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TOP 10 TRENDS OF 2014

Expert Insight Into Today's Critical Water And Wastewater Issues

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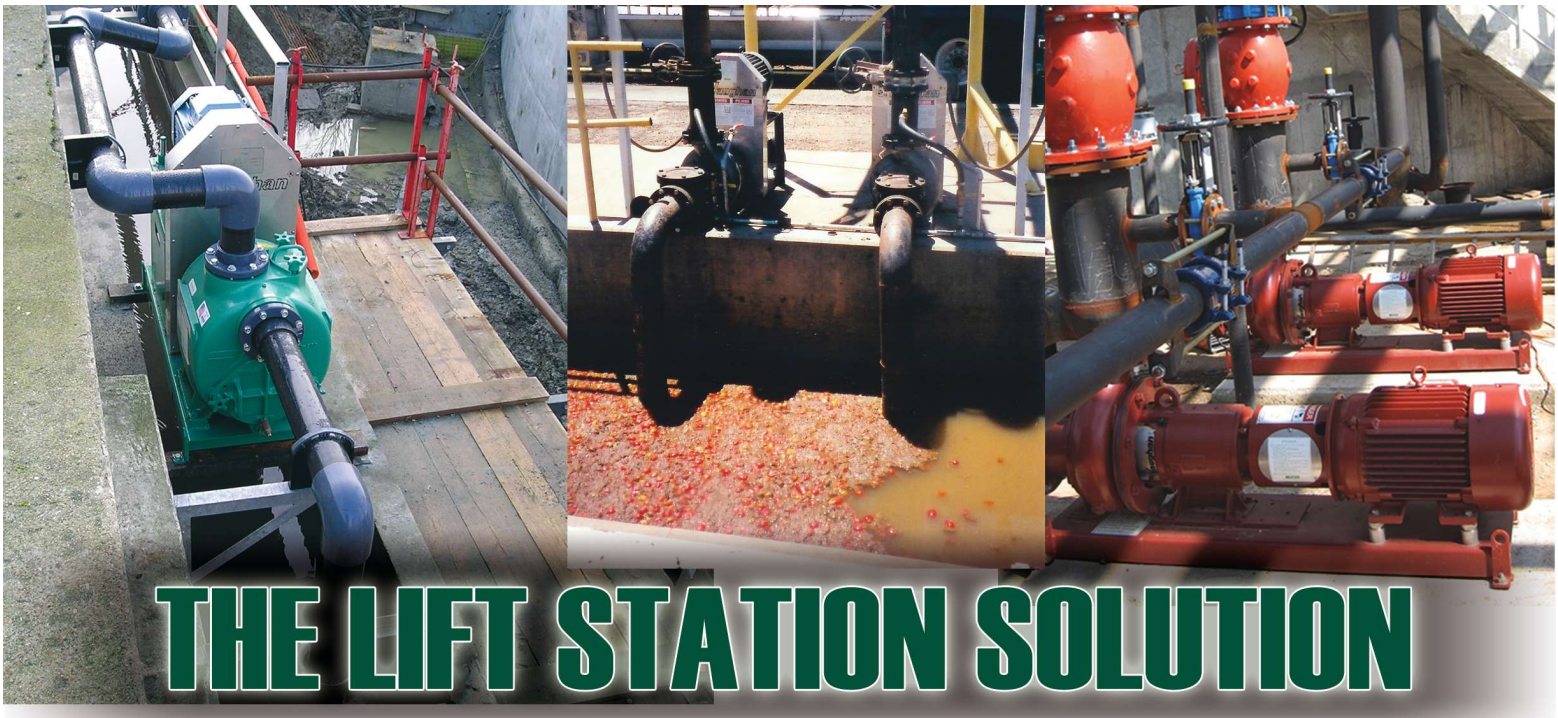

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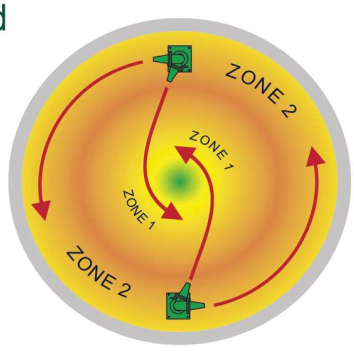

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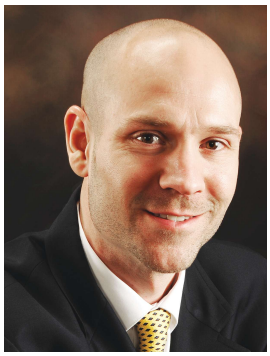

New Technologies Set To "Disrupt" The Industry

For the unfamiliar, the term "disruptive technology" initially sounds quite bad, as though it describes something that gets in the way. Far from impeding progress, disruptive technologies accelerate progress exponentially by disrupting the status quo. These technologies typically bubble under the surface, but when they finally erupt, they erupt hard. Old technologies are displaced, causing a major shift in the market. Think personal computers vs. mainframes or cell phones vs. land lines.

Which technologies have the potential to disrupt the water/wastewater industry? Three to watch are ceramic membranes, UV-LED, and capacitive deionization (CDI). Here's why.

Ceramic Membranes — According to BlueTech Research, a firm that tracks and analyzes innovations in the water industry, "Studies have shown that ceramics achieve better performance than polymeric membranes in terms of flux stability and treated water quality." Furthermore, Tyler Algeo, director of research at BlueTech, states that, "Ceramic membranes have particular advantages in harsh industrial environments such as oil and gas. Ceramics can handle aggressive chemicals and temperatures that would degrade polymeric membranes." Because they are robust, ceramic membranes can also be cleaned with aggressive chemicals, potentially reducing maintenance costs.

As the price has continued to come down, and with industrial wastewater and reuse an escalating concern, the stage is set for ceramic membranes to make their mark.

UV-LED — Algeo was equally excited by the prospects of UV-LED, which at the moment is in early-stage commercial development. Current UV systems for water/wastewater disinfection utilize bulbs — typically fluorescent tubes — that contain mercury and are susceptible to breakage. UV-LED satisfies the unique criterion of disruptive technology in that it generates UV in a new, less energy-intensive way. LEDs (light-emitting diodes) are not powered by a filament but rather by the movement of electrons in a semiconductor material. Smaller and more robust than UV bulbs, LEDs can be configured and used in a wider variety of applications.

As with ceramic membranes, the tipping point for UV-LED is cost of production. "It could be 5 or 15 years," said Algeo, "but at a certain point it's expected that UV-LEDs will be cheaper to produce than traditional bulbs, which will be very disruptive for the market."

Capacitive Deionization — CDI works by taking 99 percent of the water out of the one percent salt, rather than various conventional methods that do the opposite by removing the one percent of salt from water. The electrically-driven process draws dissolved ions (salt) out of the water with oppositely charged electrodes and membranes that selectively filter out cations and anions. Electrode polarization can then be reversed to regenerate electrodes and flush the system. According to Voltea, a CDI company tracked by BlueTech, the process typically recovers between 80 and 90 percent of the water it treats, compared to 50 to 70 percent for reverse osmosis. CDI also saves electricity by reusing the energy that is stored in the electrodes.

Prepare For The Future

There are other water technologies that may ultimately have greater market impact than the three mentioned here — disruptive technologies can sometimes "come out of nowhere" — but these highlighted few appear particularly ready to bubble over. Additional worthy candidates appear later in this issue of *Water Online, The Magazine*, as we discuss real-time bacterial sensors on page 12 and sludge pretreatment systems on page 20. The value in monitoring the development of these new technologies is to be better informed and prepared for what the future holds. The savvy water professional will harness the power of innovation rather than be blindsided by it.

Kevin Westerling
Editor
editor@wateronline.com

Water Online
The Magazine

101 Gilbraltar Road, Suite 100
Horsham, PA 19044
PH: (215) 675-1800
FX: (215) 675-4880
Email: info@wateronline.com
Website: www.wateronline.com

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

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

MANAGING EDITOR
Michael Thiemann
(814) 897-9000, Ext. 340
michael.thiemann@jamesonpublishing.com

PRODUCTION DIRECTOR
Dianna Gross
(814) 897-9000, Ext. 255
dianna.gross@jamesonpublishing.com

DIRECTOR OF AUDIENCE DEVELOPMENT
Martin Zapolski
(814) 897-7700, Ext. 337
martinz@jamesonpublishing.com

DIRECTOR Of ONLINE DEVELOPMENT
Art Glenn
art.glenn@jamesonpublishing.com

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Tips For Training Today's Operator – And Making It Stick

Introducing three training trends that improve operators' understanding and plant performance

By Jeffrey Berlin and Steve Walker

Training operators is often an afterthought in the water industry — but it shouldn't be. Increased demands and a changing workforce present training challenges. Today's operators run complicated treatment plants and face tight permit limits. New treatment processes and technologies require training to be operated effectively. Utilities also face significant risk from loss of institutional knowledge as baby boomers retire and leave the workforce. Given these constraints, quality and customized training has become a necessity.

Three emerging educational trends are gaining popularity as means to improve the training experience and information retention of operators. They are adult learning research, the use of technology, and flipped classrooms. Applying these lessons to professional development and operator training is important to the continued success of the water and wastewater industry.

Adult Learning

Most of our experience with learning comes from our own schooling. However, research has shown that adults learn much differently than children, separating the studies of andragogy (Greek for adult learning) from pedagogy (child learning). The lessons show that adult learning styles require changes in the way training is prepared and delivered. Malcolm Knowles, author of *The Adult Learner* and respected leader in the field of adult learning, offers six key points which serve both as guidelines to lesson planning and as explanations of potential barriers to retained learning:

1. Adults need to know why they should learn something.
2. Adults need to be self-directing.
3. Adults have greater volume and depth of experiences.
4. Adults become ready to learn only when life situations demand it.
5. Adults have a task-centered orientation focusing on how to use the information.
6. Adults need to perceive benefits to themselves.

These six keys can be boiled down to the adult learner's core questions:

- Why do I care?
- How do I use it?

Well-designed operator training programs take these questions into account when structuring both the training agenda and materials presented. This can be done by clearly defining the purpose and context of the training material and then building upon the trainees' experiences and daily tasks to add value (and motivation) to their learning. The purpose of a training session should be to grab the attention and interest of attendees in a way that makes them retain the information conveyed and immediately begin considering reasonable means of applying the information to their real-world experiences. The context of the training serves to focus the learning on those potential applications. One way to define context is by "following the flow" through a treatment plant and highlighting flow paths, key equipment, and interactions. Figure 1 shows an example of location context. A "parking lot" where information, references, or key questions are stored to the side of the main lesson can help anchor lessons to the purpose of the training.

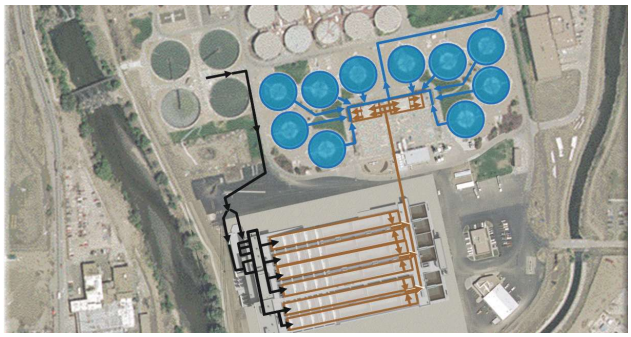

Figure 1. Following the wastewater flow provides context to process training. This color-coded aerial photograph shows primary effluent, mixed liquor, and secondary effluent process flows.

Use Of Technology

Traditional methods of knowledge transfer can be misapplied to today's workforce. Millennials grew up with instant access to electronic information. The traditional use of printed references and droning lectures do not dovetail with expectations for rapid uptake and easy access. Therefore, information must be delivered in graphical form, with links to detailed and interactive information. "Flying" through a 3D CAD model is a great way to grab attention, as shown in Figure 2.

Successful training presentations use methods and styles that mimic the way information is presented today, such as pop-ups or running bars. Rather than showing updated scores, these pop-ups provide elemental or crucial knowledge nuggets. Animated calculations can demonstrate the correct techniques to building and solving the algebraic or geometric

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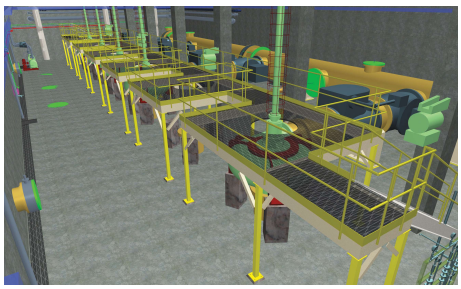

Figure 2. 3D CAD models are good training tools. Renderings such as this one of a pump station or recorded walkthroughs of the 3D model are interesting and informative.

equations used in daily plant optimization. Dashboards that graphically demonstrate process performance indicators and their expected operating ranges provide real-world feedback to the situations operators may face. A good example of these approaches is a live look at the facility's online O&M manual, as shown in Figure 3.

