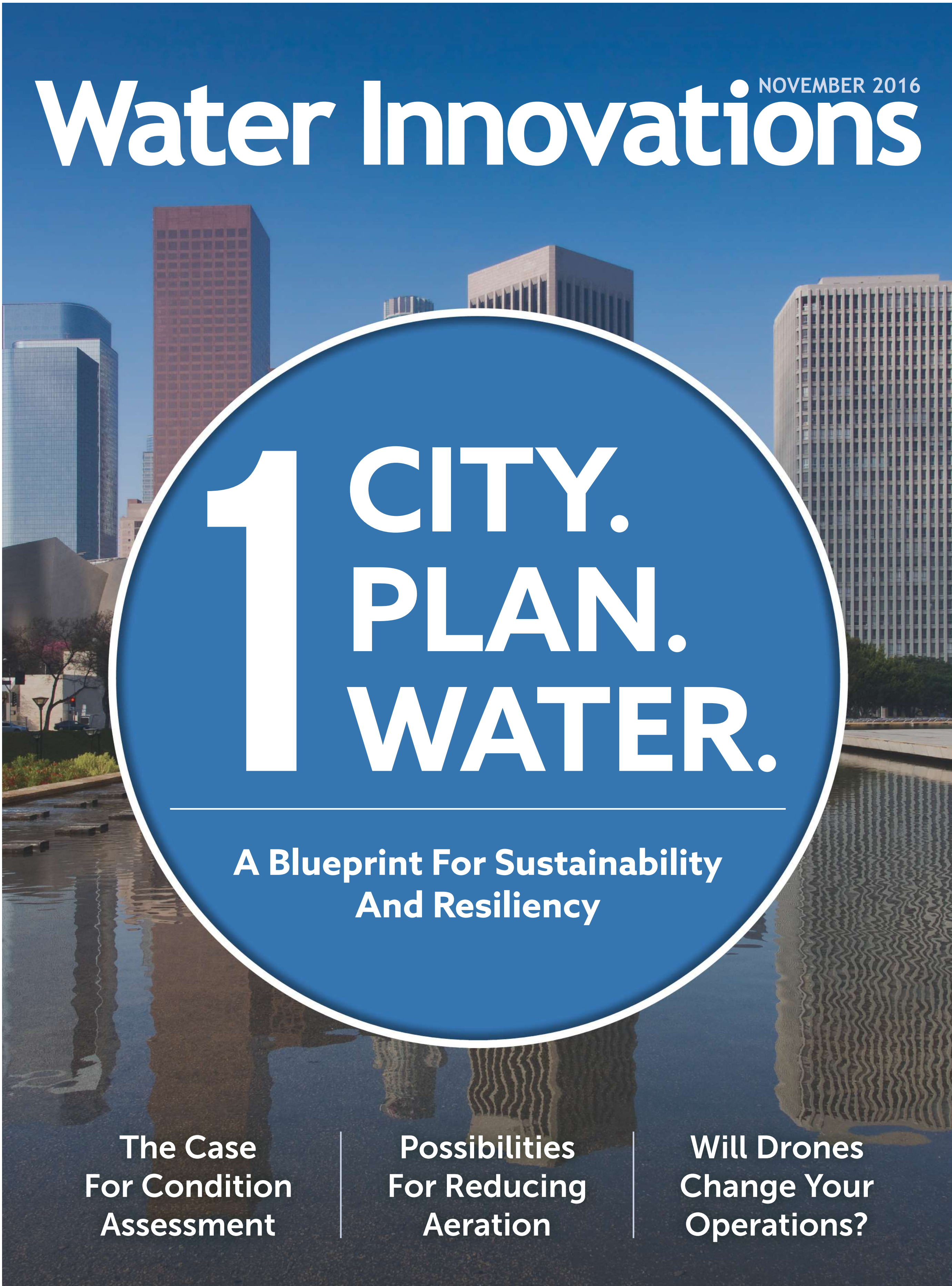
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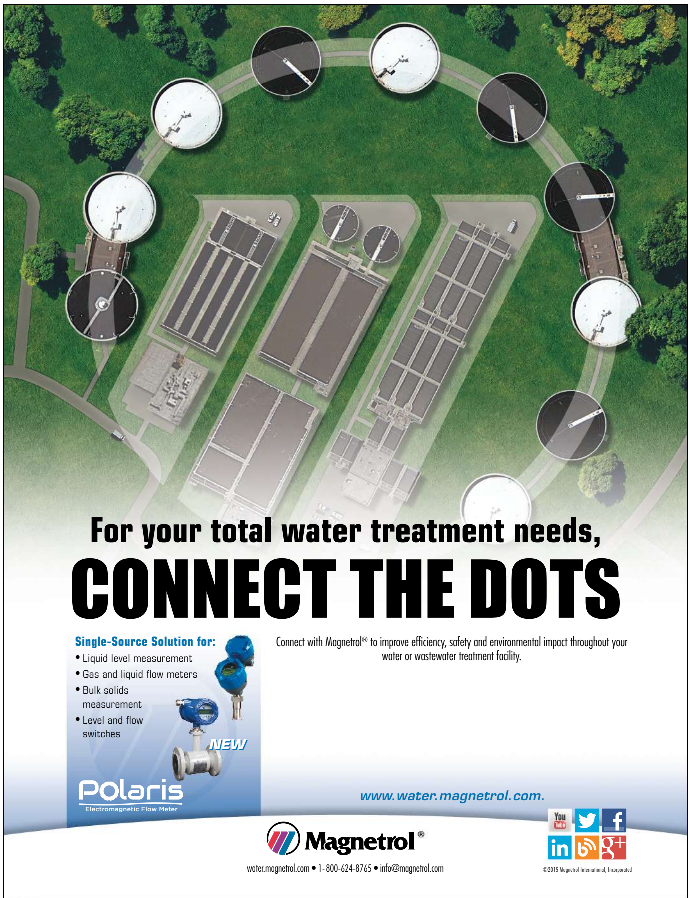

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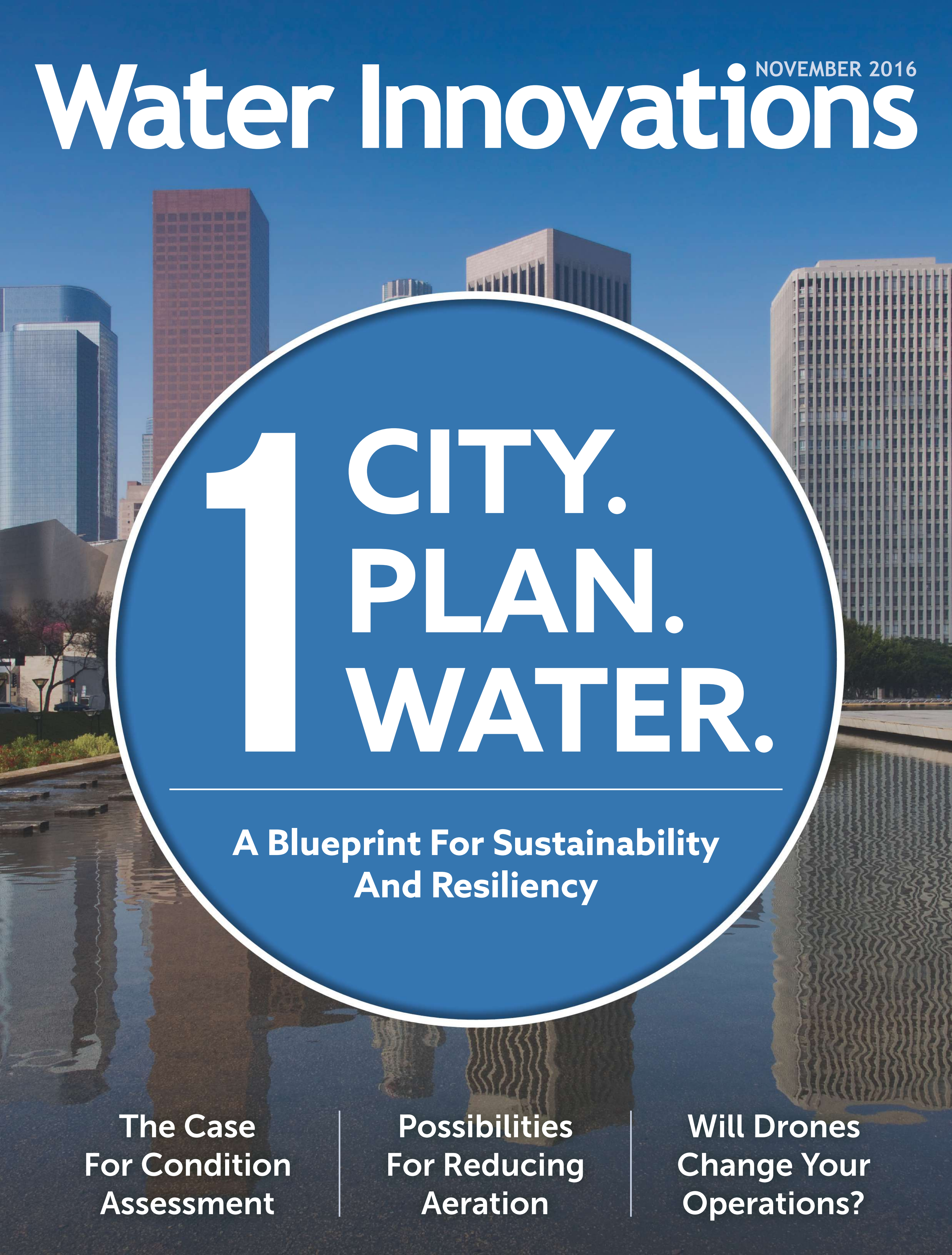

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EDITOR'S LETTER

By Kevin Westerling
Chief Editor, editor@wateronline.com

Coming To Pass: Perspective On
The Water Resources Development Act (WRDA)

Do you see the glass half empty or half full? This classic pessimism vs. optimism litmus test may also dictate how you see the passage of the Water Resources Development Act (WRDA) — the water infrastructure funding bill that recently passed with ease through Congress, albeit in different versions for the Senate and the House of Representatives.

To be sure, any money appropriated for the massive needs faced by the water industry on all sides — in drinking water, wastewater, and stormwater; at the treatment plant and throughout the distribution system; in streams and watersheds everywhere — is welcome money. However, the total doled out, especially after political compromises, is a drop in the bucket (or glass, if you will) compared to what is actually needed to repair and replace our infrastructure, ensure safe and available supply, and become resilient and sustainable for the future.

The pessimist groans at the half-empty glass, seeing all that unfilled space. The optimist gives thanks that there is any water — money, that is — in the glass at all (especially true for those who have opportunity to drink from it). Legal, financial, and industry authority Fred Andes sees it a third way: He's just happy that we now have a glass to fill, thanks to WRDA.

