Water Innovations

MARCH 2021

BALANCING THE PRACTICAL AND SUSTAINABLE

GUIDANCE FOR COMPLICATED REGULATORY, FINANCIAL, AND ENVIRONMENTAL CONCERNS

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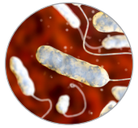

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Water Innovations

101 Gibraltar Road, Suite 100
Horsham, PA 19044
PH: (215) 675-1800
FX: (814) 899-5587
Email: info@wateronline.com
Website: www.wateronline.com

CHIEF EDITOR
Kevin Westerling
(215) 675-1800 ext. 120
kwesterling@vertmarkets.com

PUBLISHER
Travis Kennedy
(215) 675-1800 ext. 122
tkennedy@vertmarkets.com

ASSOCIATE PUBLISHER
Patrick Gallagher
(215) 675-1800 ext. 129
pgallagher@vertmarkets.com

PRODUCT MANAGER
Bill King
(215) 675-1800 ext. 100
bking@vertmarkets.com

MANAGING EDITOR
Karen White
(814) 897-9000 ext. 316
kwhite@vertmarkets.com

PRODUCTION DIRECTOR
Lynn Netkowicz
(814) 897-9000 ext. 205
lnetkowicz@vertmarkets.com

CREATIVE DIRECTOR
William Pompilii
(215) 675-1800 ext. 145
bpompilii@vertmarkets.com

PRODUCTION MANAGER
Susan Day
(215) 675-1800 ext. 101
sday@vertmarkets.com

DIRECTOR OF AUDIENCE DEVELOPMENT
Martin Zapolski
(814) 897-9000 ext. 337
mzapolski@vertmarkets.com

DIRECTOR OF ONLINE DEVELOPMENT
Art Glenn
aglenn@vertmarkets.com

Eprints and NXTprints
The YGS Group (800) 290-5460
VertMarketsReprints@theYGSgroup.com
www.theYGSgroup.com

EDITOR'S LETTER

By Kevin Westerling
Chief Editor, editor@wateronline.com

Pride And Joy: **Water Leadership Defined**

Despite overseeing our most precious resource, water professionals often go unnoticed, and hence unappreciated. To that end, it's my pleasure to highlight the efforts, accomplishments, and insights of industry leaders such as Joy Eldredge, chair of the California-Nevada Section of the American Water Works Association.

CA-NV AWWA represents an area and utility presence larger than most countries. The spate of issues is large as well, both in number and scope — and that was before the pandemic hit. The repercussions of COVID have forced difficult operational decisions, and sometimes concessions, yet the goal of sustainably achieving the highest level of water quality and customer service remains the same. Joy Eldredge embodies this goal, and her service to others is evident even beyond her professional duties. Read on to learn about, and from, her experience.

You were passed the gavel at CA-NV AWWA's 2020 Annual Fall Conference, which was held virtually in October. Can you describe your role and how COVID has affected it?

As Section Chair, I work with the chairs (vice chair, chair elect, and vice chair elect) as well as the Executive Committee to set the course and the priorities for the year. The Executive Director and 12 other staff work with the volunteers to serve our members.

The biggest change for the section was canceling our annual spring conference, which was very unfortunate. We had robust plans for a 100th anniversary celebration at Disneyland, which always draws a large crowd. We changed the format of our annual fall conference to be entirely virtual. By all accounts it was successful, and I am very proud of section staff, our ad hoc committee, and our members that ensured a successful event. Our upcoming Operator Symposium [March 23-24] will also be virtual, and we hope for similar results. [Visit www.ca-nv-awwa.org for details.]

What has COVID wrought in terms of day-to-day operations for your sector and the industry at large?

The State Water Resources Control Board has recently published survey results that indicate there is over $600 million in outstanding bills directly related to drinking water systems that customers have not paid since the start of the COVID pandemic. This is a huge impact to the industry and, as we know, water systems are already challenged with sufficient funding to maintain and replace aging infrastructure. Similar to the recent drought when associated mandates for reduced consumption reduced revenue for many systems, infrastructure does not stop aging, but the investments must be made after additional degradation, often resulting in higher overall costs to the operation. Individuals need to understand that paying their water bill needs to be among their highest priorities.

You are also deputy utilities director at the city of Napa, in the heart of California's Wine Country. What unique challenges are posed by your environment and user base, and how are they addressed?

The city of Napa has had its share of disasters in the last seven years, including a 6.0 earthquake in 2014, the Atlas and Patrick Fires in 2017, public safety power shutoffs (PSPS) of the energy grid starting in 2018, and the recent Hennessey Lightening Unit Complex and Glass Fires in 2020. We are well-versed in emergency response and I encourage others to plan ahead for emergencies. One of the most important actions is to sign up for CALWARN, the California Water/Wastewater Agency Response Network [or your state's equivalent], which provides a structure and contractual mechanism for mutual aid from other agencies. The value is that the other agencies operate and maintain systems, so they are already trained and have the materials and equipment necessary to provide immediate and effective assistance.

Admirably, you served in the Peace Corps in Kenya, East Africa, from 1995-1998. Did that experience help inform or influence your views on water? If so, how?

I spent three years building small concrete tanks for rainwater harvesting from roof catchment systems. It was very basic construction using locally available materials and purchased concrete. It was the ultimate in hands-on construction, and I realized I learned more about concrete than I did in my 300-level college courses. Spending time in a very remote part of the world where people are in a situation of subsistence living reinforced the importance of water and that it is a vital resource.

Americans often take for granted the amount of work that goes into ensuring their clean, safe tap water is available every day and reliable in times of natural disasters. When you carry every gallon of water you use with a bucket, you will value it much more than when you simply turn on the faucet and it appears.

But perhaps not as taken for granted as it once was. Hopefully, the pandemic has taught America and the world about the value of water and water services. Thank you to Joy and all our water professionals out there.

Let's Work Together To Fix Regulatory Guidance

Responsible parties all want clean water and to abide by the rules that secure it, but what if the rules do more harm than good? With a recent Supreme Court decision on wastewater discharges and a change of presidential administrations as the backdrop, this op-ed from the National Ground Water Association addresses the conundrum.

By Tim Parker

Last year, the Supreme Court of the United States (SCOTUS) issued its ruling in the case *Maui County v. Hawaii Wildlife Fund*. The case centered on the question of whether pollutants that originate from a point source can be accurately traced to reach (navigable) surface water when transported through groundwater. In a 6-3 decision, SCOTUS ruled that, yes, point discharges should require a permit if they are considered a "functional equivalent of a direct discharge." The court's decision ultimately moved the case back down to the lower courts and mandated the U.S. EPA to create guidance on applying the new standard.

The National Ground Water Association is the nation's leading nonprofit organization representing groundwater professionals from across the industry, including hydrogeologists, water well contractors, and environmental engineers. NGWA recognizes that all water is interconnected (One Water) and has high value, water must be sustainably managed through inclusive stewardships in an integrated manner, and groundwater is a local resource that is an integral part of the solution for sustainability and resiliency. Last year, NGWA filed an amicus brief in the case arguing against increasing the number of permits through the Clean Water Act, in fear that it would become overburdensome to groundwater users and diminish local control of groundwater from states. And while we did not receive the outcome we hoped for from SCOTUS, we are now focused on avenues in which we can provide our collective knowledge and expertise to ensure that new guidance developed by the EPA is created with sound science and is applicable in the field.