One roadblock is the base language that engineers and operators speak. From process models to drawings, engineers communicate in formats that are novel to operators. On the flip side, operators communicate their challenges, daily tasks, and operating procedures in ways that can befuddle the engineer. Fundamental to any successful training interaction is bridging this divide so that both parties are fully understood. Every plant has its own language, where names or numbers are surrogates for the engineering term or project. It is incumbent on the trainer to ask about, understand, and then incorporate the jargon used by the plant's staff. Not only does this help cement the new knowledge, but it also shows that the trainer has taken the initiative to learn the audience, gaining real credibility.

Figure 3. A live "look-in" to an online O&M manual can help familiarize personnel with tools already available to them. This look-in highlights short video clips from a field training course and a cutaway view of a pump.

Understanding how this knowledge affects working life addresses one of Knowles' points. Helping the audience visualize its application using scenarios that mimic real situations can drive the information deeper into the brain by using additional senses besides hearing. Asking questions that draw the trainee into the scenario establishes a lesson that can be relived when the situation happens.

Flipped Classrooms

Secondary education, mainly high schools and colleges, are implementing new teaching strategies. Flipped classrooms reverse the traditional lecture model. Instead of spending limited contact time delivering content, the class period is used for hands-on activities, interactive quizzes, and collaborative "home" work. Time outside of class is devoted to traditional lecture materials, such as recorded lectures on *YouTube*. This concept is gaining national exposure (Miller, 2013).

Colleges have used interactive classrooms, in which each student has a clicker to answer questions from the professor. Real-time results offer feedback on knowledge transfer. You may have seen similar approaches via text message polls at conferences. Interestingly, real-time answers show significant improvement if students are asked to discuss their thoughts with those around them. Such collaboration is at the heart of adult learning.

So how do we apply these concepts to our industry, where hands-on engagement drawing on operators' experiences is rare? Some ideas on how to do this are:

- Start training with introductions, asking participants' roles and responsibilities.
- Regularly ask questions, using quizzes or polls.
- Ask participants to discuss concepts with their neighbors.
- Incorporate technology, such as a link to online O&M manuals.
- Sandwich classroom time into field visits.

Conclusion

When applied to operator training within our industry, these emerging educational trends have the potential to improve interest, engagement, and retention. This will result in motivated, more knowledgeable operators and more efficient water treatment facilities overall. We can use lessons from adult learning research to flip the classroom and take advantage of new technological resources. All-in-all, training is more effective when it:

1. Clearly defines purpose and context;
2. Relates to the operator's daily experience; and
3. Encourages trainee participation and engagement.

Quality operator training is a significant investment of time and money. However, a well-planned training program will pay off in operator understanding, which translates to improved plant performance. ■

REFERENCES

Malcolm S. Knowles, E. F. (2011). *The Adult Learner, Seventh Edition*. Oxford, UK: Elsevier, Inc.

Miller, J. (August 2013). Flipped Out. *Spirit (Southwest Airlines Magazine)*, pp. 73-81.

Jeff Berlin is a senior project engineer for Carollo Engineers, with more than 12 years of experience in wastewater treatment planning, design, and construction. Berlin is responsible for training operators in a 114-MGD secondary treatment facility in Denver, CO.

Steve Walker is the principal operations specialist for Carollo Engineers, with more than 29 years of experience. Prior to working for Carollo, Walker was the treatment superintendent for a 185-MGD facility in Denver, CO. He holds top level wastewater certifications in Colorado, New Mexico, Texas, and Arizona, and serves on the State of Colorado's Water and Wastewater Operators Certification Board. Walker earned a BS in Technical and Industrial Administration and received the William D. Hatfield Award for outstanding performance and professionalism in the operation of a wastewater treatment facility.

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Sensing The Future: Water Technology's "Holy Grail"

Real-time contaminant detection, featuring a network of sensors throughout the distribution network, is poised to revolutionize the water industry.

By Kevin Westerling, editor

Scientists are scrambling to beat each other to the punch, and instrumentation companies are monitoring (no pun intended) the competition closely and aggressively. At stake is the inside track on a technology that promises to change the course of utility operations, and perhaps much more.

The breakthrough discovery is the real-time detection of bacteria and other constituents in water, with the added capability of instantly communicating the data to a central location. For drinking water utilities, it's the arrival of "intelligent water distribution," utilizing a network of these remote-communication, real-time sensors to detect contaminants throughout the distribution system. Though the technology is not yet mature, these sensors are most definitely coming — and their impact will be profound.

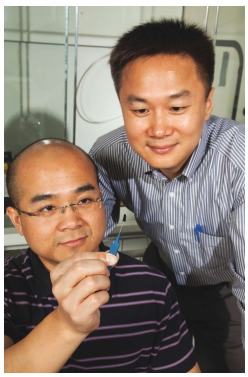

Figure 1. Inventor Dr. Junhong Chen (right) and former student Dr. Ganhua Lu see huge potential for their small sensor.

A New World Of Capabilities

"You can't control what you can't measure" is a broadly applicable adage (coined by software engineering guru Tom DeMarco), and particularly relevant to water quality. Imagine what the control operators would (or will) gain by being able to remotely see contaminants of any type, anywhere in the pipeline — from plant to tap — in real time. No longer would samples need to be gathered in the field and taken back to the lab for testing. When it comes to bacteria and viruses, the time lag between contamination and discovery that currently exists would be essentially eliminated, meaning less community exposure and illness. The benefits these enhanced capabilities bring to public health and utility operations are easy to recognize.

But what else does real-time sensing bring to the table? The possibilities are virtually limitless.

Because the sensors can be engineered on an ad hoc basis — that is, customized for specific needs and constituents — the technology has the potential to be utilized for almost any application involving liquids and to measure just about anything. The industrial and wastewater applications are further down the line, however, as the sensors are engineered to become more robust. Initially the technology will be used to detect and communicate the presence of drinking water contaminants, specifically E. coli and heavy metals (e.g. arsenic, cadmium, chromium, lead, and selenium).

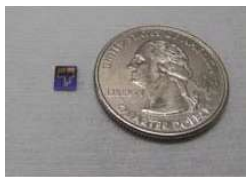

Figure 2. The incredibly shrinking sensor (miniaturization is ongoing) in comparison to a quarter.

Research And Development

As you read this, Dr. Junhong Chen is working feverishly. So, too, are his competitors. The goal is to be the first to market with this new sensor technology, and the market won't respond unless the price is reasonable. According to Chen, director of the U.S. National Science Foundation Industry-University Cooperative Research Center (I/UCRC) on Water Equipment and Policy at the University of Wisconsin-Milwaukee (UWM), that price is $10 per sensor. A second challenge is to ensure the resiliency of the units in the field, since the very idea of the technology is to "set it and forget it" (for at least a year, and then only to change the battery), thereby dispensing with the typical O&M effort of sending personnel to multiple sampling sites. The third obstacle is miniaturization of the sensors, so that many individualized contaminant detectors can be housed in a single probe.

"In the size of a fingernail, we can potentially integrate hundreds of sensors," said Chen, who described the patent-pending technology as the "Holy Grail" for the water industry.

"We'll have sensors attached to the filter cartridge, to the pump, and to the water meter so that — in addition to whatever conventional functionality the equipment is providing — we can see contamination levels," Chen predicted. "That's the future."

The rapidly developing technology is being realized due to the development of graphene, which earned the 2010 Nobel Prize in Physics for the University of Manchester researchers who discovered it. At just one atom thick, graphene is "not only

the thinnest [material] ever but also the strongest," stated the Royal Swedish Academy of Sciences, presenters of the Nobel. The Academy also noted that graphene conducts heat better than all known materials and conducts electricity at least as well as copper. Graphene's potential for electronics was recognized from the start, as it was predicted to make transistors that are significantly faster than today's silicon transistors.

Using this knowledge as foundation, inventors at the Water Equipment and Policy Research Center (WEP) — established in 2010, the same year graphene earned the Nobel — set out to create a real-time, "intelligent" sensor for water/wastewater quality and control. Dr. Junhong Chen is leading the research, working with his colleagues in the WEP network. Based in Milwaukee, WEP includes two universities (UWM and Marquette), as well as seven industry members, six of businesses (A.O. Smith, Badger Meter, Baker Manufacturing, Pentair, and Marmon Water), a consulting company (Gannett Fleming), and the local municipality (Milwaukee Metropolitan Sewage District).

The result is what Chen called a "revolution for water-related equipment" — graphene oxide (GO) field-effect transistor (FET) sensors. According to UWM, the new sensors offer the following advantages over current technology:

- **Faster** — Rapid response for real-time monitoring
- **Highly sensitive** — Detection of E. coli 0157:H7 concentrations down to 1 CFU (colony-forming unit) per mL
- **Scalable** — Fabrication can be scaled up with good reproducibility/high electrical stability
- **Inexpensive** — Materials for fabrication are relatively inexpensive
- **In situ detection** — Sensors can be placed directly in the water system.

"You can stick the sensor onto anything to tell you what's in the water," Chen projected.

Right now, the technology has been proven for E. coli, which is first on the docket for real-world application. Chen estimates that it will be a year or more before reaching that point, with sensors for the detection of heavy metal ions to follow. Now that the science has been established, however, realizing this soon-to-be transformative technology is inevitable. The progress could be hastened by additional funding — the National Science Foundation and the EPA, for instance, have programs to support innovation — and there is surely a host of competitors worldwide striving toward the same goal.

"I would say everybody would be willing to invest in this technology," said Chen.

Market Impact

Drinking water utilities may be the first to see benefit from real-time sensors, but the technology is destined to have far-reaching effects. The food and beverage industries, with so many of their products containing water, would be obvious beneficiaries. Applications in the medical field have the capacity to improve care and save lives (the technology can be adapted to any liquid — even within the human body). Real-time sensing will enable pharmaceuticals and personal care products (PPCPs), which release a vast array of hard-to-detect "emerging contaminants" into the environment, to be spotted and controlled much more easily. Wastewater treatment facilities will be able to monitor the effectiveness of their filtration and treatment systems by detecting contaminant breakthroughs anywhere in the system.

Drinking water utilities may be the first to see benefit from real-time sensors, but the technology is destined to have far-reaching impact.

Naturally, the companies who produce monitoring and instrumentation equipment are among those who see great potential. Fred Begale, VP of engineering for Badger Meter, called real-time sensing "the next paradigm" for water technology.

"First it was metering, 50+ years ago, and then communications came along about 15 years ago," said Begale. "In the last few years, we've seen the advancement of analytics-based software such as district metering and leak detection. The next stage will be real-time sensing mechanisms to maintain and support all those elements more precisely."

As a WEP member, Badger Meter shares the intellectual property rights of the technology being developed, so it may have a leg up on the competition. "If I could provide automation that also gives utilities insight into their water quality, that's a big deal," Begale explained.

"It doesn't mean that other companies aren't looking at this as well and working on it in their own space," he added. Truly transcendent technologies, after all, are nearly impossible to contain.

Once the cat is out of the bag, so to speak, the technology — and the world of capabilities it enables — will surely be shared by many, and to the benefit of nearly every citizen. While the revolution isn't upon us quite yet, the evolution that precedes it is well underway. ■

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Understanding Municipal Bonds And Their Benefits

An analysis of tax-exempt bonds, the water/wastewater market, and infrastructure funding

By Kevin Thompson and Jay Gorman

It's pretty amazing when one stops to think about the fact that Americans typically pay two to three times for cable and Internet what they pay for water service. Cable and Internet services can easily run the average family nearly $200 per month, while rates for water and sewer services usually don't crack $100 per month and often are below $50. Yet when one thinks about the necessity, capital intensity, and reliability of water as compared to other utilities, it ranks among the most vital, most consistent, and most capital-intensive. In a nutshell, water is by far the best value in utility services from both a rate and need perspective. So what drives this value?

In part, in the U.S., we've subsidized water rates for public utilities through the use of tax-exempt bonds. As with most developed nations, we place a high value on having a safe drinking water supply. We find it worthwhile to subsidize the capital investments made in our water infrastructure by excluding interest earnings on debt used to finance capital projects from taxation at the federal level. There's been much discussion about privatization and/or public-private partnerships in the water and sewer sector, but many of these models appear to be based on European or developing nation models that lack the fundamental subsidy we provide to a capital-intensive sector. While public-private partnerships and privatization can be useful in certain circumstances, it's important to understand the fundamental impact of tax-exempt debt on this sector.

Figure 1. Ratings table, highest credit to lowest

Moody's Ratings	S&P Ratings	Fitch Ratings
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B	B	B
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Ca	CC	CC
C	C	C
	C1	RD
	D	D
Moody's also supplies numerical modifiers – 1, 2, and 3 – in each generic category classification from Aa through C. 1 – higher end; 2 – midrange; and 3 – lower end.	S&P also supplies modifiers, "+" and "-" in each generic category classification from AA through C. "AA+" – higher end; "AA" – midrange; and "AA-" – lower end.	Fitch also supplies modifiers "+" and "-" in each generic category classification from AA through C. "AA+" – higher end; "AA" – midrange; and "AA-" – lower end.

