role, DiMenna is focused on environmental stewardship and making critical safety improvements to help American Water achieve zero incidents and injuries. Through her expertise in environmental leadership, she will also strengthen the company's commitment to building a culture that makes tangible progress on water quality, water management, and system resiliency, as well as other environmental, social, and governance issues. DiMenna earned an MBA from the Hagen School of Business, Iona College, in New York, and a bachelor's degree in business management and human resources from Dominican College in New York. She has earned multiple operations licenses and certifications.

IoT Sensors Prevent Leaks, Detect Anomalies, And Reduce Water Waste

To stretch water resources as scarcity intensifies, utilities and industry should lean on the latest sensing technology, enabled by the Internet of Things (IoT).

By Marc Pégulu

Water is vital to every aspect of our lives, and water usage has continued to increase as manufacturing and food production expand to meet the needs of a growing population. Water is a precious natural commodity and is wasted at distressing levels. In domestic settings alone, the U.S. EPA reports[1] that leaks can waste nearly 1 trillion gallons of water annually. This waste has to be prevented to ensure sustainability and to reduce costs.

Data from Bluefield Research indicates that water costs are increasing faster than any other household utility, at an average of 4.2%[2] per year. As water costs rise, it becomes critical to examine water usage and how waste impacts consumption costs. When leaks occur, added costs follow due to service interruptions and the labor required to fix the leak. Energy used transporting and treating water is ultimately wasted.

As water costs rise, it becomes critical to examine water usage and how waste impacts consumption costs.

Routine preventative maintenance is a common way of curbing waste, but this approach creates waste of its own, as it requires replacing parts and machinery while they're still useful. It also only accounts for preventing wear-and-tear, and may not catch issues caused by isolated incidents of damage. Equipping machinery with technology that continuously monitors performance can prevent water waste by detecting leaks and anomalies the moment they happen.

Connecting Water Systems With LPWANs

The Internet of Things (IoT) refers to equipping physical objects with sensors, providing remote visibility and control into processes that were previously analog. Whether used in manufacturing plants or in household settings, IoT sensors can be attached to multiple equipment types, including water pipelines. Once connected, sensors can detect a variety of issues, including leaks, deviations from optimal settings, and equipment malfunctions.

Sensor capability depends on the network through which they are connected. Several network options for IoT sensors are available in today's market, each with various pros and cons. Wi-Fi or cellular networks are useful for sensors that need to transmit large amounts of data continuously, including high-bandwidth information like video. Wi-Fi networks are high bandwidth, but have short ranges, so they are typically available in household settings. However, high bandwidth requires more power. These sensors must be powered through hard-wiring, which can be expensive to install and must be installed in an easy-to-access location as they require frequent battery replacements.

Low-power, wide-area networks (LPWANs) are another popular means of connectivity, especially in use cases that benefit from a set-it-and-forget-it approach. LPWAN-connected sensors can last years on a single battery. In contrast to Wi-Fi and 5G, LPWAN sensors only transmit small amounts of information at a time, so they require a low bandwidth and a lower amount of power. This allows data to travel long distances and penetrate dense building materials. None of the data analysis is completed on the sensor itself — data are transmitted to the cloud at regular intervals.

For applications that require a regular stream of low-bandwidth information, LPWANs are a popular choice due to their lower cost and easier installation as compared to other available networks.

Big Box Stores See 20% Water Savings

Wholesale retailer Costco is a prime example of a commercial environment that realized water efficiency by implementing IoT. When the company was plagued by unnoticed water leaks, the project started as a pilot in Southern California — an arid geographic area where water preservation is critical — to reduce expensive water waste.

Growing our food supply is arguably one of the most vital uses of water, and demands more water than any other use.

Costco utilized Apana,[3] a water management solution that runs on an LPWAN network, to equip its retail locations with battery-powered IoT sensors. The sensors were set to measure flow and pressure through piping networks and equipment, and transmit data at one-minute intervals. This monitors process drift, mechanical malfunctions, and failure points, alerting administrators when an anomaly is detected. Once a malfunction occurs, the alert also provides issue location as well as repair instructions.