In January of this year, the EPA issued a draft memo on its initial guidance to apply the SCOTUS decision to the Clean Water Act's National Pollutant Discharge Elimination System (NPDES) permit program. After reviewing the draft guidance, NGWA issued comments to the EPA indicating that it came up short on many technical aspects that would have made the document a usable and practical resource for its users. NGWA has also reviewed the final guidance issued by the EPA and finds it also comes up short and does not meet the objective of "guidance" on how to meet the requirements laid out by the SCOTUS decision.

The final guidance document, which was largely unchanged from the draft guidance, is simply too broad and lacks specific focus on pragmatic technical considerations to be applied. It provides almost no specific and consistent indicators of how to determine whether a pollutant discharge that may travel from a point source through groundwater to surface water constitutes a "functional equivalent direct discharge" and a permit may be required, which is at the core of the SCOTUS decision and direction to the EPA. The guidance also includes no instruction or useful direction on how industry or state regulators may evaluate individual sites to prepare for such permits and determine their best course of action. Essentially, the guidance maintains the status quo and in doing so does not address the issues brought forward by SCOTUS.

This "guidance" document and its deficiencies are, unfortunately, indicative of a larger problem endemic in many of our regulatory bodies, and especially those where so much burden falls, such as the EPA. NGWA has the utmost respect for the staff of the EPA, as they work diligently to promulgate and enforce regulations (often mandated to them by outside actors such as courts and legislators) that protect our environment and most valuable natural resources, including groundwater. Many of these agencies, especially in the last four years, have also seen their budgets cut and a drastic increase in politicians invoking their names to stoke the flames of antiregulatory policies. Simply put, regulators do not have easy jobs.

But whether due to lack of sufficient resources, outside pressure from special interests, or a scientific knowledge deficit, the guidance provided tends to be vague and impractical. This not only creates logistical issues for industry and regulators, but also can have negative impacts on our environment. Industries typically want to abide by regulations and know their importance, but they must be given clear and practical guidance on how to do so. This issue, though, cannot fall solely on the EPA or other regulatory bodies. Our industries should be taking more proactive, inclusive roles in working with the EPA to aid them in crafting the guidance that will allow us to follow the regulations they put forward.

> **Industries typically want to abide by regulations and know their importance, but they must be given clear and practical guidance on how to do so.**

NGWA has developed an approach to work with the industry through virtual and face-to-face (hopefully) meetings and events to evaluate potential functionally equivalent NPDES direct discharges using a solid foundation in groundwater science, in order to (1) provide cooperative opportunities for groundwater scientists and other professionals to participate and provide input, and (2) work collaboratively with the EPA, other interested agencies, and other interested professional associations to create practical, useful, and cost-effective technical guidance and associated educational opportunities. The approach includes reviewing the Maui and other relevant and applicable case studies and considering how to best apply the various factors underscored by SCOTUS, including time and distance, pollutant volume, geologic materials, and terrain into a pragmatic framework for application.

Our nation's groundwater supply plays a vital role in our nation's One Water security and economy. That is why NGWA works collaboratively every day with its membership, our country's leaders, and industry to ensure its protection, and why we know creating usable and meaningful guidance to meet regulatory standards is paramount in keeping this invaluable natural resource safe.

NGWA is reaching out directly to the Biden administration and urging them to reconsider the guidance issued by the previous administration and offer our support in creating a more practical and useful document. It is our hope that President Joe Biden's EPA will begin to view these types of guidance documents as genuine opportunities to work with industry and environmental stakeholders to accomplish our common goals of creating a safe, healthy, and productive environment for us all. ■

About The Author

Tim Parker, PG, CEG, CHG, is a principal hydrogeologist with Parker Groundwater in Sacramento, CA. Parker serves as a member on the Groundwater Committee of the Association of California Water Agencies, the cochair of the legislative committee for the Groundwater Resources Association of California, and director on the California Groundwater Coalition, and sits on the National Groundwater Association Board as VP of the scientist and engineers division.

How The New Lead And Copper Rule Could Impact You

As the baton was passed to a new U.S. presidential administration and EPA, so were the Lead and Copper Rule revisions, which are certain to be enacted with rigorous oversight.

By Jake Abernethy and Eric Schwartz

The U.S. EPA has just released its new Lead and Copper Rule (LCR) Revision[1], effective as of Jan. 15, 2021. This is the first major update to the rule in nearly 30 years. A three-year running clock for major aspects of the regulation started when the rule was posted in the Federal Register in mid-January. It is important for utilities to begin to take steps now so they can be in full compliance when those timelines become binding. This article will provide an overview of the major changes in the rule and insights on some of the steps that water systems can begin to take in order to get ready for the new rule's implementation.

The major changes in the new rule include testing drinking water at elementary schools and childcare facilities, improving corrosion control when elevated lead levels are found, modifying the water-sample methodology, enhancing public notification when elevated lead levels are detected, and requiring all utilities to create and regularly update service-line inventories. The new rule also reduces the required rate of service-line replacement for water systems that exceed the lead action level.

> *"For the first time in nearly 30 years, this new Lead and Copper Rule incorporates best practices and strengthens every aspect of the rule, including closing loopholes, accelerating the real world pace of lead service line replacement, and ensuring that lead pipes will be replaced in their entirety."*
>
> – Former U.S. EPA Administrator Andrew Wheeler at the new rule's release

Studies have shown that lead and copper primarily enter drinking water through plumbing materials, such as pipes. Health problems from lead and copper exposure range from stomach distress to brain damage. "In 2018, researchers estimated more than 400,000 deaths a year in the U.S. are linked to lead exposure," according to the *Chicago Tribune*.

[Note: The Biden administration has put a freeze on all pending regulation that has not yet gone into effect, including the Lead and Copper Rule. This gives the administration an additional 60 days to review all regulations and determine if changes are necessary before going into effect.]

Changes to the LCR are divided into the following categories:

- *Service Line Inventories and Replacement* – establishes a trigger level to jump-start mitigation earlier and in more communities
- *Public Communication* – water systems are required to identify and make public the locations of lead service lines (LSLs)
- *Sampling Requirements* – new sample methods that include fifth-liter draws at sampling sites with lead service lines
- *Corrosion Treatment* and *Water Quality Guidelines*
- *Specific Requirements for Children in Schools and Childcare Facilities* – mandated testing in elementary schools and childcare facilities

Service Line Inventory And Replacement Requirements

- All water systems have three years to develop an initial LSL inventory or demonstrate the absence of LSLs. Water systems should begin organizing their records to develop the inventories. The Association of State Drinking Water Administrators (ASDWA) created a guide to service-line inventories[2] that can help utilities prepare. The inventories will be publicly accessible and must be updated periodically. Systems then must develop an LSL replacement plan based on their inventories. Predictive modeling is specified in the rule as a helpful strategy in guiding inventory-and-replacement programs.

All water systems subject to the LCR will be required to create a publicly accessible service-line inventory within three years.