Water and sewer entities are capital-intensive. Fixed assets tend to be a large component of most water and sewer utility balance sheets. As such, one would expect debt to be a major component of capital funding. On an asset-based approach, Fitch Ratings provides data that show the median debt-to-net-asset ratio is just below 50 percent across the industry. Based on Moody's data, we find debt service payments average over 20 percent of revenue, or the annual cash flow requirements of a public utility, and this excludes any cash spent annually on capital needs.

Funding Costs

Capital funding for utilities comes in a variety of forms. Most common for public utilities is some combination of the following: pay-go (or cash financed); direct debt; state revolving fund loans (or grants); and possibly short-term financing of construction in process. Direct debt of water and sewer utilities tends to be fairly consistent at about 10 percent of the overall tax-exempt bond market. From 2010 to 2013, annual water and sewer debt issuance ranged from $27.9 billion to $39.9 billion. Annual debt issuance can be further divided into refinancings and new debt for new projects. New capital project funding through debt ranged from about $15 billion to $28 billion over the same period. The rating agencies perform an independent review of a utility's credit worthiness. The results of their analysis are shown through the use of letter grades, with "AAA" or "Aaa" being the highest, or best quality, and "BBB-" or "Baa3" being the lowest investment

grade, or lower quality. Lower rating levels exist, but the investor market for these credits is significantly smaller. In looking at water and sewer credits, we find almost 90 percent of public water and sewer utilities are "AA-" or better, meaning these are good credit risks and should be able to achieve the best funding rates. Default studies performed by the rating agencies indicate water and sewer credits are some of the municipal sector's best credits. Only three larger water and sewer utility credits are rated at the bottom of the credit spectrum for institutional clients — Detroit (due to the City's Chapter 9 filing), New Orleans (post-Hurricane Katrina fallout), and Jefferson County Sewer in Alabama (due to an overly heavy reliance on synthetic debt and auction rate securities).

While it is difficult to show capital funding costs for a wide range of credits and structures, we can look to generic market indices to get an idea of the borrowing rate for publicly owned water and sewer utilities. The municipal market has an index from which bonds are typically priced with a spread — or the "add on" to the index. Published by Thomson/Reuters, the index is called the Municipal Market Data (MMD) AAA Index and is considered in laymen's terms to be the equivalent of the Treasury curve for taxables (taxable bonds are typically priced with a spread to the Treasury curve). If we just look at the two basic indices — AAA MMD and the U.S. Treasury — for the 10-year maturity going back to January of 2000, we find that the tax-exempt index was on average 0.49 percent lower. Since 2000, we have had a record-setting, historically low interest rate environment. Typically, a low-interest-rate environment causes "rate compression" — a term used when low interest rates drive tax-exempt and taxable bond yields closer to each other than they would normally be. If we look prior to 2000, or the low-interest-rate period, the tax-exempt index is 1.35 percent lower going back to its creation in 1993.

In today's water environment, we find rate increases are necessary to simply maintain revenues at current levels as consumption declines – leaving little, if any, incremental revenue to fund capital projects.

In addition to the indices, the spread to the index also matters. We tend to find taxable spreads to be higher than tax-exempt spreads (the "add-on"). Spread levels are influenced by a number of factors, including differences in credit quality, state and local taxation laws, current market factors, news events, etc. While there is no proxy which incorporates spreads to compare taxable and tax-exempt rates, we can look at specific bond issues. Tucson, AZ, Raleigh, NC, and the Bay Area Water Supply and Conservation Agency, CA, all issued debt last year on both a tax-exempt and taxable basis, which we can use as indicators. Taxable spreads were higher by 0.37 percent, 0.26 percent, and 0.46 percent respectively at the 9-year maturity for each of these issuers:

- *Tucson, AZ (Water System Revenue Bonds)* — 2022 maturity tax-exempt spread: 44 basis points (bps); taxable spread: 81 bps
- *Raleigh, NC (Combined Enterprise System Revenue Bonds)* — 2022 tax-exempt spread: 14 bps; taxable spread: 40 bps
- *Bay Area Water Supply and Conservation Agency CA (Revenue Bonds)* — 2022 tax-exempt spread: 29 bps; taxable spread: 75 bps.

Coverage Requirements

Beyond credit spreads, tax-exempt bond issues can contain items unique to the structure. Bond issues that are solely based on the utility's revenues as the source for debt payment tend to have coverage requirements and a debt-service reserve fund. Coverage requirements tend to require the utility to keep rates sufficient for some multiple of total debt payments either annually and/or before issuing more debt. Depending on the requirements of the bond documents, coverage can be calculated on total revenues or net revenues after the payment of operating expenses. A debt-service reserve fund can be thought of as a savings account embedded in the bond issue. Again, differences exist depending on bond documents, but often the size of the reserve fund will be required to equal a full year of debt service.

There are discussions as to whether these items are efficient in structuring the debt. Coverage requirements based on the utility's revenues tend not to constrain the utility, as operating expenses absorb excess dollars. Coverage models based on revenues net of operating expenses need a use for the excess dollars not needed for debt-service payments. These dollars can be used for pay-go funding of capital or to pay subordinate debt, such as a commercial paper program for construction funding. Debt-service reserve funds are savings accounts and can be invested. In higher rate environments (or a steep yield curve), reserve funds can be invested at the yield on the bonds, making them somewhat neutral to overall borrowing costs

(tax regulations provide a formula for determining the maximum earnings rate on the reserve fund, which is typically slightly lower than the all-in cost of borrowing for the utility). In low-yield markets like today's, reserve funds tend to cost the utility money, as the earnings rate is less than the borrowing rate.

Municipal Borrowing And Performance

In addition to funding costs, public entities (including most municipal water systems) are subject to much greater public scrutiny than private enterprises. In part, public (and/or political) accountability may also drive rate costs down. Often public entities are viewed as less efficient than their corporate counterparts, but we've certainly found that is not always true. Public entities tend to be constrained in their revenue growth (or ability to increase rates and charges) by executive or legislative bodies which seek to manage the overall tax burden on their constituents. Water and sewer utilities, which provide necessary services, tend to be further constrained, as it is not in the public's best interest to cut off those who cannot afford to pay. Public accountability with constrained growth tends to force a level of efficiency one might not normally expect in the organization. Ultimately, most utilities do seek to run efficiently and often reduce operating and/or construction costs through the use of outside vendors when high public employee wage requirements or onerous public procurement processes might drive costs up.

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Looking to the future, much has been made of the state of the water infrastructure in the U.S. and the need for significant capital upgrades. While many have focused on the overall financial health of the country's municipalities as the gateway to securing more water infrastructure funding, this is not always the case. As was stated earlier, water utilities are generally considered one of the highest credit entities in existence. If a utility needs capital investment and can derive the incremental revenue to support it, financing is most often available for those projects. The limitation in securing new capital generally is driven by the lack of incremental revenue.

Examining the current revenue landscape for water utilities, it is important to segment those that have ample supply and those that don't. Thus, some utilities need conservation measures to manage supply, while others are facing customer conservation measures that result in declining revenues. Most water and sewer utility revenue models are consumption-based. Water charges are often based on a metered flow by pipe size and customer type, and sewer charges are often based on the metered water flow. Historically, increasing consumption could pay for additional capital needs or rising operating costs, and a rate increase was thought to directly correlate to a similar percentage increase in revenues. In today's water environment, we find rate increases are necessary to simply maintain revenues at current levels as consumption declines — leaving little, if any, incremental revenue to fund capital projects. To remedy this situation, utilities are looking to new revenue models to fund their growing operating costs and capital needs. New revenue models range from moving to larger fixed-charge amounts as a percentage of the bill to more esoteric models such as peak-set base rate models. The latter tends to smooth a utility's revenue or purchased quantity plans with higher rates for use above the purchased quantity.

As the industry moves forward, it is important to ensure we continue to utilize the benefits provided to the sector through tax-exempt bond issuance. Tax exemption provides significant subsidies to the sector, which ensures water and sewer utilities can continue to provide safe, reliable services for years to come. ■

Kevin Thompson *is a managing director with the Public Finance Investment Banking group of Raymond James. Thompson has more than 25 years' experience structuring fixed-income securities for public and private entities.*

Jay Gorman, *vice president in the Raymond James General Industrials Group, has more than 10 years of corporate finance experience, having worked myriad successful acquisitions, divestitures, joint ventures, partnerships, and other strategic initiatives for diversified industrial and basic manufacturing companies.*

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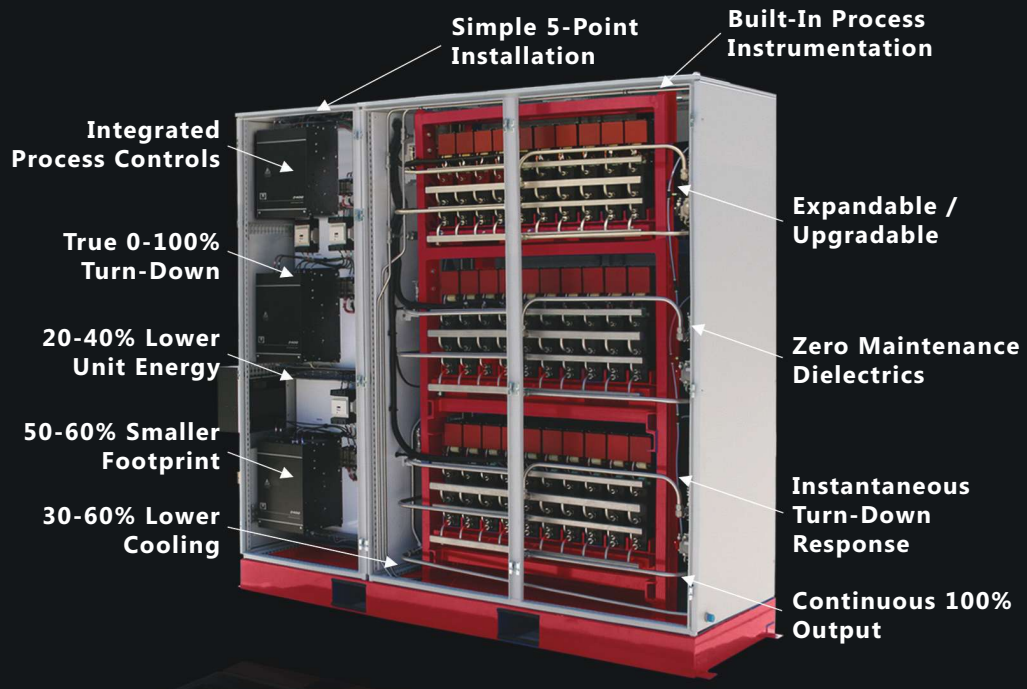

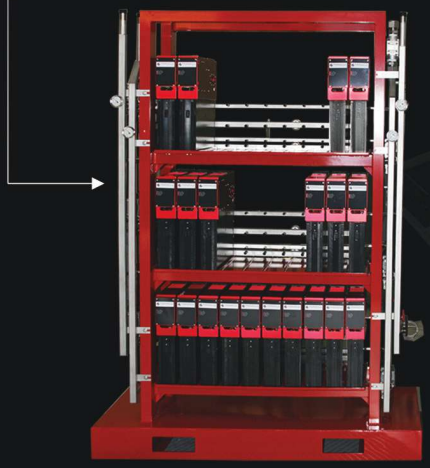

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Energy And Resource Recovery: Generating Resources, Not Waste Streams

"Sludge-to-energy" is trending in wastewater treatment, but what technologies have the most potential?

By Aoife Moloney

Increasing populations and urbanization are putting cumulative pressures on the Earth's energy, water, and nutrient resources. As wastewater contains these valuable resources, it can potentially help address these issues. Several factors are driving energy and resource recovery, including tightening regulations related to the land application of sludge, sludge incineration, and sludge disposal at landfills, as well as rising sludge treatment and disposal costs. Given that sludge treatment and disposal can account for up to 50 percent of operational spending at a wastewater treatment plant (WWTP), a strong economic driver exists for finding efficient technologies and inexpensive, long-term disposal routes to reduce sludge management costs.

Anaerobic digestion is advantageous for use in WWTPs, as it is a well-established and robust sludge-stabilization technology.

The increased emphasis on energy and resource recovery has become a primary focus for BlueTech Research, a market intelligence firm specializing in innovative water technologies. Areas of coverage, analyzed in a recent BlueTech Research Insight Report entitled *Sludge to Energy – Biogas Generation and Utilization: Technology Trends and Market Potential*, include biogas generation via anaerobic digestion (AD), biogas contaminants removal, biogas utilization via combined heat and power (CHP) technologies, and energy generation optimization practices such as pretreatment technologies and co-digestion. More efficient CHP technologies, sludge pretreatment, and co-digestion with high-energy fats, oil, and grease (FOG) can increase energy generation, reduce sludge volumes, reduce sludge management and operational costs, and provide a viable waste management solution for food wastes.