The pilot generated 22% savings in water bills, and the technology was later expanded to all of Costco's U.S. stores.

Water Savings In Urban Settings

How might LPWAN systems support an urban environment, where data must penetrate substantial building infrastructure? In the city of Panaji, India, sensors provide smart water metering to promote efficient water use.

Panaji Municipal Corporation (PMC) utilized home water management company Cranberry Analytics[4] to integrate IoT sensors into their ultrasonic water meters. These sensors enabled the availability of remote metering and consumption data, allowing PMC to diagnose issues and update its meters without physical intervention.

LPWANs' abilities to transmit signals through dense building materials and last years on a single battery enabled a highly efficient maintenance solution for the city of Panaji.

Efficient Water Usage In Agriculture

Growing our food supply is arguably one of the most vital uses of water, and it demands more water than any other use. In fact, agriculture and horticulture account for 70%[5] of freshwater usage worldwide. The amount of water each crop requires varies from plant to plant and is dependent upon location, weather, and soil type.

Farmers carefully monitor and compare myriad variables to determine when to irrigate their fields. IoT sensors can be used to measure the amount of moisture in the soil to ensure efficient water use, avoiding water waste as well as crop damage due to over- or under-watering.

As an example of IoT promoting agricultural efficiency, Sensoterra's[6] wireless sensors are built into probes, which are hammered into the ground to detect the soil moisture at varying depths. The sensors are rugged enough to last years in the field, reliably tracking moisture and temperature throughout the crop growth cycle. The technology reduces up to 30% of water usage in commercial farms.

Water monitoring in agriculture is not just a matter of efficiently growing crops. Because agriculture accounts for a significant amount of water usage, it is critical that the usage is as precise as possible to ensure sustainability.

Visibility Drives Sustainability

Whether industrial, residential, or agricultural, a real-time view into water use can dramatically improve efficiency. IoT sensors provide accurate, real-time data visibility to multiple industries in order to prevent waste and ultimately provide a return on the investment in the technology — and sustainable use of our planet's precious water. ■

References:

1. https://www.epa.gov/watersense/fix-leak-week
2. https://www.bluefieldresearch.com/ns/up-43-over-last-decade-water-rates-rising-faster-than-other-household-utility-bills/
3. https://www.apana.com/
4. https://www.cranberry.tech/
5. https://www.worldbank.org/en/topic/water-in-agriculture
6. https://www.sensoterra.com/

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Marc Pégulu has been Semtech's vice president of Internet of Things for the Wireless and Sensing Products Group since 2019. Before this, he was executive vice president and general manager of the Wireless and Sensing Products Group, a position he had held since June 2015. He held the position of vice president of Wireless and Sensing Products from June 2014. Prior to this appointment, he held the position of director of marketing and applications. Mr. Pégulu joined the company in March 2006 and was involved in several key technology initiatives, including LoRa wireless and software-defined modem technologies. He holds a Master of Science degree in electronics and telecommunications from Institut National Polytechnique of Grenoble, France, and is a graduate of the Executive MBA program of ESCP Europe.

SYSTEMS-BASED HAZARDS ANALYSIS INTEGRATES HUMAN FACTORS

"STAMP" out occupational hazards using the Systems Theoretic Accident Model and Processes approach.

By Dave Grattan

Many hazard analysis techniques such as process hazard analysis (PHA) partition a large process into smaller systems to evaluate parts individually. Reductionism is how most engineering activities occur; however, properties that belong to the system can be lost while breaking it down (i.e., structural decomposition). These lost properties are referred to as emergent properties, and they are properties of the system rather than parts of the system. For example, if a driver looks solely at the segregated parts of a car (e.g., tires, engine, headlights, etc.), the properties of the car as a whole (e.g., mobility, comfort, style, etc.) can be overlooked. Taking a holistic approach and evaluating a system in its entirety in addition to traditional methods such as PHA can provide a more complete picture of what drives risk at your facility.