- The new rule reduces the required minimum annual LSL replacement rate from 7 percent to 3 percent for exceedances of the lead *action level* of 15 µg/L. The rule also introduces a new *trigger level* of 10 µg/L, whereby exceedances would require states to work with a utility on a goal-based replacement program.
- All water systems subject to the LCR will be required to create a publicly accessible service-line inventory within three years. These inventories must identify service-line material as lead, galvanized requiring replacement, not lead, or lead status unknown. The inventories must reflect the entire service line from the main to the building inlet, regardless of ownership. Some utilities do not have records on the private side of the service line, and this rule reflects a change in what they are expected to know and report, making it even more essential that utilities be proactive in creating these inventories.

At a minimum, materials included in the inventory are to be on the basis of available records, including plumbing codes, permits, building department records, and water-system records. The initial inventory must be submitted to the state primacy agency within three years from final rule publication. Water systems have a lot of unknowns when it comes to service-line materials, and these unknowns can be difficult to communicate to the public.

There are triggers in the rule for achieving minimum replacement rates. Mandatory replacement programs can be triggered for either: (1) a lead action level exceedance of 15 µg/L, which would result in the requirement of the minimum annual replacement rate of 3 percent for large systems (smaller systems have alternative compliance options) or (2) an exceedance of the new lead trigger level of 10 µg/L, which would result in the state needing to propose a replacement rate. The new 3 percent replacement rate is based upon a two-year rolling average for at least four consecutive six-month monitoring periods.

Under the new rule, water systems: (1) must have a plan in place and start replacing lines as soon as sample results are above the action level, (2) cannot avoid replacing lead service lines through testing, and (3) are required to replace the water-system-owned portion of a lead service line when customers choose to replace their customer-owned portion of the line. Additionally, partial lead-service-line replacement, which could create a short-term spike in lead concentrations, do not count toward the replacement goals.

In the meantime, water systems should begin compiling information for their service-line inventories and begin putting together their service-line replacement plans. As part of its rule, the EPA encouraged in its Public Comment and Response Document[3] the use of predictive models for LSL inventory, replacement, and communication. "Water systems may also create a strategy that involves proactive investigation of service-line material compositions which is independent of other water system activities, such as the use of predictive models to evaluate the probability that a service line is lead and other methods provided or required by the state. Such predictive models could also inform water systems in how they can approach lead service-line replacement (LSLR) in a more efficient manner."

Public Communication

- The LCR revisions impose new public notification requirements for service-line-material identification, as well as for when sampling exceeds the action/trigger levels.

Within 30 days of completing its initial LSL inventory and annually thereafter, water systems with LSLs must provide notice to households with service lines made of lead or with lead status unknown. The LCR specifies the notice must include information about the health effects of lead, steps customers can take to reduce lead exposure, and how to identify and remove an LSL.

Systems that serve more than 50,000 people must post the inventory on their websites, whereas other systems must only make the inventory publicly available in some way (e.g., having it available for viewing at the clerk's office). Creating online maps that are user-friendly and apply best practices in public-health communication for community members to learn about service-line materials can be a helpful tool in doing this. Additionally, communicating the results of a predictive model in the public-facing maps can help residents characterize uncertainty around the material of their service lines, providing information about how to reduce their risk of lead exposure.

Once LSL inventories have been created, water systems are required to provide public education to customers in advance of infrastructure work that will affect LSLs and lead-status-unknown service lines.

The water system must take a follow-up tap sample between three and six months after completion of any LSL replacement and provide those results to the building's residents. When a gooseneck is encountered or LSL replacement occurs on an emergency basis, the system has 24 hours to deliver a pitcher filter and educational information.

Water systems will be required to notify the occupants of the residence of high-lead water concentrations within 24 hours of discovery. This is a significant change from the previous 30-day requirement.

These public notification requirements will impose a new

burden on utilities, especially for those systems that do not already have public communication strategies in place.

Sampling Requirements

- The rule adds a fifth-liter sample to water testing as part of the compliance-sampling program.
- It also expands sampling and reporting requirements based on the action and trigger levels with a "find-and-fix" strategy of taking corrective action once exceedances are observed.

To help identify areas most in need of remediation, the LCR revision prioritizes collecting samples from sites served by LSLs. This includes maintaining the existing requirement of first-liter sampling in homes without LSLs and imposing a new requirement of fifth-liter sampling in homes with LSLs. These samples will be collected after the water has been stagnant for at least six hours. Fifth-liter sampling has been part of Michigan's lead and copper compliance. Michigan's rule requires first- and fifth-liter sampling at homes with likely LSLs, whereas the new LCR only requires fifth-liter sampling at those homes. Utilities can look to resources about the Michigan requirement as they modify their sampling requirements to meet the new regulation.

Semi-annual sampling is now required of systems without compliant data and of systems with 90th-percentile lead or copper levels greater than the action level (15 µg/L). Annual sampling will be required of systems with LSLs and of systems with 90th-percentile lead or copper levels greater than the trigger level (10 µg/L) but less than the action level (15 µg/L).

To reduce elevated levels of lead in certain locations, the rule revision requires water systems to "find and fix" the causes of these elevated levels. Individual tap samples that exceed the action level of 15 µg/L require an additional tap sample to be collected within 30 days and corrective actions to be taken.

While states have the authority to require a system to evaluate corrosion control at any time, the rule explicitly requires evaluations when a system exceeds either the lead trigger level or action level (see next section).

Corrosion Control Treatment And Water Quality Guidelines

- The LCR specifies corrosion control treatment (CCT) requirements and water quality parameters for systems based on lead-sampling results and system size.

For systems with 90th-percentile lead levels of 10 to 15 µg/L, if the system does not have CCT, it must conduct a CCT study if required by the state primacy agency. If the system does have CCT, it must follow steps for re-optimizing its CCT.

Systems with 90th-percentile lead levels greater than 15 µg/L that do not currently have CCT must install CCT immediately, regardless of subsequent lead levels. Those with CCT must also re-optimize.

Community water systems serving fewer than 10,000 people and nontransient water systems can select an option other than CCT to address lead exceedances.

Systems serving more than 50,000 people must conduct regular water-quality-parameter monitoring at entry points and within the distribution system. Systems serving fewer than 50,000 people must continue water-quality-parameter monitoring until they no longer exceed lead action levels for two consecutive six-month monitoring periods.

If an individual tap sample exceeds 15 µg/L, systems must collect a follow-up sample at each location, conduct water-quality-parameter monitoring at or near the site, and perform needed corrective action. Such requirements are referred to as "find-and-fix" protocols.

Schools And Childcare Facilities

- Water systems must conduct lead-in-drinking-water testing at 20 percent of elementary schools and licensed childcare facilities in their service areas each year and conduct sampling at secondary schools on request.

This new rule revision puts in place for the first time a requirement that community water systems test for lead in drinking water in elementary schools and childcare facilities they serve. The sample results of the test must be provided to each sampled school/childcare facility, the primacy agency, and the local or state health department. This requirement excludes facilities built or those that have replaced all plumbing after Jan. 1, 2014.

Over the coming months, the EPA and water industry groups will be putting together guidance and resources to support utilities in adopting these new rules. Further details can be found in the EPA's *Reference Guide for Public Water Systems.*[4] ■

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About The Authors

Jake Abernethy and Eric Schwartz are the cofounders of BlueConduit. Additionally, Abernethy is an associate professor in computer science at the Georgia Institute of Technology, and Schwartz is an associate professor of marketing at the University of Michigan. They have pioneered the use of machine learning to help municipalities and utilities identify and inventory lead service lines, helping municipalities save millions of dollars and accelerating the remediation of this critical health issue. Initially working in Flint, MI, BlueConduit now works with municipalities across the United States and Canada. Recognized as a leader in its field, BlueConduit has provided legislative policy development support and has had its work recognized by several media outlets (https://www.blueconduit.com/blog).