According to the most recent *WEF Biogas Survey* (2012), sewage sludge is anaerobically digested at approximately 1,238 WWTPs in the U.S., most of which are more than 1 MGD in capacity. Approximately 270 of these 1,238 facilities (22 percent) utilize the produced biogas through CHP, which equates to approximately 231 megawatt (MW). The remaining 968 plants (78 percent) use the biogas for digester heating and potentially space heating; the surplus is wasted or flared. Considering the pretreatment market in the U.S., in particular for the Cambi thermal hydrolysis pretreatment (THP) technology, there is potential to increase market share considerably in the plants with AD. Cambi has installed its first THP plant in the U.S. at the Blue Plains facility in Washington, D.C., with an installed capacity of 149,000 tons of dry solids (TDS)/year. If the initial focus were primarily on the 270 AD plants, which utilize their biogas in their CHP units, the total installed Cambi capacity would be approximately 1.7 million TDS/year (assuming a two-thirds uptake rate). This would represent an 11-fold increase in installed capacity within the U.S. market for Cambi.

BlueTech's comprehensive analysis of "sludge-to-energy" technologies provides several key takeaways:

- **Anaerobic Digestion Is The Principal Sludge-To-Energy Technology**

The predominant sludge-to-energy technology on the market is AD, which has a dual purpose: It stabilizes the sludge and generates a biogas. AD is advantageous for use in WWTPs, as it is a well-established and robust sludge-stabilization technology. Also, AD does not require a dewatered sludge feedstock prior to digestion, unlike gasification or pyrolysis. This reduces the energy consumption and operation costs associated with dewatering.

- **Internal Combustion Engines (ICE) Currently Dominate The CHP Market**

Various energy-generation CHP technologies that were assessed include fuel cells, microturbines, ICE, and the Stirling engine. While ICE currently dominates the CHP market, underutilization of biogas at smaller WWTPs and tightening air regulations could alter this. Small-capacity (30kW-1MW), low-air-emissions microturbines offer an opportunity for the smaller WWTPs to start consuming their presently untapped biogas. Currently, these smaller plants do not utilize the biogas due to perceived and actual barriers, such as inadequate payback and economics. Non-combustion fuel cells, although still relatively expensive, offer the cleanest and most efficient CHP option. They

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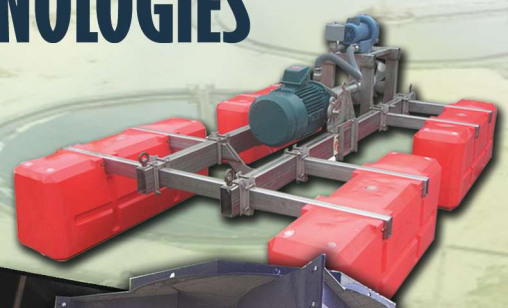

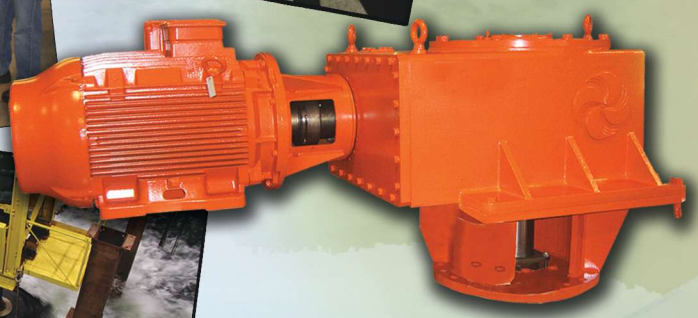

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should see increased growth in this market as air regulations tighten in the U.S. and worldwide.

- **Biogas Utilization Via CHP Or Direct Gas Grid Injection Depends On A Number Of Factors**

Decisions on whether the produced biogas should be utilized via CHP or direct gas grid injection should be made through a high-level financial analysis which takes into account the capital costs, time-value of money, and the generated annual revenue. Factors to be considered include fuel quality, local circumstances, energy costs, monetary incentives available, and the time-value of money. Naturally, high electricity costs favor CHP, and high gas prices make grid injection a viable option. In the U.S., electricity and gas prices are lower than in Europe.

- **Sludge Pretreatment Technologies Are Key To Unlocking Additional Energy**

Sludge pretreatment technologies break up the bacterial cell walls and release the cell's contents, thus unlocking all the additional energy within the cells. Pretreatment technologies include thermal hydrolysis, ultrasonic, mechanical, chemical, and electroporation pretreatment methods. Depending on which technology is utilized, advantages of pretreatment include sludge sterilization, sludge volume reduction, and process improvements, such as enhanced sludge digestibility and dewaterability and improved biogas yields. Because of growing sludge disposal costs, increasing energy costs, and tightening regulations, it appears pretreatment can offer an effective and viable solution to these issues.

- **Cambi's Thermal Hydrolysis Process (THP) Is Dominating The Sludge Pretreatment Market**

Each sludge pretreatment technology type has varying degrees of success and market infiltration. BlueTech concludes that the most dominant pretreatment technology currently appears to be Cambi's THP process. This technology is very effective at essentially "pressure cooking" the sludge, which results in a breakdown of the cell walls and a release of the extra energy within the cells. The result is a more digestible sludge with higher biogas yields and decreased sludge volume, thus reducing sludge disposal costs. Cambi's THP process also sterilizes the sludge to yield a Class A biosolid. Cambi's THP technology is currently installed in 29 plants worldwide (total installed capacity: 787,740 total dissolved solids [TDS]/year), and is a good example of a disruptive technology making inroads into the mainstream market. Recent entries into the U.S., Spanish, and Swedish markets put Cambi in an ideal position to further grow and dominate this market. Opening the pretreatment market also paves the way for others to follow, such as OpenCEL focused pulse technology. Figure 1 shows Cambi's growth worldwide since its foundation in 1996 to 2013.

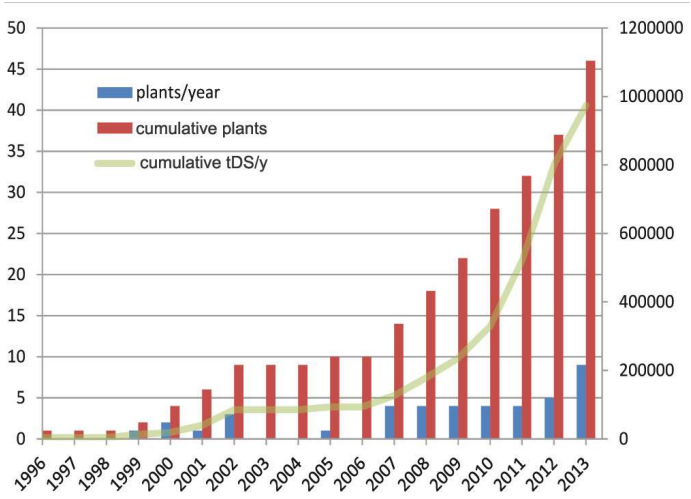

Figure 1. Cambi thermal hydrolysis growth worldwide (Source: Provided by Cambi to BlueTech® Research)

- **Co-Digestion Proves To Be Problematic In Practice**

Co-digestion appears to be an exceptional prospect: a waste management solution for high-energy food waste and FOG combined with a synergistic benefit to the sewage sludge digestion process that results in increased energy production. However, co-digestion proves to be challenging in reality. Numerous barriers exist to its application in WWTPs. Lack of clarity about post-digestion disposal regulations, waste collection methods, de-packaging and pretreatment of the waste, and guaranteed digester capacity into the future are hindering co-digestion from becoming a standard practice in WWTPs.

Finally, although several barriers for biogas-to-energy exist, such as lack of capital investment, operational challenges, and technical issues (e.g. high energy use), none appear to be insurmountable. These barriers could be overcome with a combination of efforts. Detailed financial calculations could address and give confidence to prove the economic viability of such sludge-to-energy projects, and operational challenges and technical issues could be addressed with increased research and technological development.

In summary, a combination of efficient CHP technologies, pretreatment technology, and co-digestion can significantly improve the process operations of WWTPs through a combination of increasing energy generation and efficiency, enhancing overall sustainability, and reducing final sludge volumes and overall operational costs. ■

Aoife Moloney, *water technology market analyst for BlueTech Research, has 10 years of experience in process control and optimization, auditing, and implementation of process improvements at wastewater treatment plants. Moloney recently completed a master's degree in civil engineering (energy and environmental) at the Cork Institute of Technology.*

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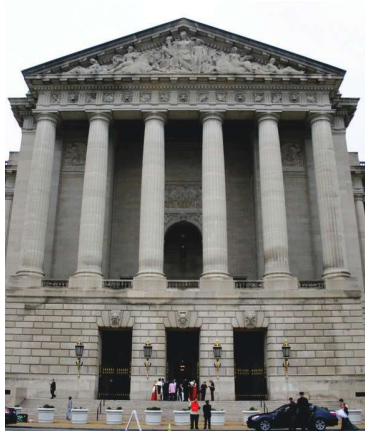
EPA's Top Priorities For Water In 2014

New rules focus on water quality, industrial operations.

By Bridget Dorfman

The Nov. 26, 2013, publication of the U.S. EPA's annual Regulatory Plan and semiannual Regulatory Agenda — wherein EPA describes the significant regulations that it expects to issue in proposed or final form during the coming year — provides a good opportunity to forecast what regulatory issues are going to be hot in 2014. According to EPA, the quality of the nation's waters demands renewed regulatory focus because "despite considerable progress, America's waters remain imperiled. Water quality protection programs face complex challenges, from nutrient loadings and stormwater runoff to invasive species and drinking water contaminants. These challenges demand both traditional and innovative strategies."

Here is a brief summary of some of the new rules and proposals that we can expect from EPA in the coming year.



Definition Of "Waters Of The United States"

The expected proposal in 2014 of a rule to clarify the definition of "waters of the United States" under the Federal Water Pollution Control Act, commonly known as the Clean Water Act (CWA), will likely have critical and wide-ranging significance for the regulated community. By way of background, the federal government has geographic jurisdiction over "waters of the United States," but two decisions by the U.S. Supreme Court — *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, 531 U.S. 159 (2001) and *Rapanos v. United States*, 547 U.S. 715 (2006) — regarding the scope and meaning of that term have created more confusion than understanding. Moreover, guidance memoranda issued by EPA and the U.S. Army Corps of Engineers (the "Corps") provided little actual guidance on how the agencies and CWA permittees should proceed.

To that end, EPA and the Corps have together drafted a rule to clarify the meaning of "waters of the United States," which is currently under review by the Office of Management and Budget (OMB). According to EPA, the proposed rule will be based on the best available science and take the legal considerations expressed by the U.S. Supreme Court into account. After OMB has completed an interagency review, the proposed rule will be published in the Federal Register for public comment. EPA states that the "proposed rule will provide greater consistency, certainty, and predictability nationwide by providing clarity in determining where the CWA applies." Early indications suggest that the regulated community believes that the proposed rule will greatly expand EPA's jurisdiction pursuant to the CWA, creating a huge economic impact.

Cooling Water Intake Structures

Cooling water intake structures are commonly used by power plants and manufacturing facilities to withdraw large amounts of surface water to cool process water and equipment. When water is withdrawn by an intake structure, fish and other aquatic organisms may get trapped against intake screens (known as impingement) or may get drawn into the process itself (known as entrainment). Section 316(b) of the CWA requires that the "location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."

Since Section 316(b) was passed by Congress in the 1970s, EPA has made several attempts to establish nationwide technology standards for impingement and entrainment reduction at existing facilities, only to have those rules remanded, withdrawn, or rewritten either voluntarily, through settlement agreements, or by court order. According to a 2010 settlement agreement, EPA was initially required to finalize its latest Section 316(b) rulemaking effort by July 27, 2012. That date has been extended four separate times — the most recent missed deadline was Jan. 14, 2014 — because EPA required additional time to finalize a rule.

Steam Electric Power Plants

In June 2013, EPA published proposed amendments to the effluent limitations guidelines (ELGs) and standards for discharges from steam electric power generating facilities, which apply to the approximately 1,200 steam electric power plants nationwide that use nuclear or fossil

Early indications suggest that the regulated community believes that the proposed rule [clarifying the definition of "waters of the United States"] will greatly expand EPA's jurisdiction pursuant to the CWA, creating a huge economic impact.

fuels. The steam electric power plant ELGs, which are found at 40 CFR Part 423, were first issued in 1974 and last updated in 1982. EPA acknowledges that the current ELGs "do not adequately address the pollutants being discharged and have not kept pace with changes that have occurred in the electric power industry over the last three decades." According to EPA, steam electric power plants contribute more than half of all toxic pollutants discharged to surface waters by all industrial categories regulated under the CWA.

Accordingly, EPA has proposed amendments that would strengthen the existing controls on steam electric power plants and that would set limits on the levels of toxic metals that may be discharged. Pursuant to a consent decree, EPA has a deadline of May 22, 2014, to issue the final regulation. However, on Dec. 16, 2013, EPA filed a status report with the court stating that it requires more time to issue the final rule, pushing the publication date further into 2014.

ELGs Construction And Development Point Source Category

The CWA also regulates the discharges of stormwater that leave certain earth disturbances associated with land development and building construction. In December 2009, EPA proposed new regulations and ELGs which, for the first time, would have required the land development industry to sample stormwater discharged from certain larger construction sites and analyze the samples for turbidity, to which the proposed regulations included a maximum standard. As part of a 2012 settlement agreement, EPA agreed to amend several nonnumeric portions of the ELG for the construction and development point source category found at 40 CFR Part 450 and to withdraw the numeric limit for turbidity. EPA proposed a rule to accomplish this in April 2013 and agreed to take final action on the proposed rule by Feb. 28, 2014.