Accident Model

STAMP (Systems Theoretic Accident Model and Processes) is a relatively new risk assessment model based on systems theory. Professor Nancy Leveson at MIT created this model in the 2000s — with influence from Danish safety science pioneer Jens Rasmussen — to help understand all factors involved in accidents, including human social and organizational influences. One of the main premises of this model is that accidents can happen even when there has been no component failure; sometimes, the variation (resonance) in normal work processes superimposed together in a complex and tightly coupled system produces accidents. Rather than a linear series of events over time with an initiating event, like "falling dominoes" or the "Swiss cheese barrier" model, STAMP considers the non-linear web of factors that ultimately lead to an accident; it focuses on interactions among the parts rather than the parts themselves or failure of the parts.

STAMP incorporates several features of Rasmussen's model, including a broad system boundary expanded beyond potential proximal causes, to include conditions (e.g., design errors or maintenance deficiencies) as well as system factors (e.g., management decisions, employee turnover, engagement, etc.).

Hazard Analysis Tool

STPA (Systems Theoretic Process Analysis) is the tool for analyzing STAMP. It uses a control-theory-based hazard analysis technique similar to PHA but works top-down (i.e., top event to specific causes). It begins by identifying the top event, "loss," which should be related to the emergent property (caused by interactions among the parts) needed to control or constrain. In practice, the top event loss is identified from a PHA, and the STPA study is independently invoked to further evaluate the scenario. The interactions among the parts, not the parts themselves, are analyzed on a custom control structure drawing prepared prior to the study. This drawing uses arrows to show the causal direction and interaction among parts and calls out specific control actions and feedback.

STPA is grounded in classic control theory (i.e., control signals with feedback loops), and safety resides in the constraints (i.e., control actions). Hence, there is only one term used in STPA — "unsafe control action" (UCA) — that looks at what safety constraints are needed or ways the control action is unsafe or otherwise violates the safety constraints leading to accidents. This gives a much broader interpretation for the potential causes of accidents than simply looking at "what can fail." The loss event is documented by identifying "causes" of the UCA that lead to the loss, which can be broad, working from proximal causes to conditions to systemic issues. The mode or state in which the UCA occurs can also be established in what is typically outside the scope of a Hazard and Operability (HAZOP) study or Failure Modes Effects Analysis (FMEA). This includes transient or non-routine operating states such as maintenance, start-up, or response to abnormal situations.

In similar fashion to PHA, recommendations can be generated related to unsafe interactions and preventing the loss event and documented in a table format similar to a HAZOP or FMEA spreadsheet.

Engineering For Humans

The STPA extension called "Engineering for Humans" incorporates human factors into the accident analysis. It has the ability for a broad scope with respect to the system studied, as well as causes. For example, while a HAZOP study or FMEA may list "human error" as a proximal cause, STPA has the ability to study the "human error" as a system, including mental models, conditions, and systemic factors related to the potential error. It takes a deeper dive into the causal scenarios of the loss related to human operator behavior and error (i.e., addressing "Why would they potentially violate the safety constraints of the system?"). It's not looking to assign blame but rather to identify how the system may influence behavior.

In this model, the "controller" could be a human. When evaluating a human controller (i.e., operator), especially when cognition is involved with responding to an abnormal event, understanding the operator's mental model can be an important aspect of the task analysis. Both the positive and negative human factors are evaluated, and this qualitative analysis can help determine and fix negative human factors associated with the task to decrease the likelihood of a procedural error.