REUSE TO THE RESCUE:

Recycling Municipal And Industrial Wastewater For A Sustainable Future

In recent years, limited water resources combined with the growing demand for freshwater, rapidly changing weather patterns, and environmental concerns have spearheaded water reuse as a leading solution in the battle to secure water resilience.

By Lior Eshed

What Is Water Reuse?

Also known as water recycling or reclaimed water, water reuse is the process of capturing wastewater, stormwater, saltwater, or graywater and treating it as needed for purposes such as domestic consumption, industrial processes, surface or groundwater replenishment, and watershed restoration. The term municipal wastewater reuse commonly relates to the process of tertiary treatment followed by desalination, which produces potable water from wastewater at a fraction of the cost of seawater desalination.

Across the globe, communities and businesses are investing in water reuse to ensure that residents have safe drinking water supplies, industries can utilize water to enable ongoing operation and create jobs, farmers have water to grow food, our environment is protected, and our economic future remains secure.

Water reuse is a proven method to improve water resilience by supporting a broad water portfolio. In recent years, a growing number of countries are incorporating water reuse into their water management strategies to ensure a drought-proof, safe, reliable, locally controlled water supply.

According to a recent survey by the water-market intelligence firm Bluefield Research, the reuse market stands at $1.8 billion and is expected to grow 27 percent by 2027. In the U.S. alone, the volume of produced recycled water is projected to increase from 4.8 billion gallons per day (BGD) to 6.6 BGD by 2027, marking a staggering increase of 37 percent.

The U.S. Reuse Landscape

Overall, a growing trend in water reuse is evident in the United States. According to Bluefield Research, 39 of 50 U.S. states currently have reuse regulations or guidelines, with three more in the process of adopting regulations. Florida, the leading state for installed water reuse capacity, is considered a largely mature market, whereas California, the South, and the Midwest represent the greatest opportunity for near-term growth, especially regarding industrial reuse opportunities.

Although California isn't as reuse-ready as Florida just yet, it does have a close relationship with water recycling that started long ago. Beginning with the first use of recycled water for landscape irrigation 100 years ago, agencies across California have continued to innovate and improve the process to treat and beneficially reuse their wastewater. Today, recycled water supplies offset approximately 9 percent of the state's urban water demands, and agricultural reuse provides reliable water supplies for farmers throughout the state.

Increased use of recycled water provides a steady, long-term water supply source and helps to increase drought resilience in regions throughout California. In addition, water reuse plays a strategic role in environmental protection in the state. By safely and effectively reusing water for potable, industrial, and agricultural purposes, many areas of California are able to reduce current and future reliance on environmentally stressed imported water sources.

Water Reuse In Singapore And Neighboring Countries

Singapore's successfully executed water supply initiative called Four National Taps[1] has set an impressive precedent for its neighboring nations to follow. Its robust and diversified water supply system is based on four "water pillars": high-grade reused water, also called NEWater; local catchment (i.e., rain and stormwater reservoirs); imported water (primarily from Malaysia); and desalinated water.

This integrated water-management approach maximizes the efficiency of each source, addresses the water-intensive needs of local industries, and serves the growing awareness of global issues such as climate change, increasing droughts, expanding urbanization, and the rising cost of energy.

Neighboring countries have also implemented similar plans of action to establish water stability, drawing inspiration and principles from the Singaporean model. The premise was simple — four main strategies that include natural and artificial water sources, when intertwined, are designed to solidify the nation's resilience against frequent natural disasters and seasonal water scarcity.

As to the industrial water landscape, some of the top Far-Eastern industrial sectors, led by the semiconductors industry, are extremely water-intensive in their day-to-day operations. To add to the challenge, industrial facilities are typically located in populated areas and compete for the use of the same natural freshwater sources.

In 2015, approximately 360 million cubic meters (m³) per year of recycled water were used for agricultural irrigation in California, representing 31 percent of the total amount of recycled water used in the state.

The ability to produce substantial quantities of high-quality water, while maintaining minimal environmental impact and adhering to the strictest discharge regulations, has led the Far-Eastern water-reuse market to gain serious momentum in recent years.

IPR Or DPR?

One of the biggest contributors to the changing views on water reuse is the formal recognition of its importance in recent years by entities such as the United Nations. The 2017 "World Water Development Report,"[2] for example, focused on wastewater as a safe and sustainable water resource, while successful case studies of water reuse have expanded its frontier from agricultural irrigation and limited urban uses to a variety of applications, including potable reuse.

What are IPR and DPR, and what is the difference between them?

These two potable-water-reuse options are currently gaining prevalence: direct potable reuse (DPR) and indirect potable reuse (IPR). In the case of IPR, treated wastewater is released into groundwater or surface water sources and, later on, reclaimed and treated to meet potable water standards. In the case of DPR, purified water created from treated wastewater is introduced directly into a municipal water supply system, without an environmental "buffer" of any kind.

After decades of IPR applications, a combination of improved effluent water quality, advanced treatment technologies, and increasing demand for water supplies has finally sparked the interest in DPR. While states such as California, Arizona, New Mexico, Texas, and Oklahoma are actively moving toward the adoption of DPR, other states prohibit DPR use and employ IPR methods exclusively.

Because of that, despite a noticeable trend and an overall readiness to employ reuse applications, the U.S. remains slightly behind countries such as Singapore when it comes to widespread deployment of DPR. This is mainly due to tighter regulation as well as an overall public concern regarding the potential health hazards of DPR, when not performed with meticulous care.

While there is no reliable epidemiological evidence[3] that the use of reclaimed water for any of its applications has caused a disease outbreak in the U.S., the potential transmission of infectious disease by pathogenic organisms and the release of organic contaminants remain the principal public concerns regarding DPR. These concerns, however, are fairly ungrounded in developed countries, where dozens of tightly regulated DPR facilities produce high-quality potable water while adhering to the strictest health standards.

Wastewater Reuse For Industrial Applications

The main industrial sectors that utilize wastewater reuse are power plants, food and beverage industries, chemical manufacturing, hydraulic fracking, oil and gas, and petrochemicals. What are the main factors driving the need for more efficient industrial-water-reuse technologies?

In most cases, water scarcity, increased awareness of Corporate Social Responsibility (CSR), and the need to reduce costs by maximizing water recovery play major roles. Some industries, however, still hesitate to adopt reuse solutions on a wide scale.

Electricity utilities are challenged by a competitive use of water in water-scarce regions and therefore need to rely on alternative water sources. Water-use applications in electricity utilities include cooling tower make-up, boiler feed, environmental control, sanitation, irrigation of landscape, and environmental stewardship. The day-to-day operation of a thermoelectric power plant, for example, is especially water-intensive and requires a large quantity of freshwater to sustain its activities.

To address this pressing need for water in such large quantities without exhausting freshwater supplies or competing with municipalities over local water resources, reused municipal wastewater can offer a feasible alternative water supply for the power sector.