Water Quality

EPA has issued a proposed rule (the comment period closed on Jan. 2, 2014) that was written to provide clarification and greater specificity in connection with six areas of the water quality standard (WQS) regulation found at 40 CFR Part 131. The six areas include: (1) the EPA Administrator's determinations that new or revised water quality standards are necessary, (2) designated uses for water bodies, (3) triennial reviews of state and tribal WQS, (4) antidegradation provisions to protect water quality, (5) variances to WQS, and (6) compliance schedule authorizing provisions.

National Pollutant Discharge Elimination System (NPDES) Updates

EPA also plans to issue a proposed rule in 2014 that would update and harmonize the NPDES application system and its forms in an effort to improve permit documentation and transparency. This effort may include making NPDES forms more consistent with each other and ensuring that the forms reflect current EPA standards.

Long-Term Actions

In addition to expected proposed and final rules in 2014, EPA's Regulatory Agenda also identifies a series of "long-term actions" for which regulatory action is not projected to take place until after December 2014, but which EPA will be working on. These efforts include the development of drinking water regulations to address lead and copper, perchlorate, and carcinogenic volatile organic compounds (VOCs), as well as development of effluent guidelines and standards for "unconventional oil and gas production" utilized in directional drilling and hydraulic fracturing. Of particular note, as EPA continues to battle the harmful effects of stormwater discharges into surface waters, is a long-term action to address stormwater discharges from already-developed areas (as opposed to an area actively undergoing earth disturbance). As land development increases the amount of impervious cover every year, EPA is evaluating actions that it could take pursuant to the CWA that may require stormwater management from developed and redeveloped sites or additional regulation of municipal separate storm sewer systems. In each of these areas, opportunities for public participation may be afforded in 2014. ■

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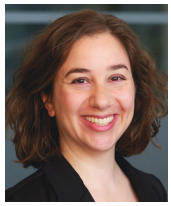

Bridget L. Dorfman is an attorney at the environmental, energy, land use law, and litigation firm of Manko, Gold, Katcher & Fox, LLP in Bala Cynwyd, PA. She can be reached at (484) 430-2330 or bdorfman@mankogold.com.

Assessing Key Unconventional Shale Wastewater Trends And Opportunities

The shale-gas boom could make water the most important commodity product of the 21st century.

By Ankur Jajoo

The dynamics of the unconventional shale wastewater treatment market has provided a huge business opportunity for existing and emerging water solutions providers. The emergence of companies offering water management and treatment services in the shale market has created some confusion as to what is the best form of dealing with the wastewater. The industry has, at present, four main options:

1. Treat the flowback to levels for reuse in fracking
2. Deep-well injection disposal
3. Reuse for fracking without treatment, which causes the wells to block over time
4. Treat flowback to potable level standards

The varying degrees of competitors in the market are able to provide different services and treatment options. For the operator, it boils down to which one is the most applicable and cost-effective solution for its given location. The industry is asking, "Will a mainstream technology ever be utilized?" The answer for now is no — and various types of technologies will be used. Total dissolved solids (TDS), total suspended solids (TSS), and sulfur-reducing bacteria (SRB) are the main contaminants that need to be addressed for wastewater recycle and reuse in fracking operations. The industry is heading toward the use of multifunctional systems that are skid-mounted or on mobile trailer systems. This helps address key industry challenges for space and lower energy consumption and is more cost-effective than using different systems for different contaminants. This is likely to be a critical game-changer for the evolution of wastewater treatment into other industrial markets by leveraging the synergies of efficient treatments and addressing similar industry challenges. Some critics may argue that due to the significant variance in wastewater quality found in the different shale plays, many of the systems would not be economical to use.

Addressing Contamination

For all of the innovation and new systems being developed in the market, the shale industry is not without its own challenges for its high water consumption and environmental footprint. Over the years, we have seen the challenges associated with groundwater contamination and the harm hydraulic fracturing does to the water table. It is a known problem commonly raised by environmentalists without fully understanding the dynamics of hydraulic fracturing and the impact on water.

The water table is significantly higher in depth than where the fissures are drilled. The water contamination likely occurs from surface spillages from flowback water in the immediate stage of drilling and from produced water over time, which seeps into cracks in the ground. The drilling company is responsible for making sure the drill casings are properly sealed and there are no potential water leakages. The probability of water contamination from methane gas or from the fracking process is extremely small due to the large differences in depths between the water table and the fissures in the ground. There are far more pressing challenges associated with using daily machinery and power generators that cause air pollution or consume energy, rather than the process of hydraulic fracturing. This disconnect in the industry is portrayed by environmentalists without the real understanding of what the underlying challenge is in the industry.

Water Recycling

The value of freshwater has grown exponentially across all industries, but most critically in the oil and gas industry. The global impact the oil and gas industry has on domestic and foreign supply and demand for energy resources — and the importance of oil for the manufacturing industry — is becoming more critical postrecession. However, the issue starts at water availability for drilling operations, which has impacted big markets such as China. The importance of water manage-

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ment for drilling operations has grown due to environmental regulations and operators' understanding of the significant costs associated with the fracking process. Furthermore, in Bakken Shale (North Dakota), freshwater for fracking is not the only process that is water-intensive. Freshwater for "maintenance water," as it is called, is being used to continue the oil flow. Without it, salt buildup from the briny groundwater will restrict the flow of oil, block the wellbore, and damage the pumping equipment. Hence operators are required to consume even more freshwater for aiding the flow of the oil. This is an interesting industry dynamic, as in the Canadian oil sands, the high viscosity of the oil/bitumen requires water to help increase flow rate. In North Dakota, the additional maintenance water is used to increase oil flow due to blockages from brine buildup.

Trucking has often been blamed for road damage, noise and air pollution, and spillages. Here, trucks move to a drill site in Weld County, CO. (Photo Credit: Bruce Finley, The Denver Post)

Recycling the produced water, which is high in brine concentration, would be a good option. This would reduce overall freshwater consumption, reduce on-site trucking, and create a byproduct that can be used for deicing in harsh winter climates. However, the use of cross-linked gel fracs in specific basins is more difficult and expensive to recycle for water treatment companies and drives costs up instead of reducing costs. Slick water fracs will be important to maintain steady and lower prices. The misconception over the last few years in the wastewater industry that a singular development at one shale play would apply to all basins has, at times, created widespread joy and excitement of industry best practices for greater water management. However, this indicates a failure to understand the dynamics of a single, particular basin.

The topography and groundwater quality varies significantly enough in certain basins that it is common for different water management techniques to be implemented. Bakken Shale produces greater volumes of wastewater compared to other shale plays, requiring for wastewater treatment equipment such as thermal evaporators and distillation systems. The impact on drilling is critical because, if the price of freshwater increases too much, it will not be economical for wells to be drilled. In the Permian Basin (Texas), strategies to use alternate sources of freshwater are being deployed by operators. This includes brackish water and recycling — reusing the produced water from the well. In Colorado, there is a slow trend for recycling wastewater, but currently the favored method is using disposal wells. This is likely to change due to the need for reusing the wastewater and also to eliminate the trucking of wastewater to injection wells.

Tapping The Water Market

A possible scenario is an increase in privatization of water sources. We may see investors buy land that has access to groundwater within close proximity to oil and gas drilling. This type of trend may seem likely if the industry fails to reuse and recycle enough wastewater for the fracking processes. This will lead to the price of water becoming very high — some investment firms are rightly calling it the commodity product of the 21st century. This will, in turn, raise the bottom-line costs for exploration and production, and thus the price of oil.

The fact that water consumption is a critical element for hydraulic fracturing has put a huge emphasis on the effective management of water in drilling operations. Historically, operators for drilling, completion, and production have worked independently from each other to complete the respective jobs. However, an increasing focus for integrating operational silos generates significant cost savings for water management in the field. In order to maintain long-term reservoir performance, operators will need to understand the total water life cycle from a holistic perspective, to make better use of the reuse and recycle options available in the industry.

Global markets instantly recognize the value of natural resources such as oil and gas, but now the value of water in all forms — clean, highly contaminated, briny, brackish, or seawater — will be even more important. Without proper management of water, the unconventional oil and gas industry will struggle for as long as the hydraulic fracking process is being utilized. Operators are looking at the prices of freshwater sourcing, which may be logistically cheaper, but as supply falls and demand rises, so will the price. The biggest challenge to the unconventional shale industry is freshwater consumption, and wastewater recycling and reuse is the key to the future for unconventional drilling. ■

Ankur Jajoo is an industry analyst in Frost & Sullivan's Environment & Energy Group with four years of consulting experience in market research and growth. His industry expertise includes water and wastewater management in oil and shale gas, petrochemicals, biosolids handling, and power generation.

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Let's Solve Water

7 Ways To Optimize Your Water Utility

Streamlining utility management and operations yields significant savings.

By Scott Haskins

"Do more with less" is a mantra that many companies and individuals have adopted over the past several years as they look for opportunities to streamline operations and manage budgets and resources more efficiently. Water utilities and public works agencies are no different. Recently, we have seen a trend in utility optimization as a way to operate water and wastewater systems more effectively, better manage limited budgets, and identify efficiencies to generate additional revenue.

Utility optimization is similar to managing a household budget. When considering personal finances, a monthly budget that takes into consideration total income versus total living costs is beneficial in helping trim expenses and spend dollars more effectively. On a grand scale, this is what many utilities and public works agencies are doing. Rather than settling for a historically based plan and budgeting approach, advancements in best practices and technology have given utilities access to new tools and models for analyzing multiple alternatives to find the optimal solution to streamline business processes, manage capital spending and funding needs, make better decisions, train staff, and enhance facilities to ultimately lower costs.

Operating and maintaining water infrastructure is costly, especially given that much of the United States' aging water infrastructure needs repair or replacement. Combine this with stricter environmental regulations and customer demands, and it's easy to see why utilities and public works agencies are looking for ways to streamline operations and do more with less while meeting safety, service, operational, and financial goals. Utility optimization involves finding the most favorable solution to generate cost savings and greater economic benefits for water and wastewater systems, while maintaining desired levels of service and managing risk.

When streamlining utility management and operations, there are seven things to consider:

- **Cost efficiency:** Identify early wins to get buy-in from stakeholders and provide the best value for taxpayers' dollars.
- **Risk management:** Establish mitigation plans to more effectively manage risk and avoid surprises.
- **Maintenance effectiveness:** Enhance reliability and reduce life cycle costs for assets.
- **Service levels:** Continually improve regulatory compliance, customer service expectations, and design standards.
- **Sustainability:** Approach green infrastructure opportunities, energy, and consumables holistically to maximize triple-bottom-line benefits.
- **Knowledge transfer:** Share knowledge across organizations through training and documentation of best practices and procedures.
- **Technology:** Invest in smart infrastructure and new technology to improve performance and overall efficiency.

Utility Optimization In Action: 3 Examples

The City of Columbus' Department of Public Utilities (DPU), one of the largest water, sewer, stormwater, and power utilities in the U.S., began its optimization journey in 2008 by adopting an asset management approach. DPU now implements a more rigorous business case analysis process before starting major capital improvement projects. Rather than delaying necessary upgrades and asset replacements until after system failures, DPU has developed long-range, data-driven infrastructure failure models that outline optimal levels of investment to replace and upgrade proactively to avoid service interruptions.

In 2010 and 2011, DPU evaluated operations at its two wastewater treatment plants and three water treatment plants for potential energy and chemical savings. Using asset management tools and process models, each plant was analyzed, and potential opportunities were identified, taking into consideration the feasibility and cost of necessary improvements when compared to the financial and operations gains.

Since beginning its optimization initiative, DPU has saved millions, avoiding $55 million in capital and operations expenditures as a result of a $7 million investment. DPU will continue to keep operating costs down through its ongoing strategic plan, commitment to optimization, and further important recalibration of its maintenance and reliability efforts.

The City of Cincinnati's Greater Cincinnati Water Works (GCWW) and the Metropolitan Sewer District of Greater Cincinnati (MSDGC), Ohio's largest water and wastewater utilities, providing drinking water and wastewater services to approximately 800,000 people, are leading the industry in terms of adopting transformative utility optimization practices. In an environment when budgets are strained, the city adopted an innovative,

risk-based, asset-management approach to reduce maintenance costs, saving $5 million annually, while maintaining its high-quality utility services.

The MSDGC operates and maintains 3,000 miles of combined and sanitary sewers, high- and low-pressure force mains, seven treatment plants, approximately 130 pump and lift stations, several package plants, real-time control facilities, high-rate treatment plants, levees, dams, and floodgates to protect the Mill Creek Valley. Annual operating costs are $180 million. The GCWW provides more than 130 million gallons of water a day to several counties in Ohio and Kentucky. Before distributing to customers, drinking water is tested more than 600 times from the source through the distribution system to ensure the highest quality.

