

2018
Black & Veatch
Strategic Directions

WATER REPORT



About This Report

The Black & Veatch *2018 Strategic Directions: Water Report* addresses contemporary issues affecting water service providers around the globe. In light of climate change, resilience, regulatory and sustainability challenges, utilities are tackling regional issues with innovative water solutions.

Water is becoming a high-tech proposition. Data drives much of the discussion as increasingly powerful analytics give operators actionable information for optimizing systems, cutting costs and allowing them to do more with less, even as assets grow older. The battle against time remains top of mind for water utilities, who again this year named maintaining or expanding the life of their assets as their biggest sustainability issue.

Coastal living can have its benefits, but when hurricanes or tropical storms roll in and disrupt power, these oceanside havens can deliver unique water challenges for homeowners, businesses and water and wastewater utilities. This report examines those resilience issues and, along the way, dissects the still-underexploited opportunities in water and power management that could strengthen communities and drive sustainability efforts.

In addition, this year's report features analyses by leading industry experts, diving into the issue of rates and related funding matters, while addressing persistent worries about the world's ever-graying water infrastructure.

We welcome your questions and comments regarding this report and/or Black & Veatch services. You can reach us at [**MediaInfo@bv.com**](mailto:MediaInfo@bv.com).

Sincerely,

CINDY WALLIS-LAGE | President, Black & Veatch's water business

JOHN CHEVRETTE | President, Black & Veatch's management consulting business

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Executive Summary

MARRIAGE OF DATA AND WATER LAY THE FOUNDATION FOR TOMORROW'S SMARTER CITIES

By John Chevrette and David Mayers

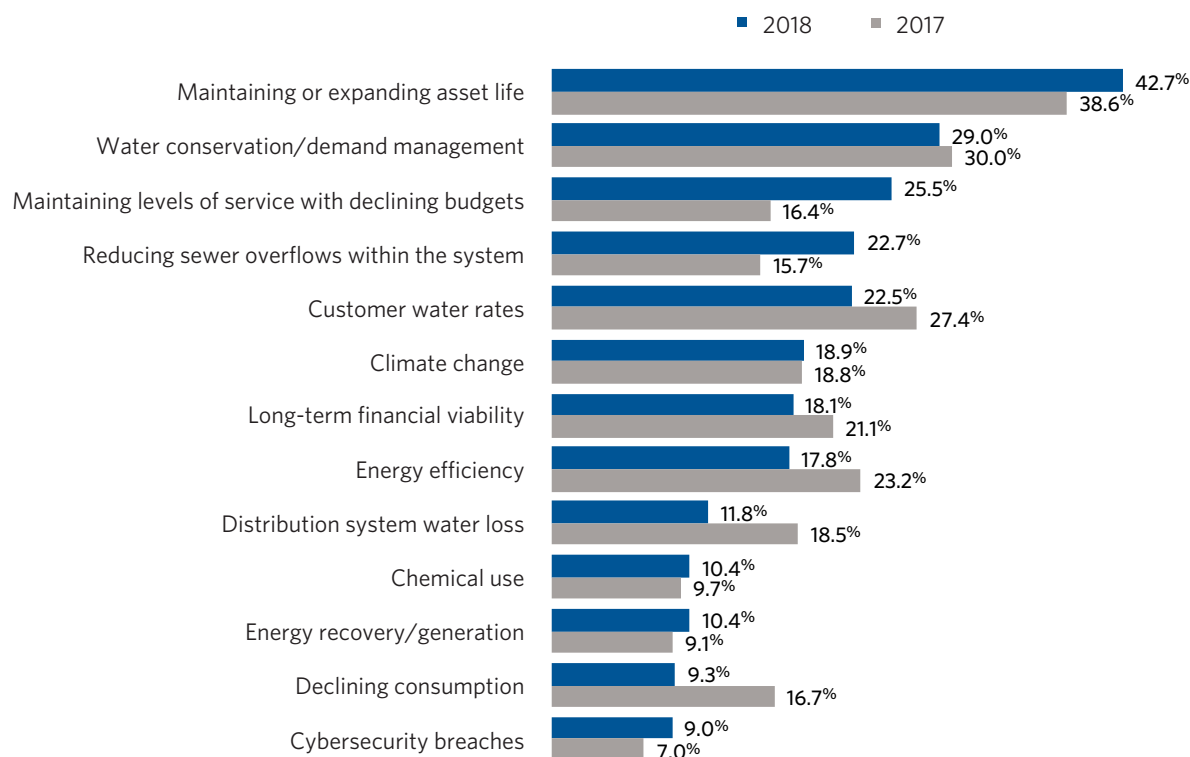
The water industry has reached a turning point. Utilities are finally recognizing the power in digitizing operations and increasing economies of scale to extend asset life and address legacy funding issues. As the industry focuses more on sustainability, value and innovation, a new water economy appears to be emerging: Utilities are embracing data and infrastructure in new ways to maximize efficiencies.

The reality conveyed throughout the *2018 Strategic Directions: Water Report* is that capital costs will continue to rise as infrastructure ages well beyond end-of-life expectations and regulatory uncertainty increases. Skepticism about a proposed federal infrastructure plan adds additional complexity to questions about who will pay for vital repairs and upgrades. Calls to prepare for climate change and build resilience against extreme weather events also are stretching already thin budgets. However, water industry leaders in the United States and abroad are now innovating at an unprecedented pace, reinventing how technology is used to solve industry challenges.

The water industry's digital evolution continues to be linked to conversations regarding sustainability, as maintaining or expanding asset life again was chosen as the most significant sustainability issue for utilities (Figure 1). As we see throughout this report, utilities are examining how data analytics can inform smarter operations and maintenance decisions and they are integrating these programs in their capital planning. Technology also is helping utilities communicate more effectively within their workforces and to their ratepayers and stakeholders, as well as within their infrastructure systems.

FIGURE 1

Which items represent the most significant sustainability issues for water utilities? (Select top three choices)



Source: Black & Veatch

This year's report explores how data are supporting innovations in alternative water supply, smart water solutions and case studies from state-of-the-art water infrastructure projects from around the world. Key areas covered in the report include the following:

Coastal States' Alternative Water Supply Solutions

Coastal states such as California and Florida face unique drought and seawater intrusion challenges that threaten their local water supply. Because of their proximity to the Atlantic and Pacific oceans, desalination would seem like a logical long-term solution for adding supply to their respective portfolios. However, high upfront costs and lengthy project schedules prevent implementation of desalination solutions, while public perception

and reliability issues affect other alternative water supply options in these regions.

Asset Management

Data analytics is helping water distribution, collection and treatment facilities operate more efficiently. We explore how organizations are leveraging automated monitoring systems to lower operating costs, manage processes and extend asset life.

Integrated Planning

Water utilities increasingly are relying on comprehensive integrated planning to drive efforts forward. In addition, today's planning is evolving to incorporate new technology and smart water infrastructure, all of which will help utilities gain the greatest return from their investments.

Coastal states such as California and Florida face unique drought and seawater intrusion challenges that threaten their local water supply.



Rates

Water utilities have made great strides in improving stakeholder education and engagement through an expanded array of communications channels. However, much work remains to help utilities communicate the value of water to a skeptical ratepaying public. Performing cost-of-service reviews to address equitable cost-recovery issues, developing innovative rate structures and communicating with elected officials are just some of the ways today's utilities are creatively seeking multi-year rate approvals.

Power-Water Nexus

The traditional structure of the U.S. power sector is transforming, and utilities are beginning to examine how this will impact costs, reliability and resiliency. At the same time, environmental regulations and other market forces are pressing the nation's energy-intensive water and wastewater sites to lead the charge in efficiency, starting with new resource utilization strategies. As these disruptive forces collide, many utilities still lack a plan to address and gain from a greater understanding of the nexus of water and power.

Commercial and Industrial Water Trends

Commercial and industrial water consumers no longer can take for granted a limitless supply of potable water – an unsettling proposition for organizations that view water as the lifeblood of operations. Heavy water users, from power plants to oil and gas refineries, chemical plants and data centers, are recognizing that they need to manage water differently. Business success may depend on it.

Many utilities still lack a plan to address and gain from a greater understanding of the nexus of water and power.

Resilience is too often viewed as a project-by-project endeavor.

Safety/Resilience

Major projects throughout the United States are underway both to address the near-term threats of transcendent wet-weather events and to proactively plan for long-term resilience. Despite the advancement of critical tunneling systems and the establishment of “Chief Resilience Officers (CROs)” in several cities and municipalities, survey respondents reveal that resilience is too often viewed as a project-by-project endeavor versus a programmatic long-term solution.

Storage and Conveyance

Agencies and utilities continue to explore and advance opportunities for water storage and conveyance projects to enhance the reliability of their systems, provide environmental benefits and meet growing demand for a sustainable supply. But the path forward will not be easy. The industry sees a lack of project funding, long and drawn-out project development cycles, and challenges linked to environmental clearance, regulatory review and permitting.

Water as Mission-Critical

The U.S. Department of Defense faces challenges similar to those of water utilities: limited funding, regulatory pressures and aging infrastructure – on top of already strenuous mission requirements. Leading military facilities are demonstrating how water supply can be integrated into mission requirements to address budgetary restraints, meet compliance mandates and deliver long-term value.

Maintenance Emerging as a Priority for UK Water Utilities

Driven by guidance from Ofwat, the United Kingdom water sector’s economic regulator, water utilities are being tasked with dedicating more of their capital expenditure toward better maintenance of existing assets to meet service, environmental and water quality goals. As capital programs continue to change, English and Welsh water utilities will need to implement increasingly sophisticated asset management strategies and capital maintenance regimes, with data analytics as a key enabler.

Communication-Centric Solutions

While the power of data is an obvious common thread throughout the report, data stand no chance of providing the solutions the water industry needs without proper communication infrastructure. For condition-based monitoring and data analytics to enable extended asset life to the largest margin possible, equipment will need to communicate to provide meaningful insights on system performance. Internally, information technology (IT) networks need to support technician-to-technician communications to back resilience efforts, especially after natural disasters. During maintenance projects, utilities must be able to provide critical information to ratepayers on service outages and impacts to billing. To secure vital infrastructure funding and rate increases, utilities must collaborate with stakeholders on the local and federal levels. At the end of the day, data can, and should, play an integral role in supporting these communications.

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Innovations in Alternative Water Supply

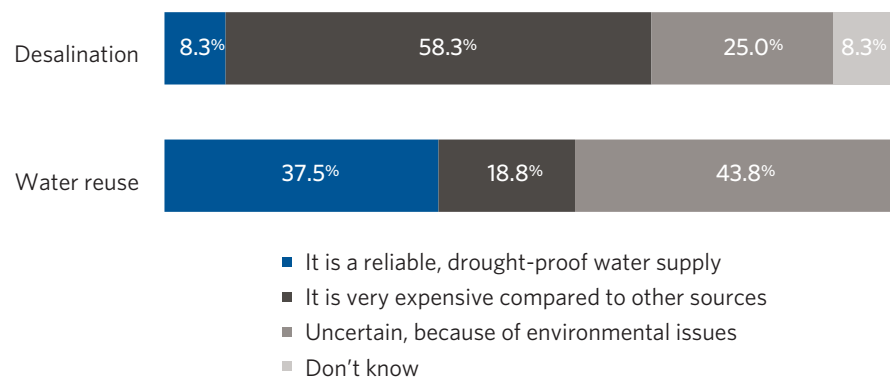
COASTAL STATES TAKE THE LEAD IN ALTERNATIVE WATER INNOVATIONS

By Ann Bui, Jeff Neemann and Amanda Schwerman

Alternative water supply (AWS) is taking on a more prominent role in portfolios, particularly in coastal U.S. regions that face unique water challenges such as drought and seawater intrusion. California, Florida and Texas are moving forward with projects to develop and maximize alternative water supplies to meet demand and achieve sustainability and resilience goals.

FIGURE 2

Which of the following statements BEST represents your community's overall impression of desalination and water reuse? (Select one choice for each)



Source: Black & Veatch

Desalination Project Barriers

Despite its popularity in regions like the Gulf Cooperation Council (GCC), Asia Pacific and South America, desalination projects have been slow to gain momentum in the United States. Though desalination seems like the most logical alternative water supply option for seaside communities, there has been a general lack of support stemming from permitting delays and high upfront costs compared to water reuse options. Survey results from the *2018 Strategic Directions: Water Report* echo this sentiment, with 58 percent of respondents expressing that desalination is perceived to be very expensive compared to other sources of alternative water supply (Figure 2).

Within the U.S., a lack of experience with desalination processes means that these projects also tend to be viewed as complex to build, operate, finance and ultimately, manage. Project timelines represent a major perception barrier. For example, a community already generates wastewater so in theory, it would be quicker to just treat that source and make it available versus building out a new desalination plant.

Further, while desalination is a proven water supply option that essentially is “drought-proof” and reliable, it does lack one feature: it does not address the other part of the water

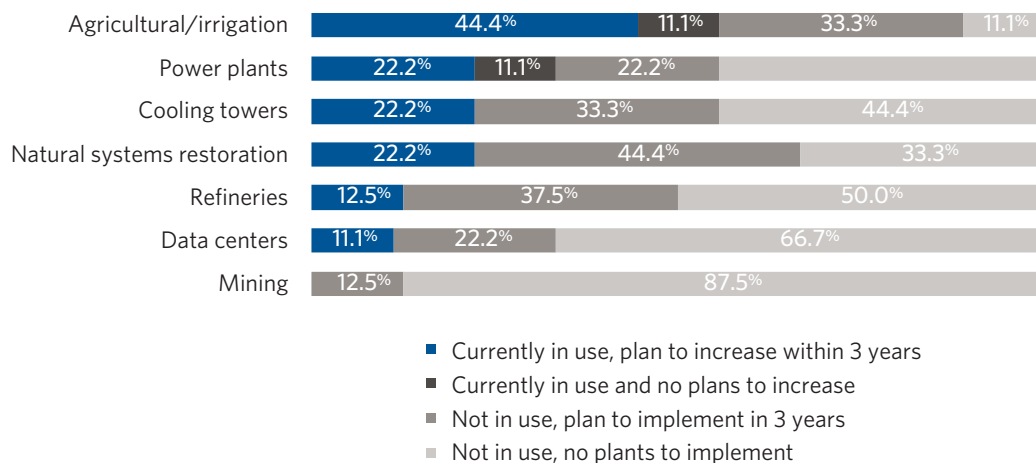
cycle – wastewater discharge requirements or limitations. When comparing desalination to water reuse or augmentation projects, many utilities find that opting for a reuse alternative could address more of their total utility needs, whether it is traditional recycled water or groundwater/surface water/treated water augmentation. Up against these obstacles, many coastal states are looking into more advanced projects that utilize reuse water.