Degraded or non-traditional water supplies are constantly being considered by the power sector to offset water consumption. However, although reclaimed wastewater seems to be an obvious choice due to its easy accessibility and unlimited availability, Bluefield Research reports that only 60 of 5,000 power plants across 16 states in the U.S. currently use municipal reclaimed water.

One of these rare examples for a reuse-centric plant is Palo Verde, the largest power generator in the U.S., with a total output of 4,030 net MW, which meets the electricity needs of approximately four million people around the clock. Because of its desert location, Palo Verde is the only nuclear power facility that uses 100 percent reclaimed water for cooling. Unlike other nuclear plants, the Palo Verde Water Reclamation Facility (WRF) maintains zero discharge, meaning no wastewater is released to rivers, streams, or oceans.

Industrial facilities owners typically think of water-management issues in their facilities in two ways:

- Securing water supplies for operations, including supply and discharge
- Complying with quality standards for wastewater discharge.

On one hand, a smart reuse-management plan helps facilities:

- Reduce their freshwater demand
- Bring down generated wastewater volume
- Minimize subsequent discharge permits
- Bring down the costs of freshwater acquisition and effluent treatment
- In some cases, provide recycling opportunities for certain industrial byproducts.

On another hand, properly managed reuse requires knowledge, financial investment, and, understandably, modification of current operations for both DPR and IPR applications. Weighing the pros against the cons, implementing a reuse-management plan often proves to be the most sustainable, resource-efficient, cost-effective, and environmentally oriented alternative.

Evolving regulation that supports rapid reuse-market growth and encouragement at the legislative level are also key factors contributing to market readiness. Therefore, despite minimal pushback, all predictions indicate a much broader adoption of water-reuse-management plans in industrial facilities across the globe.

From Drain To Drink — Water Reuse For Potable Water Applications

Reclaimed water has proven to be more sustainable and cost-effective than developing alternative supplies:

- Reused water is environmentally sound, as it alleviates pressure on freshwater sources and natural systems
- It's safe — water is purified to meet the strictest water quality standards
- It's sustainable — wastewater is a constantly renewable source of freshwater
- It's locally controlled — communities are not obligated to drain natural water resources or rely on neighboring counties for their water supplies, leading to full water independence.

Taking Conventional Water Reuse To The Next Level

Standard water reuse usually includes ultrafiltration (UF), reverse osmosis (RO), and ultraviolet advanced oxidation process (UV/AOP) units. Chloramine, which is typically dosed in the RO process, helps to control biofouling of the membranes. However, chloramine is a precursor to the formation of disinfection byproducts such as NDMA — a dangerous organic contaminant and a suspected carcinogen.

The presence of chloramine not only increases the risk of membrane oxidation in the case of overdose, but it also acts as a free-radical scavenger, is more energy-intensive, and requires larger treatment systems that demand higher CAPEX and OPEX.

To overcome this problem, solutions such as Pulse Flow Reverse Osmosis (PFRO™) enable a completely chloramine-free water reuse process. As opposed to standard RO systems that operate under continuous hydraulic and osmotic conditions, PFRO utilizes alternating hydraulic conditions, switching between dead-end production mode and flushing mode, during which brine is flushed out at high velocity.

The constantly changing hydraulic conditions make it very hard for microorganisms to sustain themselves, thereby reducing the risk of biofouling and scaling. This allows the system to operate at very high flux rates (50 percent higher than normal), eliminating the risk of rapid increase in biofouling and resulting in overall CAPEX savings of about 20 percent.

Our ground- and surface-water supplies are at risk of overuse around the world, and it's only a matter of time before demand will surpass water supplied by rain, rivers, lakes, and reservoirs. Because of that, water conservation and reuse are gaining acceptance as sustainable, feasible, and practical methods for alleviating industrial and municipal water demand and ensuring water resilience for generations to come. ■

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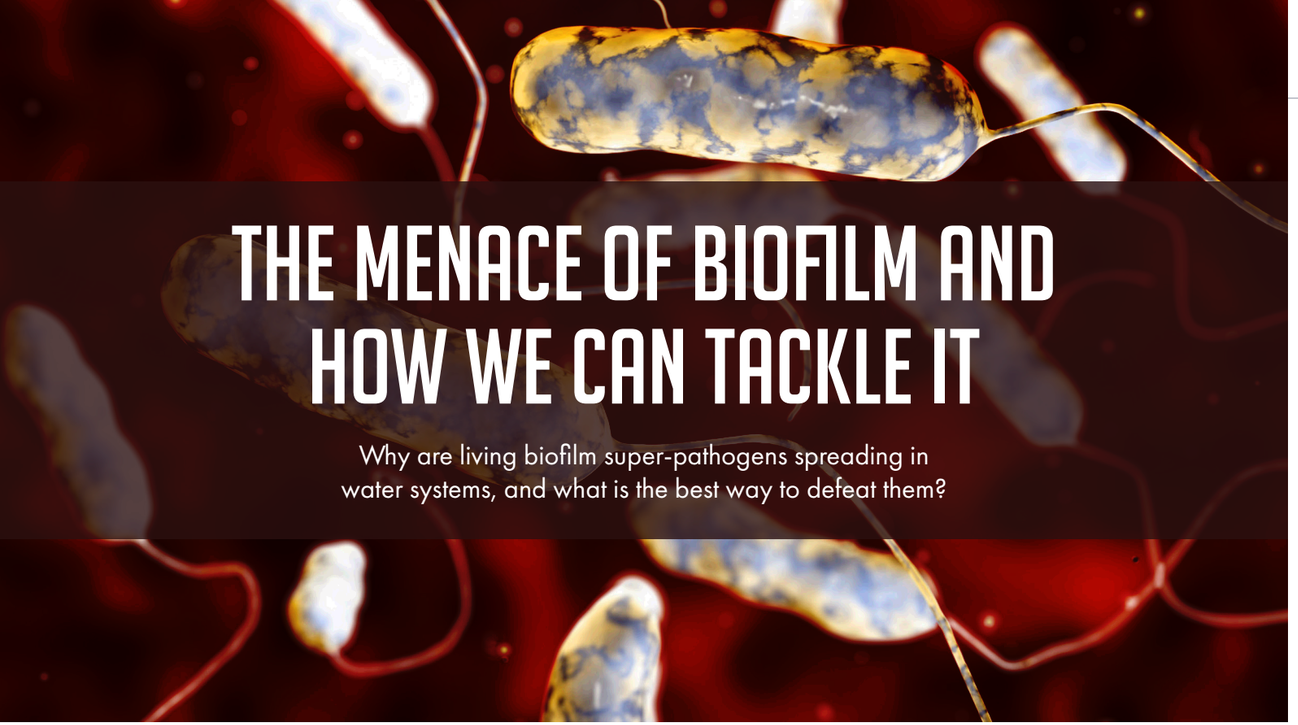
About The Author

Lior Eshed graduated from Technion - Israel Institute of Technology, with BSc and MSc degrees in environmental engineering. He started at IDE Technologies in 2015 as a process engineer and was soon promoted to team leader and member of the R&D team, where he focuses primarily on advanced reuse technologies. Previously, Lior was an R&D manager at Emefcy (now Fluence), a startup company that develops membrane aerated biofilm reactors and microbial fuel cells. Currently, Lior is in charge of new product development at IDE and is an inventor of various patents in the field of water treatment.