DPU utilized a business case evaluation approach to optimize its investment in the OARS Deep Sewer Tunnel and save $7.6M. DPU determined it could reduce the size of the tunnel's surge shafts without significantly increasing its risk exposure. (Credit: City of Columbus Dept. of Public Utilities)

To comply with regulatory requirements, GCWW and MSDGC needed costly infrastructure improvements. Looking across both utilities, Cincinnati identified numerous ways to improve the effectiveness of its water and wastewater operations, including opportunities to save money by reexamining policy and administrative procedures. One example includes changing GCWW's policy to replace 30 miles of pipe every year at a cost of $40 million. The savings from replacing pipes based on risk rather than a set annual rate allowed the utility to make other more critical investments. Additionally, MSDGC and GCWW are combining administrative services to save between $68 million and $105 million over a 10-year period. Identifying quick wins and working with a bottom-up and top-down approach, Cincinnati is transforming the way it operates to keep costs low for ratepayers.

Taking a long-term, community-wide approach to major investments, Cincinnati is effectively considering green infrastructure alternatives, economic development, and environmental and social costs, benefits, and risks. They are also engaging their workforce in new technology and maintenance efforts. Working with consultant experts, the city has developed strategic plans to align the utility missions with customer service level expectations, asset reliability, regulatory compliance, organizational efficiency, employee development, financial viability, and community sustainability. Additionally, MSDGC has been recognized for Excellence in Management by the National Association of Clean Water Agencies (NACWA) for their significant efforts toward improved efficiency and effectiveness. The utility was also the recipient of *Uptime Magazine's* 2013 "Best Emerging Maintenance Reliability Program."

Boston Water and Sewer Commission (BWSC) owns and operates New England's oldest and largest water and sewer system, providing water and sewer services to more than 1 million people through 1,500 miles of sewers and 1,000 miles of distribution piping. BWSC has faced increasing challenges managing and maintaining its aging infrastructure, including more intense storm events and regulatory scrutiny. Despite these hurdles, BWSC has been able to provide rapid response to system failures, while recognizing the need to become proactive about identifying system needs before failures occurred.

Through a comprehensive facilities planning, asset management, and CMOM (capacity, management, operations, and maintenance) program, BWSC is able to respond quickly to system problems, provide comprehensive reporting to regulators, identify needed infrastructure repairs, and proactively plan for capital improvement projects. Numerous operational improvements are being implemented to dramatically increase system inspections and maintenance activities with limited staff through efficient field tablet applications, sophisticated risk-based task prioritization tools, and workflow mapping and streamlining. The program began in 2011 and is approximately halfway through the planning stage, but BWSC has already made many significant changes to improve the function of their organization and meet their goals.

Conclusion

Utilities across the United States are following suit, looking for ways to reduce costs and stretch limited budgets. By conducting diagnostic assessments and taking a proactive approach through asset management, utilities and public works agencies can better identify focus areas and prioritize capital improvement projects based on asset performance. Sometimes simple solutions, like eliminating duplicate work processes or postponing expensive replacement or rehabilitation projects, can yield immediate savings and lead to long-term solutions. ■

Scott Haskins is a senior VP and director of strategic consulting at CH2M HILL. He's active in leadership roles with water sector associations, serves on the EPA's Environmental Finance Advisory Board, and has been engaged in numerous finance, asset management, benchmarking, and utility management water research projects.

Keeping Pace With Data Management Evolution

How to harness technology and information to overcome modern municipal challenges

By Dr. Bruno Levine

According to the Water Research Foundation, the volume of data generated by water/wastewater utilities is doubling every three years with increasing automation and adoption of new systems and applications. Simultaneously, operators are retiring at an unprecedented rate, leading to a tremendous loss in knowledge and experience. The recent economic downturn created a third stress point, asking utilities to do more with less, in spite of infrastructure challenges. Fortunately, the Internet, tablet-based computing, and various wireless technologies are providing operators and utilities with a new set of tools to tackle the challenges at hand.

The purpose of this paper is to provide the reader with a cursory overview of the data management evolution taking place today, recognizing that we are in the early stages of this transformation and that many professionals are still in discovery mode.

Recent Technical Evolution

Leveraging The Cloud — Until recently, the two biggest hurdles small and midsize utilities faced when it came to IT projects were hardware and software costs. With the introduction of cloud-based solutions, the point of entry to undertake IT projects has dropped significantly, leading to more cost-effective alternatives.

In the case of cloud-based solutions, the utility has the option to hire a third party to manage its software and hardware risks through a hosted solution. In doing so, the data generated by the utility can securely reside off-site. The immediate benefit for small-to-midsize utilities is a lower-cost solution, because hosting vendors are able to spread their costs over a larger number of customers, providing significant economies of scale. Be aware, however, that not all cloud solutions are identical, and the market offers public, private, and hybrid clouds with varying feature-sets and associated capital and maintenance costs. Utilities will need to carefully evaluate their internal corporate, compliance, and security policies before adopting a specific path.

Additionally, for a utility, not all systems should be made available over the Internet. For security reasons, utilities are advised to keep operational control systems such as SCADA (supervisory control and data acquisition) off the Web, using desktop-oriented client/server technology. The recommended practice is to dissociate enterprise data management systems from operational and plant-critical platforms. Under this configuration, data is pushed with no direct link among systems. In other words, SCADA systems should be managed separately from enterprise data management platforms, the first providing real-time operational control and the second near-real-time operational oversight focusing on business and operational intelligence.

The following table outlines a high-level comparison between Web-based and client/server systems. In the coming years, utilities will continue to leverage both technologies.

Categories	Web-Based	Client/Server-Based
Interface	Web browser	Operating system
User requirements	Internet access	Hardware and software
Benefits	Accessible anywhere; scalable, low cost	Faster and more powerful; established technology
Challenge	Cybersecurity	Enterprise implementation and maintenance cost
Delivery mechanism	Software as a Service (SaaS)	Software acquistion/license

Building An Integrated Data Management Vision — Other key innovations taking place are shaping the future of the industry. The vision proposed by Biju George, Greater Cincinnati Water Works general manager, is a fully integrated solution bringing together wireless technologies, field data collection improvements, and mathematical and predictive engineering models. A set of targeted services for the utility manager to help operate the plant in an optimal mode is built around this. Hardware and software innovations are, once again, among the key building blocks to this vision.

Wireless Technologies: While meter companies have undergone tremendous changes in the last few years by combining drive-by and fixed network solutions, the most groundbreaking innovation is yet to come. Companies such as Qualcomm are starting to integrate smartphone technology into meters, enabling utilities to leverage existing cellular networks as a means of pushing data. Soon, 3G smart meter technologies will be integrated in pH meters, turbidity meters, and most online analyzers.

The immediate benefit of such technologies will be a lower

installation and integration cost, since these systems will be in a position to push data without having to be hard-wired to a data logger. This can be further improved if system and data compatibility across carriers and vendors is established.

Data Standards And Exchange Guidelines: The water industry is moving toward the concept of industry-wide data standards and exchange protocol guidelines. This effort removes fragmentation within the market where vendors have developed internal data schemas and middleware services and removes hurdles for safe and secure data exchange. Vendors, such as engineering companies, can then focus on their core product offerings, many of which include predictive modeling and design-related functionality.

In 2012, the Water Research Foundation funded a meter data management project. State regulatory agencies have begun transitioning toward reporting practices that incorporate data standards such as NetDMR (network discharge monitoring report), the EPA's electronic reporting tool. The challenge for the industry will be to consolidate all these initiatives under one group and assure consistency. This concept is not new. Other vertical markets, such as the power and banking industries, have undergone such initiatives. In all cases, individual companies and the industry at large benefited from direct savings due to faster and cheaper data integration projects.

Applications Architecture: Until recently, enterprise-class operational applications were developed as client/server applications and fell under one of two categories: GIS (geographical information system)-based systems or forms-based applications. Under this second category are two additional

subcategories: compliance- and asset management-based applications. While all three categories are well-suited for their original intent, they are not sufficiently intuitive from a process-based perspective.

Categories	Description	Example
GIS Base	All data is linked by latitude and longitude coordinates. These applications have been shown to be extremely successful in tracking well-defined data sets on "horizontal" assets, such as networks or collection systems.	TakaDu
Form Base: Asset Management	Originated from other vertical markets, asset management applications have been shown to be extremely powerful tools in the case of large systems. Most applications issue work orders and provide tracking and planning tools.	Maximo
Form Base: Compliance Focus	Compliance focus tools fall under two categories: strict compliance reporting applications and laboratory information management systems. Both have been shown to be extremely successful in large systems or enterprise-specific applications.	WIMS
Process-Driven	These applications focus first and foremost on the operator, providing the user the ability to drill down to individual systems or processes at the plant or network level, with a powerful ability to roll up data at the enterprise level. These systems will serve as data integrator with data feeds coming from the fields or existing data loggers.	FLOWatch

A new class of applications is now entering the market. This new class is based on newer technologies such as HTML5 and CSS3, but still incorporates solid process engineering principles, providing the user with greater flexibility to address all business-critical operational reporting needs. For small and midsize utilities, this new design presents two benefits: affordability and configurability. With this new class of software, small-to-midsize utilities will be able to access all key functions under one interface, while preserving any investments they have already made. The table above compares these four categories of applications.

Future Impact

As a result of the ongoing technical evolution, utilities and operators will need to adjust to this new paradigm, leading to organizational and functional changes impacting core business practices. If managed correctly, there are potential benefits for the utility in operational costs savings, as well as establishing a consistent and reliable reporting framework.

As a result of the ongoing technical evolution, utilities and operators will need to adjust to this new paradigm, leading to organizational and functional changes impacting core business practices.

Change Is Coming — In order to achieve these savings, utilities will need to adjust their existing processes, procedures, and policies. However, care should be taken so that changes will not impact the primary purpose of any water/wastewater utility, which is to protect the health and wellbeing of both the environment and the public. Additionally, the changes should not negatively impact the operators' capacity to act correctly and swiftly in times of crisis. Taking into account these basic principles, here are some examples of changes and adjustments utilities will need to make moving forward.

Staffing Changes: New positions will be created, and new skills will be required to integrate these technologies. Here are two examples:

- Business Analysis: The role of a business analyst (BA) will be to assess the operational efficiency of a plant or system based on near-real-time assessment of the data. A BA will work in tandem with operators to see how operating conditions can be enhanced but also work with other key players within the organization such as reporting, finance, and executive leadership to incorporate their needs into a single, consistent vision.
- Operational IT: IT managers today are responsible for managing servers and providing direct hardware/software support across the enterprise. Moving forward, specialized Operational IT positions will be created to support operators in their specific IT and reporting needs. These positions have to be filled by candidates who are grounded in engineering but have an interest in technology and the capability to mix the two with meaningful impact. This service could also be fulfilled by third-party contractors.

Organizational Changes: In addition to bringing on board new skills, the organization will need to develop new procedures around the use of data.

- Data Quality: As information footprint increases, utilities will have to develop data-related procedures and policies to ensure data quality. Emphasis will be on structure, storage, and organization of various streams of data, integrity checks during any data transformation, and auditing capability. This can be a new opportunity for engineering and consulting firms to assist the utility manager and can lead to other products and services to improve and sustain operational performance.

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While meter companies have undergone tremendous changes in the last few years by combining drive-by and fixed network solutions, the most groundbreaking innovation is yet to come.

- Key Performance Indicators (KPIs): With operational data becoming readily available, organizations will be able to analyze, create, and keep track in near-real-time KPIs that were previously not available. The KPIs can be operational but also compliance- or management-related, such as a water-quality violation or cross-plant variability where the utility owns and operates several treatment plants.
- Partnership and Collaboration: As a result of data becoming more ubiquitous across the enterprise, utilities will have the opportunity to revisit their communication and outreach strategy with upstream or downstream utilities, as well as environmental and public advocacy groups. As a result, new business and partnering opportunities will surface where organizations can act in tandem and make decisions that benefit not just one community, but groups of communities.

Benefits: Due to the lack of historical data, most studies identifying the long-term benefits to utilities and operators following the implementation of such solutions are strictly speculative. However, based on past implementations of early-stage technologies, the general consensus identifies savings of up to 30 percent across all operating expenses. According to Swan Analytical, a U.K.-based smart water network group, the overall potential savings could exceed $70 billion worldwide. The following table identifies some of the areas where utilities can see substantial benefit.

Categories	Benefits
Physical Asset	Extend service life • Improve performance • Reduce life cycle cost of the asset
Staff	Increase productivity (output) • Decrease labor hours
Customer	Improve service level • Enhance communication opportunities
Information Technology	Improve data accessibility • Increase performance • Favor system interoperability • Enable business process improvement • Improve compliance
Knowledge	Enhance business intelligence analysis • Increase knowledge transfer and knowledge reuse
Financial	Lower implementation cost • Delay specific investments

Service-Oriented Approach: In this evolution, there will be a new market for consultants and engineering companies that specialize in technology-related services. Until now, many utilities have housed IT departments in-house and have made procurements in software and hardware. With the maturing of cloud-based solutions, the utility will be an attractive alternative to outsource significant IT operations. SaaS and Infrastructure as a Service (IaaS) are two areas where utilities can decrease their footprint in software and hardware, respectively. This also reduces the capital expenditure for the utility and will be considered an operational expense.