Drought Continues to Drive Water Sustainability Efforts in California

In California, drought continues to drive conversations about alternative water supply, and leading utilities throughout the state are pursuing lofty goals for water reuse. Eastern Municipal Water District (Eastern) in Southern California, for example, is embracing a “zero-discharge” philosophy by taking 100-percent of its wastewater effluent and turning it into non-potable reuse water or blending it with other sources for groundwater augmentation. Eastern’s approach is part of their long-term strategic plan to provide sustainable water supplies at a reasonable cost to ratepayers.

FIGURE 3

What is your organization's current level of usage and future plans for the following types of non-potable industrial reuse? (Select one choice per row).



Source: Black & Veatch

Florida and Texas Water Providers Focused on Balanced Portfolios

Many water utility master plans throughout the state of Florida are now attempting to combine alternative water supply sources in their portfolios for a balanced “toolbox” of solutions. Stormwater harvesting and non-potable reuse are gaining popularity – not only in the state, but in the overall industry, with 42 percent of respondents saying they are extremely likely or somewhat likely to develop surface water/ stormwater harvesting.

In Texas, water supply issues are a continuing concern, and utilities are seeking balanced alternative supply portfolios to bolster reliability. In the Rio Grande Valley, the recent regional facility plan combined sustainable quantities of surface water, brackish water, direct reuse and desalinated seawater to meet growing demand for drinking water and supply for irrigation. Black & Veatch helped evaluate several alternative water resources and conservation options to determine what would ensure the most return on investment and meet long-term regional needs.

Determining what resources will work best for each community should take several factors into account such as availability, accessibility and

cost. After assessing these factors for the Rio Grande Valley, the utility implemented a plan to maximize all water resources, starting with utilizing the most affordable first. Brackish water supply is maxed out at 35 million gallons per day, and then would convert to surface water supply, followed by increasing reuse water. The implementation plan specifies the use of ocean desalination to fill the gaps with up to 80 million gallons per day. This integrated plan provides a balanced, sustainable supply for the Western Texas residents and local economy.

Changing Public Perceptions

Unlike desalination, there are perception issues around the use of recycled water. For example, ratepayers often wonder who exactly uses recycled water. Survey results reveal that 56 percent of reuse water is being allocated for agriculture (Figure 3). Another question that often arises is: Are we subsidizing recycled water rates? Survey results indicate that only 22 percent of respondents charge the full cost of service for recycled water. One-third of survey respondents charge customers recycled water rates that are a percentage of potable rates. This practice is common in the industry and is intended to encourage use of recycled water and decrease the use of potable water.



The cost of adding recycled water to a utility's supply portfolio can be high, particularly if the service area is large. One of the biggest deterrents involves the cost of laying "purple pipe" (the distribution) system for a relatively small number of customers. In partial recognition of this challenge, the industry's latest advancements involve the growing attraction of potable reuse. Rapidly gaining in popularity, this option involves producing highly treated water and using it for augmentation of potable supplies such as groundwater or surface water. This approach helps minimize the costly need for building separate distribution systems. Regardless of the alternative, there remains a need to educate the public about the benefits of using treated water sources to supplement drinking water supply.

San Diego is taking this challenge head-on. Backed by the full support of its city council, mayor and environmental groups like Surfrider and Coast Keeper, the city is launching the first phase of its Pure Water Program, which will produce up to one-third of the city's water needs by 2035. As part of the city's public education and outreach plan, [Pure Water San Diego partnered with California's Stone Brewing](#) to brew a beer using water produced by San Diego's Pure Water demonstration facility – a plant that produces high-quality water for potable reuse. The beer served at a one-time-only event made national headlines and highlighted the significant role potable

reuse can play in the larger AWS picture. With many ratepayers, some concerns still remain when thinking about consuming recycled water, but in many cases, treatment technology is so advanced that the reused end product is cleaner than normal tap water – which is the case for San Diego's Pure Water.

Several customer-education pilots are underway in other communities, mostly in California and Texas, which also are investing in potable reuse projects. Utilities are conducting visitor tours that showcase the water treatment technology for local residents, and social media channels share information about links to sustainability and community benefits. Utilities also are beginning to communicate non-potable reuse applications that benefit local economies by providing sustainable supply to agricultural, irrigation, landscaping and industrial customers.

The Future of Alternative Water

Alternative water supply projects are beginning to gain traction in other regions, particularly in the Midwest, to prevent the need for digging up new groundwater wells. New uses for effluent streams also are increasing as treated water must meet more stringent environmental regulations — which can be costly to comply with — and are looking for more end uses aside from local discharge. There are many factors that will grow the discussion about how AWS fit within a water supply portfolio, but for now the coastal states seem to be leading the pack for implementing these sustainable solutions.

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Innovations in Alternative Water Supply

RECYCLED WASTEWATER PLAYS STARRING ROLE IN RESILIENCE, RELIABILITY

By [Jon Loveland](#)

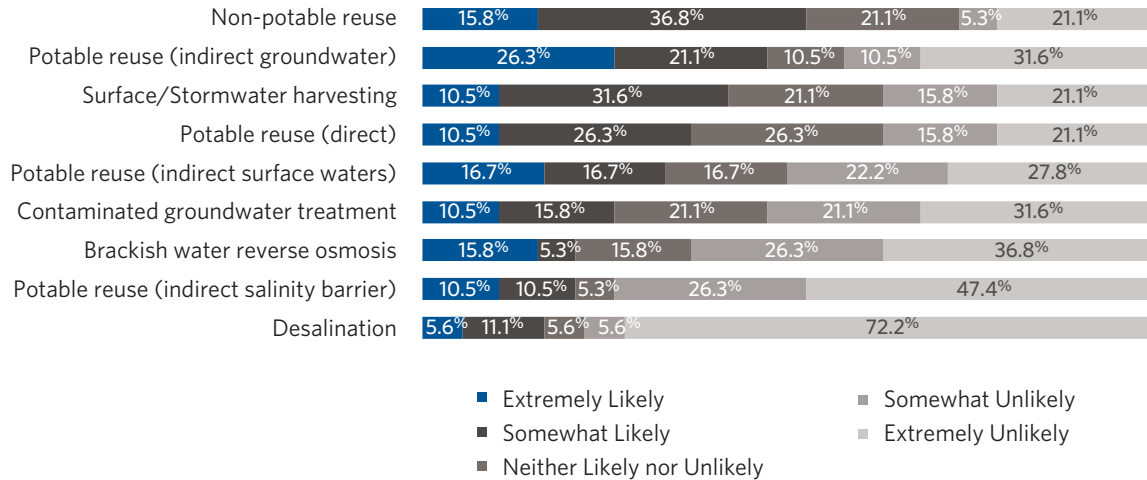
Scarcity and drought concerns are many driving water utilities to adopt AWS solutions as part of rapidly transforming resilience and reliability programs. But as states and municipalities work to diversify their portfolios to ensure a reliable, resilient water supply, direct potable reuse (DPR) — when wastewater is treated to the extent that it meets drinking water standards and then is added into the drinking water supply — is coming up in the ranks as a subject of research and development.

DPR Gains Traction

The concept of using recycled wastewater to offset potable water demands is not new – parks and landscaping rely on non-potable reuse, as do industrial and cooling water applications. This year however, several states either have put forth a pathway to potable reuse, or are working on frameworks and needs assessments for implementation. On Jan. 1, 2018, Arizona issued a complete regulatory approach to direct potable reuse, joining Texas on a pathway to DPR implementation. Based on statutes issued in 2001, Arizona's new regulations allow the state to offer permits to facilities that perform advanced treatment on reclaimed water to produce potable drinking water.

FIGURE 4

How likely is it that your community will develop new Alternative Water Supplies? (Select one choice per row)



Source: Black & Veatch

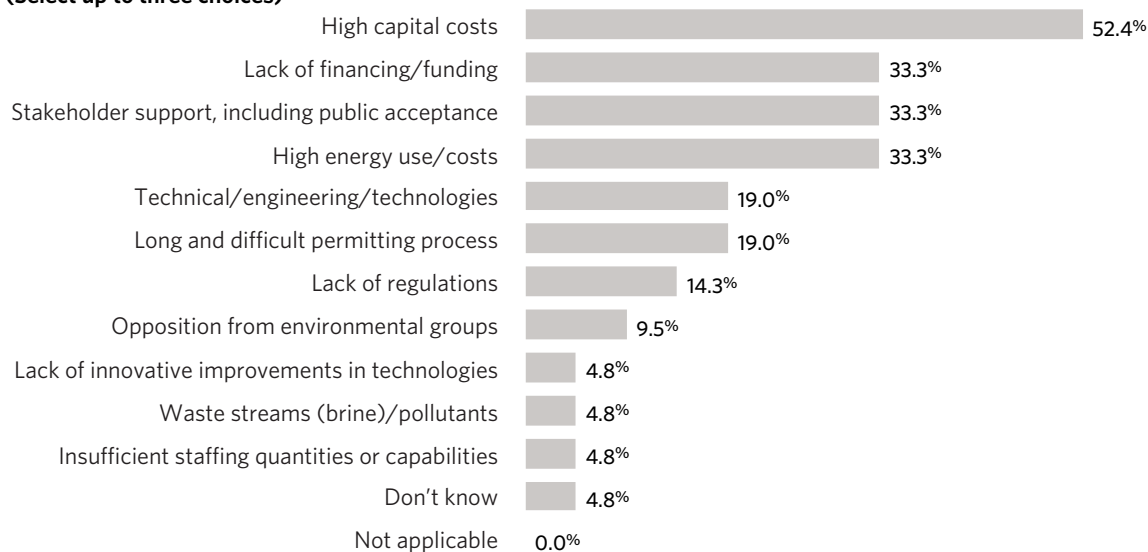
Similarly in March, California issued an expert panel report identifying the research that would be necessary to regulate direct potable reuse. For decades, the state has regulated a version of indirect potable reuse that allowed treated wastewater to be added to aquifers to mix with groundwater before being treated and added to the drinking water distribution system. The state recently provided similar guidance for surface water reservoirs and plans to release new regulations focused on DPR in 2023.

Texas permitted potable reuse during its 2010 to 2013 drought, with the Texas Commission on Environmental Quality continuing to accept applications and issue permits on a case-by-case basis today. Florida recently formed a Potable Reuse Commission to begin the process of developing their version of a comprehensive framework for potable reuse.

When polled on their plans to invest in new alternative water supply solutions, 11 percent of the *Strategic Directions: Water Report* survey respondents said it was “extremely likely” that they would develop direct potable reuse options – ranking it in line with other options such as surface water/stormwater harvesting, contaminated groundwater treatment and potable reuse (indirect salinity barrier) (Figure 4). Meanwhile, a little more than a quarter (26 percent) of respondents said investing in direct potable reuse was “somewhat likely.”

FIGURE 5

What are the biggest challenges your organization faces in developing new Alternative Water Supplies projects? (Select up to three choices)



Source: Black & Veatch

It's not surprising that this type of reuse ranked fourth, given the capital commitments involved. The leading three options — non-potable reuse (53 percent), potable reuse (indirect groundwater, 47 percent) and surface water/stormwater harvesting (42 percent) — all are less costly than DPR, which requires more complex treatment processes and operations that offer a higher level of public health protection.

Additionally, smart monitoring infrastructure such as smart metering and real-time controls/data analytics will be critical to this effort because of the monitoring requirements that inevitably will be put in place once states begin to move to DPR. Implementing direct potable reuse will have a direct correlation to a greater demand for data collection and analysis in real time.

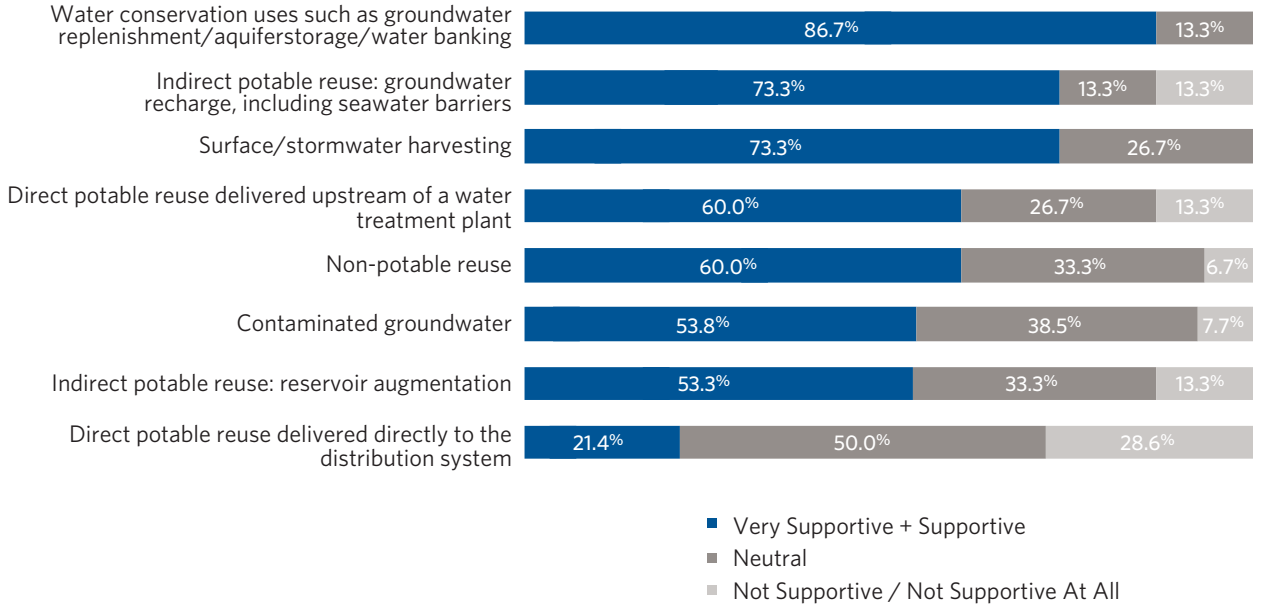
Challenges in Alternative Water Supplies

More than half (52 percent) of survey respondents state high capital costs are a major barrier to developing new AWS projects, followed by a lack of financing/funding, stakeholder support and high energy use/costs (Figure 5). These responses are not surprising, given the level of major infrastructure investment needed to make recycled drinking water a reality. But today, we're hitting a critical mass and city, environmental and utility leaders have to talk about those programs and the importance of expanding them.