THE MENACE OF BIOFILM AND HOW WE CAN TACKLE IT

Why are living biofilm super-pathogens spreading in water systems, and what is the best way to defeat them?

By Daniel M. Early

The latest water safety challenge emerging in the United States may be small, but its effects can be deadly. It's called *biofilm*, a sticky substance consisting of bacteria, fungus, and other organisms that colonize in water. Together, they can act like a sort of "super-pathogen."

Wreaking Havoc In 2021

For example, take one Portland apartment complex. In January of 2021, a breakdown in water maintenance left one person dead and three hospitalized after an outbreak of Legionnaires' disease[1] — a severe form of pneumonia caused by *Legionella* bacteria. Where did it come from? Biofilm.

Diseases from biofilm are happening frequently in populated areas like cities and urban environments. According to the CDC, Legionnaires' disease is on the rise in the U.S. The number of reported Legionnaires' disease cases has increased 350 percent from 2000 through 2016.[2]

Why Biofilm Is A Major Water Problem

First, biofilm is made up of 90 percent water and cannot live without it. It becomes this replicating, perfect storm of an environment where substances layer themselves together and live in this terrible package that will accumulate in pipes, inside boiler systems, and even in your stomach. We don't want biofilms accumulating in our bodies or in the environments that people are going into.

Now, biofilms are not exclusively one type of bacteria, and that's the problem. All those types of bacteria living together in one substance don't react the same way to chemical treatment or antibiotic treatment, making them extremely hard to kill. Further, they mutate, they grow, they change their DNA structure, and they adapt to the climate and the environmental conditions they are exposed to. They are incredibly good at surviving, which is good for them, but not good for us.

The underlying issue that plagues most large, centralized potable water utilities is the simple fact that it is nearly impossible to provide "completely safe" drinking water.

Some of the bacteria can even walk or travel to another spot, then attach themselves and start growing all over again. These big, slimy clumps of biofilm can contain tons of powerful material that will continue to produce bacteria, increase in population, and cause chronic recurring infections in people. We can be exposed through drinking water, hot tubs, and even steam.

17 million Americans get biofilm associated infections each year.[3]

Almost 80 percent of global bacterial infections are associated with biofilm bacteria.[4]

The cost of biofilms on human health has become apparent: their tolerance to antibiotics is at least twice — and perhaps as much as 10 times — stronger than normal bacteria.

Aging Infrastructure Is Putting The Public At Risk

All of this centers on the current state of modern drinking water supply systems and drinking water distribution systems that you find in every major urbanized and metro area around the world. The struggle is that these systems are starting to age. The piping materials, network systems, pump stations, even at the treatment plant level are starting to break down, while piping systems are starting to leak, and so on. That's what we face with these big, urbanized water distribution systems.

Unfortunately, many of these systems have not been maintained, and the resultant contamination can have catastrophic effects on everyday people. What we are starting to see — and it has become readily apparent over the last several decades — is that as modern drinking water systems age, they are being compromised by the formation and propagation of new biofilms.

The intent of a modern drinking water system is to deliver clean drinking water to the user without the fear of contamination that would make people sick or even kill them. Yet we are seeing bacterial infestation and contamination.

We have to ask ourselves as engineers and as scientists: "Why are we seeing that occur? And what can we do to prevent it?"

The Reason

This ties into the ability of pathogens to adapt and survive. A modern, urbanized drinking water system is designed to remove pathogens and bacteria that can lead to waterborne illness and diseases. Those pathogens that we are trying to remove are adapting to this disinfection system and the treatment processes that are being deployed to remove them. They adapt and they survive. And once a pathogen that has made its way into a water distribution system achieves some level of resistance to chemical disinfection systems and so forth, it becomes established — and that's when things can get ugly.

Biofilm Sludge In Everyday Water Filters

I have done the repairs of drinking water systems in some of these customer locations such as hotels and resorts. When we go onsite and remove the old filters, we extract a damaged, corroded, and filthy filter that's been in place too long. And these have, essentially, biofilm sludge and slime built up on them, oozing from both ends, and it's *disgusting*. That is the water system that people are actually drinking from, and that is what's in place everywhere.

It's all too common to see public drinking water supply systems succumb to the effects of pollution and the formation of biofilms and the resultant diseases. Very unfortunate, but it is the nature of what we're dealing with, and we need to do something about it.

While this drinking water may be "statistically safe," meeting an established water standard relative to safety, that does not mean it's completely safe. They are two completely different terms.

The underlying issue that plagues most large, centralized potable water utilities is the simple fact that it is nearly impossible to provide "completely safe" drinking water. Pathogens are very small and have a natural survival capability, such as using biofilm protection.

So, what can we do about it? How can we take control where infrastructure is failing?

Decentralized Technology

Decentralized treatment technologies are the key, where the customer no longer relies on the city or the municipality that is failing them. For example, this could be installing treatment technologies in a single-family water service connection or a hotel or commercial entity that has its own water service and is taking water from a public utility.

So, how can we do this?

Ultraviolet Disinfection

The first option is to use ultraviolet light (UV) for disinfection. UV essentially gives the biofilm and the pathogens a deadly sunburn. You destroy their DNA that way, and it's a very effective form of disinfection.

The pros: It's easy to buy, inexpensive, and easy to operate.

The cons: The bulbs do wear out and require annual replacement, and if you lose power, you lose your disinfection capability. So, there are some potential downsides to UV.

Chemical Disinfection

The other form of treatment is chemical disinfection. It's been around a long time and does a good job. As mentioned, biofilms can be resistant, and they can adapt and be partially resistant. But with enough chlorination, with enough chemical disinfection, you can sterilize your pipe, your whole house piping system, your hotel piping system, etc.

The pros: Chemicals are very inexpensive, have been around a long time, and are easy to use.

The cons: They are very harsh on equipment and on distribution and piping systems — especially in older facilities. They're also messy, and there are some chemical byproducts that you have to deal with.

> **RO does an excellent job of removing bacteria and viral pathogens, and you take out the risk of their building up resistance.**

Reverse Osmosis Treatment Systems

In my opinion, based upon everything that I know to date, including the experience I have as a professional engineer and looking at the existing conventional water treatment technologies, one of the most effective ways is to implement a filtration process is at the point of use, like nanofiltration or reverse osmosis (RO).

Why? Take something like the *Legionella* bacterium. It is not some ghost or spirit. It is an organism that has matter, size, and mass to it, and as a particle it can be removed from the water supply system coming to the end user.

That is what an RO treatment system does, and it is currently the most capable way of addressing these types of issues. It does an excellent job of removing bacteria and viral pathogens, and you take out the risk of their building up resistance.

Ancillary Benefits

Water distribution systems are laden with all sorts of other chemicals in trace amounts, and these things bioaccumulate in human tissue. So, on top of filtering and removing things like *Legionella*, *Cryptosporidium*, and *Giardia*, you also get the benefit of removing other problematic chemicals and compounds that are present in the drinking water systems that further impact human health.