While these distinctions are important, the process by which utilities should evaluate the service offering has not changed. A few key concepts to keep in mind are:

- Is the application configurable by the user?
- Are customizations required as part of the implementation?
- Are there significant costs to onboarding and off-boarding?
- Is a phased rollout possible?
- How do applications interact with other vendor systems?
- Are systems available 24/7 (99.9 percent availability is considered a good benchmark)?
- Are there disaster-recovery options in place?

Conclusion

The operational data management evolution is bringing to operators and utility managers new means of tracking monitoring and managing their systems in near-real time. In the coming years, utilities will be increasingly leveraging these tools, driving change across the industry.

The three key factors driving this change are (1) the use of the cloud to store data, (2) the use of mobile devices to push and access this data, and (3) the adoption of easy-to-use and easy-to-implement operational data management platforms. Of these three categories, the latter is the most difficult to choose.

In selecting a platform, the utility is in reality selecting a partner. In other words:

- Spend time with the technology and implementation team.
- Understand the genesis of the technology and the company's vision.
- Ask for a pilot as part of your valuation process.
- Don't be dazzled by fancy and slick presentations. ■

Dr. Bruno Levine (bruno.levine@flowatch.com) has more than 20 years of water, wastewater, and water reuse experience in research, operational engineering, and business development, working for utilities in the U.S. and Europe. Levine is currently president and cofounder of FLOWatch. He holds a doctorate in environmental science and engineering from UCLA and an MBA from Columbia Business School.

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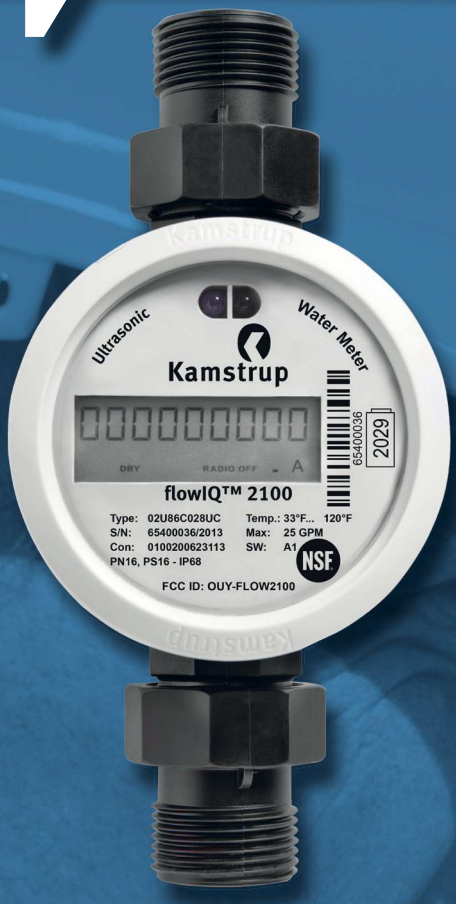

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Municipal Water Reuse Done Right: Lessons In Efficiency

California water reuse program provides multiple benefits, serving as a model for other municipalities.

By Barry Dugan

Just to the north of San Francisco, where the shores of San Pablo Bay give way to the coastal hills and valleys that are home to California's premium wine country, a regional water reuse program is stretching limited drinking water supplies by utilizing the latest in treatment technologies to recycle the region's valuable water resources. Highly treated wastewater that is permitted for discharge into the bay is being reused for multiple benefits: to enhance wildlife habitat, protect groundwater, irrigate world-class vineyards, and keep parks and golf courses green.

The North Bay Water Reuse Program (NBWRP) is a coordinated effort of three counties and seven water and sanitation agencies, working together as one entity to address water supply shortages from a watershed perspective. The region is not immune from the water scarcity issues that persist throughout the arid west: The North Bay counties of Sonoma, Napa, and Marin face long-term water supply challenges. Surface and groundwater supplies are stretched to their limit. Some groundwater sources are over-pumped and threatened with seawater intrusion. A reliable supply of recycled water not only offsets limited potable water, but provides a variety of benefits that support the area's quality of life.

As part of the NBWRP, the Sonoma Valley County Sanitation District completed this reservoir storage project that provides storage of up to 100 acre-feet of water that can be used on a year-round basis by grape growers.

From its inception, the NBWRP has approached water recycling by providing multiple benefits for multiple end users and has planned for treatment, storage, and distribution projects that meet the broadest needs of its members. An example of a multiple-benefits project is the recent construction of a pipeline that serves high-value, wine-grape growers on the way to providing water for wetlands and riparian habitats.

By using this multiple-benefit approach, the NBWRP is able to offset urban and agricultural demands on potable supplies and impacted groundwater basins, enhance local and regional ecosystems, improve local and regional water supply reliability, maintain and protect public health and safety, promote sustainable practices, give top priority to local needs for recycled water, and implement facilities in an economically viable manner.

A key to the success of the program is the support of both state and federal agencies. The U.S. Bureau of Reclamation has been a partner in developing the recycled water program. The State of California is also a partner, and the NBWRP's watershed approach is consistent with their Integrated Water Resources Planning program.

When the NBWRP was undertaken in 2001, it was envisioned as a two-phase program. Phase 1 is 65 percent complete and valued at $104 million. Phase 1 provides 3,800 acre-feet/year (AFY) of water for irrigation and up to 1,700 AFY for environmental restoration. This includes 46 miles of pipeline, 100 AFY of storage, and 6.5 MGD of new tertiary treatment. Phase 2 is in the planning stage and is estimated at $150 million in projects, which will build on the Phase 1 infrastructure by increasing storage, distribution, and groundwater management. When fully implemented, the program will yield 33,000 AFY of recycled water.

Treatment Technologies And Partnerships

Recycled water produced by NBWRP projects meets or exceeds the standards established by the State of California Department of Health Title 22 Code of Regulations and is approved for use in a variety of applications, including irrigation of food crops, parks and playgrounds, school yards, and residential landscaping. The treatment process and the technologies utilized are determined by each agency, depending on their needs and the end user.

The Las Gallinas Valley Sanitary District (LGVSD) completed a new advanced Recycled Water Facility in 2012.

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The $8 million project was funded in part by $1.6 million in federal and state funds obtained through the district's participation in the NBWRP. The facility utilizes ultrafiltration and UV disinfection to produce up to 0.7 MGD of tertiary recycled water with full redundancy. LGVSD partnered with another NBWRP member, the North Marin Water District (NMWD), to distribute the recycled water to customers to the north of the facility. NMWD distributes the water throughout its service area to schools, parks, and commercial landscape users.

LGVSD designed the facility to be expandable up to 5.4 MGD, which can be accomplished by simply installing additional filtration units, according to District General Manager Mark Williams. The recycled water facility includes two ZENON ZeeWeed 1500 ultrafiltration membrane units, with current capacity of 0.7 MGD each, but can be expanded to 1.35 MGD. The two Trojan UVFit ultraviolet disinfection system units each have a capacity of 1.8 MGD.

"We started with a small plant, but as we worked through the design process, our board and staff recognized the importance of having it readily expandable," he said. "One of the unique features is our ability to add plug and play filtration units that come on a skid." Williams also noted that the ultrafiltration and UV disinfection treatment technologies provide the first step in a direct or indirect potable reuse process. "We selected this technology in anticipation of potable reuse, should it become a treatment option as the first step in that process," he said.

The Napa Sanitation District (NSD) has leveraged its participation in the NBWRP to fund a portion of its expanded recycled water facility. The district produces about 2,200 AFY of tertiary quality recycled water that it distributes to nearby customers for irrigation of golf courses, industrial and commercial landscaping, schools, and parks. The NSD also uses recycled water on its own property to raise fodder crops.

All of the wastewater at the NSD plant receives secondary treatment, utilizing both activated sludge and pond treatment methods. For the tertiary quality recycled water, the NSD expanded its capacity by adding additional Dynasand continuous backwash sand filters to its existing system. After going through the sand filter treatment, the recycled water receives extended chlorination. The facility is designed with the capability of adding additional components as demand for recycled water increases. To date, the NSD has spent $15.3 million on the project and received $2.1 million federal and state funding. It anticipates additional federal grant funding for the project.

Storage Is A Key Component

Because demand for recycled water is greatest during the dry summer months, storage during off-peak months is a critical component of any water reuse program. In Phase 1, the Sonoma Valley County Sanitation District completed a reservoir storage project that provides storage of up to 100 acre-feet of water that can be used on a year-round basis by grape growers. The Sonoma Valley system also includes two large storage reservoirs, with a capacity of 355 acre-feet, that can be used for vineyard irrigation, and it also provides water for habitat enhancement for wildlife, including a variety of waterfowl and other birds.

The NBWRP's next phase will include a greater emphasis on storage, with as many as 18 storage projects in the planning stages, including projects that will again integrate multiple benefits into their design. For example, a storage pond could provide habitat enhancement for wildlife, protection against sea-level rise, assist with groundwater recharge, and provide community recreation and open space.

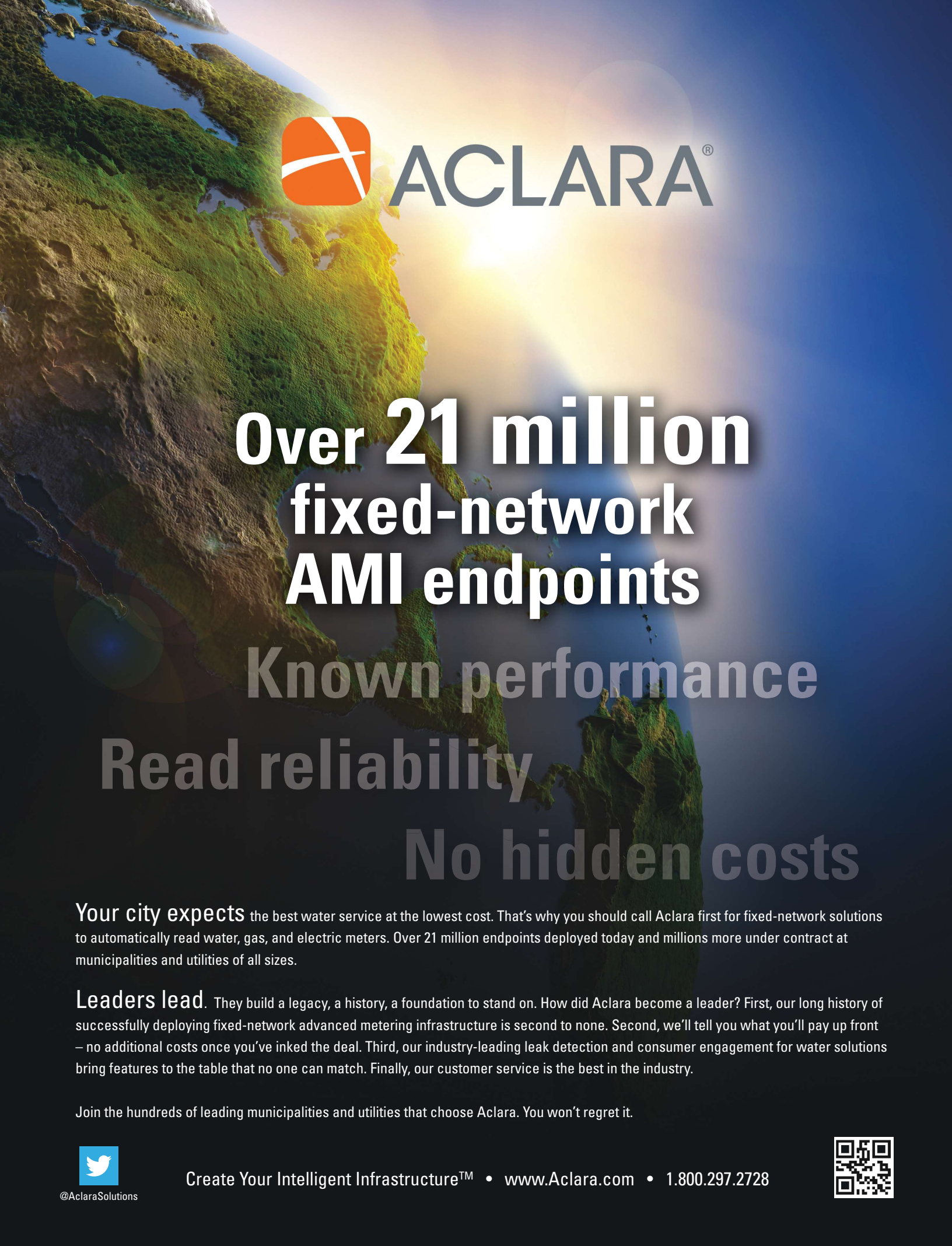
Recycled water is distributed to a variety of locations in the program area for a variety of uses. The Novato Sanitary District and the Las Gallinas Valley Sanitary District treatment facilities both provide water to the North Marin Water District, where it is distributed to its customers for irrigation landscaping, parks, playgrounds, and a golf course.