Conclusion

The value of the STAMP risk assessment model and its hazards analysis tool STPA is not in having another tool to conduct a process hazard analysis. Those methods already exist and have the capability to evaluate UCAs as part of a Business Planning and Control System (BPCS) or human-error-initiating causes. Rather, STPA and its extension "Engineering for Humans" provide an opportunity to evaluate human-factors scenarios related to potential major accident hazards that are currently not analyzed by traditional methods, as well as evaluate non-routine and transient modes such as maintenance and abnormal situations. STPA and its extension consider human error not as the cause, but as a consequence of the system, in order to identify latent conditions and systemic factors that increase the potential for catastrophe. An STPA is executed as a separate study from PHA, yet together, they provide a more complete systems perspective of major accident hazards. ■

About The Author

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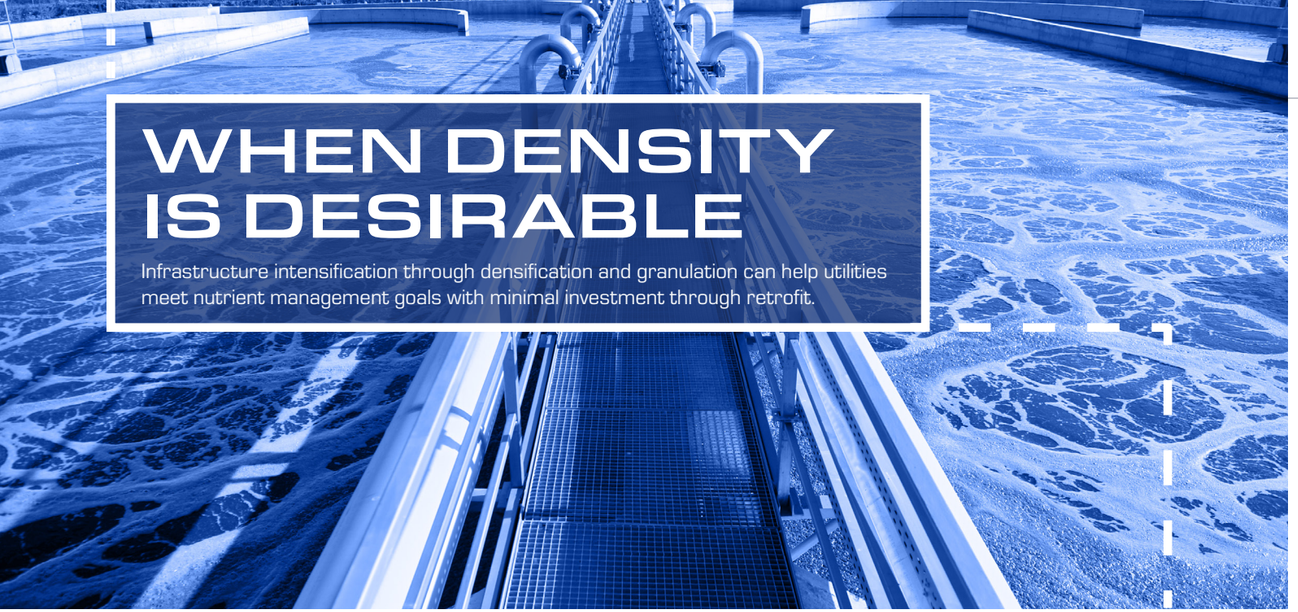


WHEN DENSITY IS DESIRABLE

Infrastructure intensification through densification and granulation can help utilities meet nutrient management goals with minimal investment through retrofit.

By Leon Downing, Eric Redmond, and Isaac Avila

The Clean Water Act of 1972 called for the cleanup of U.S. waterways. Over the past 50 years, regulatory focus has shifted from the removal of pollutants to recovery of water and embedded resources such as phosphorus and energy. When water sector stakeholders who participated in "Black & Veatch's 2022 Water Report"[1] were asked to select all expected reasons for adding new technology, "new regulation" was the most common response, followed by "nutrient removal."

Solutions and specific technologies that help utility managers simultaneously meet multiple needs, such as regulatory compliance and performance optimization for nutrient management, are especially valuable. Mixed liquor densification and granulation has become attractive to utility managers because this technology enables managers to easily retrofit upgrades into existing infrastructure.