Focus On The Hospitality Industry

Recently, I have experienced a great deal of understanding in the hospitality sector — hotels and resorts. They understand that when they are sourcing water from public drinking water systems, they need to implement this type of technology — not only to keep their customers safe, but also to help prevent liability and financial risk caused by any sort of outbreak. The benefits far outweigh any costs, and the peace of mind that RO treatment systems offer is priceless. You do *not* want to get onto front-page headlines for a deadly outbreak!

Americans Abroad

Another area that I have seen implementing RO filtration is the Department of State, such as in its U.S. embassy facilities and consulate facilities overseas. When the U.S. government takes its ambassadors and their staffs overseas, and they occupy an embassy facility in a foreign country, often they get their drinking water from the public water supplies of somewhere like London or New Delhi.

But when they go to far-flung places like somewhere in Sub-Saharan Africa or Southeast Asia, where the infrastructure is not there, they've got to do something. They still have drinking water systems in those places, but really, you are taking your life in your own hands. Mexico is a neighbor of ours, and that country is improving its infrastructure fast, but people still say "Don't drink the water" when you go to Mexico. There is a reason they say that.

So, these same types of RO technologies are being deployed at that level to keep our ambassadors and officials safe everywhere they go. The versatility, reliability, and drop-in-place nature of RO treatment systems is ideal anywhere that the public drinking water infrastructure is failing its users.

Helping Put Power Into The Hands Of The End User

RO treatment systems have been commoditized. We can now install them at a house, a place of business, a hotel, a school, a nursing home, etc. We can help people take charge of their water and provide an enhanced level of treatment and protection so they don't succumb to the ill effects of disease related to biofilms and waterborne pathogens.

If *Legionella*, *Giardia*, or *Cryptosporidium* is in the water supply system and can make its way around the main water supply treatment processes and to the customer, we have the ability to remove it before it ever touches their water glass.

That is why decentralized water technology, and in particular reverse osmosis, is my preferred method of solving the ever-present threat of a contaminated water supply. I believe taking the power away from the massive, failing infrastructure of the past and putting the power into the hands of the end user is the way of the future. ■

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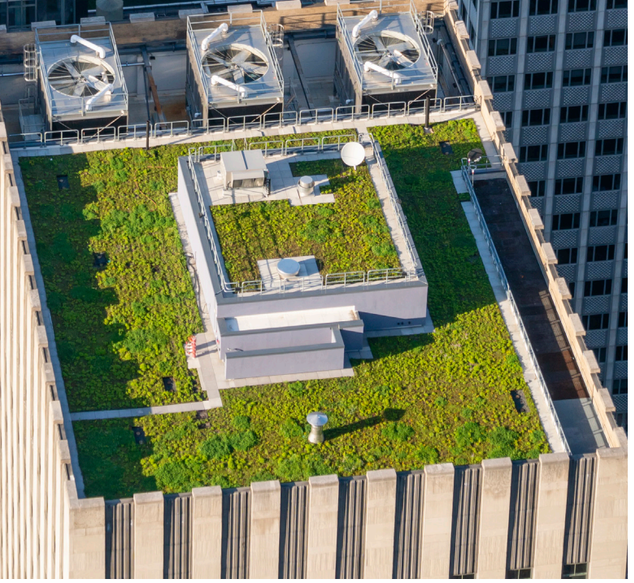
About The Author

Daniel M. Early is the chief engineer at OriginClear, Inc., specializing in the R&D and deployment of next-generation water infrastructure technologies using heavy plastic manufacturing. His initiatives and innovations led to the granting of six patents issued in his name for various inventions related to these infrastructure products. He holds a BS in Civil Engineering from Virginia Polytechnic Institute & State University (Virginia Tech) and is licensed as a Professional Engineer in Virginia, North Carolina, West Virginia, Montana, Pennsylvania, Maryland, New Mexico, and North Dakota.



Why Businesses Could (And Should) Utilize Green Roofs To Become More Resilient

Green roofs aren't just for the most progressive, environmentally focused organizations, though early practitioners should be lauded for leading the charge. The stormwater solution also saves money, protects assets, and improves workplaces — all reasons to be broadly implemented.

By Eric Meliton

Flooding is a critical issue facing businesses across North America. This issue will only become more challenging as we continue to experience the long-term effects of climate change. Businesses in urban centers are particularly vulnerable to rising flood costs and resulting infrastructure damage.

Businesses in urban centers are seeing more flooding across North America, having been constructed in floodplains and low-lying areas prone to flooding. Increased precipitation as a consequence of climate change, aging and insufficient infrastructure, and the abundance of impermeable surfaces are all common issues to overcome for businesses in urban centers.

Impermeable areas prevent water from seeping into the ground as it naturally should, forcing it to flow overland into municipal storm sewers with limited capacity. Utilizing green roof systems with additional stormwater detention capacity in conjunction with other onsite green infrastructure systems can effectively restore the hydrological functions of natural areas found on corporate properties and make businesses more resilient.

Unexpected costs and disruptions to business operations are all factors related to a lack of flood resiliency. Not only are businesses prone to damage to existing assets and infrastructure, but they can also experience supply chain disruptions, negative effect on employees' physical and mental health, and the long-term costs of stormwater charges and fees imposed by local governments.

Many municipal governments in North America have been actively promoting the use of green infrastructure systems on public lands, but there has been a lack of uptake of this notion amongst private landowners and industrial, commercial, and institutional buildings. The lack of understanding in the private sector concerning the risks of urban center flooding, and minimal awareness of green infrastructure as a viable solution, have limited their effective use on corporate properties.

By utilizing green roof systems that are designed to lower flood risk, businesses can then also improve water runoff quality, provide energy savings, increase property values, and earn positive stormwater charge credits. These are all beneficial aspects for industrial, commercial, and institutional building owners to consider.

Echion Group interviewed 45 green infrastructure professionals across North America to understand some of the emerging growth trends for the green roof segment to consider. Insightful discussions with municipal staff, design and engineering firms, and green roof technology solution providers assisted in identifying and validating these four trends.

Utilization Of Holistic Design Capacity For Green Roofs In Urban Centers

Progressive developers and responsive design and engineering firms are seeking effective ways to maximize rooftop capacity, not only for onsite stormwater options but also for holistic use by employees. Holistic access by employees heightens the positive impact of designing green roof capacity to encompass accessibility to green space for businesses located in heavily urbanized areas. The new version of LEED 4.1 (https://www.usgbc.org/leed/v41) expands the scoring parameters to reward businesses that provide access to green spaces, which creates a positive secondary benefit to employee health and wellness. Many national and multinational corporations are attempting to expand their Environmental Social Governance, United Nations Sustainable Development Goals, and Corporate Social Responsibility initiatives to tackle various social and environmental aspects that can be addressed on their corporate property portfolio. These include green roof designs to improve employees' access to green spaces to improve corporate health and wellness. By utilizing green roofs in this manner, corporations can also positively improve air quality and flood resiliency as secondary co-benefits of these installations.

Transitioning From Retention-Based To Detention-Based Design Capacity

Innovative green roof technology solution providers have been expanding the capabilities of green roof systems and designs to maximize their capacity. Standard green roof designs provide stormwater retention, which captures rainwater for the plants and evaporates naturally. Emerging detention green roof systems slow the rainwater and also allow it to drain, allowing for a larger volume capacity so it is not limited by natural evaporation. Businesses with limited onsite stormwater runoff capacity may elect to utilize detention green roof designs to effectively satisfy municipal requirements. The demand from businesses for these progressive detention green roof systems will continue to grow to mitigate flood risk due to climate change.