Traditional financing routes include low-interest loans through the federal government or grants and loans offered at the state level. These options have their pros and cons – primarily, loans need to be repaid, so they still will impact the rate base. Municipalities may be better served if they investigate new, innovative methods of managing rate impacts such as subsidies and alternative rate structures.

FIGURE 6

**How would you rate your community's level of support for the following alternatives to desalination?
(Select one choice per row)**



Source: Black & Veatch

When looking at community support, the majority of respondents say their communities are most likely to get behind water conservation efforts such as groundwater replenishment, aquifer storage and water banking (Figure 6). Conservation is often the most popular option – not only is it the least expensive, but small steps toward conservation go a long way when implemented at the community level.

This is followed by indirect potable reuse (73 percent), where treated wastewater is added back into the groundwater supply, and surface water/stormwater harvesting (73 percent). All in all, the fact that survey respondents believe their communities would show support for the majority of the suggested treatment options demonstrates awareness and understanding of their alternative water supply.

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Andrew Shaw is a Global Practice and Technology Leader in Sustainability and Wastewater for Black & Veatch. He has more than 20 years of experience in wastewater treatment design projects in the UK, Australia, Asia and North America. His expertise includes nutrient removal, computer modeling, instrumentation, process optimization and lifecycle assessments.

Innovations in Alternative Water Supply

TECHNOLOGY BREATHES NEW LIFE INTO NUTRIENT RECOVERY, ENERGY OPTIONS FOR WASTEWATER TREATMENT

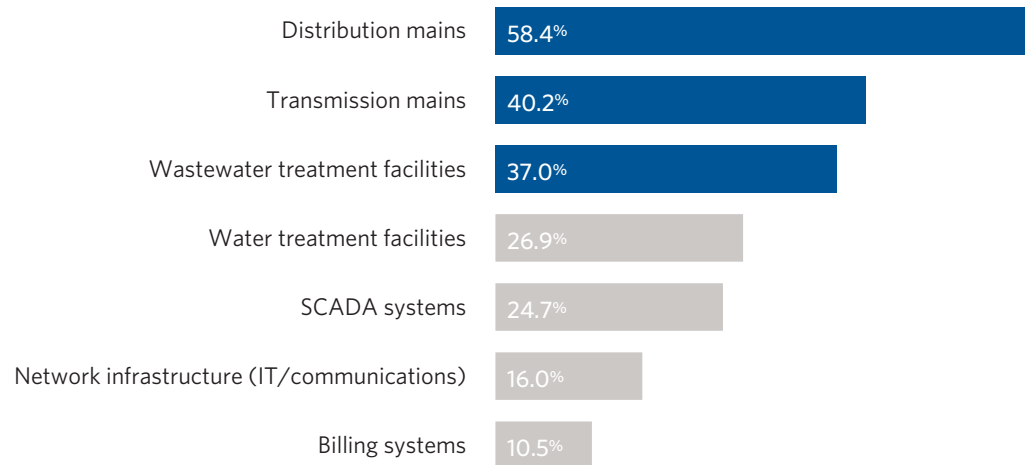
By Joerg Blischke and Andrew Shaw

Leaving absolutely nothing to waste, operators of the Oceanside, California, wastewater plant credit biogas — generated from sewage they process — for covering one-third of their site's energy power needs. In cities across the U.S., from Seattle to the Washington, D.C., metropolitan area, and from Boston to Austin, human waste conveyed by sewer systems to waste resource recovery plants undergoes a heated, microbial makeover, ultimately emerging as a nutrient-rich and safe biofertilizer. The benefits don't stop there; microbes also convert part of the solids under anaerobic conditions into biogas, a renewable fuel.

It's all a snapshot of ways in which some U.S. wastewater plants — significant energy consumers often viewed as rigid in their ways in the face of evolving technologies — are rethinking how a sustainable waste supply can be morphed into something greater and greener.

FIGURE 7

**Which of the following are in the greatest need of repair and/or replacement due to age within your organization?
(Select all that apply)**



Source: Black & Veatch

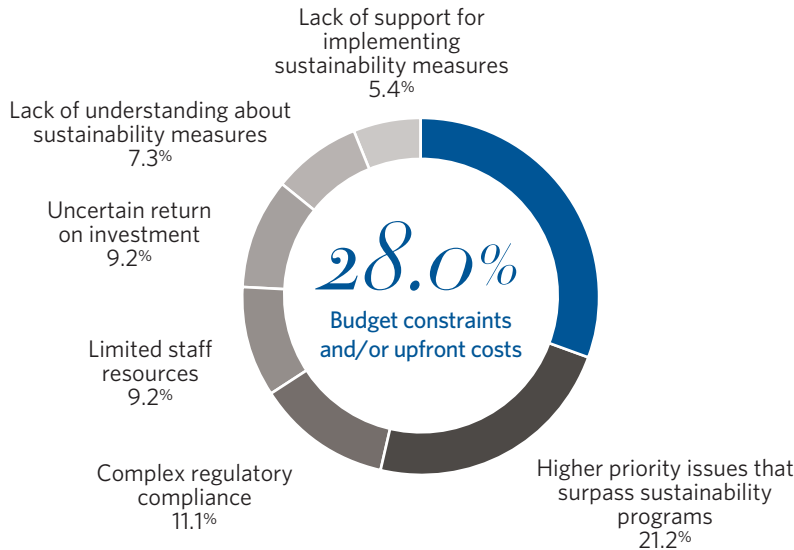
Yet the question remains: With advances in nutrient recovery and waste-to-energy presenting a potential shift in paradigms about extracting more ecological and agronomic benefits from treated wastewater, is the pace of evolution by U.S. wastewater plant stakeholders too slow?

According to Black & Veatch's *2018 Strategic Directions: Water Report* survey, energy recovery got scant traction in terms of what the industry considers to be the most sizeable sustainability issues for water utilities. Just 10 percent deemed that matter significant, a vast outlier to the roughly 43 percent who placed maintaining or expanding asset life atop the sustainability list.

Separately, more than one-third of respondents said their wastewater treatment site is in the greatest need of repair or replacement because of its age, trailing only concerns about distribution and transmission mains (Figure 7).

FIGURE 8

What is the biggest challenge for water utilities to pursuing water and/or energy solutions? (Select one choice)



Source: Black & Veatch

The conventional practice in the wastewater space has been to treat the incoming municipal wastewater and meet discharge limits, with thoughts of doing anything different typically cast as a distraction or hassle, often with a considerable price tag attached. In fact, as the infrastructure of wastewater sites continues to age and stakeholders fret about how to address that in the most reasonably cost-effective ways, roughly half of survey respondents listed budget constraints or higher priority issues as the biggest challenges for municipal agencies to pursue nutrient, water or energy recovery solutions (Figure 8).

Even so, opportunities abound in terms of adopting technological upgrades or, even simpler, making better use of what’s already there. That includes maximizing the capacity of existing anaerobic digesters harnessing the generated biogas for beneficial use, or using

those digesters to create soil-like “biosolids” or biofertilizer that are free of harmful pathogens and odors while rich in phosphorus and nitrogen, key elements in agriculture and urban farming.

That biogas typically requires refinement before it can be used, for example, as a fuel in boilers or energy generators to meet the plant’s heat or power needs, or be used in vehicles that accommodate compressed natural gas (CNG). While using the gaseous leftovers of wastewater treatment to create energy is common in Europe, the United States appears to be slow to putting low-tech biogas to use, perhaps because of the depressed prices of natural gas. Nearly half of survey respondents say their biogas is simply burned off, meaning it is not harnessed for economic or social benefits.

On the biosolids front, water resource recovery facilities in many U.S. metropolitan areas — Milwaukee, Seattle, Tacoma, Austin, Houston, Washington, D.C., Boston and Baltimore, to name a handful — are turning organic matter left over from sewage treatment into endlessly renewable fertilizer. Near Seattle, this soil application is marketed as “Loop,” while it’s “Dillo Dirt” in Texas, “Milorganite” in Milwaukee and “Bloom” near Washington, D.C.

But the plusses are the same: Phosphorus-rich biosolids dispersed as tightly-regulated fertilizer on land, from farm acreage to brownfields and many urban farms and homes in between, keep carbon from making its way into the atmosphere while cutting demand for commercial fertilizers, which require fossil-fuel-based energy to make. Phosphorus and other nutrients in soil-building biosolids also otherwise don’t make their way with other effluent into waterways, causing oxygen deficiencies or “dead zones” that choke out aquatic life.

At a time when the wastewater sector appears poised for a significant shift toward greater sustainability, it looks likely that utilities, municipal administrators, lawmakers and other stakeholders can progressively broker a broader embrace of methods such as nutrient recovery and waste-to-energy. Breaking from historically staid practices to more ecologically-minded ones will require drivers and champions on the local, state or federal level; a financial commitment; and working with experienced engineers to enable them to offer customized solutions.

Some big municipalities have taken the plunge. San Francisco, for instance, is waging a fledgling 20-year, \$6.9 billion push to upgrade its aging sewer infrastructure, including spending \$1.3 billion to replace its 60-year-old solid wastewater processing plant and site digesters that handle 80 percent of the city’s wastewater.

Other wastewater utilities should follow that bold lead, appreciative that the return on investment comes in heightened resiliency and a greener path forward.

Nearly half of survey respondents say their biogas is simply burned off, meaning it is not harnessed for economic or social benefits.

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Smart Water Solutions

MANAGEMENT TREND: COMPREHENSIVE PLANNING & OPERATIONAL INTELLIGENCE SOLUTIONS DRIVE WATER SERVICE EFFICIENCY

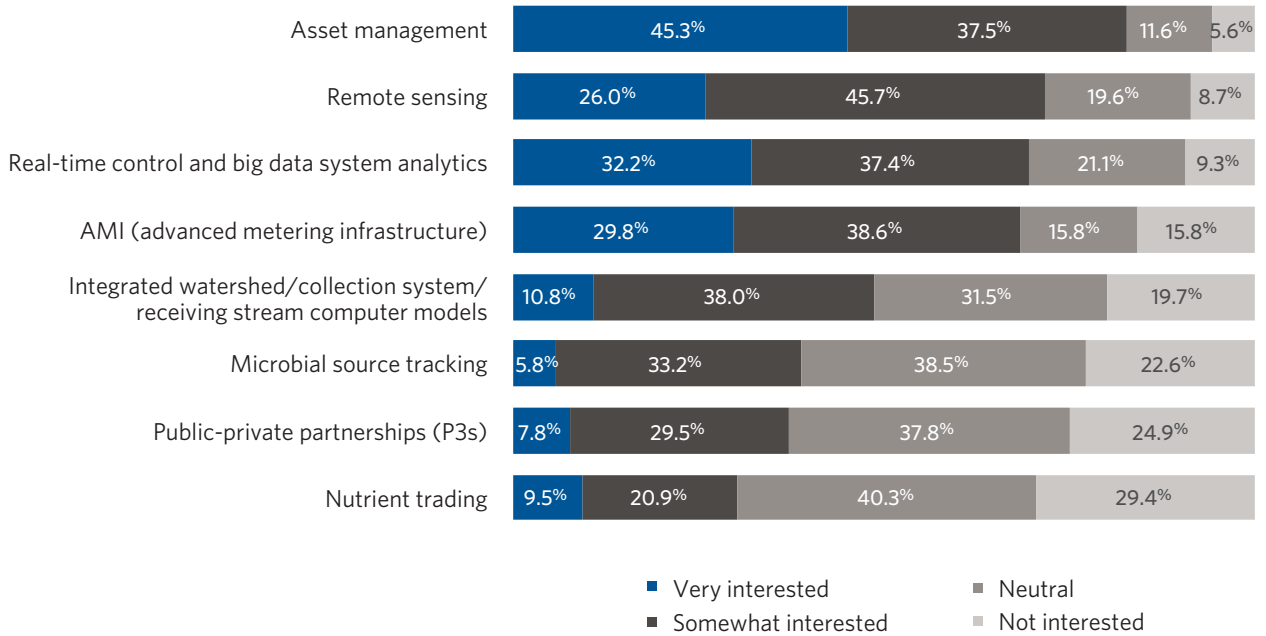
By Jim Schlaman and Forrest Small

Utilities today face a critical need to invest in the nation's aging water and wastewater infrastructure, at no small cost. **According to the U.S. Environmental Protection Agency (EPA)**, \$472.6 billion is needed to maintain and improve our drinking water infrastructure, with \$271 billion required to maintain and improve wastewater infrastructure over the next 20 years. In a push to make smarter investments, the industry is accelerating adoption of advanced technologies and "smart water" infrastructure in their comprehensive planning efforts.

Utilities that are actively investing and integrating smart infrastructure — a combination of sensor technology, automation and control devices paired with data analytics — into their water, wastewater and stormwater systems are opening the door to unprecedented levels of systems intelligence. In doing so, they are helping to reshape the future of water as we know it.

FIGURE 9

How interested are you in implementing the following integrated planning techniques and technologies moving forward?



Source: Black & Veatch

Embracing Smarter Systems

Utilities are starting to see the benefit of investing in smart infrastructure. According to results from the 2018 Strategic Directions Report: Water Report survey, 83 percent of respondents are “very or somewhat interested” in the larger effort of asset management. This demonstrates industry awareness of the critical role that asset management can play in managing water, wastewater and stormwater in today’s world of omnipresent connectivity and technology, while helping utilities maximize existing capital and investments.

The majority of respondents expressed interest in the three major technologies that enable this effort: remote sensing (72 percent), real-time control and Big Data system analytics (70 percent), and advanced metering infrastructure (AMI) (68 percent) (Figure 9). These technologies all are closely tied to and accentuate one another.

The majority of respondents expressed interest in the three major technologies that enable this effort: remote sensing, real-time control and Big Data system analytics, and AMI.



AMI Technology Delivers Valuable Data

Advanced Metering Infrastructure (AMI) is an advanced technology that offers two-way communication between a water utility and its sensors, enabling a vast network of sensing devices which transmit valuable operational and customer data. This type of predictive technology gives utilities the information they need — such as additional operational efficiencies, system insights and customer services — to make preventative, rather than reactive, decisions.