Another Perspective

Spearheaded in bipartisan fashion by Senators James Inhofe (R-OK) and Barbara Boxer (D-CA), the new bill won't come close to resolving all of our water needs — not even halfway — but Andes nonetheless recognizes WRDA as an important legislative step in a long journey toward reinvestment, restoration, and ultimate stability.

A Harvard Law School alumnus, Andes is a partner in the Chicago and Washington, D.C., offices of Barnes & Thornburg LLP and the leader of the firm's water team. He explained: "It's not a panacea, but every little bit helps, and you never want to leave money on the table. WRDA and the Water Infrastructure Finance and Innovation Act (WIFIA) provisions will allow some communities to go forward with badly needed projects, but there's still a funding gap in the trillions, based on all the studies.

"I think the sense here is 'Let's get something going.' You can't solve the problem all at once, so let's take some bites out of it. Let's see what works and what doesn't. In the current political climate, that's the way you have to do it. What's important is that the discussion has started and is going to continue."

Role Call

Andes recalled a time when the federal government invested heavily in water and wastewater infrastructure, particularly in the construction of wastewater treatment plants. Since then, however, the pendulum of financial responsibility has swung to local utilities and ratepayers. Does WRDA signal that the pendulum will swing back to the federal government? That would seem unlikely, and maybe even unwise, as there is great opportunity for municipalities to save and create revenue through innovation on the local level (the focus of the articles herein), but perhaps with a federal assist.

Beyond the Fed or ratepayers shouldering the burden alone, Andes again points to a third option. "There are other ways to promote the financing of projects and make it easier to creatively use the financial and capital markets. The provisions put forth in WRDA have teed that up in terms of what the federal government can do to get money to where it's needed without necessarily creating a multitrillion-dollar bank of money that gets parceled out.

"You want to hear from the regulators and the municipalities to get a sense of the needs and concerns of each party in the process, including the people with money."

By facilitating public-private partnerships, bond innovation, or alternative project delivery concepts, the federal government can help create financing opportunities that will be more cost-effective and cover more ground than traditional loans and grants. And while this isn't new information — water agencies have lobbied for such help for years, pushing WRDA and WIFIA to the finish line — it is Capitol Hill's simple acknowledgment of the industry's needs, of the glass that needs to be filled, that is most important.

How these needs, this glass, will be (ful)filled is the ongoing challenge. Are you an optimist or a pessimist?

The Case For Condition Assessment

The need for using condition assessment as part of an overall asset management program has been documented over the past two decades, but the value of this work for the cost has eluded many utilities.

By Bryon Livingston, PE, and Derek Wurst, PE

The AWWA's 2001 *Dawn of the Replacement Era: Reinvesting in Drinking Water Infrastructure* report identified concerns about the age of infrastructure in the U.S. and outlined the need for condition assessment and reinvestment in our pipelines. Increased understanding and application of asset management principles over the past 15 years is changing the way we think about monitoring, managing risk, and prioritizing capital investment. To effectively manage any asset, we first must know something about its current condition. Assessing the condition of buried infrastructure, especially the critical pipelines we depend on to reliably deliver water, is not as difficult as it may seem, but it does require a practical, programmatic approach.

Condition Assessment Defined

The U.S. EPA defines condition assessment as "the collection of data and information through direct and/or indirect methods, followed by analysis of the data and information, to make a determination of the current and/or future … status of the pipeline." (EPA/600/S-09/003 April 2007) The amount of data required to conduct a condition assessment varies with the risk of failure associated with the pipeline. Indirect testing methods such as close interval potential survey (CIPS) or other soil corrosion potential measurements area adequate for low-risk pipelines, but high-risk pipelines require direct testing to collect measurements of pipe wall thickness; many pipelines require some level of testing between the two, depending on the risk of failure for a particular pipeline.

The EPA's 2007 publication, *Distribution System Inventory, Integrity and Water Quality*, reported that condition assessment was at the time either not used or not used routinely by most utilities, and utilities often had limited data about their systems besides what was installed and when it was installed. Where analyses have been conducted, it is common to see qualitative indicators such as "good" and "poor" assigned to pipes in the system. These indicators do not help utilities plan and schedule future improvement nor identify quantitative indicators such as "remaining useful life" that could be used to do so. Many water utilities are unsure of the effectiveness of advanced inspection techniques, such as electromagnetics, and want inspection data that is collected through these techniques validated by physical inspection before they readily accept such data. Potential users of advanced inspection technologies may need more information about the benefits received by implementing such technology to justify the cost.

Condition Assessment Applied To Asset Management

Earlier this year AWWA shared findings from its *2015 Establishing the Level of Progress in Utility Asset Management Survey.* The report includes summaries and analyses of reported asset management practices collected from the survey of 545 utilities across the U.S. and Canada.

Question 14 of the AWWA survey asked, "Does the organization have a process in place to assess the condition of linear assets (distribution system pipes) and store the condition data in a spreadsheet or database?" The response indicated 63 percent are at least somewhat engaged in the practice, and about half of those (33 percent of total respondents) are using historic leak data as the basis. Only 13 percent of the respondents reported using advanced condition assessment techniques on critical pipelines.

Collectively, these and other surveys and studies show that despite an increased use of condition assessment since 2001, utilities don't always apply the process as effectively as possible. The majority of water utilities have an annual repair or replacement method in place, using various methods to identify which pipelines to repair or replace each year. Although a majority of utilities plan to incorporate condition assessment into their overall pipeline management programs, relatively few have a programmatic approach in place to guide the implementation of condition assessment. Identification of critical pipelines using risk analysis is a key first step in implementing a condition assessment program. And, as

Figure 1. Ultrasonic and guided wave testing equipment

indicated in the 2015 AWWA survey, relatively few respondents use available advanced condition assessment technologies, such as electromagnetic testing.

Reactive Condition Assessment Programs

The main goal for condition assessment is to prevent a catastrophic failure of a critical pipeline that results in significant loss of service and expense. So why don't more utilities use condition assessments to develop repair and replacement programs? Possible reasons include expense, potential disruption to operations, and required modifications to the piping. Fear of change — especially if the process seems to be working well for now — is another potential reason why some might avoid condition assessment.

Utilities tend to establish a proactive and aggressive program for condition assessment after they have experienced a catastrophic failure and experienced political and social pressure to prevent more failures. Although it is difficult to obtain funding to invest in buried infrastructure, the growing evidence from pipe failures across the U.S. gives credence to acting proactively to avoid major problems. Condition assessment enables utilities to make informed decisions about pipeline management armed with the knowledge to understand the risk.

Moving From Reactive To Proactive

The value of condition assessment is best illustrated by examples.

One example is a steel lock-bar pipe installed in the 1920s. The pipe originally had a coal-tar enamel coating but was relined with cement mortar in the 1960s. The pipeline was selected for inspection through a risk-based process based on its age and high consequence of failure.

The pipeline was inspected internally while it remained in operation using a camera specifically designed for insertion into potable water mains. In addition, external, nondestructive testing (ultrasonic thickness, guided wave, and broadband electromagnetic testing), visual inspections, soil corrosivity testing, and a geotechnical evaluation of the pipeline alignment were performed to document liner integrity, structural integrity, and other localized defects that can affect pipeline reliability and/or serviceability.

Data collection and subsequent engineering evaluations enabled the assessment team to determine the current condition of the pipeline, estimate its remaining service life, and identify rehabilitation needs. Condition assessment revealed that despite mortar-lining deficiencies, the pipeline has sufficient thickness to withstand internal and external loads and will provide long-term reliable service.

Recommendations also included spot repairs to the cement mortar lining rather than full liner replacement after the two options were compared by calculating their equivalent uniform annual costs. The spot repairs were deemed to be the preferred alternative based on a life-cycle cost perspective. Ultimately, condition assessment revealed that the pipe had sufficient estimated remaining service life to justify mortar-lining spot repairs. The assessment and findings enabled the owner to prioritize capital-improvement resources, improve pipeline reliability, and mitigate risk (Figure 2).

Another example is a prestressed concrete cylinder pipeline (PCCP) installed in the 1970s with pipe made with Class IV prestressing wire, which is known for being susceptible to failure. Risk analysis ranked this pipeline as the second most critical pipeline in the prioritization plan. Inspection required coordination with a shutdown of the treatment plant and installation of access taps for the inspection equipment (Figure 3). Due to the high-risk ranking and potential for failure, the entire pipeline was inspected with electromagnetic inspection technology and a closed-circuit television (CCTV) camera that was inserted into the pipeline (Figure 4). Condition assessment revealed no pipe segments with broken prestressing wires and no observed defects. The results, which were not anticipated given the historical high rate of failure in this specific pipe type, enabled the utility to focus available funding in the most appropriate way on other priority pipelines.

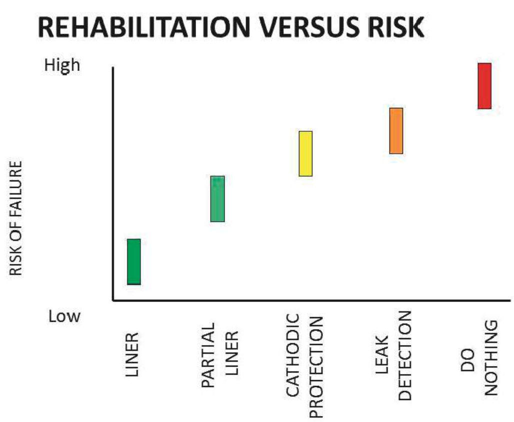

Figure 2. Evaluation of risks

Figure 3. Installing the tap saddle on pipeline for access

Figure 4. Insertion of the inspection tool

More Knowledge Is A Valuable Thing

Condition assessment is an important component of asset management, but it also has value in the annual budgeting process to determine which pipelines should be replaced each year. As demonstrated by the 2015 AWWA survey, many utilities budget funds each year for replacement of pipelines based only upon age or leak history. The value of condition assessment is in the process of prioritizing risks to determine the level of data collection required for a particular pipeline and then inspecting the highest-priority pipelines. Condition assessment can be relatively inexpensive for indirect methods or a desktop analysis or more costly for a comprehensive field inspection to gather direct condition data. High-priority pipelines justify more data collection, whereas medium- and low-ranking pipelines may only call for indirect testing and possibly data collection at selected locations based on the results of indirect testing. A phased approach for data collection allows utilities to adjust the amount of data collected to address the level of risk they are willing to accept. The cost of condition assessment increases with the amount of data collected.

It is difficult to justify the cost of condition assessment without having a process in place to compare the cost of the assessment with the expected benefit. Knowing the condition of high-priority infrastructure can reduce the risk of catastrophic failures and the associated high costs. Knowing the condition can also prevent utilities from needlessly replacing pipeline based on assumptions when limited repair or rehabilitation might be sufficient and make more sense financially, as indicated by the examples. Condition assessment can be justified by considering the value of selective replacement of pipelines based on known condition.