Environmental Benefits For Fish And Wildlife

The NBWRP has gone beyond the traditional uses for recycled water by including a significant habitat restoration project: the Napa-Sonoma Marsh Restoration Project. This is a multiagency effort, involving the Sonoma County Water Agency, Sonoma Valley County Sanitation District, California Department of Fish and Wildlife, the Army Corps of Engineers, the state Coastal Conservancy, and federal Bureau of Reclamation. Recycled water from the Sonoma Valley County Sanitation District will be used to dilute a 300-acre pond that was formerly used to produce salt. The highly saline contents of the pond could, if left in its current condition, harm fish and wildlife if a storm or flood breached the levees surrounding the pond. By diluting the contents of the pond with fresh recycled water, the salty mixture can be slowly released into the nearby San Pablo Bay.

The Napa-Sonoma Marsh Restoration Project, which is expected to take up to 10 years to complete, has additional environmental benefits. The NBWRP provided the 3.5-mile pipeline that carries water to the salt pond. The pipeline travels through the Carneros wine-growing region, a notoriously dry region where the groundwater basin is under pressure from urban development and agriculture. Studies have indicated groundwater levels are dropping, and there is the threat of seawater intrusion.

Grape growers along the pipeline route now have access to the recycled water for vineyard irrigation, decreasing pressure on groundwater and allowing much higher yields for the world-class vineyards. Vineyards in the Carneros region are farmed with very little water, and yields are typically about one ton to the acre. With abundant water for irrigation, those yields could triple or quadruple, providing additional economic benefits to the region.



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Program Provides Multiple Benefits: Environmental, Social, And Financial

In a water-scarce region such as the North Bay, one of the main benefits of a water reuse program is the offset to limited potable water supplies. With a goal of 33,000 AFY at the end of Phase 2, the program will provide a reliable water supply as communities prepare for drought, climate change, and the competing demands from agriculture, development, and the environment.

With the NBWRP's multiple-benefit approach, Phase 2 projects are being carefully designed to address numerous environmental issues, including the effects of sea-level rise on member agencies' facilities. For example, the Las Gallinas Valley Sanitary District is considering an upgrade to an existing storage pond that would include design elements, such as raising of levees, which would provide flood protection, increased storage, and protection from sea-level rise.

The NBWRP provided a 3.5-mile pipeline that carries water to a salt pond that is being restored as part of the Napa-Sonoma Marsh Restoration Project. The recycled water is also available to grape growers along the route in the Napa Carneros region, where water is scarce.

A significant benefit of the program is that it allows agency members to share costs for planning, engineering, and environmental studies — costly studies they could not afford to conduct individually. Members also benefit from shared federal and state advocates and have access to expertise often beyond the reach of small districts. Though program costs are shared, members implement their own projects, thereby incrementally contributing toward regional supply reliability.

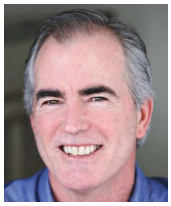
In an effort to more accurately assess the value of investments in the program, the NBWRP is considering the use of a triple-bottom-line (TBL) economic assessment during Phase 2 to identify, quantify, and (to the extent possible) monetize the many financial, social, and environmental benefits that the program generates for the region. A TBL assessment would examine the values of restoring key environmental assets, such as salt marshes along the Pacific flyway, enhancing in-stream flows and riparian habitat for threatened and endangered species, and protecting groundwater supplies. It would look at the social value of agricultural and municipal water supply reliability and local control over water supplies. From a financial perspective, a TBL assessment would analyze the avoided costs for potable water supplies and the avoided wastewater disposal or storage costs.

A Water Reuse Model For Other Regions

By working from a watershed perspective to develop recycled water as a new water supply, the NBWRP serves as a model for how communities can work together to plan for self-sufficiency and, in turn, gain supply reliability using recycled water, yielding a variety of benefits.

In recent months, the NBWRP has provided outreach to key members of the water community in the western U.S., including the Texas Water Conservation Association, Western States Water Council, Association of California Water Agencies, National Water Resources Association, WaterReuse Association, and the Family Farm Alliance. Its outreach efforts have focused on enlisting support for proposed federal legislation that would provide new tools and funding for water infrastructure projects across the West. The 21st Century Reclamation Infrastructure Finance and Innovation Act of 2014 (RIFIA) proposes to aggregate and amend existing Bureau of Reclamation (Reclamation) authorities to provide assistance to the NBWRP and other water managers across the West. There are three key "tools" addressed in RIFIA: federally guaranteed loans; transfer of title of reclamation facilities or elements of facilities; and Integrated Regional Water Management and regulating storage-competitive cost-shared grants.

Cities, counties, and states throughout the water-scarce West are searching for new and creative ways to conserve limited water supplies and get the greatest return on their infrastructure investments. The NBWRP has developed a successful model that addresses water supply shortages from a watershed perspective and invests in diverse recycled water projects that provide multiple benefits to support the region's way of life. By approaching water recycling from a regional water supply perspective, the program has been able to partner with the Bureau of Reclamation and the state of California and has been successful in receiving support for its projects. As a group of water and wastewater agencies in three counties, the NBWRP has been able to accomplish together what would not be possible individually. ■



Barry Dugan works with Data Instincts, Public Outreach Consultants (Windsor, CA), which provides public outreach services to the North Bay Water Reuse Program and other water-related projects, including recycled water, groundwater, desalination, and water conservation. He has more than 30 years of experience in journalism, public outreach, and communications.

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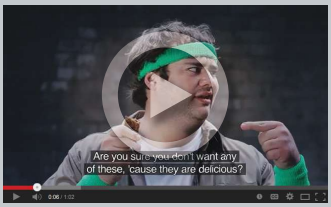

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How To Utilize Nutrients To Your Advantage

Using nitrogen and phosphorus to create algal biomass may be the energy solution for tomorrow.

By Art Umble

Few argue that one of the greatest challenges facing our world in the 21st century is to meet the energy demands necessary to support the economic growth resulting from the expanding global population. Though fossil fuels have been the mainstay in providing energy for increasing demands, the limitations of these sources call for more sustainable solutions to be advanced. Algae production has the possibility to rise to the occasion as one of these sources, and wastewater treatment plants may be able to become factories for its production.

Energy experts estimate that global demand for energy will outpace its supply by more than 40 percent by 2030. Though fossil fuels will continue to dominate the supply landscape, algal biofuels potentially could replace more than 10 percent of fossil fuel sources in this time frame, which would stand to be a significant contribution. Moving in the algae direction is attractive — its energy conversion efficiency exceeds that of terrestrial biofuel sources (e.g. corn ethanol) by more than 10 times.

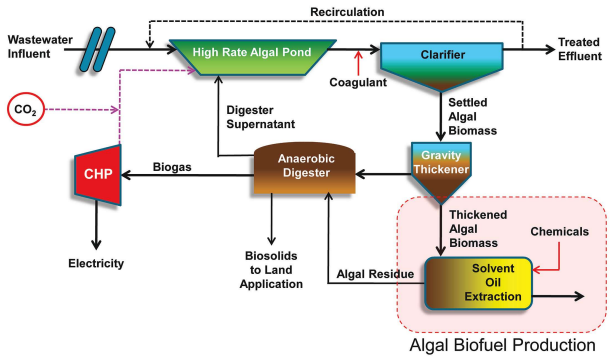
Moving in the algae direction is attractive – its energy conversion efficiency exceeds that of terrestrial biofuel sources (e.g. corn ethanol) by more than 10 times.

Turning Nutrients Into Algae

Domestic wastewaters contain an abundance of nutrients, specifically nitrogen and phosphorus — key ingredients in algal growth — which have negative environmental consequences if not substantially removed from treated discharges. However, integrating controlled algal production into the treatment process addresses two key environmental objectives: nutrients are removed from the treated effluent, and the algal biomass produced can be harvested and converted into usable energy. It all sounds positive, but could it be too good to be true?

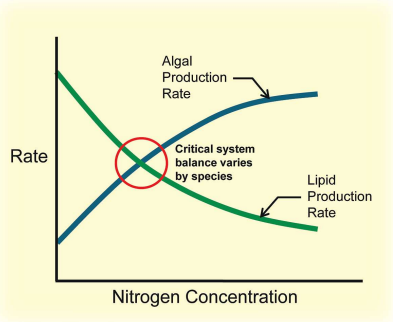
Historically, the deterrent to widespread algae production from wastewater is the fact that large acreages are required to produce significant quantities, making it practical only in rural areas where

Supplementing Anaerobic Digestion Energy Recovery with Algal Production



Source: Hutton, et al. (2011)

Nitrogen Balance for Productivity and Lipid Concentration



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land remains inexpensive. Furthermore, because photosynthesis is the driving force, algae production has generally been restricted to geographies where sunlight abounds. But recent technological advances in high-rate algal ponds (HRPs) and photobioreactors are rapidly broadening the geographic regions that are fit for production. Additionally, the use of artificial light technology (including LEDs) minimizes the need to be in locations of abundant sunlight.

Technological advances not only expand the geographic possibilities for growth but affect the productivity of the algae. Where algal biomass productivity cultured in conventional large-area ponds rarely exceeds 300 mg/L, high-rate ponds typically exceed 3,000 mg/L, with photobioreactors achieving more than 10,000 mg/L (though the capital costs of photobioreactors today exceed that of HRPs by about 10 times). At these high rates of biomass production, nutrients can be reduced to very low levels in discharged effluents, and the biomass can be harvested for energy production via either biofuel combustion or conversion to biogas through anaerobic digestion.

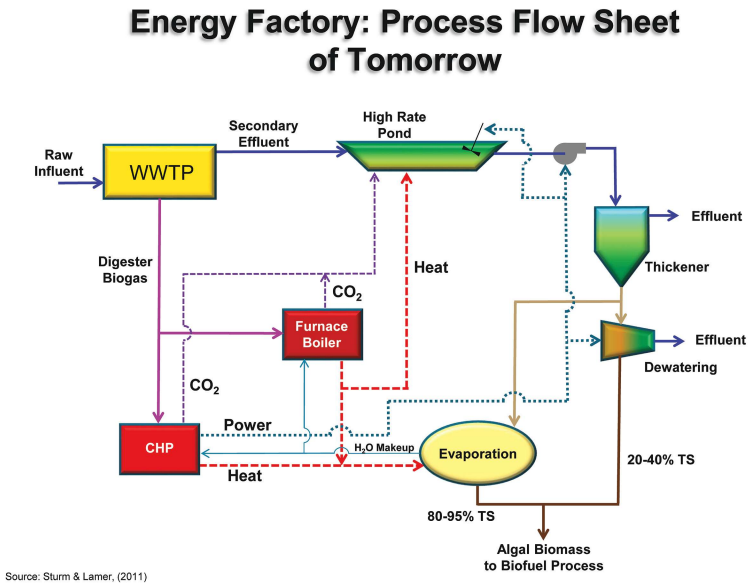
The energy challenges of this century require a new way of thinking about the treatment of wastewaters to meet the growing demand.

From Algae To Energy

Biofuel production from algae requires maximizing productivity while simultaneously maximizing the concentrations of intracellular lipids during productivity. Maximum productivity occurs when neither nutrients nor carbon are limiting. Municipal wastewaters have excess nutrients but lack sufficient carbon, requiring carbon dioxide supplements to sustain productivity. Maximizing lipid content is achieved by "starving" the algae of nutrients, primarily nitrogen. Thus, when using municipal wastewater to produce algae for biofuel, a balance must be struck between making sufficient nutrients available to produce enough algae, while at the same time limiting these same nutrients sufficiently to enhance enough lipid production to support enough biofuel production to be economically viable. Today's process for producing commercial biofuel from the algae involves a series of steps between harvesting and thickening the algae biomass to producing the final product via complex chemical reactions, rendering it an expensive proposition. These factors make direct biofuel production for the public utility difficult to justify.

On the other hand, algae production can be beneficial to the public utility because the energy "stored" in algal biomass can be recovered via anaerobic digestion, a process that is already present in many wastewater treatment facilities. In full-scale digestion systems, the methane generation potential for algal biomass is about 50 percent that of raw sludges, thus providing an opportunity to supplement biogas production from the raw sludges to enhance energy generation. Additionally, the carbon dioxide in the biogas can be extracted and then reinjected into the HRPs or photobioreactors to balance the stoichiometric inorganic carbon requirements for maintaining optimal algae productivity.

The energy challenges of this century require a new way of thinking about the treatment of wastewaters to meet the growing demand. Producing algae from the nutrients present in wastewaters offers two significant benefits. First, algae productivity removes nitrogen and phosphorus from treated effluents to reduce negative environmental impacts. Second, energy can be recovered from those same algae — via anaerobic digestion — and used to reduce the amount of power needed to operate a wastewater treatment facility. Think about it! ■



Source: Sturm & Lamer, (2011)

Dr. Umble is the wastewater practice leader for MWH and provides technical analysis and support to design teams for new and rehabilitated municipal wastewater treatment facilities. Umble is a leader in initiatives promoting environmental stewardship, serving as a technical advisor/reviewer for Water Environment Research Foundation, International Water Association, and the WateReuse Foundation collaborative research projects.

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