The city of South Bend, Indiana, relies on a **“smart sewer” AMI system** to monitor and control its wastewater system in real time. The utility installed 140 flow meters and level sensors in its 500-mile sewer network — including the 36 combined sewer outfall points within the city — to gain immediate analysis on the depth and flow of its stormwater and wastewater. This allows the utility to better understand how the system responds in dry and wet weather events.

In Portland, Oregon, Clean Water Services uses water flow metering integrated into supervisory control and data acquisition (SCADA) systems

and their geographic information system (GIS). At any given moment, the utility can run a status check and pull up an immediate snapshot of its sewer system, allowing them to identify and mitigate issues in real time. And in Cincinnati, Ohio, the Metropolitan Sewer District formed a Watershed Operations Group to better understand the watershed in order to manage and operate it similarly to that of any large-scale water infrastructure. The utility theorizes that metering these systems will allow for operational decision-making on a larger watershed scale, not just at the individual treatment plants.

By painting a comprehensive picture of all the water systems in a municipality — from the creek to the sewer systems — a utility can gain a better understanding of how these systems respond in wet weather and droughts to better system resiliency, and even be able to predict the anticipated sewer response. This level of intelligence will not only allow utilities to recognize and reduce the potential of adverse environmental impacts, but it will allow them to elevate their ability to optimize water and wastewater treatment.

Remote Sensing

A growing field within AMI, remote sensing — using aircraft, drones and/or satellites to record and return data — allows for exceptional levels of situational and operational awareness. With numerous applications for water, wastewater and stormwater, (e.g., tracking watershed dynamics such as rain, snow pack, reservoir levels and water quality) remote sensing can greatly improve predictive capabilities, enabling smarter, faster, more informed decision making.

Remote sensing can be used to identify and proactively identify potential adverse conditions. That data can be integrated with a data analytics platform such as **Black & Veatch's ASSET360®**, to provide utilities with increased opportunities to make data-driven decisions. ASSET360 integrates data from multiple systems, assets and devices into one cloud-based platform to enable better-informed decisions and actions. By analyzing data, the platform generates quick, actionable insights to improve operations and drive data-supported future planning.

Satellite sensors linked to a customized data analytics dashboard could detect when conditions are favorable for a harmful algal bloom by recording water temperature and nutrient concentrations. Having the ability to proactively predict those conditions would alert local municipalities and utilities that conditions may result in an emergency situation, allowing them to minimize or completely avoid impact to the water supply.

Monitoring Strengthens ROI

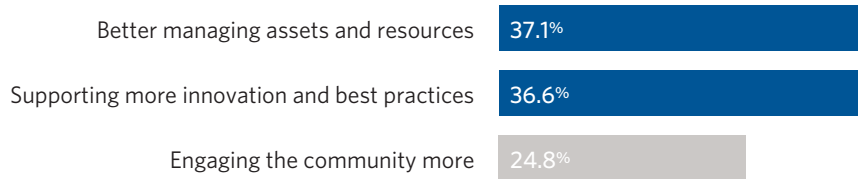
Data acquisition through smart water infrastructure will allow utilities to make targeted financial decisions — another key component of integrated planning. Investing in AMI takes capital but the dollars spent on monitoring will offer a greater return on investment when compared to the massive expenditures necessary to repair and rehabilitate aging equipment.

South Bend has already seen financial benefit; according to its [website](#), the municipality invested \$6 million in smart sewer technology, including sewer modifications and control valves, which provided an environmental benefit equivalent to implementing about \$120 million of conventional system improvements. This investment helped the city avoid millions of dollars in capital expenditures associated with more conventional approaches to combined sewer overflows.

Some utilities are becoming more creative by taking an increasingly entrepreneurial approach when it comes to recovering costs from AMI investments. One utility considered installing AMI through a network of smart meters on homes and businesses. By featuring Wi-Fi and connected technology, these smart meters effectively become a network of data hubs that could potentially generate revenue by being offered to area cable and telecommunications providers for a fee.

FIGURE 10

Which of the following do you feel are most beneficial in helping your organization overcome the barriers that prevent you from having stormwater/integrated planning programs? (Select top three choices)



Source: Black & Veatch

Innovation is the Future

Utilities are invested in better managing their assets and resources, as survey responses show equal weight (37 percent) to supporting more innovation and best practices, believing that these efforts would also overcome the barriers that are preventing integrated planning programs (Figure 10).

Entrepreneurial leaders steadily are rising to the forefront of the water sector. For example, one utility raised the possibility of partnering with technology companies to develop smarter flow meters. The utility would give the technology company access to its systems and treatment plants in the hopes that the company would use that space to operate to perfect budding technology, at scale, and ultimately help drive costs down.

Strategic approaches that involve AMI, remote sensing and data analytics as integral components of asset management have the potential to offer utilities unlimited levels of systems intelligence. As reflected in the survey results, we see the industry beginning to understand the importance and value of these capabilities, but there still is room for improvement when it comes to widespread adoption.

Like many other sectors, the water industry is undergoing a technological revolution. Those utilities that understand and embrace this nexus of data and water — and have the foresight and vision to invest in smart water infrastructure today — will reap the long-term benefits tomorrow.

Andrew Chastain-Howley is a Director of Water Solutions for Atonix Digital, a Black & Veatch software subsidiary. He specializes in reducing water loss and managing water demand. He is based in Fort Worth, Texas, and has 26 years of experience in the fields of water loss control and water conservation.

Smart Water Solutions

BIG DATA BRINGING OPTIMIZATION TO LIFE FOR WATER UTILITIES

By [Andrew Chastain-Howley](#)

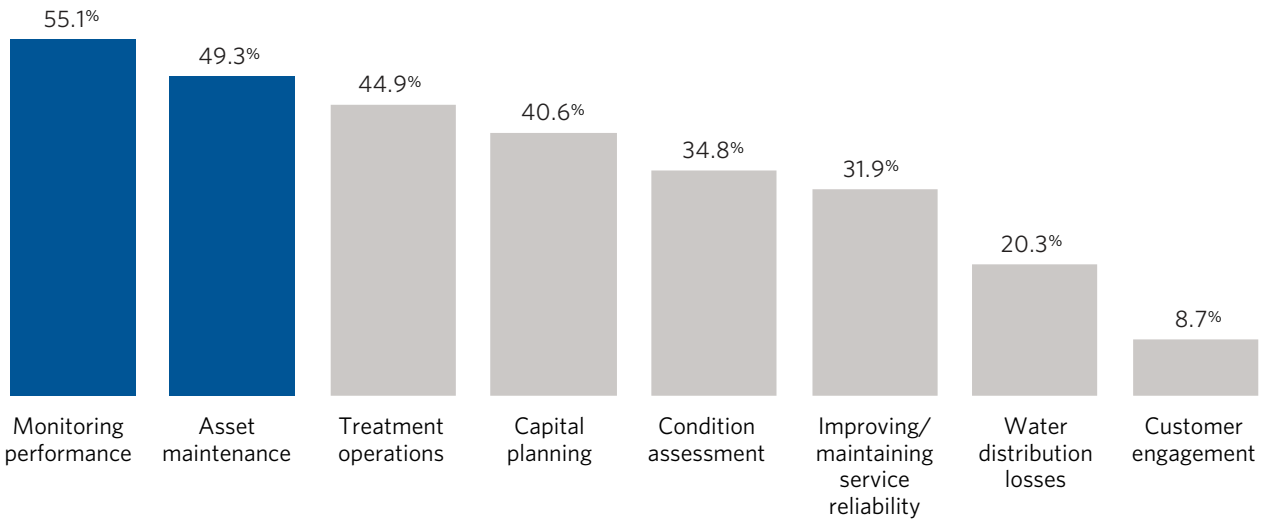
Big Data and the complicated algorithms that help translate that data into intelligence can be difficult concepts for any organization, regardless of industry, to swallow. With a plethora of data available through monitoring systems and sensors, how do utilities gather, mine and, most importantly, analyze that information to make a tangible impact on long-standing asset management challenges?

Until now, water utilities have seemingly been caught in a bind between time and resources. Their water and wastewater infrastructure is deteriorating, pumps are breaking down, pipes are springing leaks and other assets are reaching the end of their natural life cycle, but cash-strapped utilities have not had the money or the infrastructure knowledge to make necessary upgrades.

Water providers are now beginning to make the most of their data to save on operational costs and improve efficiency by focusing with a new sense of urgency on core issues. In the [2017 Strategic Directions: Water Industry Report](#), only 10 percent of survey respondents were utilizing cloud-based software across all parts of their business; this year that figure jumped to 28 percent.

FIGURE 11

What three operational areas do you feel that data analytics and automated monitoring will help improve most at your organization? (Select top three choices)



Source: Black & Veatch

Utilities identified monitoring performance, asset maintenance and treatment operations as the top three operational areas that data analytics and automated monitoring would help improve most (Figure 11). These focus areas appear to be where utilities can best leverage data to lower operating costs, optimize processes and extend asset life, which are some of the leading industry challenges identified in this year’s report.

Data’s Emerging Role

Water utilities always have collected data, but historically they have used that information to perform traditional tasks, such as SCADA for real-time monitoring of critical systems and advanced metering to improve customer billing. Only 14 percent of respondents are currently using their SCADA data to predict asset failure. Thirty-eight percent of utilities are using SCADA for operational purposes only, and 47 percent are using SCADA to monitor system health and for operational purposes.

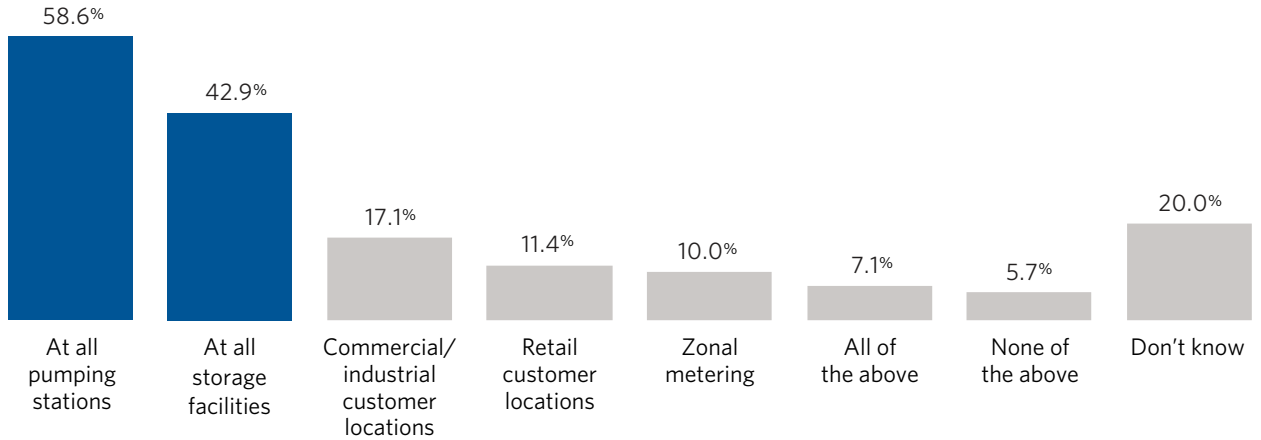
There is no shortage of raw data. Nearly 60 percent of water utilities surveyed said they have remote data collection systems at all of their pumping stations, and 43 percent have data collection at all of their storage facilities (Figure 12).

To best utilize system data, survey respondents indicated they are most in need of operations data, including information on sewer maintenance and hydrant flushing, plus information from SCADA systems and customer maintenance and management systems (CMMS). While data collection mechanisms seem to be advancing, many utilities can still improve how data is dissected to inform better business decision-making. It is also encouraging to see the variety of ways that utilities are increasingly using data to assess asset health and predict failure .

A new generation of innovative analytics tools offers water utilities an opportunity to meet those basic needs and to transform raw data

FIGURE 12

Where do you currently have remote data collection on your network? (Select all that apply)



Source: Black & Veatch

into actionable intelligence at both the tactical and strategic levels. Data analytics can quickly identify failing infrastructure, reduce water loss, prevent sewer overflows and measure asset health. In addition, data can unlock operational efficiencies, inform proactive maintenance opportunities and guide long-range planning and investment strategies.

Solutions powered by our **ASSET360® analytics** platform can provide a 360-degree perspective of all raw data being collected, from SCADA to laboratory and maintenance system monitoring data, to streamline sources and apply intelligent analytics. Using prescriptive calculations and advanced visualization, water organizations can prioritize capital spend, analyze risk and get the most out of their operations and maintenance programs.

Key Performance Indicator Monitoring at City of Lawrence Amounts to Cost-Savings

The ASSET360 platform consolidated and presented data from multiple sources onto a single dashboard to provide valuable information to the city of Lawrence, Kansas. Data from the city’s wastewater plant and laboratory management department is now aggregated with U.S. Geological Survey (USGS) and National Oceanic and Atmospheric Administration (NOAA) data to allow advanced asset evaluation.

The smart analytics program provides quick and repeatable trending, plotting and analysis across multiple data sets. In addition, equivalent laboratory and instrument data can be compared to understand and track discrepancies between real-time sensors and obtain sample data analyzed in the laboratory.

The value of having all available data in one location is demonstrated during significant rain events. Wet weather puts more inflow and infiltration into the sewer collection system, thus into the plant. The operator needs to turn

on sidestream processes to cope – but when and for how long?

The dashboard can stream data from NOAA to show rainfall rates in the area, USGS data to determine water level at local rivers, and SCADA data to show plant inlet flow rates from the sewer system. These all are available in the same cloud-based system, enabling the plant operator, plant supervisor and consultants to see the same information simultaneously, enabling intelligent decisions for the side stream treatment.

So far, the project has enabled the city to more accurately quantify its energy and chemical use and needs, and using that data to drive operating decisions, rather than through institutional biases and assumptions. Black & Veatch process engineers also are able to use the system to remotely monitor and analyze data, and then work with the city to identify additional opportunities for process improvement.

The Future of Data Analytics

As we move into the era of Big Data and the Internet of Things (IoT), water utilities will be able to deploy advanced sensors that will be able to pick up previously undetectable changes in infrastructure performance. These predictive technologies will help companies anticipate equipment failures and leaks, as well as build a roadmap of how best to replace capital equipment.