The Black & Veatch *2016 Strategic Directions: Water Industry Report* describes a process employed by the Tulsa Metropolitan Utility Authority (TMUA) in Oklahoma. TMUA is using advanced analytics and improved collaboration to make informed investment decisions. Understanding which projects can be deferred and how deferred projects affect overall risks helps cities like Tulsa prioritize and optimize capital; knowing the true, versus suspected, condition of buried assets is an important step in determining where limited capital improvement dollars will do the most good.

Making the determination to rehabilitate, replace, or do nothing to pipelines and other assets on the basis of field-verified data yields a better capital improvement plan. The amount of data required is determined by the priority of the pipeline from the risk-analysis program. Capital investment decisions based on condition assessment results are more cost-effective and valuable in mitigating risk than decisions based on leak history and age alone. ■

About The Authors

Bryon Livingston is a senior project engineer at Black & Veatch with more than 35 years of experience, including several years in municipal and industrial operations. He specializes in condition assessment and rehabilitation of buried infrastructure and has extensive project experience in the condition assessment, design, rehabilitation, and construction of solutions in water transmission and wastewater collection.

Derek Wurst is a condition assessment manager at Black & Veatch and has dedicated his career to the assessment of water and wastewater infrastructure to help clients extend the useful life of their assets. He has more than 15 years of focused condition assessment experience in the evaluation of water and wastewater facilities. Wurst has directed and provided technical assistance in the analysis of water transmission, wastewater and stormwater collection systems, pipelines, pump stations, and treatment facilities.

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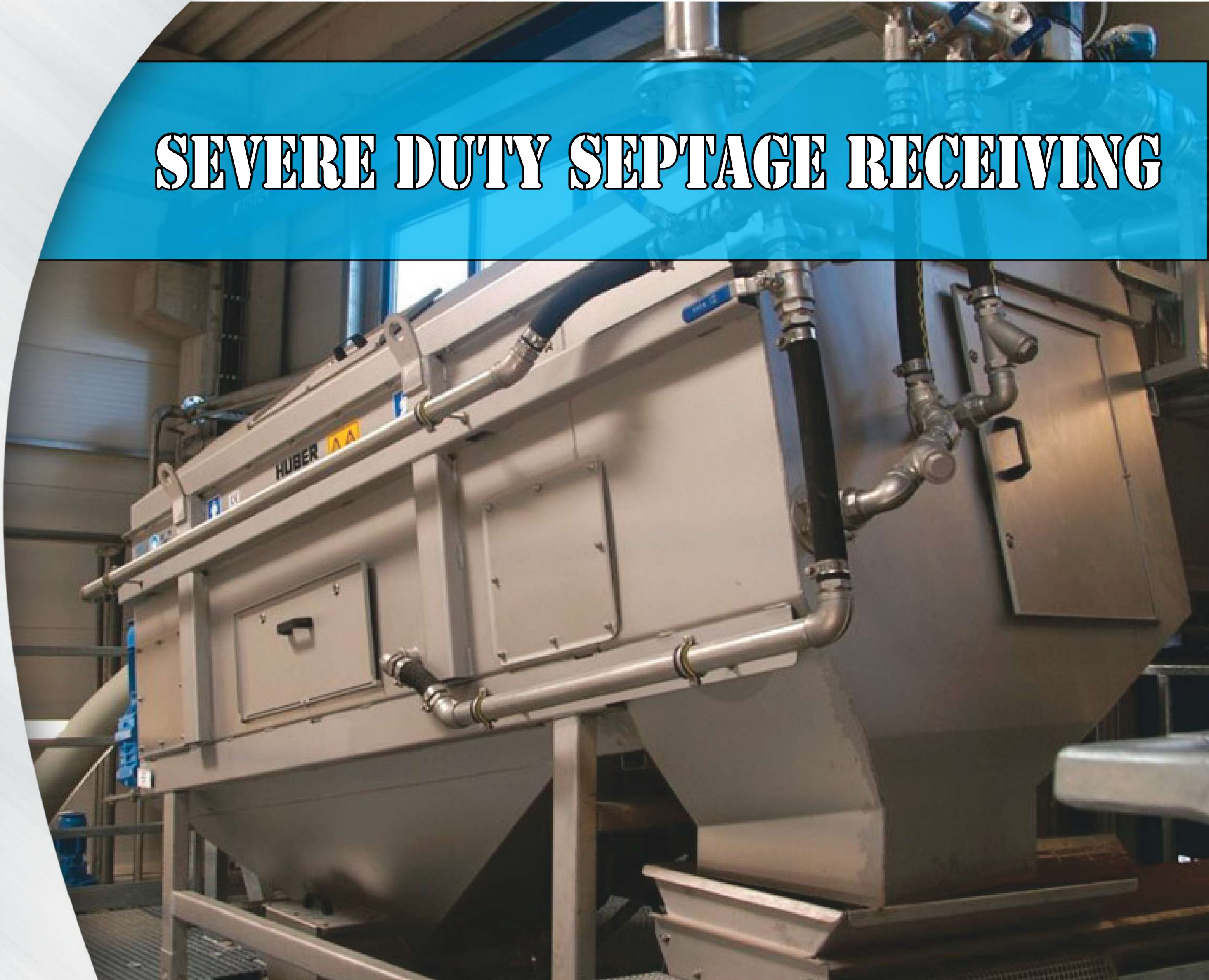

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Sludge Acceptance Plant

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One City, One Plan, One Water: How Los Angeles Is Transforming Water Management

Carollo Engineers unveils an ambitious plan to turn one of America's most water-stressed cities into a model of sustainability and resiliency.

By Paul Flick and Inge Wiersema

Los Angeles rambles across nearly 500 square miles of coastal basin in Southern California, brandishing vast beaches, wooded hills, and some of the largest companies and industries in the nation. With a population topping 4 million, a reliable water supply is one of the keys to keeping the city growing and vibrant.

Yet California is now in its fifth year of a persistent and unforgiving drought, straining the city's ability to effectively manage its various water supplies and sources to meet customer demands. On Oct. 14, 2014, Los Angeles Mayor Eric Garcetti issued Executive Directive Number 5 in response to the lack of rainfall and ongoing drought. From this directive was born the city's "One Water LA 2040 Plan," which is an integrated approach for combining water supply augmentation, wastewater treatment, and stormwater runoff capture and management into a $10- to $20-billion capital improvement program. The capital improvements will be part of the city's ongoing efforts to expand local water supplies by more than 200,000 acre feet per year through recycled water, groundwater recharge, and stormwater (both dry and wet weather) capture and use.

Once complete, this collaborative plan will both chart the course for managing the city's future water needs for the next 25 years and answer Mayor Garcetti's call to make the city's water supply more resistant to the effects of drought and climate change.

Ultimately, the city hopes to be able to use the river not only as an ecological asset, but as a way to store water for either groundwater replenishment or an alternative to potable water for irrigation.

A Model Plan

Carollo Engineers is partnering with the city of Los Angeles in developing and implementing the One Water LA Plan — an effort that is forging new collaborative relationships across the city and driving the development of new tools and technologies to meet the city's project goals.

The actual One Water LA Plan began with a comprehensive, integrated water model that linked multiple water types and sources to create a water balance tool. This involved an innovative adaptation of Carollo's Blue Plan-it™ model, which was configured to account for all of the city's key water supply sources, including a dozen sewer sheds, four wastewater treatment plants, and hundreds of miles of storm drains and channels.

Once the Blue Plan-it modeling framework was in place, Carollo was able to help the city develop and evaluate multiple water supply scenarios against a series of specific criteria, including resiliency to climate change, distributed versus centralized infrastructure, and cost. In addition, the city was able to explore a number of sensitive scenarios to determine the overall robustness of potential solutions to various kinds of uncertainty. The results of these efforts will become detailed facility plans for the production and maximization of recycled water to augment local water supplies, the capture and infiltration of more than 100,000 acre feet per year of runoff to augment groundwater supplies, and the capture and targeted reuse of 85 percent of the stormwater traditionally lost to the ocean. Each of these plans will include triggers that establish clear guidelines for when the city proceeds with subsequent phases of facility construction.

"We reached some interesting conclusions during our modeling efforts," notes Gil Crozes, Carollo's One Water LA project director. "We determined that while some of the water management solutions could come from adapting current treatment and monitoring technologies, some of the things the city wants to do in the future will require new and innovative technologies developed by the water industry itself."

One example of the need for new technologies is found in the city's oldest waterway, the Los Angeles River. From the earliest days of Los Angeles, the LA River was a key water source for the pueblo and early city residents. However, a series of severe floods in the early 20th century resulted in several flood control measures that transformed the once untamed river into a series of concrete channels.

With growing interest in the LA River as both a water source and recreational area, Carollo is leading the Los Angeles River Flow Study as part of the One Water LA Plan. The study's objective is to develop a consistent understanding of existing and future flows into the LA River and the water needs to meet the restoration objectives being completed by the U.S. Army Corps of Engineers. This will require new methods to monitor and evaluate the river's hydrological conditions and sensitive habitats, as well as new ways to maintain existing ecosystems. Ultimately, the city hopes to be able to use the river not only as an ecological asset, but as a way to store water for either groundwater replenishment or an alternative to potable water for irrigation.

Communication As A Key To Success

Naturally, with any large-scale effort involving multiple departments, regulatory agencies, and a host of stakeholders across the city, communication and outreach is critical to project success. To effectively manage stakeholder participation, the city used a three-level framework (Inform — Involve — Collaborate) to better articulate where stakeholder input was going to be most sought. In addition, the city used four different groups to provide input: one-on-one meetings, an advisory group, special topic groups, and the general stakeholder group. Using this layered approach, the city has been able to more quickly and more effectively get the input needed. With Carollo's support, the One Water LA program has held stakeholder outreach meetings and town hall events for more than 80 neighborhood councils, 15 council districts, and more than a dozen local, state, and federal agencies.

The results from the city of Los Angeles' One Water LA will be some of the most collaborative and forward-thinking water management planning in the country. One Water LA is demonstrating the ability of a major metropolitan city to come together, cooperate both internally and externally, and make the significant capital planning decisions needed to secure a reliable and sustainable water supply for both new residents and future generations. For Los Angeles, the overall result will be greater public and business confidence which, in turn, will help with raising the funding necessary to implement the One Water LA program. While the lessons learned in Los Angeles will translate to similar cities across the country, until that happens, the One Water LA Plan will set the standard for integrated approaches to water management across a vast range of residential, commercial, and environmental demands. ■

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Paul Flick is Carollo's corporate communications manager and has 22 years of experience in the civil and environmental engineering industry. He has been with Carollo since 2005.

Inge Wiersema, PE, is Carollo's project manager for the One Water LA 2040 Plan. She has more than 20 years of experience in water system planning and water resource development.