Water resource recovery facilities (WRRFs) with fixed or limited infrastructure are challenged to manage increasing nutrient loads while meeting stringent effluent requirements. Often, new effluent requirements dictate modifications to the activated sludge process, such as adding unaerated zones, increasing sludge retention times (SRTs), and addressing higher energy demands due to increased aeration requirements. These changes can result in the need for new tanks — particularly final clarifiers — when using traditional approaches to achieve nutrient removal.

Why Consider Densification And Granulation?

The main benefit of densification and granulation is that improved settling rates of mixed liquor suspended solids (MLSS) increase the overall capacity of the activated sludge system without the addition of new tank volume. Facility owners can achieve more rapid settling of sludge through MLSS densification and granulation.

Granulation is a descriptive word for large flocs in an activated sludge system. These large flocs settle rapidly in final clarifiers and provide stratified growth environments to improve biological nutrient removal. Facilitating the formation of granules in the MLSS intensifies the activated sludge process and minimizes additional capital investment in infrastructure.

Densification is the overall process that results in closely compacted activated sludge flocs. It is indicative of a continuous flow activated sludge system with granules making up the majority of the MLSS. Mixed liquor densification and granulation has become attractive to utility managers to easily retrofit existing infrastructure with performance enhancements that expanded capacity and improved effluent quality with reduced capital investment.

Facilities that have applied granulation and densification have observed faster settling rates that have increased the capacity of their activated sludge systems by 20 to 40%. Increasing the available capacity enables WRRFs to comply with new nutrient management regulations, which would typically require large infrastructure investment, with relatively minor investment.

The second benefit is nutrient removal. Improving settleability decreases effluent total suspended solids (TSS). This reduction in TSS reduces the effluent's total phosphorus and total nitrogen concentration. In addition, the larger granules lead to simultaneous biological nutrient removal (BNR), further reducing the soluble phosphorus and nitrogen concentration in the effluent from the activated sludge facility. In the north central U.S., densification resulted in an additional 10 mg/L of net nitrogen removal and an additional 0.5 mg/L of total phosphorus removal in one facility's BNR configuration.

As the water sector looks to intensify the activated sludge process at WRRFs to avoid the capitally intensive addition of new tanks, the rate at which MLSS settle in final clarifiers has become a focal point. The capacity of an activated sludge system rarely is limited by the hydraulic retention time of the aeration basin or the surface area of the final clarifiers. It more often is limited by how quickly the solids in the MLSS settle in the final clarifiers.

As facility operators increase SRTs to manage increasing nutrient loads — and more volume is converted to unaerated rather than aerated volume — the concentration of MLSS in the activated sludge process increases. If the MLSS do not settle at a rate that allows the solids to be removed in the existing clarifiers, new tanks or substantial retrofits to existing infrastructure are required. One retrofit option would be to increase the volume of the aeration tanks to reduce the MLSS concentration. The other option would be to increase the surface area of the final clarifiers to increase settling time for the MLSS. These retrofit options carry a high cost for utilities.

To avoid costly infrastructure retrofits and expansions, engineers, operators, and researchers have been refining the approach to activated sludge settleability. Since the first publications related to activated sludge design by Ardern and Locket in 1914, designers and operators of WRRFs have focused on consistent settling of the MLSS created in the activated sludge process. Given the financial pressure to optimize capital investment, the focus now extends beyond consistent settling to rapid settling.

When granules can be formed in a continuous-flow activated sludge system, the densified activated sludge process has been demonstrated to: (1) increase capacity by improving sludge settleability without the need for costly system modification or expansion; (2) increase biomass inventory, thus increasing the ability to handle higher loads and operate at higher SRTs; and (3) potentially improve biological nitrogen and phosphorus removal and improve solids removal.