Smart technologies also can help water utilities improve their customer service. For example, a self-service analytics system using advanced metering and water quality data could allow a commercial customer to monitor and optimize their own water usage.

In this year's survey, only 12 percent of companies considered themselves early adopters who were benefitting from smart technologies, while 33 percent were reviewing the benefits of these applications. Twenty-three percent had smart technologies built into their long-term capital improvement plans.

There is still a long way to go, but the water industry appears to be moving in the right direction. To make the most of these technology investments, utility leaders should have a clear vision of their organizational goals and strategic objectives. Utilities need to match their objectives to the best available enabling technologies, while prioritizing implementation and adjusting business processes.

The ultimate goal of data analytics is to give utility leaders better information to support future action. The use of data analytics moves water utilities from a reactive to a proactive stance, helping managers develop new opportunities for cost control, risk management and improving levels of service.

Prabha Kumar is a Director for Black & Veatch management consulting. She leads the water, wastewater and stormwater utilities offering within the Advisory and Planning group. Kumar specializes in stormwater utility feasibility studies, utility development and implementation. She also helps utilities with both internal stakeholder education and engagement and external public education and outreach.

Smart Water Solutions

RATES: THE “EXISTENTIAL REALITY” REQUIRES INNOVATIVE BALANCING ACT

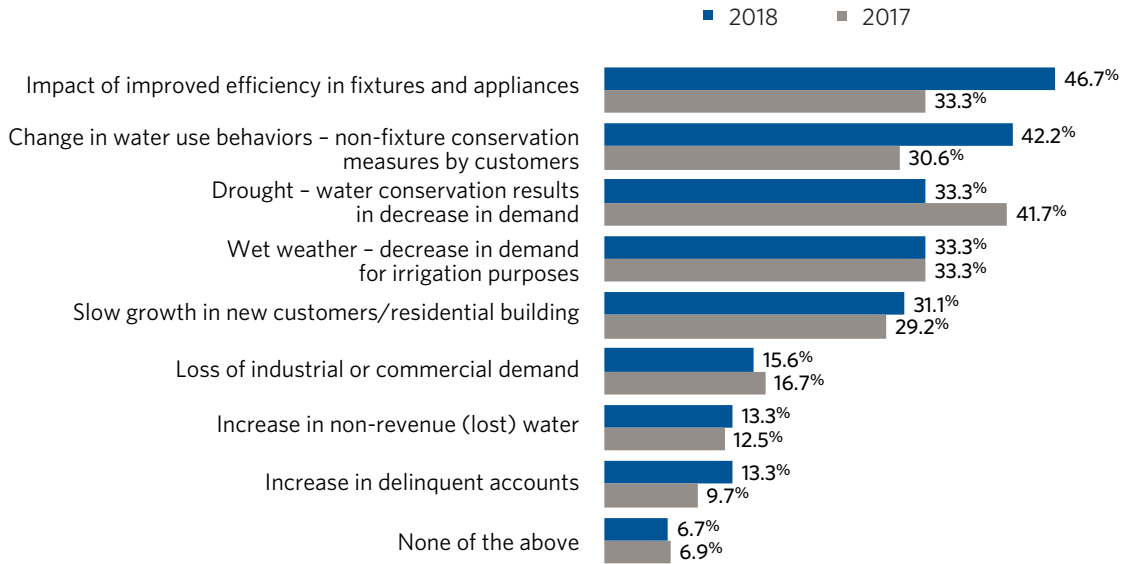
By Prabha Kumar

The “existential reality” of managing declining revenue in the face of increasing investment needs has become the new norm for the water sector nationwide. Utilities consistently face competing pressures – changes in water use behavior and advances in water efficiency help sustain precious resources, but impact utility revenues. Addressing aging infrastructure and water quality needs enhances service reliability and public health but puts significant cost pressures on utilities.

This is compounded by external influences such as resistance to timely rate increases, and a continuing awareness gap on the value of water, leaving utility managers perennially facing a perfect storm. To navigate their reality, utility managers have to proactively explore alternative approaches to managing resources, building financial resiliency and optimizing utility costs.

FIGURE 13

Select the items that have negatively impacted your utility's revenue stream during the last five years.
(Select all that apply)



Source: Black & Veatch

Funding Adequacy and Cost Recovery

In Black & Veatch's 2018 *Strategic Directions: Water Report* survey, utility leaders shared their insights on the main drivers of revenue decline. Consistent with what we see in many utilities, 47 percent of the participants say efficiency advances in fixtures and appliances have had the highest impact, up from 33 percent last year (Figure 13). Forty-two percent say conservation successes have impacted revenues, also a substantial increase from 2017. While drought also continues to be a key factor, only 33 percent this year cited drought as one of the revenue decrease factors, down from 42 percent last year.

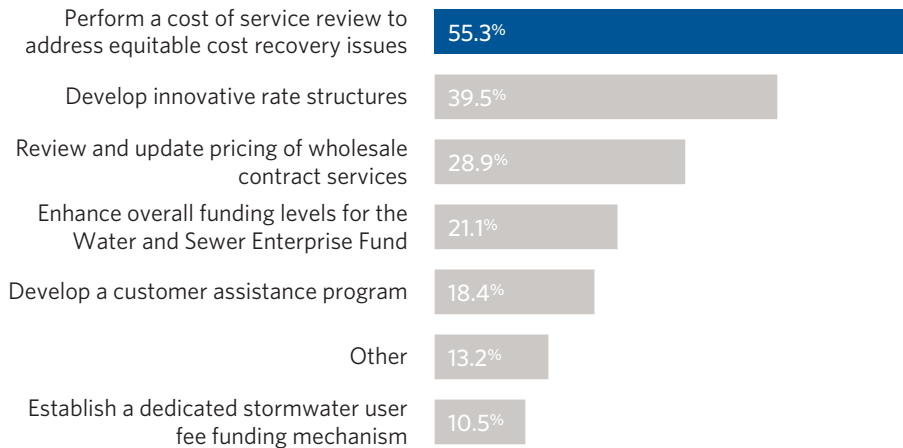
The responses reflect an emerging phenomenon – utilities are placing greater emphasis on cost

of service and rate analysis to transition from focusing on a “single benefit” outcome, such as funding adequacy, to a more holistic “multi-benefit” outcome that addresses the competing needs of revenue stability for infrastructure investments, enhanced equity in cost recovery and opportunities for revenue enhancements.

Utility managers have to proactively explore alternative approaches to managing resources, building financial resiliency and optimizing utility costs.

FIGURE 14

What challenging user rate issues does your utility need to address in the next two years? (Select all that apply)



Source: Black & Veatch

According to the survey, more than 55 percent say they will focus on cost of service review and 40 percent cited the development of innovative rate structures as two key issues that they would focus on during the next two years. Interestingly, only 21 percent of the participants indicated a need to enhance overall funding adequacy in the immediate term (Figure 14).

While funding adequacy in the immediate term may not be a critical issue for many of the survey participants, approximately 44 percent

of the participants state they do not have the funding adequacy to meet future service and infrastructure management demands. Within this category, 29 percent say they can cover current, but not future demands, while 16 percent say their funding structure is in more of a dire situation where it can cover neither.

Utility Management Strategy Trends

Effective utility management strategies and initiatives are critical to managing both the revenue and the cost side of a utility's fiscal health, prompting the survey question about what strategies utility leaders have engaged in or are considering, to enhance funding capacity and service delivery.

On the revenue side of the fence, the following three strategies are noteworthy:

- **Regular User Charge Increases:** Ninety-one percent of the participants indicated they have adopted and/or are considering rate increases to sustain financial capacity. This approach is consistent with industry recommended financial best practices such as diligent multi-year financial planning and rate adjustment process.
- **Meter Replacement Program:** Recovering usage revenues commensurate with the actual water use is as important as managing costs. Eighty-four percent of participants indicate they have engaged in or are considering implementing a proactive meter replacement program to ensure meter reading accuracy and thereby mitigation of potential revenue loss.
- **Stormwater User Fee Funding:** Many water utilities that have stormwater management responsibilities still recover stormwater costs through sewer charges or other mechanisms, without an explicit stormwater user charge. However, utility leaders are recognizing the viability of a stormwater user fee both for generating adequate funding capacity and, more importantly, enhancing equity of cost recovery. Nearly 27 percent of participants indicate that they are actively considering a stormwater user fee funding mechanism.

To best manage costs, utilities are engaging in the following four key strategies:

- **Regional Cooperation:** The water utility service delivery is highly fragmented with more than 40,000 utilities, many of which serve small population centers. With most of the utility costs being fixed, mid-size and small

communities face a greater challenge in managing costs because of lack of economies of scale. The concept of regional cooperation is beginning to take hold as 43 percent of the participants indicate that they are actively considering cooperation approaches.

- **Energy Performance:** Energy costs are a significant component of a utility's operations and maintenance (O&M) budget. While effective energy performance contracts are still in their infancy, 39 percent of the participants indicate that they are considering this as one of the cost management strategies.
- **Resource Recovery:** Complimenting energy management initiatives, resource recovery initiatives such as waste to energy, biosolids reuse, and aquifer recharge not only help optimize resources and cost but also provide some revenue-generation opportunities. While resource recovery is still a nascent phenomenon, nearly 37 percent of the participants are considering such strategies.
- **Alternative Capital Program Financing and/or Delivery:** Utilities that have scalable programs are beginning to explore alternative financing and delivery options, such as community-based public-private partnerships (CBP3) and other forms of partnership, to address multiple aspects including capital funding, risk management, and execution capacity. The survey indicates that while only 15 percent are engaged in private partnerships, 36 percent are considering them for the future.

As Figure 15 indicates, utilities overall — relative to the responses of the previous year — seem to indicate a slightly lower reliance on debt financing through municipal bonds and state revolving fund loans, and an increasing focus on alternative delivery approaches such as public-private partnerships. One plausible reason is that utilities are beginning to realize that traditional debt financing approaches can only go so far and that alternative capital funding mechanisms that also ensure performance must be examined.

FIGURE 15

Has your utility adopted, or is currently considering, any of the following strategies and tactics to help finance and/or deliver services and major capital programs? (Select one choice per row)

	By Year	
	2017	2018
Regular increases in user charges	87.3%	91.1%
Meter replacement program	87.5%	84.2%
Grants	83.9%	80.5%
Regional cooperation	71.7%	74.3%
Municipal bonds	80.3%	71.1%
State revolving funds	74.6%	67.6%
Water loss mitigation	69.0%	64.9%
Stormwater user fee funding	51.2%	57.7%
Resource recovery	58.3%	54.3%
Public-private partnerships or alternatively-financed projects	36.5%	51.5%
Energy performance or service contracts	60.0%	48.7%
Contract operations	38.1%	32.4%
Sales tax funding	13.0%	32.3%
Water Infrastructure Finance and Innovation Authority (WIFIA) funds	40.9%	29.0%

Source: Black & Veatch

Financial Policies

In utility financial planning and rate development, well-defined financial policies with financial metrics, especially those authorized by charter, provide a defensible and compelling basis for rate increases and a utility’s financial health. These metrics that ratings agencies value typically include debt service coverage of 1.2 or higher, rate stabilization funds to protect rate volatility and manage unforeseen costs, and equity enhancement through some level of cash financing of capital expenditures.

Most participants indicate adhering to basic principles such as revenue requirement being

supported by user charges, and at least 60 percent indicate having a reasonable operations and maintenance reserve balance. However, only one-third to less than half of the participants indicate achieving metrics on financial indicators that rating agencies typically use in assessing fiscal health.

This indicates a continuing need to educate utility administrators and decision-makers on the critical roles financial policies and financial performance play in building and maintaining financial resilience.

The road ahead in effective utility fiscal management would involve holistic planning and an implementation approach that focuses on multi-benefit initiatives and outcomes.

Stakeholder Engagement

Insights were sought on the following three factors pertaining to stakeholder engagement and customers, namely communication, rate approvals and customer assistance:

- **Communication:** Utilities appear to continue to stick to the conventional means of engaging with decision-makers and elected officials. Over 60 percent of the participants indicate using facility tours, workshops and briefings, and only 40 percent of the participants appear to leverage technologies such as web portals to disseminate information and engage with stakeholders. As councils, boards and commissions begin to include a more tech-savvy generation of leaders, it would be prudent for utilities to take advantage of available technologies for a more interactive and responsive stakeholder engagement.
- **Rate Approval:** Proactive stakeholder engagement can help garner multi-year rate approvals, which provide for funding certainty for the operations and capital initiatives in the immediate term. It is noteworthy that more than 71 percent of utilities report they are able to get approval for at least two consecutive years or more of rate increases. In contrast, almost 30 percent of utilities indicate they are unable to seek any multi-year rate approvals.
- **Customer Assistance:** Balancing rate increases with customer assistance programs could not only enhance customer experience but also help navigate the rate approval challenges. The survey indicated that nearly half of the participants offer low-income programs, and only 31 percent offer even payment plans. The recovery of revenue loss associated with any customer assistance is a challenging phenomenon as some state regulations may explicitly prohibit the recovery of such revenue loss from other ratepayers that do not qualify for customer assistance.

Overall, utilities are beginning to engage in strategies and practices that help address revenue and cost management, evaluate alternative capital program funding and delivery mechanisms, and navigate the rate approval process. The road ahead in effective utility fiscal management would involve holistic planning and an implementation approach that focuses on multi-benefit initiatives and outcomes.

Lynn Allen is a Managing Director in Black & Veatch management consulting. He specializes in energy management and resource planning in the municipal and public power sectors, advising clients on supply alternatives and market analytics to optimize portfolio operations and mitigate energy price risk. Allen has advanced innovative analytics and methodologies across multiple utility platforms to identify opportunities for energy optimization and supply portfolio design.

Ajay Kasarabada is the Distributed Energy Solutions Manager at Black & Veatch. He focuses on providing power, industrial and water/wastewater utility clients with technical solutions related to distributed energy resources and microgrid applications.

Wesley Smith is a Client Services Manager for Black & Veatch's water business and focuses on energy management in the water sector. He provides technical solutions and project delivery options related to energy efficiency, energy generation and energy recovery.

Smart Water Solutions

AMID WATER AND POWER NEXUS, FORWARD THINKING DRIVES SUSTAINABILITY

By Lynn Allen, Ajay Kasarabada and Wes Smith

The U.S. power sector has entered a period of transformation, and water and wastewater utilities are responding by examining and addressing how these changes are impacting costs, reliability and resiliency. In recent years, federal environmental regulators have gently pressed the nation's energy-intensive water and wastewater sites to lead the charge in energy efficiency, starting with a comprehensive strategy to make that happen.