Integrating Innovative Technology Into The Public Water Sector: A Need For Equilibrium

If we are to realize the promise of innovation, implementation cannot be a risky proposition for water managers.

By Art Umble

The water industry needs no convincing that it plays a critical role in shaping how communities develop. Water that is plentiful, accessible, and available at a usable quality is at the core of stable public health as well as the production of goods and services which build economies that form the social and cultural fabrics of a society. Water is, therefore, the resource of life.

Preserving water as a resource requires continual innovation in the means and methods necessary to maintain its quality to at least the minimum standard essential to sustain public health and keep economies growing. Innovation is required to expand water supplies, to collect used water and treat it to acceptable quality standards, and to recover it for reuse. Clearly, many innovations in water treatment for potable uses have resulted in significant positive advances in public health over the past century. Our challenge now lies in promoting new innovations in the treatment and reuse of used water, thereby closing the loop in the water cycle. This will result in further enhancements to the environment and a long-term platform for business and industry to sustain economies. The question is, what exactly is innovation, and how can we better apply its value to the treatment of used water and water reuse?

Many have provided definitions for innovation, but there is a wide range of perceptions across the water industry in terms of the role that innovation plays. As a result, many remain unconvinced that innovation must be a crucial component of water management strategy for sustainable communities. By definition, innovation is a systematic process that translates an idea into a good or service to meet an existing or new need, *and* creates a value for that good or service. The value piece can take on a variety of forms — for instance, improved cost- or time-effectiveness, improved safety for the end user, increases in a customer base, etc. The key is that the value has to show up as an increase to the economic bottom line for the entities implementing the innovation.[1]

To date, the water industry, which serves the public interest, has placed primary responsibility for innovation on the shoulders of the technology developers and providers and has expected them to navigate complicated pathways to integrate their innovation into the public water market spaces. Furthermore, the water industry has set high expectations for innovative technologies, requiring innovations to be “disruptive” — that is, providing a standard of operation that shifts the needle of performance by as much as 30 percent or more over conventional technology.[2] Are expectations such as these hindering the adoption of new, innovative technologies within the water industry? If so, perhaps a more balanced expectation between the public water sector and the technology developer/provider, i.e., an equilibrium of sorts, is in order.

The public water sector has traditionally been a risk-averse industry, and for good reason. Protecting public health and environment are responsibilities that cannot be compromised. Adopting new, innovative technologies must therefore be viewed with great care and scrutiny. But there are elements in the innovation process that the public sector should consider which could bring more equilibrium to the responsible parties in adopting innovative technology. Such could result in greater benefit to both the public end user and the technology provider.

First, traditional methods of delivering technology solutions to the public water sector have been that the technology developer/provider, and all others in the supply chain for that delivery, must assume all risk associated with the solution. If the solution is a success, the end users (the public) receive all the benefits/rewards generated from that solution. Conversely, the developer (and the supply chain) are shackled with all the consequences if the solution fails. This tradition is a significant disincentive to the technology developer/provider, and the result is technologies possessing potentially great benefit rarely reach adoption. Therefore, the public water sector would be prudent to rethink how contracting for new technology products and services is done. There need to be contractual mechanisms in place that no longer push all the risk up the supply chain, but instead provide means to share the risks and the rewards. [3]

Secondly, the public water sector and the technology provider must invite the regulatory community to a partnership table. Too often, implementation of innovative technology is discouraged because few mechanisms are in place for regulators to permit a technology process. Additionally, regulations are often faulted for being so prescriptive that they stifle innovation advancement and adoption. One way to overcome this is for competing technology providers to first partner with each other and then with the regulator and owner. Though it is provocative, and perhaps controversial, precedents for this approach exist. For example, in the aerospace industry, which is one of the most heavily regulated industries today, it is not uncommon for competing companies to work together on facets of technology developments because they all recognize that the public's confidence can never be jeopardized.[4]

These partnered competitors then work alongside regulators and their potential customers to shape the regulations to be consistent with the technologies they need to integrate, showing that though standards need a degree of deviation, there is no compromise of public safety or increased risk. In other words, it's in *all* their best interests to cooperate.

Finally, the public water industry must recognize that moving an innovation from invention, development, and pilot/demonstration testing into outright adoption requires various skillsets. Often, innovative ideas are conceived in academic laboratories where research and development skills are readily available and researchers are highly experienced in R&D objectives. The public water industry should not expect, then, that these same skillsets will be necessary for moving the innovation into the market. Rather, the skillsets necessary for adoption include focus on marketing, sales, business management, and socio-economic strategies. This is not to imply that the academic role is forever sidelined. Rather, it merely takes a diminished leadership role, but continues to provide the technical support necessary to ensure applications are appropriate and perform as intended.

Adopting innovative technology requires a balanced approach, an equilibrium of sorts, between the technology developer/provider and the public water sector. This equilibrium is critical to the adoption of new, innovative technology into the water sector market space. When risk is more equitably shared, when proactive, triangulated partnerships are established between technology providers, regulators, and owners, and when the appropriate skillsets are recognized and appreciated for their respective and specific roles in the innovation and adoption process, only then can the public water sector begin to envision the real value that innovation poses for the industry. Only then will the industry close the loop on the water cycle and realize the benefits of a "One Water" culture. ■

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About The Author

Art Umble is the wastewater practice leader for MWH Global, now part of Stantec. He provides technical analysis and support to design teams for new and rehabilitated municipal wastewater treatment/resource recovery facilities. Umble is a leader in initiatives promoting the integration of emerging technology with environmental stewardship. He serves as vice-chair of the Research Council for the Water Environment & Reuse Foundation, and advisor/reviewer for collaborative research projects at both WE&RF and the WateReuse Foundation. He is also a Fellow of the Water Environment Federation.

Possibilities For Reducing Aeration Through Carbon Diversion Technologies

Water resource recovery facilities (née wastewater treatment plants) move further toward the goal of net-zero energy with technologies that maximize carbon recovery while minimizing energy-sapping aeration.

By WE&RF staff

Process intensification is a standard term used in engineering that can be applied broadly. For instance, wastewater treatment intensification could be defined as any system that significantly outperforms conventional designs. New approaches are needed to intensify treatment of wastewater within existing infrastructure, because sustainable increases to wastewater treatment capacity and capability are necessary.

In 2015, a group of scientists, engineers, entrepreneurs, and other wastewater professionals gathered to accelerate, develop, demonstrate, and further implement innovative technologies to enhance recovery of water, nutrients, energy, heat, and other valuable products at water resource recovery facilities (WRRFs) at reduced costs. Over 30 new technology developers shared their innovations with nearly 150 leading experts and practitioners from utilities, consulting firms, universities, regulators, and other areas of the industry. Among the technologies examined was carbon diversion — using enhanced primary treatment, filtration, or high-rate systems to increase carbon resource recovery.

Recently, several carbon diversion technologies discussed during that gathering have been accepted to the Leaders Innovation Forum for Technology (LIFT) Technology Scan process. LIFT Technology Scans identify and evaluate innovative technologies to inform water facility owners, funders, advisors, and end users in order to promote early adoption of the technologies. They offer technology providers an optimal platform to introduce their emerging, precommercial, and newly commercialized technologies.

Diverting organics from the biological oxidation process, which demands large amounts of energy for aeration, and redirecting them to anaerobic digestion, where these organics can actually help produce energy, could significantly alter treatment facilities. In fact, studies in *A Guide to Net-Zero Energy Solutions for WRRFs (WE&RF ENER1C12)* indicate that carbon diversion using chemically enhanced primary treatment or A-stage processes could help plants achieve energy neutrality.

Diverting organics from the biological oxidation process, which demands large amounts of energy for aeration, and redirecting them to anaerobic digestion, where these organics can actually help produce energy, could significantly alter treatment facilities.

However, the specific impact of carbon-diversion technologies will depend on a number of factors, including a plant's configuration and its current level of energy efficiency — and because carbon is required for biological nutrient removal (BNR), there is also the lingering issue of meeting nutrient discharge limits. If mainstream shortcut nitrogen removal processes can be developed, the demand for carbon would decrease drastically, paving the way for carbon diversion to reach its full potential.

A recently completed Water Environment & Reuse Foundation research report, *State of Knowledge and Workshop Report: Intensification of Resource Recovery Forum (TIRR1R15),* summarizes a suite of carbon diversion technologies and their apparent technology readiness levels. In that report, the technologies are divided into three types: primary effluent filtration, biologically enhanced primary treatment, and anaerobic treatment alternatives.

Primary effluent filtration technologies under consideration include ones by Schreiber, BKT, Trojan Technologies, and ClearCove Systems. Schreiber has taken its Fuzzy Filter, a compressed media filtration technology that is well-established for use in tertiary treatment and wet weather management, and adapted it for use in primary effluent filtration. Full-scale

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Telog, A Trimble Company Ph: 585.742.3000 www.telog.com TelogSales@telog.com piloting and demonstrations are under way at the Dry Creek and Linda County treatment plants in California. Schreiber reports that primary filtration yields a 37 percent increase in digester gas production, a 25 percent decrease in blower power requirement, and a 34 percent increase in secondary process capacity. BKT's biofiltration system (BBF™), an upflow process system that has previously been used for wet weather treatment, is now being applied to primary filtration. The BBF unit uses expanded polypropylene as a floating media layer for filtration. A BBF pilot plant has been operating for primary and wet weather treatment for 12 months using a small coagulant dose to enhance filtration. Two full-scale BBF systems (320 MGD total) have been designed for wet weather treatment in Seoul, Korea. Trojan Technologies Salsnes Filter is a rotating belt filter that removes suspended solids and provides thickening and dewatering up to 30 percent dry weight. Trojan estimates that the filter requires 10 percent of the land of a primary clarifier and that existing clarifiers could be transformed into extra secondary tank capacity with the addition of the filter. The company offers a demonstration unit for site evaluation. ClearCove Systems' enhanced primary treatment (EPT) technology performs screening, grit removal, primary clarification, and equalization in one single step. This proprietary technology would completely replace headworks in order to divert nearly all organics to the digester. ClearCove's findings indicate that the EPT system yields three times more biogas than a thickened sludge sample and produces an energy savings of 52 percent for aeration. In order to meet carbon demands for BNR, ClearCove suggests that online control could divert effluent from EPT to secondary treatment. The New York State Energy Research and Development Authority (NYSERDA) conducted a technology demonstration project in Ithaca, NY.