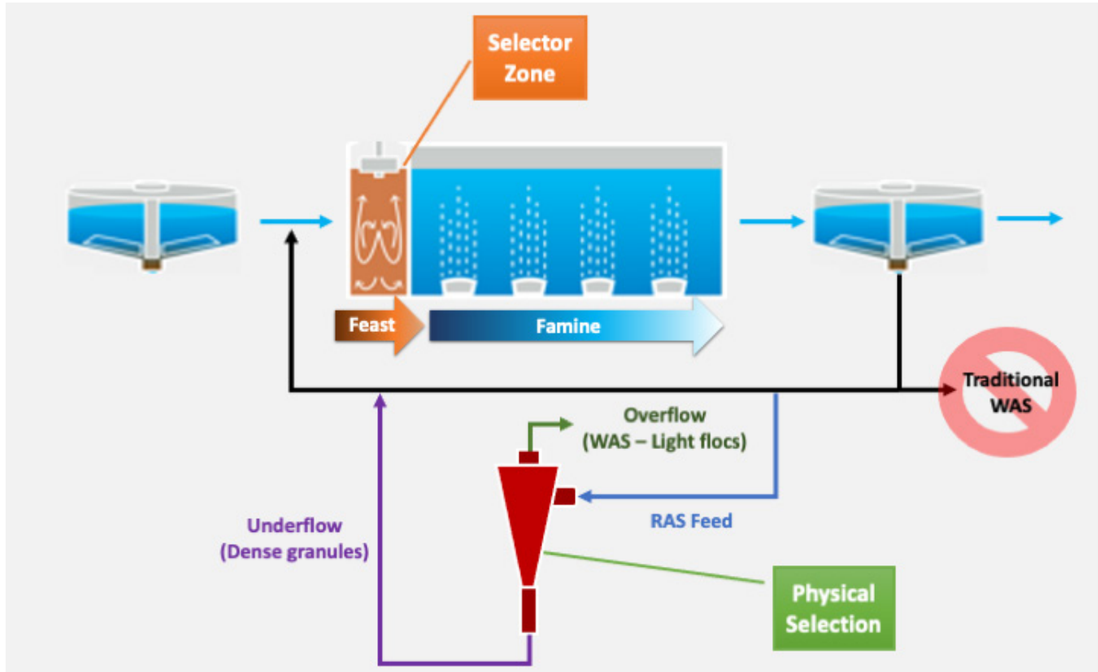
Research And Application Revelations

The key question is how to actively induce granules and promote densification in activated sludge facilities. Decades of research at pilot and full-scale facilities has shown that the combination of selector zones, feast-and-famine conditions, and physical selection are key contributors to the formation of granules in activated sludge systems.

Selector zones. Promotion of biomass growth in unaerated zones, called biological selector zones or selector zones, is a critical element of densification and granulation. These selector zones located at the influent of aeration basins provide biological selective pressure that enables the formation of granules. Growth pressure for granular sludge requires high food-to-microorganism (F:M) loadings in the selector zone at the head of an aeration basin to create large flocs. This is a feast condition, where a high amount of food (represented at WRRFs by biochemical oxygen demand) is available relative to the microorganisms present in the MLSS of an activated sludge system. The high F:M loading provides the growth pressure required to diffuse BOD into a larger floc and form beneficial extracellular polymeric substance (EPS) in the floc. This EPS is the "glue" required to form stable granules.

Selector zones are typically designed and operated to achieve anaerobic conditions. Anaerobic conditions have been studied more than aerobic selector zones, but research also has documented the impacts of aerobic selector zones on the formation of granules and densified activated sludge.

Feast-and-famine conditions. It is important to create a famine period in plug-flow aeration basins after exposing the MLSS to a high F:M loading in a selector zone. Famine conditions, where



Key contributors to induce mixed liquor densification and granulation in a continuous flow activated sludge system (Credit: Black & Veatch)

A hydrocyclone facility like this one is used for physical selection in combination with selector zones to induce granulation and promote densification in a continuous-flow system. (Credit: Black & Veatch)

Incorporation of selector zones often requires the addition of a baffle wall and mixers at the influent of an aeration basin, as shown here in operation at Trinity River Authority's granulated activated sludge process. (Credit: Black & Veatch)

a low F:M is present, encourage the biomass in the granules that make up the MLSS to consume any stored food in their cells. This ensures that they are essentially "hungry" when they return to the selector zones of the aeration basin after being settled and recycled in the final clarifiers with the return activated sludge (RAS).