Yet even as immense opportunities for greater sustainability and resiliency abound through rethinking energy use, many utilities remain on the sidelines in this potential game-changing nexus of water and power.

In an industry replete with aging infrastructure and a mindset of doing more with less, water and wastewater treatment sites are traditionally among a community's biggest users of energy, given the pumps, motors and other equipment that run around the clock.

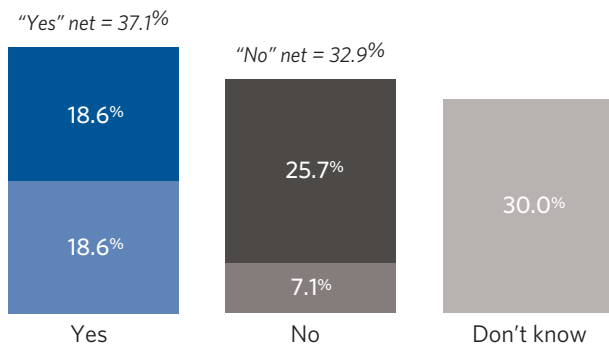
Some water utilities are turning to solar power, and facilities with limited land space for solar installations are adopting innovative solutions.



FIGURE 16

Does your utility have an energy master plan? (Select one)

- Comprehensive
- No plans in development
- Not comprehensive
- Working on a plan

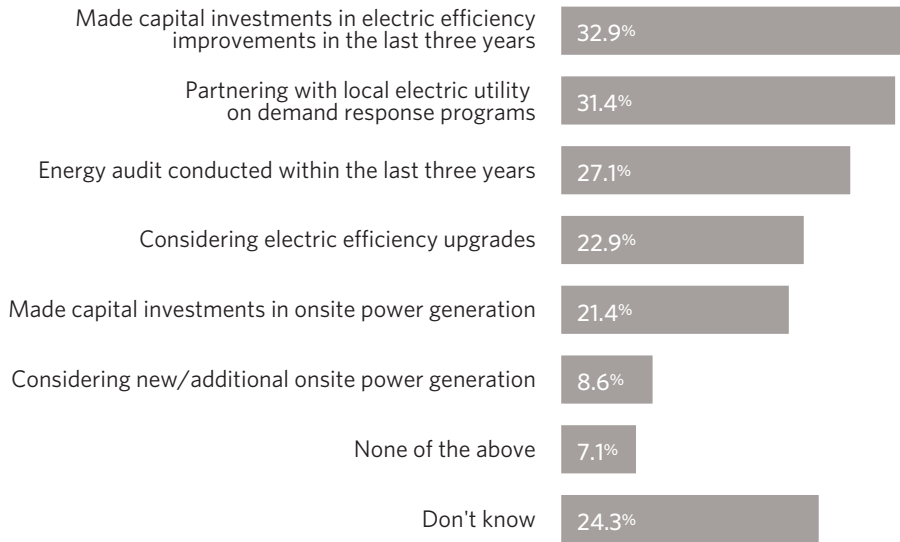


Source: Black & Veatch

However, a survey for Black & Veatch’s 2018 *Strategic Directions: Water Report* shows that only a little more than one-third of respondents have an actual foundational energy master plan. And even then, half of those respondents said their plan could not be considered comprehensive. An additional 30 percent were not sure if they had any energy master guide, while another one in four respondents said piecing together such a plan together was not in the works (Figure 16). In both of those respects, the takeaway may be the lack of recognition of the significant energy impacts in the water industry.

FIGURE 17

What is your utility currently doing to manage electricity usage costs? (Select all that apply)



Source: Black & Veatch

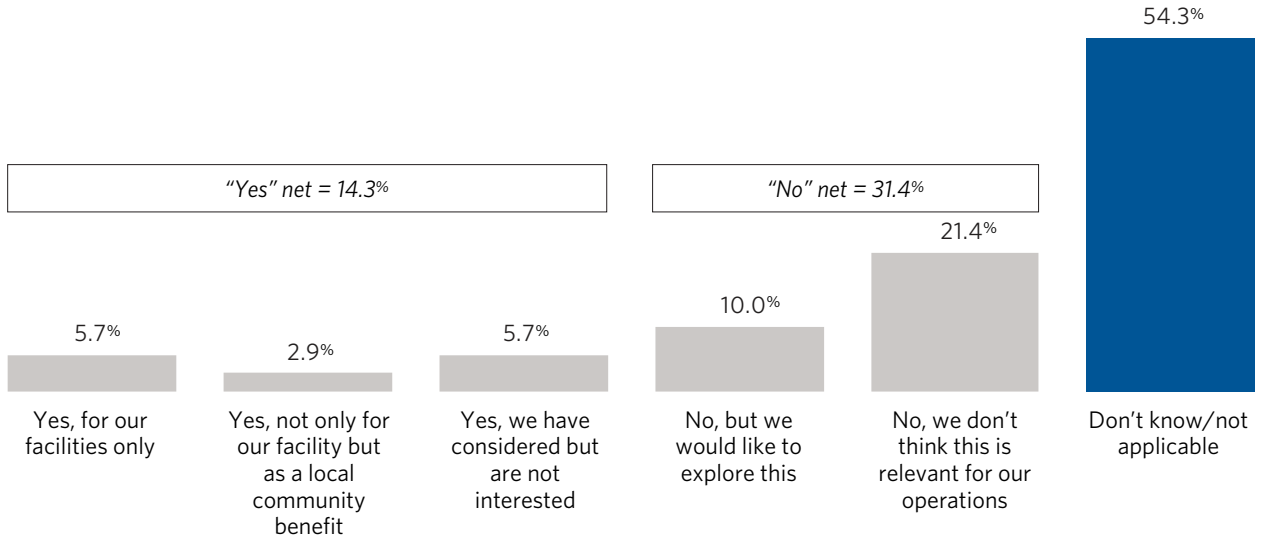
Still, according to the survey, many in the water sector are taking steps to control electricity costs, with nearly one of every three respondents saying they either have made capital investments in power efficiency upgrades in the past three years, or they have partnered with a local electric utility on demand-response programs. Such investments may include installing more efficient pumps, aerators and blowers. Less than 10 percent of respondents, however, said they were considering new or additional on-site power generation (Figure 17).

Diesel engines overwhelmingly prevail as the backup electricity source that water and water treatment plants have at the ready for critical generation if power disruptions hit, typically because of severe, violent weather events or even earthquakes, but such backup generation is only temporary.

Some water utilities are turning to solar power, and facilities with limited land space for solar installations are adopting innovative solutions. In 2017, Hong Kong’s government hired Black & Veatch to examine the feasibility of floating solar farms across 17 impounded reservoirs. By turning to Black & Veatch, an integral player in development of Hong Kong’s water supply since 1930, Hong Kong hopes to curb evaporation-related water loss while quelling algae growth and, of course, generating renewable power. Studies so far have shown the arrays do not observably affect water quality or wildlife. Similar tests of floating solar are under way elsewhere in Asia.

FIGURE 18

Has your utility considered microgrids for resilience and revenue generation? (Select one)



Source: Black & Veatch

Water and wastewater utilities typically are less familiar with the concept of a microgrid than other major utilities. Microgrids hold the promise of greater resilience through reliable service when catastrophic events lead to extended loss of grid power, although the 2018 *Strategic Directions: Water Report* survey again suggests that water providers are not seizing on that potential. A sliver of respondents — just six percent — said they have considered microgrids only for their sites, while three percent have pondered it both for their facility and as a community benefit (Figure 18).

An overwhelming three-quarters of the respondents did not consider microgrids relevant to their operations, or the respondents did not know whether that option had been considered or was applicable. Reasons for such inaction vary from a preoccupation with tending to key processes and the plant's core operations to a complacency or reticence about investing in anything ancillary to their distribution, collection or treatment systems.

On the energy recovery side, opportunities also are legion through such options as collecting

and cleaning biogas recovered during the waste digestion process or power generation from effluent water flows. Biogas can be used to generate power using on-site engines, or it can be injected as a renewable natural gas into existing pipelines. These processes create energy through feedstocks that are constantly available at a wastewater plant. Effluent wastewater flows can be harnessed to generate electricity for behind-the-meter supply, providing added value from what would otherwise constitute an expense-side byproduct.

As the nexus of water and power becomes more deeply seated and defined, it is time for water utilities to address their energy usage patterns and costs and to scrutinize their resiliency and sustainability, perhaps beginning with an energy audit that gives a granular look at their power use and portfolio capabilities. More forward-thinking influencers are needed in the water utilities industry and municipal operations to systematically engage decision-makers, step beyond convention and hasten change by exploiting technology that cuts costs while generating revenue with on-site assets.

Smart Water Solutions

COMMERCIAL AND INDUSTRIAL WATER: FIT-FOR-PURPOSE GAINS TRACTION

By [Jim Fitzpatrick](#) and [Mike Preston](#)

Jim Fitzpatrick is a Senior Process Engineer in Black & Veatch's Water Technology Group. He has supported Black & Veatch's water and power businesses with planning, studying, designing and commissioning water and wastewater treatment facilities for industrial, utility and municipal clients for 24 years.

Mike Preston is the Industrial Water Treatment Section Leader and a Project Engineer at Black & Veatch. A registered professional engineer, Preston has spent his 30-year career in Black & Veatch's power and oil & gas businesses evaluating and designing industrial water and wastewater treatment systems.

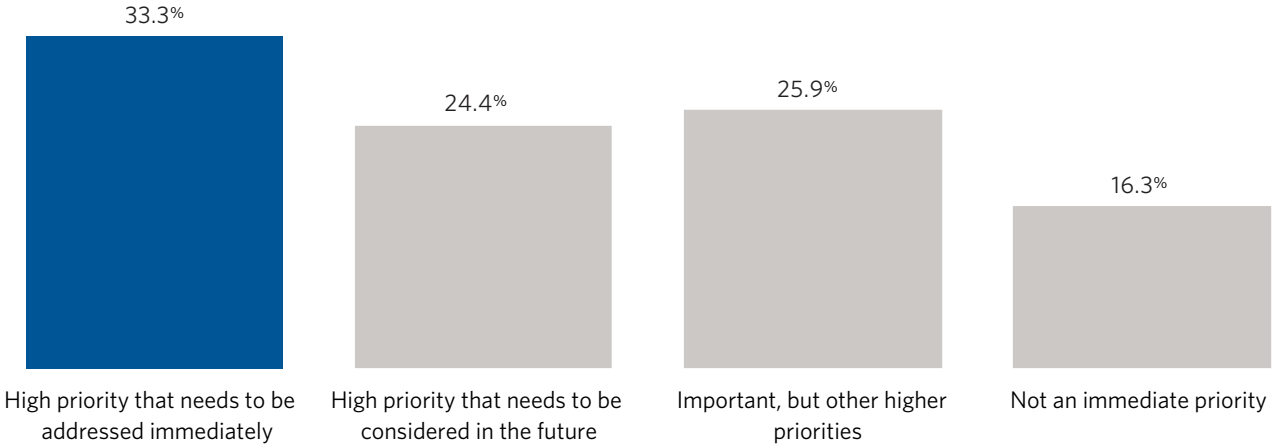
A limitless supply of potable water no longer can be taken for granted by commercial and industrial water consumers, which can be unsettling for organizations where water is the lifeblood of their operations. Heavy water users, from power plants to oil and gas refineries, chemical plants, data centers and more are recognizing that they need to manage water differently. Business success, and even corporate survival, may depend on it.

The cultural transition is underway, with multiple forces driving it. Water is becoming more expensive (or accurately valued) as government subsidies related to water supply and treatment are being reduced, leaving consumers increasingly exposed to the true costs behind producing and maintaining that water supply.

Water scarcity is also a growing concern, with 58 percent of water industry professionals from the *2018 Strategic Directions: Water Report* survey naming water supply/scarcity the most significant climate change issue for water utilities. This isn't just an issue in arid regions, either. For example, along the U.S. gulf coast, river watersheds are becoming over-allocated from heavy use. Public perception is another factor – when a company consumes as much water as thousands or millions of residential users, they likely will come under scrutiny. Reducing their water footprint demonstrates that they are a good steward of resources in their community.

FIGURE 19

How would you define the priority of water management and water/wastewater treatment for your organization? (Select one choice)



Source: Black & Veatch

Thinking Differently About Water

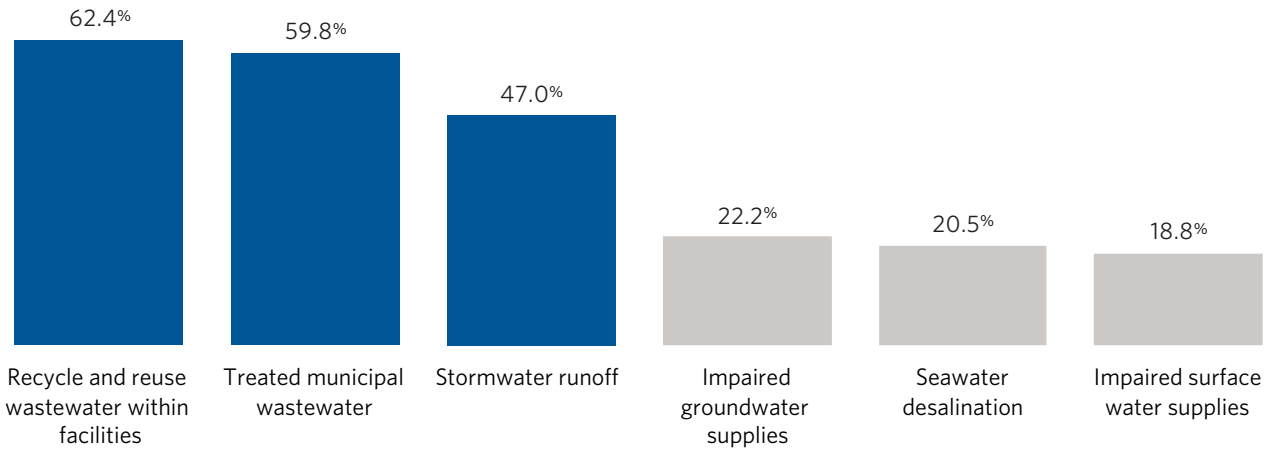
For all the above reasons, companies across the nation are recognizing that they may not need pristine drinking water for their industrial processes. They are revisiting their operations, considering new approaches and looking for smarter ways to manage their water supply.