The biologically enhanced primary treatment technologies reviewed thus far include A-stage processes, alternating activated adsorption and an Evoqua system. A-stage processes have been used since the 1970s. A high-rate activated sludge process using adsorption to maximize carbon capture (the A-stage) is followed by secondary treatment that can perform BNR (the B-stage). The A-stage uses an aeration tank with a high surface-loading rate, aeration for a short hydraulic retention time (~ 0.5 hr), and a sludge retention time of 0.1 to 0.5 day. The A/B process is compatible with nitrogen removal, especially if shortcut pathways are used, which have a lower carbon demand. Although the process was designed to reduce overall volume of treatment, today it is mainly used to improve the energy balance or increase plant capacity. There are more than 20 full-scale installations in Europe and a few in the United States. Alternating activated adsorption (AAA) is a new configuration of the A-stage process consisting of two alternating sequencing batch reactors that can be retrofitted into rectangular basins. The Captivator System® blends waste-activated sludge with incoming wastewater in an aerated contact tank prior to dissolved air flotation. This system uses biosorption to capture soluble biochemical oxygen demand not captured in primary treatment, along with particulate biochemical oxygen demand. Evoqua claims the system reduces aeration energy requirements by 40 percent while increasing biogas production by 40 percent and has a footprint that is one-fifth that of conventional primary treatment. A 32-MGD installation has been operating since 2013 in Pima County, AZ. An example from Philadelphia was also presented in which two out of five existing primary clarifiers would be transformed to the Captivator, and the remaining three would be converted to secondary aeration to meet a pending nitrification requirement. A 300,000-GPD pilot plant is also available for on-site evaluations.

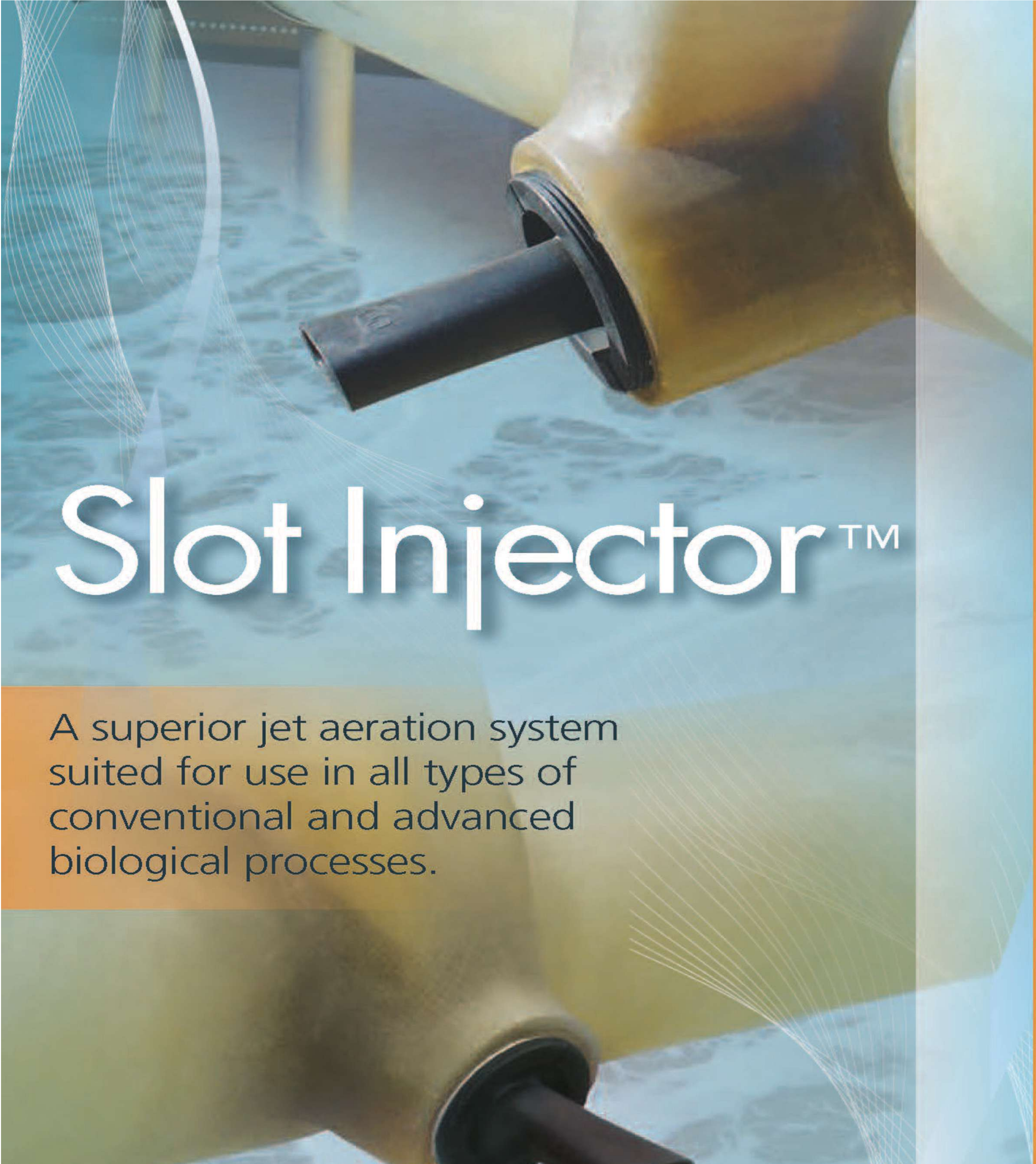
There is a growing interest in anaerobic treatment of domestic wastewater due to the potential to reduce energy demand and increase energy recovery. Anaerobic systems also have low overall sludge production, which can save capital and operational costs. Anaerobic treatment has been studied for more than four decades, and the upflow anaerobic sludge blanket (UASB) reactor is widely applied in South America. More recent interest is on the development of anaerobic membrane bioreactors. The major disadvantages of anaerobic treatment are the reduction of sulfur and production of H2S (a corrosive and odorous gas), the production of supersaturated dissolved methane (a potent greenhouse gas), and the presence of residual organics. Anaerobic treatment is also less efficient at low temperatures, which may limit application. If anaerobic treatment were realized, nutrient removal would be integrated as a downstream treatment process. Traditional BNR is challenging with anaerobic effluents, and new denitrification processes are being developed that use H2S and methane as reducing equivalents (in lieu of carbon). Nitrite shunt and deammonification are also promising processes when used downstream of anaerobic mainstream treatment.

If anaerobic treatment were realized, nutrient removal would be integrated as a downstream treatment process.

While there are technologies that show promise for energy savings, there still is a need for additional research into the full potential of carbon diversion technologies that would have the most benefit to WRRFs. WE&RF's research will advance our knowledge and promote early adoption of technologies. For more information on carbon diversion technologies accepted by LIFT, visit the WE&RF website for available research reports at www.werf.org. ■

About The Author

The Water Environment & Reuse Foundation (WE&RF) is a 501(c)(3) charitable corporation seeking to identify, support, and disseminate research that enhances the quality and reliability of water for natural systems and communities with an integrated approach to resource recovery and reuse, while facilitating interaction among practitioners, educators, researchers, decision makers, and the public.



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Innovations Bring Southern Delivery System Online On Time And Under Budget

Colorado Springs Utilities creates the modern-day blueprint for pipeline project delivery with the timely completion of the historic Southern Delivery System.

By John Fredell

In an era when many water projects are stalled in the permitting phase, water utility managers can learn from Colorado Springs Utilities (CSU), which in 2016 completed one of the largest recent water projects in the West both on time and $160 million under budget.

Getting the $825 million Southern Delivery System (SDS) water project to the finish line this year required a management philosophy that embraced innovation every step of the way. From value engineering to strategic procurement, concurrent permitting to proactive stakeholder engagement, the SDS team was creative and aggressive in keeping the project moving forward.

SDS is a regional project now serving four southern Colorado communities: Colorado Springs, the state's second largest city, and the neighboring communities of Fountain, Security, and Pueblo West. Operating since April 2016, the project can deliver up to 50 MGD, piping water 50 miles uphill from Pueblo Reservoir.

The components of SDS include a new connection to Pueblo Reservoir, 50 miles of mostly 66"-diameter pipe, three raw-water pump stations, a water treatment plant, and a finished water pump station. In a future second phase, the project can be expanded, when demand for water increases, and calls for building two reservoirs and expanding the capacity of the raw-water pump stations and the water treatment plant to deliver more than 100 MGD.

While value engineering is not new to water infrastructure projects, few projects have embraced cradle-to-grave value engineering as thoroughly as SDS.

A Time-Sensitive Permitting Approach

Like most water infrastructure projects today, SDS required extensive permitting and approvals. For example, the Environmental Impact Statement (EIS), required under the National Environmental Policy Act (NEPA), took almost six years to complete. Additionally, hundreds of federal, state, and local permits were required before construction could begin. Remarkably, SDS was able to complete permitting and construction in 12 years.

That's because, rather than taking a linear approach to permitting, acquiring one before embarking on the next, the SDS management team adopted a concurrent permitting strategy. The process to obtain critical permits, such as a complex controversial local land use permit and a 404 permit required under the Clean Water Act, started while the EIS was being finalized and prior to the issuance of the Record of Decision (ROD). By managing permitting through a rolling, concurrent timeline, SDS was able to begin construction only a year after its ROD was issued.

A Blended Management Team

CSU recognized early on that the complexity and size of the SDS project warranted a unique delivery approach. MWH Global, Inc. was selected to provide significant program management support in a number of areas where CSU did not have in-house expertise. The team of public and private sector employees was integrated and co-located in CSU offices.

Hiring an outside firm to support project management allowed CSU to bring expertise on board for the duration of the project. The team melded MWH's globally experienced consultants, who had built very large infrastructure projects, with the CSU staff's knowledge of the project, political considerations, and the needs of the partner communities. Additionally, MWH had no financial stake in changes to design or construction, so the firm's engineers were empowered to link


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arms with their CSU counterparts to innovate to deliver best value projects, instead of hiring the entire team in-house and being forced to have layoffs at the completion of SDS.

A Unique Delivery Approach

CSU and MWH shared a common vision of achieving the best value for every portion of the project. To that end, they used the strategies of continuous value engineering, strategic procurement, and stakeholder outreach and engagement to succeed.

Construction components were divided at the onset of construction into more than 20 separate work packages to encourage local bidding and competitive pricing. With a project the size of SDS, only a handful of international companies could have completed the entire project, but project leadership committed to ensuring that at least 30 percent of the work went to local companies. Using local businesses facilitated competition and negotiation and ultimately cost savings. It also gave local communities a vested interest in seeing the project get funded and built.

SDS leadership then set high expectations and stringent budget requirements for each work package. Design engineers were assigned a "design-to" monetary value, wherein designs had to meet specific performance criteria at a price 10 to 20 percent lower than conceptual design estimates. Value engineering ideas were then evaluated and documented at 30 percent, 60 percent, and 90 percent of design. If the contract involved competitive bidding and bids came in far below initial budgets, project managers deposited the difference in a management reserve account and expected the project to be built at the best-value bid plus 5 percent. If change requests came in over a limit, project managers had to justify the change before a committee that included the top managers. As a result, the program achieved a very low cumulative change order rate of 3.2 percent based on final construction.