Physical selection. Physical selection involves selectively wasting lighter, smaller flocs out of the activated sludge system while retaining the heavier, denser flocs and granules. Although not required to induce granule formation, physical selection increases the fraction of granules in the activated sludge process and ultimately facilitates shifting to a densified activated sludge system. This process has been documented to occur in surface wasting facilities, where waste activated sludge (WAS) is wasted from the top of aeration tanks rather than from RAS. This non-proprietary process removes lighter flocs but requires a much larger flow rate of WAS due to the lower concentration of MLSS compared to RAS.

More recently, hydrocyclones have been used to gravimetrically separate dense granules and light flocs from RAS. The dense granules are returned to the aeration basins in the underflow of the hydrocyclones, while the lighter flocs leave in the overflow from the hydrocyclones. The overflow from the hydrocyclones typically replaces traditional wasting of WAS from the clarifier. This physical selection approach ensures retention of any granules formed in the system.

The Bottom Line

Given the benefits of densification, it is important to understand the investments that are required. Densification will avoid the need for new tanks, but there will likely need to be several lower-cost improvements. To add selector zones and ensure feast-and-famine conditions, some aeration basins may require the addition of interior baffle walls and mixers. For physical selection, facility owners can incorporate surface wasting into new activated sludge facilities. For retrofit applications, which is the typical use of intensification, adding hydrocyclones to RAS/WAS lines is essential. Use of a hydrocyclone system, combined with modifications to pumps and piping, is necessary for such retrofits. Given the cost of new tanks, the addition of baffle walls, mixing, and selective wasting can typically be accomplished at 20 to 30% of the cost of a typical expansion.

Densification can help WRRFs increase capacity and improve performance through biological and physical selection. Existing facilities, including continuous flow systems, can be retrofitted to form granular sludge, which makes densified activated sludge a comparatively cost-effective way to do more with less investment. Understanding the benefits, necessary conditions, and options is crucial to the successful application of this technology. ■

References:

1. https://www.bv.com/resources/2022-water-report

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New-Generation AI Overcomes The Barriers To Proactive Leak Detection Adoption

An estimated 90% of leakage never shows above ground,[1] but adoptable technologies are challenging our accepted wisdom on economic levels of leakage (ELL).

By Emma Quail

Climate change and the prospect of increased regulation are prompting many forward-thinking U.S. utilities to reexamine their attitudes to water leakage.

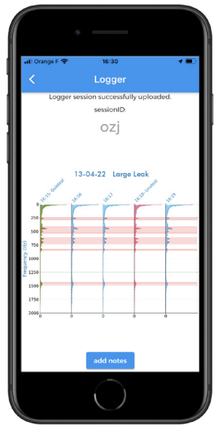
And it's difficult to ignore. Water main breaks make daily headlines, due to collateral damages and risks to public health and safety.

Tapping into the world's last best source of new water is the most obvious solution to water scarcity, and the utilities that grasp the concept first will reap the most benefits both financially and operationally.

In fact, according to researchers in California,[2] reducing leaks may already be a cheaper way for most median utilities to save water than even conservation campaigns and rebate programs.

For large utilities, the potential rewards are even greater. Reducing leaks reduces the need for large capital investment into processes such as desalination or water reuse which, ironically, make leakage even more unsustainable. If leaks are barely acceptable when a gallon of water costs under a cent, how will a water utility justify rate increases when it tops $2?

So why aren't all water utilities investing in a water loss recovery program when water scarcity and aging infrastructure will not support future demand?