As an example, the data center industry consumes large quantities of water to cool their servers and other equipment. Reliability is essential, and potable water long has been viewed as the only way to provide it. But alternative cooling methods have emerged, including treated wastewater shown to provide acceptable quality. These initiatives are being replicated across water-intensive industries as companies look closely at newly available options.

Survey results reflect this increased awareness. Of nearly 200 professionals with an industrial operations or engineering/technical role, one-third consider water management and water/wastewater treatment a high priority for their organization that needs to be addressed immediately, while a broader 84 percent see it as important to their business (Figure 19). Survey respondents were from multiple sectors, including chemicals, manufacturing, and metals and mining, suggesting that interest in water reuse and alternative water supplies is pervasive.

FIGURE 20

With regard to water supply, which alternative water supplies would you consider as viable options? (Select all that apply)



Source: Black & Veatch

Alternative Water Supply Sources

Survey results also suggest what types of alternative resources will be the focus of initial efforts. Sixty-two percent of respondents consider recycling and reusing wastewater within their facilities a viable option, while 47 percent see opportunities in using stormwater runoff (Figure 20). Both of these categories can be considered low-hanging fruit, involving process changes where water could be used more efficiently without a major capital investment. There also are areas under a company’s direct control, which simplifies implementation.

The second highest response is significant for other reasons. Nearly 60 percent of those surveyed believe treated municipal wastewater will be a viable option for their operations – as it is increasingly being seen as reliable, cost-effective and sustainable.

With this new model, for instance, a utility will make treated wastewater available to its industrial customers at a purity level suitable for a company’s application. These are collaborative projects that not only benefit industrial users but also provide value for the utility and its residential customers. Not only is there more

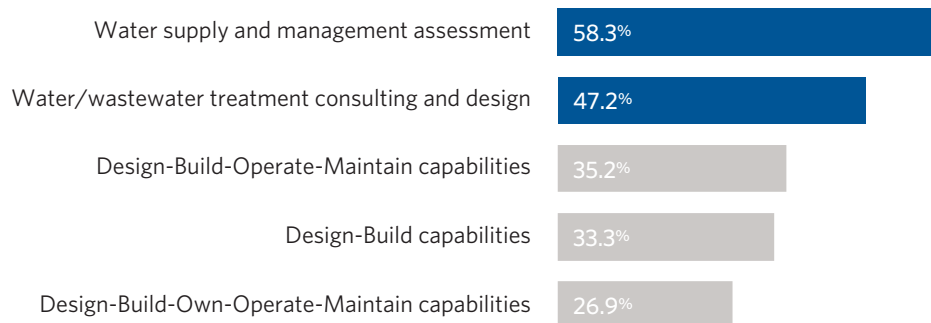
fresh water and drinking water to go around, utilities may be able to avoid costly capacity additions because using wastewater for heavy industrial applications greatly eases the demand for potable water.

These mutually beneficial collaborations are another area where Black & Veatch is providing assistance and expertise. For example, Koch Fertilizer, LLC, recently accepted the inaugural Oklahoma Water Resources Board “Water for 2060 Excellence Award” for a Black & Veatch-designed water plant upgrade that is reducing its dependence on city potable water by more than four million gallons daily using treated water from the city’s wastewater treatment plant.

In northern California, a partnership between East Bay Municipal Utility District and Chevron is reducing the refinery’s demand for potable water by treating water for reuse to the level of purity required. And in Mankato, Minnesota, the city is partnering with Calpine Corporation to use treated wastewater effluent to cool the local power plant. Other collaboration projects are underway or planned.

FIGURE 21

What type of third party services would your organization value in regards to water supply, water management, and water/wastewater treatment? (Select all that apply)



Source: Black & Veatch

Getting Started

Survey results also suggest that much of the work at this stage involves determining how to proceed – how to use water appropriately and the different options for water management at industrial facilities. Many organizations are interested in the expertise of an outside party that can provide these services, with nearly 60 percent of respondents stating their company would value a water supply and management assessment. A somewhat smaller number, 47 percent, would value water/wastewater treatment consulting and design, and still lower for building and operating — suggesting that most initiatives are in their initial stages (Figure 21).

A water supply and management assessment examines how a facility currently uses water and provides suggestions for practical conservation measures as well as the estimated savings from fit-for-purpose water management. An assessment also can help evaluate how water is managed, what water quality various operations require, what can be done differently, and the pros and cons of each option.

Meeting the Water Challenge

Rising costs, limited supplies and relentless demand are forcing commercial and industrial users into new ways of thinking about water. While potable water has been the gold standard for industrial water users for generations, today’s challenges require a fit-for-purpose approach.

Making it work is more complex than simply turning on the tap, but it is essential when consumption is high and resources are finite. The first step is to determine what level of water purity is required for specific processes, and then make that water available in a way that is reliable, cost-effective and environmentally sustainable.

Companies also are recognizing that they no longer can be isolated from the needs of other water consumers, both industrial and residential. Industrial and commercial facilities increasingly are collaborating with public utilities and other partners in holistic solutions for water use that benefit all stakeholders.

With the right approach, it is possible to manage water effectively in today’s challenging environment – both as a good corporate citizen and a successful business.

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Chris Mueller is an Associate Vice President and Regional Practice Manager for heavy civil at Black & Veatch. With more than 30 years of experience, Mueller led major heavy civil and construction management programs on the West Coast before relocating to Colorado. As a Practice Manager for Black & Veatch's water business, Mueller specializes in tunnels, dams and geotechnical engineering related to water storage and conveyance.

Smart Water Solutions

RESILIENCY, REDUNDANCY PROPEL PUSH TO WATER STORAGE

By [Faruk Oksuz and Chris Mueller](#)

Water service providers continue to explore opportunities for water storage and conveyance systems to enhance the future and reliability of their systems while also providing environmental benefits and security in meeting growing demand for safe, reliable water. According to the *2018 Strategic Directions: Water Report* survey, demand for water storage and conveyance projects is driven primarily by resiliency and redundancy (79 percent) goals, population growth (67 percent) and the need to replace aging infrastructure that is at or beyond its design life (63 percent) (Figure 22).

The path forward will not be easy. The industry sees the lack of project funding and long, drawn out project development cycles — including environmental clearance, regulatory review and permitting — as among the key challenges (Figure 23). As a result, most utilities inevitably opt to patch their systems with short-term remedies; sometimes an inability to take systems out of service for complete rehabilitation or replacement leaves them no other choice.

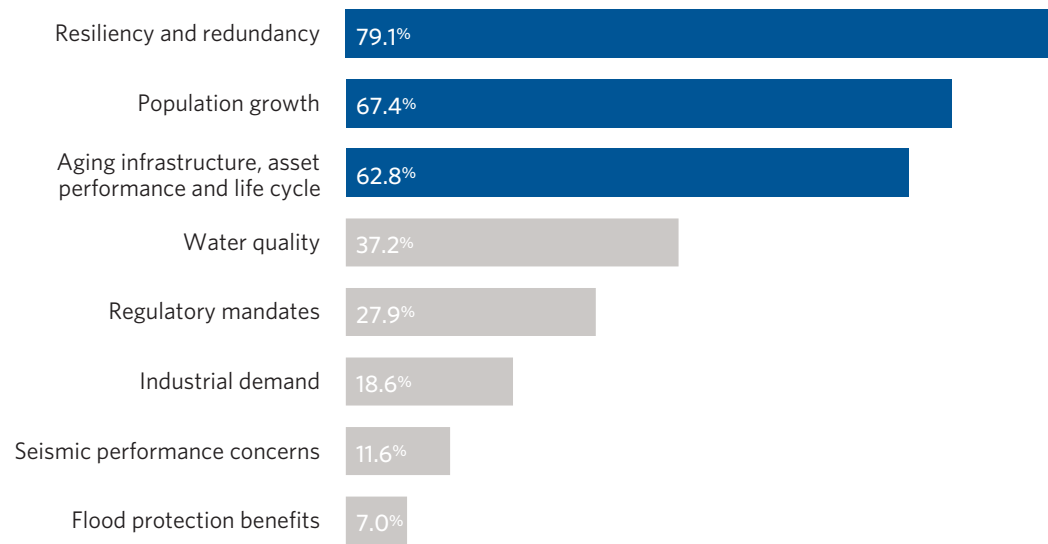
No matter the challenges, there is a dire need to harness and store water in the western United States, where climate change and prolonged periods of drought impact the ability of municipal agencies to meet water supply demand in dry years. In other parts of the country, changing patterns in climate have contributed to unprecedented flood events with corresponding impacts to water quality and billions of dollars in damage to property. Throughout the Midwest and South

Central region of the country, cities and municipal agencies are looking at large capital spends involving tunnels and other forms of underground storage and conveyance to address flood concerns and combined sewer overflows (CSOs).

In addition, much of today's aged infrastructure is being taxed at capacity and has reached the end of its useable service life. Survey results show that all respondents agree that the top priorities are renewal and replacement.

FIGURE 22

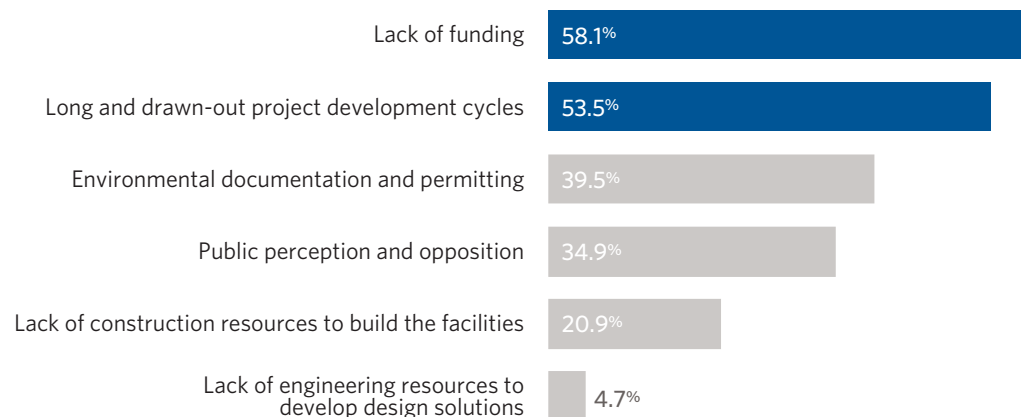
What are the drivers contributing to your needs for additional water supply storage and transmission infrastructure? (Select all that apply)



Source: Black & Veatch

FIGURE 23

What are the major challenges you see in the development and delivery of water storage and transmission infrastructure? (Select all that apply)



Source: Black & Veatch

Tunneling also can allow for a more practical solution in built urban environments because it removes surface disruption to nearby buildings, utilities and structures.

Investing in Technology and Innovation

When it comes to the design, construction, and operation and maintenance of dams and tunnels, vast opportunity lies in utilizing the power of data and predictive data analysis to identify solutions related to long-term system reliability and redundancy, as well as the efficiency and energy neutrality of systems operations. In addition, the import of construction technology from other parts of the world continues as part of the innovation in the construction of these types of facilities.

Looking to dams as an example, there are two projects nearing construction that will make use of an asphaltic concrete core because of limitations on locally sourced materials that would more typically be used to provide the effective “plug” for these dams.

There are huge improvements in tunnel construction methods, specifically using single pass and pre-cast concrete segments with sophisticated tunnel boring machines (TBMs). Compared to 10 to 15 years ago, today’s TBMs are sophisticated machines, the result of years of technological advances. Not only can they address difficult and differing ground conditions that were once considered impossible to tunnel through, but these advances in TBM technology are allowing project managers to manage and marginalize many of the ground risks.

Tunneling also can allow for a more practical solution in built urban environments because it removes surface disruption to nearby

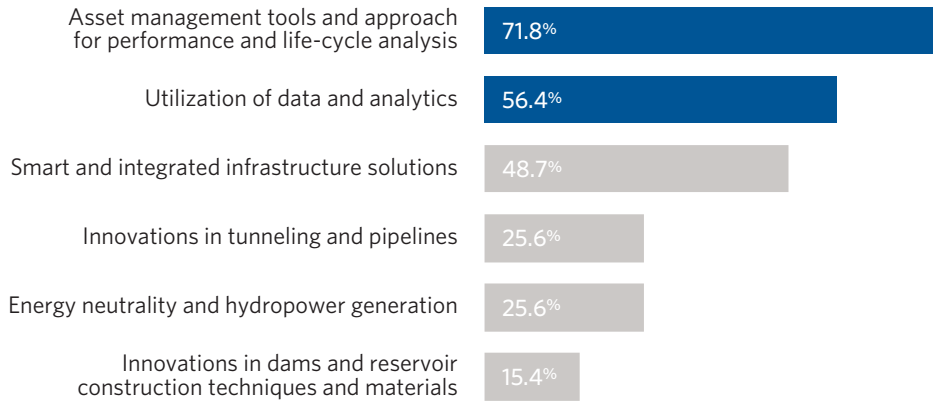
buildings, utilities and structures. Plus, surface area in urban settings is limited, leaving little opportunity to perform the work necessary to address a flood issue or CSO (e.g., install large basins that could store the CSO that occur during rain events). In rural or mountainous regions, tunneling can serve as a solution to spare the landscape. Tunneling can mitigate the significant impacts that would otherwise occur with surface construction and the challenges that make surface construction difficult or challenging.

With increased use and economies of scale, the cost of high-strength and fiber-reinforced pre-cast concrete segments has come down, affording owners a higher quality and more reliable tunnel lining system in all types of ground conditions.

Today, mega water tunnels are being considered for marquee conveyance projects such as the California Department of Water Resources’ California WaterFix project, which will rely on two large, four-story tall tunnels and associated intake structures to carry fresh water from the Sacramento River. Harris County in Houston, Texas, is also investigating a large tunnel program to address stormwater and flood issues. These projects — and many others like them — will likely directly benefit from advancement in TBMs and tunnel segments.