Inside the new Edward W. Bailey Water Treatment Plant

Continuous Value Engineering

While value engineering is not new to water infrastructure projects, few projects have embraced cradle-to-grave value engineering as thoroughly as SDS. The team adopted a philosophy that "these are ratepayer dollars" and, therefore, examined every work package to carve out cost savings for customers. The project was launched by a value engineering workshop that included a multidisciplinary team that debated everything from the number of pump stations to the layout of the water treatment plant. Prior to the groundbreaking, the team reduced the cost of the project by $50 million. As SDS progressed, dozens of other money-saving innovations were identified. The most significant cost savings resulted from value engineering strategies used in planning and building the water treatment plant and raw-water pump stations.

The SDS water treatment plant carried the highest price tag of any project component, with an original cost estimate of approximately $190 million. Early in planning the water treatment plant, the plant's operators were consulted on the design. The team expressed concerns about the size and layout of the campus, citing multiple buildings as costly to construct and operate. These concerns were taken into account in later iterations of the design, reducing the number of buildings and the plant's overall footprint.

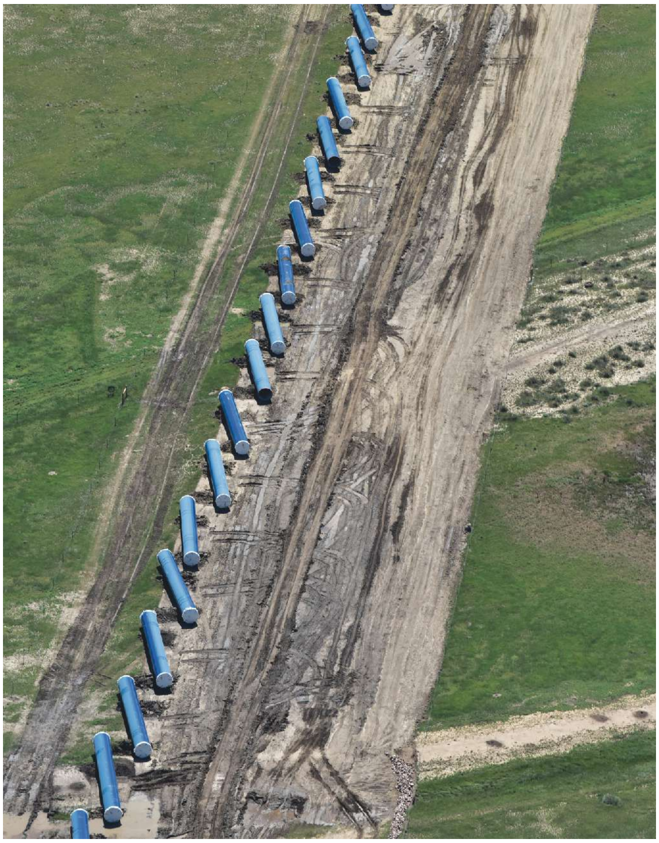
Value engineering was also integrated into the water treatment plant procurement process. Contractors bidding on the work were directed to include comprehensive value engineering concepts within their technical proposals. As a result of further creative ideas generated during this process, the construction costs for the water treatment plant were reduced, and the project was completed at $124.6 million, a 34 percent savings from the initial estimates. The cost savings never came at the expense of water quality or capacity, which met requirements throughout the duration of project construction.

The SDS management team used a similar approach in building the three raw-water pump stations. Changing from horizontal to vertical pumps allowed for shrinking the physical footprint of the pump stations and, in combination with other progressive ideas, reduced the estimated costs by $24 million.

When it came time to procure the pumps themselves, the SDS team wanted machines that struck the best balance between capital costs and life-cycle operating costs. Manufacturers were requested to estimate operating costs given the SDS project conditions for 30 years, and their estimates, as well as projected electricity costs, helped determine which pumps provided the best value. In addition, the selected pump manufacturer had to meet or exceed efficiency projections or face a dollar reduction in their contract. Interestingly, all pumps exceeded those benchmarks.

Strategic Stakeholder Engagement

In addition to advancing value engineering to a whole new level, SDS gave stakeholder engagement as high a priority as the technical, legal, and permitting aspects of the project.



Miles of large pipe set for installation

Opposition and negative public relations issues can create costly construction delays and derail the project's goal of an on-time, under-budget delivery. While many project managers believe they make stakeholder relations a priority, rarely do they give this function the strategic importance it deserves.

Before the first shovel of dirt was turned, the SDS communications team spent significant time educating the public on why the project was needed, how local communities would benefit, and how impacts would be mitigated. The communications team branded the project with the tagline "Water for Generations" and gave it a unique logo and project-specific website, which emphasized the benefit customers would derive from the project now and into the future. The website also provided detailed financial information, which included a monthly report that tracked spending against the approved budget.

When it came to crossing private lands, the team conducted considerable outreach to affected property owners to ensure they were listened to and informed. While several SDS permits dictated requirements about communications and outreach, project leadership committed to going above and beyond requirements to better inform nearby stakeholders. The pipeline crossed more than 270 parcels, which included homes, ranches, and government-owned land.

An innovative public involvement approach was tailored to meet the needs of individual property and business owners. Two property owner liaisons worked closely with residents and business owners and were available 24/7 to discuss and resolve concerns in a timely manner. House visits and a staffed hotline gave residents access to a project team member around the clock.

To keep people apprised of every step of this part of SDS construction, letters and door hangers were used to notify all affected neighbors living within 1,000 feet of construction about upcoming activities. Established construction update pages on the website, e-newsletters, fliers, printed newsletters, and other communications tools were used to inform businesses, schools, and homeowners of construction activities.

Through this proactive approach, successful relationships were built and maintained with business and property owners, even in neighborhoods that were heavily impacted by construction. SDS avoided any delays in construction due to public complaints or organized opposition.

Innovations at each stage of the SDS process led this critical project to completion, and the timing could not have been better. Just months prior to completion, project partner Pueblo West encountered a break in the single pipe that delivered water to its 11,000 households and businesses. SDS was able to deliver water early to the community, for the second time, and avert a water emergency. Then, within months after SDS went online, partners Security Water District and the City of Fountain had to eliminate their use of well water due to exceedances to an Environmental Protection Agency Health Advisory for perfluorinated chemicals (PFCs). With SDS infrastructure in place and the ability to transport more surface water, these water providers were able to deliver clean water to their communities. SDS has already proven its worth in less than six months of operation.

Very few infrastructure projects come in on time and under budget. SDS did both. SDS puts Colorado Springs and its partner communities in a strong position to support population growth and prepare for drought and improves their systems' reliability. While SDS faced its share of challenges, the project has been a very good return on investment and a resounding success. ■

About The Author

John Fredell has served as the program director for the Southern Delivery System (SDS) since September 2007. In that role, he is responsible for planning, permitting, and construction of the SDS, a major water delivery system that will bring water from the Arkansas River to Colorado Springs and its project partners. John has been with Colorado Springs Utilities since 1993 and has been closely involved with SDS development since 2002. He holds a Bachelor of Science degree in finance from Oklahoma State University with a minor in economics, as well as a Juris Doctorate from the University of Oklahoma.

Hexavalent Chromium Treatment Using Strong Base Anion Exchange With An Innovation In Brine Management

Researchers examine the feasibility of treating hexavalent chromium – the carcinogen made famous by the movie "Erin Brockovich" – with strong base anion exchange (SBA-IX).

By Mary Smith, Chad Seidel, Craig Gorman, and Taj Dufour

On July 1, 2014, many California utilities faced a new reality as the Department of Drinking Water (DDW) of the California State Water Resources Control Board adopted the nation's first hexavalent chromium (Cr[VI]) maximum contaminant level (MCL) for drinking water.

After initial monitoring, an MCL of 10 micrograms per liter (µg/L) of Cr(VI) triggers implementation of quarterly compliance monitoring at individual water sources or entry points to the distribution system after treatment. Compliance with the MCL is determined by a running annual average of quarterly samples. The new rule does not include a compliance implementation schedule and was technically enforceable as soon as the MCL was finalized. California's existing 50 µg/L total chromium MCL is to remain in effect unchanged.

With five critical groundwater sources having Cr(VI) concentrations between 7 and 40 µg/L that would potentially be impacted by the new MCL, the Soquel Creek Water District (hereafter, District) proactively conducted a 2011 paper-based study considering technologies that might be best suited for Cr(VI) treatment at their wells. The screening process identified SBA-IX, potentially with spent brine minimization and handling. Two key factors that drove the process toward selecting SBA-IX were (1) the availability of nonhazardous regenerant brine discharge to the local sewer and (2) the high alkalinity of the groundwater. The availability of the sewer offered the potential of lower-cost disposal; however, high alkalinity could result in significant operational costs if a treatment technology requiring pH adjustment, such as weak base anion exchange, were selected.

Through the Water Research Foundation's (WRF's) Tailored Collaboration funding program, the District initiated WRF project #4488, *Hexavalent Chromium Treatment with Strong Base Anion Exchange*, to demonstrate the Cr(VI) removal performance of SBA-IX treatment through bench- and pilot-scale testing. In addition to characterizing Cr(VI) removal performance, the project also considered waste minimization strategies for SBA-IX brine residuals. The pilot testing protocol was developed to support full-scale treatment design and answer key operational questions that can impact capital and life-cycle costs.

Soquel Creek Research Approach

For the SBA-IX testing, the primary goals were to compare and validate commercially available SBA-IX resin performance for Cr(VI) exchange capacity, regeneration quality, and frequency requirements. As with any SBA-IX application, the ability to manage the regenerant brine was a critical operational parameter. Bench- and pilot-scale testing investigated innovative brine management techniques including brine reuse and treatment methods to render the spent regenerant brine waste nonhazardous. The techniques investigated included treatment of the spent brine to remove Cr(VI) and other co-contaminants using single-use weak base anion exchange (WBA-IX) resin, chemical reductive media (CRM), and reduction/coagulation/precipitation with ferrous sulfate to sequester the Cr(VI).

To achieve the District's research objectives, SBA-IX testing was conducted at bench scale, followed by on-site pilot-scale testing at the District's San Andreas well site. Objectives for each testing phase are shown in Table 1.

Table 1. Bench-Scale and Pilot-Scale Objectives

Bench-Scale Objectives	Pilot-Scale Objectives
Determine optimal empty bed contact time (EBCT) to conduct subsequent experiments	Demonstrate how bench-scale results could be replicated at pilot scale
Screen SBA-IX resins to identify the best performing resin	Determine the feasibility of reusing the sodium chloride regenerant brine
Demonstrate SBA-IX treatment performance through multiple loading and regeneration cycles	Generate sufficient brine to conduct treatment investigations at bench scale

Strong Base Anion Exchange (SBA-IX) Overview

Strong base anion exchange is a process that involves the exchange of ions from one phase to another. It has been implemented by drinking water utilities with nitrate, arsenic, and other groundwater contaminants and, as such, has been researched extensively. During water treatment, negatively charged anions in the liquid or water phase are transferred to the solid phase of the resin by replacing anions, typically chloride, from the resin matrix. The SBA-IX process is shown schematically in Figure 1.