Phone app showing a large leak result and graphs

Barriers To Leak Detection

Although benchmarking non-revenue water (NRW) as a percentage is not a reliable performance indicator and doesn't reflect all the physical losses through leakage, the cited 16% national average of NRW as reported by the U.S. EPA is still alarming. No other industry would find it acceptable to bleed so much retail product and revenue.

A big problem is that many U.S. utilities are challenged internally with a deficit in dedicated leak detection resources and budget restraints.

This is not their fault. The U.S. water sector is facing critical and worsening staff shortages.[3] The fear is that this will diminish the knowledge base, and the leak detection discipline will be the loser in the battle to attract and retain new talent.

Budgetary restraints have also been aggravated by a shift in consumption patterns and billed revenues after COVID. While water utilities are getting back on their feet, the imperative is to provide a reliable and safe drinking supply. Leak detection may be perceived as a distraction and an unwelcome expense.


FIDO Bug sensor glowing within a low-pressure plastic network fitting in Bangkok, Thailand


In-hand look at the Bug sensor

The absence of nationwide water loss control reporting means that, currently, only around half of U.S. states must account for their finished water. A one-size-fits-all approach to enforcement may not deliver the best outcomes for all utilities (California researchers again[2]), but as a sector we do need a consensus on what should be done. A reactive approach to leak detection, even one with ad hoc acoustic leak detection equipment to address known leaks or an annual system survey, is not sustainable and is labor-intensive. We need to get smarter.

Disruptive Technology Offers New Answers

Overcoming these challenges will take more than piecemeal improvement in conventional processes and technologies. Fortunately, a new generation of solutions designed with accurate artificial intelligence (AI) has emerged that minimizes labor requirements, the need for high-skilled employees, and CAPEX restrictions offers revolutionary new levels of accuracy based on real life data.

What makes AI particularly exciting is how it allows utilities with no current proactive or digitized capabilities to set up a complete systemwide, end-to-end smart leak detection program almost overnight. This type of long-term proactive approach will almost guarantee reductions in NRW.

New AI business models based on data as a service (DaaS) now include simple, low-skill, no-calibration, acoustic sensors that also act as accurate in-field correlators and ground microphones to pinpoint leaks, as well as repair validators for evidenced revenue assurance. This upends the need to invest heavily in new equipment before seeing returns.

Continuous Adaptation To Sector Challenges

But the real value of machine learning (ML) technology lies in its ability to constantly learn from actual field data to reduce false positives and provide new kinds of actionable insight.

Leak-sizing[4] is a great example of this. Not only has AI delivered accurate leak/no leak results from any source on any material, but it has also been trained to listen for leak size using acoustic files. This previously unavailable insight lets managers prioritize investigations on the leaks that matter — and that's not always the large ones. As we know, multiple small leaks left undetected can result in pipe failure and be cumulatively more expensive. But ongoing visibility of where leaks are and how they're changing over time means being able to take informed action when the timing is right and is a smarter allocation of not only money but also limited resources.

Armed with a heatmap of leaks, next-generation acoustic technologies like this are really taking the leak detection industry to another level. Adoptive utilities have halved their overall leak run time just by concentrating on their large leaks. With the imminent addition of remote control and monitoring using the Internet of Things (IoT), managers will remove even more human input from the process, allowing skilled talent to be deployed to where it delivers most value. ■

References:

1. https://www.adb.org/sites/default/files/publication/27473/reducing-nonrevenue-water.pdf
2. https://cwee.ucdavis.edu/leaks-an-untapped-opportunity-for-water-savings/
3. https://www.epa.gov/sites/default/files/2020-11/documents/americas_water_sector_workforce_initative_final.pdf
4. https://www.fido.tech/fido-ai/leak-sizing/

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Emma Quail has more than 20 years' experience in non-revenue water practices and methodologies in the U.S. and currently is U.S. director of sales at FIDO Tech Ltd., a pioneering software company applying AI in the global water sector.

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