Combined Sewer Overflow (CSO) And Sanitary Sewer Overflow (SSO) Consent Decree Implementation

U.S. municipal consent decree agreements with the U.S. EPA allow short-term and long-term implementation of innovative solutions not yet established as standard-practice technologies. Heavily urbanized municipalities and those with aging buried infrastructure across the U.S. may encourage businesses to utilize progressive detention-based green roof designs to adhere to municipal consent decree agreements, while exploring their use on existing municipal buildings. CSO and SSO overflow capacity issues happen every year and are intensified with climate-change adaptation and mitigation flood resiliency needs — an aspect yet to be fully utilized by green roof service and technology providers.

Mechanism For Social And Green Bond Investment Options

With the recent trends of major North American pension funds and venture investors to diversify their investment portfolios with sustainable options, enhanced green roof implementation could become a viable infrastructure opportunity for alternative financing. Social impact investment portfolios typically have a modest financial return on investment, but the focus on environmental and social metrics is becoming heightened. These investment portfolios could lead to a long-term financing capacity for businesses to utilize green roof systems, influencing decisions beyond typical return on investment criteria. ■

About The Author

Eric Meliton is the principal consultant of Echion Group, a business growth advisory specialist in the cleantech and sustainability sector. Eric assists with stakeholder engagement, partnership development, and the pursuit of ESG/SDG/CSR objectives directly with businesses and governments across North America.

Trending In Wastewater Treatment: Industrial Vacuum Evaporation Systems

Sought after in a variety of market sectors for their performance and utility, industrial vacuum evaporation systems are in the midst of a surge. For the unacquainted, this primer explains the reasons why.

By Nikhil Kaitwade

Numerous campaigns and efforts are directed toward a single direction — to optimize the use of water. While at household levels there are various ways to conserve water and prevent wastage, at the industrial level the scenario is quite different.

At the industrial level, the focus is on using sophisticated technologies that can help conserve the good water and resolve the issue of wastewater management. Among these technologies, industrial vacuum evaporation systems have gained recent popularity.

Vacuum evaporation is a technique using evaporators to treat as well as recycle wastewater for a myriad of industrial purposes. Its popularity may be attributable to its efficiency in separating contaminants from water using high boiling points.

Industrial vacuum evaporation systems occupy a lot less space and use less energy compared to the other evaporation technologies.

What Is The Underlying Technology?

Vacuum evaporation is an effective means for recycling wastewater to use it for various industrial processes such as metal forming and finishing, chemicals, pharmaceuticals, food and beverages, and more. Wastewater is then combined with other processes — e.g., reverse osmosis — for the development of a complete wastewater treatment system. In addition, vacuum evaporation is a highly utilized process for the removal of water while manufacturing products.

These industrial vacuum evaporation systems are developed with high concentration ratios and separation to facilitate different industrial applications. Some of the industrial vacuum evaporation systems can treat wastewater from 150 liters to about 500 liters (~40 to 130 gallons) in as little as 24 hours. These vacuum evaporators are fully automated and support high levels of water removal.

While there are numerous concerns associated with the conservation of water, it should not be at the cost of the excess use of energy. Industrial vacuum evaporation systems occupy a lot less space and use less energy compared to the other evaporation technologies.

The technology is characterized by the transformation of liquid (i.e., water) into two different flows — treated water and concentrated waste. The water that is now separated from the waste is clean and safe. The vacuum evaporation process significantly reduces the volume of liquid waste.

Given the efficiency of the evaporation techniques, the industrial vacuum evaporation systems are gaining a lot of traction for wastewater treatment.

What Are The Top Benefits?

Industrial vacuum evaporation systems are highly suitable for all types of industries, including petrochemical and power, automotive, food and beverage, mining, and more. Below are some of the top benefits of the industrial vacuum evaporation systems:

Industrial vacuum evaporation systems are highly suitable for all types of industries, including petrochemical and power, automotive, food and beverage, mining, and more.

- Two Types of Water Available — Industrial vacuum evaporation systems can produce reusable as well as clean water at the same time, thereby optimizing the use of the water.
- Reduction in Waste Volume — High-tech industrial vacuum evaporation systems enable a reduction in the volume of waste generated in the environment.
- Reduction in Water Pollution — Since the chief cause of water pollution is contaminated particles, it is crucial to get them separated from the water. The use of industrial vacuum evaporation systems helps prevent water loss by eliminating the pollutants.
- Environmental Conservation — Upon the treatment of the water, the harmful contaminants are disposed of in a way that does not harm the environment, thereby conserving it.
- Reusable Minerals and Elements — In addition to the conservation of energy and the environment, water treatment can also help in recovering methane. Even the natural fertilizers used for farming can be recovered.
- Adhering to Quality Standards — Every region has a particular standard for wastewater treatment. It is crucial to meet these standards through continuous monitoring, which makes industrial vacuum evaporation systems an important process.

Popularity In End-Use Industries

Since water is the basic requirement to serve various industrial purposes, a broad range of end-use industries have been striving to adopt industrial vacuum evaporation systems and are making them central to numerous processes.

At the forefront of demand for industrial vacuum evaporation systems is the food and beverage sector. The food and beverage industry is spreading horizontally with innovation and vertically with the proclivity of consumers toward packaged products. As a result, the pressure is on food and beverage manufacturers to develop products with utmost accuracy and hygiene. Given this, there has been a high demand for numerous sophisticated technologies to optimize internal processes.

Food technologists use the evaporation process to make food look more concentrated. In addition to the fundamental use of industrial vacuum evaporation systems for the treatment of water, the equipment holds high prominence for the extraction of additional water content in various food products and fruits. This is done to improve the shelf life of food products.

As consumers living in urban areas with hectic schedules look for packaged food and beverages, the industrial vacuum evaporation systems market could witness more opportunities.

The healthcare industry is also one of the leading end-use sectors for the industrial vacuum evaporation systems market. The wastewater produced by clinics, ambulatory care centers, hospitals, and similar healthcare institutions has been raising concerns. In a hospital setting, where hygiene is critical, there is a high incidence of soap, drugs, urine, blood, disinfectants, and similar products that pollute the water.

As a result, incorporation of industrial vacuum evaporation systems in healthcare institutions helps to reduce water wastage while also allowing the water to be recycled for nonpotable purposes.

During the pandemic of COVID-19, the demand for industrial vacuum evaporation systems did drop. However, there is a significant demand for them from the healthcare industry, as surfaces and healthcare equipment are cleaned on a frequent basis.

Future Of The Industrial Vacuum Evaporation Systems Market

Given the nature and influence of technology, it is certain that novel technology will soon find its way into the development of industrial vacuum evaporation systems. Demand for self-recovering equipment is likely to bring in collaborations of AI development companies to industrial vacuum evaporation systems manufacturers. Further system innovation through automation will likely give rise to additional partnerships and acquisitions as well. ■

About The Author

Nikhil Kaitwade heads the industrial automation domain at ESOMAR-certified market research and consulting firm Future Market Insights (FMI). The award-winning firm is headquartered in Dubai, with offices in the U.S., UK, and India. The insights presented in this article are based on a report by FMI on the Industrial Vacuum Evaporation Systems Market.