Raw water containing Cr(VI) is pretreated as required. Pretreatment typically includes prefiltration to protect the resin bed from particulate fouling. Since the functional groups of SBA-IX resins remain ionized over a wide pH range, there is not typically a

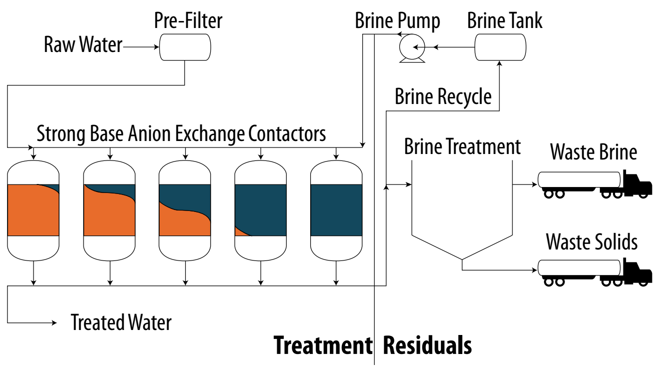


Figure 1. SBA-IX process schematic

requirement for pH depression for operation (Clifford 1990). Once pretreated, the water passes through pressure vessels containing SBA-IX resin where the Cr(VI) and other anions are exchanged for chloride. Following the ion exchange step, the treated water is typically disinfected, and if needed, pH adjustment and/or other stabilization may be performed prior to sending the water to the distribution system.

When the exchange sites are filled with contaminants, the resin is said to be exhausted and requires regeneration (Brandhuber et al. 2004). Regeneration is accomplished by using a 1.5 to 12 percent sodium chloride (NaCl) solution to impart a concentration gradient to replace the contaminant anions on the resin with chloride. Multiple bed volumes (BVs) of the regenerant are typically used to restore the exchange capacity (Siegel and Clifford 1988).

Brine Management

Management of brine often limits the applicability SBA-IX for drinking water treatment. Brine management options typically include the following:

- Discharge to a sewer or septic system
- Waste volume reduction using drying beds
- Trucking to an off-site approved disposal location
- Ocean discharge through a coastal pipeline
- Deep well injection
- Advanced treatment and disposal

Waste brine quantity and quality characteristics (e.g., salinity, metals, and radionuclides) and geographical location can affect the feasibility and costs of these disposal options. Proximity and access to offshore disposal options, such as a brine line to the ocean, can also be significant factors in determining the burden of brine disposal. Without the ability to dispose of the brine in municipal sewers or via a brine line, the regenerant brine requires off-site disposal. This can be complicated, as it is likely to be designated as hazardous waste due to elevated concentrations of hexavalent chromium and other co-occurring contaminants.

Alternatively, the regenerant brine can be treated to remove the Cr(VI) rendering it nonhazardous. Siegel and Clifford (1988) conducted bench-scale experiments with different reductants to evaluate their ability to reduce Cr(VI) to Cr(III) and determine the optimal conditions for precipitation of $Cr(OH)_{3(s)}$. The results showed that acidic sulfite, ferrous sulfate, and hydrazine are all capable of reducing Cr(VI) to Cr(III); however, ferrous sulfate was the only reductant that did not require pH adjustment for the reduction reaction to proceed and did not require additional chemical feed to achieve precipitation. In laboratory studies, Cr(VI) recovery with sodium chloride regenerations of SBA-IX was always demonstrated to be less than 100 percent, which was attributed to Cr(VI) reduction to trivalent chromium with subsequent precipitation of a greenish solid (chromium hydroxide) (Clifford 1990).

Regenerant brine optimization has also been investigated for Cr(VI) treatment during pilot-scale testing conducted in Glendale, CA (McGuire et al. 2006). In that case, a regenerant brine with a sodium chloride concentration of 6 percent was found to be insufficient to fully regenerate SBA-IX, and the BV to breakthrough during treatment declined from 1,900 BVs with fresh regenerant to less than 500 BVs after the first recycle pass. Further treatment capacity reduction after subsequent regeneration cycles was also noted. Increasing the sodium chloride concentration from 12 to 26 percent improved performance; however, the Cr(VI) exchange capacity continued to diminish after subsequent cycles. In this instance, the diminished capacity was attributed to sulfate accumulation in the brine.

Soquel Creek Research Results

Research conducted with the Soquel Creek Water District's San Andreas well proved that SBA-IX can be effective for Cr(VI) treatment. At bench scale, commercially available SBA-IX resins were able to achieve 15,000 to 30,000 BVs of treatment prior to an 8 µg/L treatment threshold. SBA-IX operating in this fashion is extremely efficient (greater than 99.97 percent water-efficient), especially when compared to its use for nitrate removal where resins are typically regenerated after only 500 to 1,500 BVs. While some diminished capacity was observed, performance generally appeared to stabilize after the initial loading cycles. Regeneration of the resins at bench scale showed that the Cr(VI) could be recovered from the resin with mass balances showing 76 to 106 percent recovery of the Cr(VI), with the variability likely due to sampling and analytical limitations.

At pilot scale, the exceptional loading capacity of the initial loading cycle was replicated, but without the subsequent diminished capacity experienced at bench scale. This reduced capacity observed at bench scale may be the result of irreversible fouling of the resin that occurred when the feedwater became contaminated with organic material. Regardless, there was no discernible performance decrease of the SBA-IX resin after five loading and regeneration cycles.

The feasibility of direct brine reuse was also proven at pilot scale. Regenerant brine was used eight times consecutively at pilot scale with each of the reuses yielding loading cycles of at least 15,000 BVs prior to 8 µg/L Cr(VI) breakthrough. A caveat to this is that there is extended leakage of total chromium, which is illustrated in

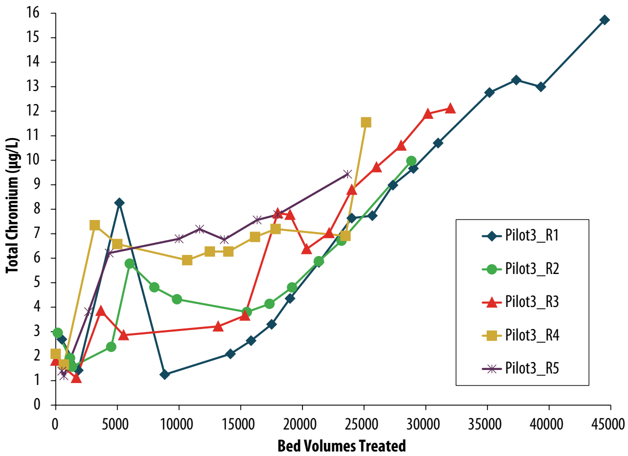


Figure 2. Total chromium results of Column 3 after five passes (regenerated with recycled brine after R2) at pilot scale

Figure 2 by the rise in the "floor" of the breakthrough curve. While not explicitly clear from the data, it is speculated that this rise results from an accumulation of co-contaminants in the brine. The pilot-scale testing also effectively generated sufficient volumes of brine for subsequent bench-scale brine treatment testing.

While SBA-IX is incredibly efficient for Cr(VI) removal when compared to other contaminants (e.g., nitrate and arsenic), the biggest challenge and operational cost of the process remains management and disposal of resulting regenerant waste brine. All of the brine generated at pilot scale would be designated a hazardous waste based on the total chromium concentration (> 5 mg/L). Traditional regeneration approaches typically use three to five bed volumes of an approximately 12 percent sodium chloride solution to regenerate the SBA-IX resin. Removing the chromium and other hazardous constituents from the brine increases disposal opportunities and lowers the associated cost of brine disposal. Three technologies were evaluated as means to treat the chromium-laden brine: reduction/coagulation/precipitation with ferrous sulfate, WBA-IX, and CRM. While each technology is capable of removing chromium below the hazardous threshold, reduction/coagulation/precipitation with ferrous sulfate appears to be most promising. If a utility does not want to manage the chemical feed systems required for reduction/coagulation/precipitation, a flow-through column-based approach with CRM may be feasible.

Conclusions

The ability to effectively manage brine production and disposal is crucial for the long-term viability of SBA-IX treatment. The results from this project suggest that direct brine reuse is feasible and that Cr(VI) can effectively be removed from the brine solution by either reduction/coagulation/precipitation or CRM. While optimizing the regeneration process was not fully investigated in this project, simple strategies such as decreasing and optimizing the brine strength and volume could provide significant operational cost savings and should be further investigated. More complex strategies, such as segregated regeneration, where the highly concentrated portions of the regenerant are removed from the bulk solution prior to reuse, offer the possibility of significantly reducing the volume of brine requiring disposal.

The project findings confirmed SBA-IX as the best available treatment technology for the District, and the success of the regeneration studies prompted the District to construct the first SBA-IX system specifically for potable Cr(VI) treatment in California. This 1,000-gpm IonexSG system is being used as a stopgap treatment measure while the District completes the design and construction of permanent treatment facilities, which are anticipated to be operational in 2018. Utilizing this process has the potential to reduce the overall volume of brine for disposal by nearly an order of magnitude, thus reducing the overall cost of the SBA-IX Cr(VI) treatment. ■

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About The Author

Mary Smith is a research manager at the Water Research Foundation and has 14 years' experience in the drinking water industry, working primarily in distribution systems, emergency planning, and hexavalent chromium removal. She holds an MS in Environmental Science and Engineering from the Colorado School of Mines.

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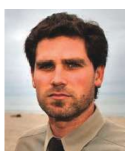
Craig Gorman, PE, Corona Environmental Consulting, has more than 11 years of experience leading treatment technology selections; bench-, pilot-, and full-scale evaluations; and cost-estimating and design efforts for inorganic contaminants. He holds an MS in Civil Engineering (University of Colorado at Boulder) and a BS in Environmental Science (State University of New York at Plattsburgh).



Taj Dufour, PE, is the engineering manager/chief engineer for the Soquel Creek Water District. He holds a BS in Mechanical Engineering from Cal Poly in San Luis Obispo and a grade D-4 Water Distribution Certificate and a grade T-3 Water Treatment Certificate issued by the California Department of Public Health.

Driving Your Digital Road Map To The Future

KC Water transforms otherwise ‘useless’ zeros and ones – i.e., raw data – into invaluable intelligence for improved utility operations.

By Jennifer Rusch

It’s the same old story: Water and wastewater utility leaders are presented with incredible challenges. Aged and crumbling infrastructures, along with heightened regulations, are creating capital needs that far exceed available revenues, and mounting utility rates are generating fatigue and frustration in ratepayers. Leaders are caught in a constant balance between the need to address existing issues and the responsibility for planning for the future. Terms such as “smart infrastructure” and “data management” are floating around like solids in a clarifier.

The mortgage and the dream vacation aside, how does a modern utility manager resist the urge to walk — no, run — away from it all? The answer may be simpler than you realize.

“I am in the business of legacy building,” states KC Water’s chief engineering officer, Andy Shively. “We are the stewards of the people and gatekeepers for tomorrow’s generation. People are our most precious resource.”

Leaders are caught in a constant balance between the need to address existing issues and the responsibility for planning for the future.

Shively’s approach has been referred to as the “people paradigm shift” — and it’s the catalyst that drives the application of massive amounts of data in Kansas City, MO. KC Water has collected more than 30 terabytes of data, and the department is adding over 200 additional gigabytes each month.

Data Management

With this quantity of records, it is not a surprise that many utility directors across the nation are now including the management of data as part of the capital improvements planning process. Technology companies, such as Microsoft and Esri, are rising to meet this need by providing suites of application products or “apps” specifically designed to help water and wastewater utilities collect, analyze, and share data. Industry organizations such as the National Association of Clean Water Agencies (NACWA) and the National Association of Sewer Services (NASSCO) have also responded to this trend by releasing standards by which that data should be collected, formatted, and coded.

“The water and wastewater industry is experiencing an incredible shift in the use of information and maps,” states Mark Robbins of Esri’s Global Water Practice. “Four years ago, utilities were primarily focused on mapping their assets and tracking some information on leaks and breaks. Now, utilities are collecting and analyzing even more information as they respond to ratepayer pressure for greater transparency in proving the value of their work.”

Data management may be a hot, new topic, but Shively believes that data management is not a new practice. “Simply put, data is information. Our forefathers used information, or what we now call data, to make important decisions about our nation’s infrastructure.”

Shively further states that the smart use of data has a multigenerational effect. Like a time capsule, our nation’s aging water and sewer lines contain a deep history of information laid by the stewards who managed the infrastructure generations before. This data is the key to unlocking answers to today’s increasing number of challenges.

The People Principle

This brings us back to what Shively says is our most important resource: people.

“Data alone is a useless collection of zeros and ones. Our infrastructure is literally a digital road map to the future, but we need drivers to find solutions,” states Shively. ”To function, data requires the element of people — those who are willing to apply critical thinking to our collective history of infrastructure and connect data with real solutions that impact future generations.”

Kansas City is on a mission to become the most connected

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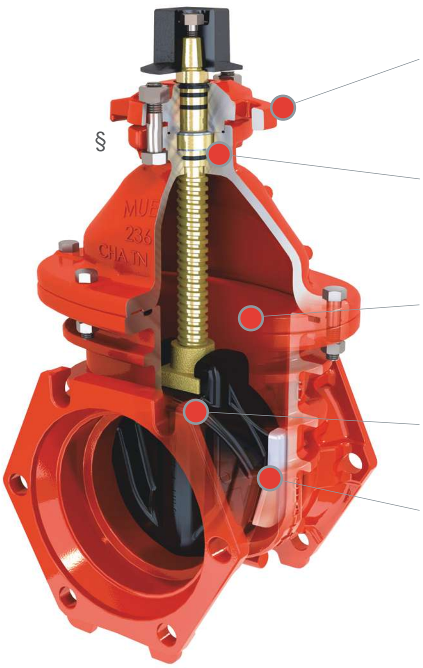

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Smart City in the world, and Shively serves as part of the city's Smart City Advisory Board, representing the caretakers who are helping to build the smartest city on the planet — from the ground up.

Working The Numbers

In Kansas City, Shively and his team examine all possible impacts to determine the reasons for systems failures and to make smart decisions about future investments. The first step for the team is to collect information, or data, about all aspects of the city's water, wastewater, and stormwater system. This data includes the pipes' dates of installation, diameters, and break histories. Shively's team then adds people to the equation by rating the consequences of failure each pipe segment will have for the residents of the city. Through this approach, Shively has helped find multiple solutions that have proven to increase service reliability, reduce expenditures, and create smart plans to address the city's specific infrastructure needs.

By analyzing more than a century of data, Shively discovered that certain water main segments carried higher likelihoods of failure — those segments included pipe 6" and smaller, pipe installed from the 1940s through the 1960s, and segments with histories of multiple failures. This data was used to strategically and proactively replace the city's most critical and break-prone water mains. This 100-year plan has already reduced water main breaks from 1,839 in 2011 to only 746 in 2015.

The city's private inflow and infiltration program, considered to be among the largest in the nation, also makes smart use of system data and feedback from residents. The program, called Keep Out the Rain, was developed using a combination of data collected through smoke testing, dyed-water testing, and closed-circuit television (CCTV) work. The data pointed Shively's team to the areas of the city most impacted by inflow and infiltration issues. Keep Out the Rain teams are now targeting those areas to perform free sewer connection evaluations and provide free plumbing repairs that will reduce the amount of stormwater entering the system. Data helps customers find out if they are within the work areas simply by entering their addresses online. On-site evaluation teams are able to access data in real time to immediately calculate whether or not repairs are cost-effective for the city; and outreach teams use real-time data entry from the evaluators to catalog customer feedback and adjust communication efforts, which encourage participation in the program.

In 2012, Shively worked closely with the city's information technology team and with Esri developers to create a solution to the city's annual hydrant inspection process. The team customized an "off-the-shelf" Esri application to eliminate a paper process that was resulting in delayed repairs to hydrants. Inspection teams can now locate hydrants using a GIS and instantly upload inspection reports and pictures of hydrant defects. Work orders to repair damaged hydrants are automatically generated. This process has dropped the percentage of out-of-service hydrants from 4 percent in 2011 to a consistent less than 1 percent out-of-service number since 2013.

CCTV camera data is an important part of Kansas City's sewer rehabilitation program.

In 2016 Shively and his team completed a 100-year plan for strategic sewer main rehabilitation based on information provided through CCTV video data, NASSCO coding, and pipe maintenance history. The team is also launching a data-driven water main repair application which helps inspectors triage break situations in the field and quickly and accurately locate the correct valves to shut.

In Kansas City, data is a key element in providing responsive and reliable service to customers, and it supports the framework for the city's 100-year water and sewer infrastructure investment plans. Still, the equation is not complete without industry leaders, such as Shively, to find and implement solutions that will have multigenerational effects.

"Everyone has been to the school of hard knocks, but unfortunately there is no alumni association," remarks Shively. "We each have a responsibility to share successes and learn from failures so that we can all build a legacy for the next generation."

Building A Better Future

This year, Shively initiated a national challenge to city leaders and utility contractors encouraging them to be proactive in finding the strategic and data-driven solutions necessary to relieve future generations of the crisis of infrastructure funding gaps that cities face today. Kansas City's billion-dollar smart infrastructure challenge includes the use of data management to find and implement these solutions.

More information about Kansas City's smart city approach can be found at kcmo.gov. ■

About The Author

Jennifer Rusch is a strategic marketing professional at Burns & McDonnell, specializing in communicating complex infrastructure programs in relatable and understandable ways. She lives and works in Kansas City, MO.

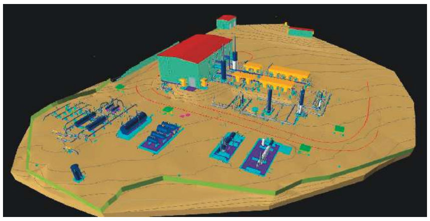
Drones: How They Can Change Your Water Operations

An eye in the sky offers a new dataset for treatment plant and pipeline infrastructure planning and decision making.

By John Doughty

As water and wastewater operations continue to upgrade, expand, and improve maintenance procedures, the new kid on the technology block can help.

Drones, also known as unmanned aircraft systems, are usually outfitted with camera systems that can be used for aerial photogrammetry. Photogrammetry is a form of photography that ties to preset data points on the ground. The visuals taken by a drone then align with the data points, enabling creation of 3D images and interactive models.



3D scan created by surveyors from drone images

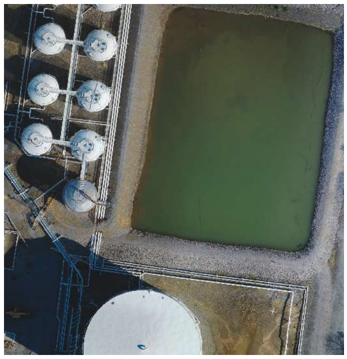
A photo taken from a drone of a wastewater processing facility and nearby stream

How can this help a waterline system operator, water or wastewater treatment plant, or pipeline installer?

The information collected from a drone can be used to create a comprehensive set of plans detailing a facility or underground utility system — if the utilities are in trenches and viewable from above. Over time, most water operations go through multiple stages of additions, add pipelines, or establish new phases of operations. Site information is contained in separate documents in multiple places, and perhaps only one or two of your staff who have worked with you for years know all of the ins and outs of your facility. A drone can collect thousands of photographs of existing facilities and utilities being installed or updated, and skilled surveyors and data managers can combine those images into an interactive, visual map for use in all future planning needs. Your information is then easily accessible, contained in one place, and as thorough as possible. The map includes precise measurements. The photos and informaton collected can also be turned into an Orthoprint or 3D model for engineers to use in helping design upgrades to facilities or operations.

Drones can also be used for inspections during the construction process. Rather than budgeting dollars for an inspector to walk the pipeline every few days, a drone can fly over regularly, taking photos to inspect construction progress and integrity. If an issue is found and needs to be reported, high-definition photos taken by the drone can be included in the report. In some cases, when there are disagreements between a project owner and a contractor, a drone can collect real-time information to review and pinpoint material amounts or other discrepancies.

If you're interested in collecting your facility or infrastructure information via drone, look for an experienced surveying firm to complete the work. RETTEW was granted an exemption by the Federal Aviation Administration to use a drone for commercial purposes, which is an important factor in selecting a surveying company. The firm is also insured for drone operations. Surveyors that are well-trained in aerial photogrammetry skills know how to place control points in the right places and can quantify and qualify the data collected. Expert surveyors also use national mapping standards, ensuring a final product trusted by water and wastewater operators.



Orthoprint from a drone flyover

Using a drone for data collection can help you with projects ranging from updating processes to designing additions, as well as building changes, maintenance, and demolition. The specific plans and measurements detailed with an easy-to-use visual software can make your life easier as your operations continue to evolve. ■

About The Author

John Doughty is vice president of land development and surveying at RETTEW. He has more than 35 years of experience as a survey director, senior project manager, and geospatial data coordinator. He oversees the day-to-day operations of his groups as they provide services such as topographic surveys, land development plans, and as-built surveys. Mr. Doughty specializes in developing environmentally sensitive land use projects and has been instrumental at keeping RETTEW at the forefront of survey technology, including remote sensing, terrestrial photogrammetry, and high-definition scanning.