FIGURE 24

What are some of the innovative approaches you have considered in evaluation and development and rehabilitation of your storage and transmission infrastructure? (Select all that apply)



Source: Black & Veatch

Dam Safety Relies on Asset Management

Aging dam infrastructure has caused dam safety to become a major concern for owners and the public, with recent significant flood events resulting in the failure or near failure of these facilities. There are considerable challenges in evaluating the condition of dams and their appurtenances because of limitations on direct observation and testing. In addition, key questions exist with respect to current and representative design criteria for dams and reservoirs related to flood. The cost to address repair and rehabilitation of dams — or their appurtenances such as gates and spillways — is staggering, and can be on the order of five to 10 times the amount of the original construction costs. This does not take into account the even more significant socioeconomic aspects and threat to life, property and the environment.

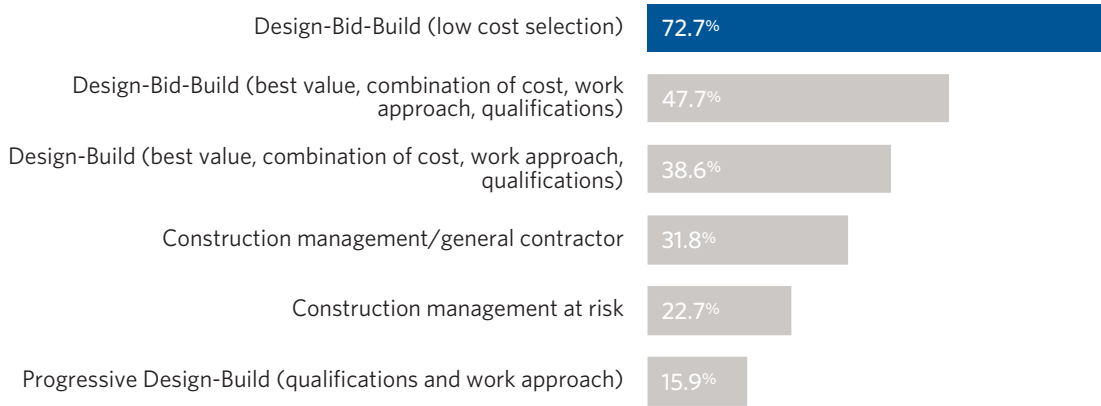
To address this critical issue, Black & Veatch is advancing an asset-management approach to dam safety that is integrated with the standard

practice. Data analytics and asset management strategies are successfully used for complete assessment and safety of dams, and owners/operators are helped to identify gaps in their management of these critical and often vital assets.

Survey results show that the industry is on board with this approach because the majority of agencies and utilities are considering implementing asset management tools and approaches (72 percent), followed by data and analytics (56 percent), and the corresponding smart and integrated infrastructure solutions (49 percent) (Figure 24).

FIGURE 25

What forms of project delivery does your organization utilize? (Select all that apply)



Source: Black & Veatch

Encountering and Managing Risk

Dams, tunnels and other heavy civil construction involve significant risks because of the extensive use of the ground in construction and the linear nature of construction operations. Data analytics and rigorous business case evaluations have enhanced understanding of these risks — as well as the associated uncertainty in cost and schedule for these types of projects — allowing for better decisions to be made on the configuration of projects that meet a particular need. In addition, implementing a formal risk process over the full life cycle of planning, design and construction is demonstrating benefit by allowing companies to anticipate and mitigate project challenges ahead of their potential occurrence.

Heavy civil dams and tunnels for storage and conveyance can benefit from the full arsenal of risk management strategies – from planning to design, construction and commissioning. As shown in the survey results, most owners (73 percent) continue to rely on traditional design-bid-build and low cost selection processes (Figure 25).

There is great opportunity to embrace the benefits of pre-qualification, early contractor involvement or alliance contracting approaches. The same goes for contract risk management documents such as geotechnical baseline reports and escrow documents, and management tools such as risk register.

While it is true that conventional design-bid-build is still used extensively, it is encouraging to see increasing use of program or project development strategies using owner’s engineer, construction managers and even alternative delivery options such as progressive design-build and construction manager at risk (CMAR) to achieve early contractor involvement in these projects.

Moving from “Future-Ready” to Now

Obstacles remain as many agency and utility leaders continue to struggle to educate a skeptical public about the value of water – whether harnessed or actively in use.

The world is changing, and clients who invest in smarter, leaner ways to deliver projects — and who are open to ideas of program management, owner’s engineering, risk assessment and asset management — will be in the right place at the right time.

As the water industry continues to advance, “future-ready systems” won’t be a buzzword much longer because those that have the foresight to invest in risk and gap analysis — and take a hard, unbiased look at their assets — begin to see greater success when planning projects to make their systems more resilient and reliable.

Clients who invest in
smarter, leaner ways
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Andrew Smith is the national watershed, stormwater and flood management Practice Lead for Black & Veatch's water business. Based in Kansas City, Smith leads the development and delivery of a range of solutions ranging from watershed management and green infrastructure to complex hydraulic modeling and design. He is a recognized leader in the fields of strategic program development and asset management for stormwater.

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Smart Water Solutions

CAN'T AFFORD RESILIENCE? EXPENSIVE STORMS CHANGE THE COST QUESTION

By Brian Gettinger, Rafael Frias, Andrew Smith and James Strayer

With its idyllic perch on a harbor inlet of the Atlantic Ocean, the city of Charleston, South Carolina, adroitly manages both the risks and rewards of life by the sea. Residents enjoy the temperate conditions common to southern climes while wrestling with the wet-weather consequences of its ocean neighbor. Statistics revealed by city leaders recently showed that by 2040, Charleston's water conveyance systems will be impacted by elevated waters on 180 days of each year – a stark data point for an exposed city coping with a stormy and rising sea.

From Charleston to Houston and Chicago to California, diverse factors are pressuring government and utility leaders to consider the long-term health and resilience of their water management systems. In the West, arid conditions and frequent drought cycles challenge supplies and force innovative alternative water supply and recycled water solutions. In the Midwest and Northeast, heavy rain events challenge sewer overflow systems and often put water in the basements of homes and on the floors of businesses. Along the Gulf and Eastern Coasts, increasingly frequent extreme storms are outmatching legacy conveyance strategies, while sea level rise and seawater intrusion pose concerns for low-lying cities along the Atlantic.

Increasingly frequent
extreme storms are
outmatching legacy
conveyance strategies.



Major planning and construction projects are underway in these regions to address the near-term threats of increasingly common flooding events and to proactively plan for long-term resilience. In Charleston, a massive large-diameter tunneling project to increase stormwater management capacity is being followed by programmatic efforts to holistically create resilience. Besieged by Hurricane Harvey in 2017, Houston recently announced a feasibility study to determine whether a large-scale tunneling system could help it cope with future storms. To the north, recently completed phases of the massive, years-in-the-making Tunnel and Reservoir Plan (TARP) is helping Chicago more effectively handle the combined sewer overflows generated by heavy rains.

Tunnels, which often are proposed under larger programs for population centers, are advantageous because they remove floodwaters from problem areas and improve mobility by keeping streets free of water. They generally do so without requiring significant property acquisition or causing damage to environmental habitats. Black & Veatch is the construction manager for the city of Dallas for the largest stormwater tunnel in Texas - a 5-mile-long tunnel more than 30 feet in diameter that will collect and convey floodwater, significantly reduce flooding south of the tunnel, and protect East Dallas businesses and residents from flood damages.

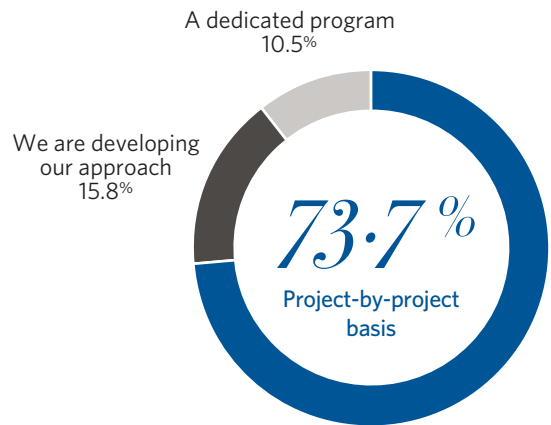
Such programmatic approaches to water system and flood resilience grab headlines for their size and scale, but they also appear to be glaring exceptions to the rule. Black & Veatch's 2018

Strategic Directions: Water Report survey shows that respondents often view resilience on a project-by-project basis that approaches the topic through a near-term prism and neglects the potential benefits of systems integration and long-term effectiveness (Figure 26).

Vulnerable to a host of well-known challenges — changing climate conditions, aging infrastructure, growing populations, increasingly complex water quality issues, limited resources and other economic stressors — utilities, agencies and municipalities end up tackling issues individually (many times driven to action by a weather event) without an overarching plan.

FIGURE 26

How is your organization approaching resilience-associated planning and/or improvements? (Select one)



Source: Black & Veatch

Rise of the Chief Resilience Officer

Recent estimates by the National Oceanic and Atmospheric Administration indicate the combined costs of 2017 hurricanes Harvey and Maria at \$215 billion, ranking as the second and third most expensive storms on record, respectively. Flooding in Asia and South America added to the global bill, bringing the disaster toll into staggering focus and sparking urgent conversations about the long-term mitigation of risks associated with aging or schematically outdated water conveyance systems.

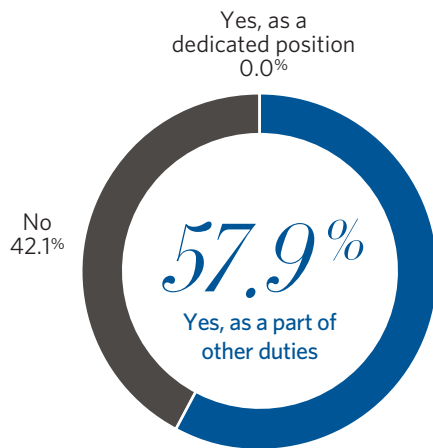
Not too many years ago, suggesting to a major coastal city that it should deploy infrastructure meant to withstand a once-a-millennium flood event might have produced surprised looks. Now, not only are those cities looking at extreme scenarios, they are looking harder at who within the organization is focused on such events. The survey results show room for improvement. About 42 percent of respondents reported having no one assigned specifically to resilience, while about 58 percent reported resilience as being among a position’s various duties. While none of the surveyed organizations had a position dedicated to the topic of resilience, there are emerging examples as follows (Figure 27).

Some cities that once tacked strategic resilience planning onto the job description for broader managerial roles are devoting new positions to resilience alone – directly addressing a potential weakness demonstrated in the Black & Veatch report survey. In South Florida, multiple jurisdictions have begun appointing Chief Resilience Officers (CROs) to take leadership roles in managing long-term resilience-focused water infrastructure strategy. The city of Miami, Miami Beach, Broward County, Miami-Dade

County and Palm Beach County all have CROs. After Superstorm Sandy battered New York City in 2012, the city created the Mayor’s Office of Recovery and Resiliency, which aggressively has pursued projects aimed at shielding Manhattan from the effects of major storms and climate change. For instance, the office has started work on the East Side Coastal Resiliency Project, which seeks to use a large-scale system of levees and walls to create a flood protection zone while providing increased access to the city’s waterfronts.

FIGURE 27

Does your organization have a position identified to advance the topic and practices of resilience? (Select one)



Source: Black & Veatch

FIGURE 28

Which of the following do you feel are most beneficial in helping your organization overcome the barriers that prevent you from having stormwater/integrated planning programs? (Select top three choices)



Source: Black & Veatch

Asset Management and Risk

CROs likely understand that their job involves asset management and that any planning for resilience starts with an asset vulnerability assessment. Better asset management ranked highest among factors critical to integrated planning programs, according to survey responses (Figure 28).

Resilience in many ways is a means to adequately identify and manage risk. Utilities or jurisdictions with robust planning mechanisms identify risks and vulnerability, while including contingency planning and establishing mitigation strategies and evaluations of how future conditions may change and affect the organization. An important distinction exists between having contingency plans for dealing with predicted events and adaptive strategies aimed at reducing future risks and the consequences of vulnerabilities.

Acknowledging the importance of resilience is one task. Determining how to finance it — in a do-more-with-less environment — is quite another. Having a common approach to prioritize investments that will improve environmental, customer, health and safety, financial and resilience factors as investment drivers is essential. Public engagement and communication of that plan also are essential to demonstrate to customers the dangers of doing nothing.

Resilience as the New Sustainability

Though formal plans may be slow in materializing, resilience concepts in recent years have resonated with water organization leaders, who now attach to them the kind of reverence once associated with sustainability. Just as sustainability has multiple meanings to multiple stakeholders — financial sustainability, environmental sustainability, etc., — so too does resilience. But the storms of recent years have given “resilience” in a weather and climate context special significance. As the **2017 Strategic Directions: Water Industry Report** noted, “A mounting focus on system resilience is clearly communicated through the increasing prioritization of climate change as a concern. Utilities are concerned with protecting assets from natural disasters and storms.”

One year later — a short span that brimmed with once-in-a-lifetime storm events — has only added to the urgency around resilience and how water conveyance infrastructure can be developed and managed to rebound from system shocks. Many cities are, so far, sitting out such planning because of understandable concerns over cost.

Other cities, however, are flipping the question on its head: Can they afford the costs of anything other than a holistic approach to planning and readiness?

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Leon Schieber, P.E., PMP, is Managing Director of Business Development for Black & Veatch Special Projects Corporation. He has worked on infrastructure projects for the U.S. government since 1990, serving in a variety of roles in planning, engineering, project/program management and business development. In his current role, he drives business strategy, communications, organizational effectiveness and new business sales and growth.

Smart Water Solutions

INTEGRATING MILITARY WATER SUPPLY INTO MISSION-CRITICAL PLANNING

By [Arlene Over](#) and [Leon Schieber](#)

The Department of Defense (DoD) has garnered considerable attention for its initiative to deploy more renewable energy at military facilities worldwide. Green energy goals have pushed facilities to implement distributed energy resources (DER) through integrated microgrids and other solutions to boost system resilience and energy security – all in the name of keeping missions on, even if local grid power is compromised. The benefits are easy enough to understand, but how could personnel perform their missions without an equally critical commodity, water?

High-profile energy projects such as the microgrid under development at **Marine Corps Air Station Miramar** are starting to evolve and prioritize water's role in base-wide initiatives. The initial project design included an base's Energy Operations Center, which will house all microgrid controls for operators, but is now being billed as an Energy and Water Operations Center to include water system monitoring. As military water supply and power continue to become more interconnected, integrated planning will be vital for infrastructure modernization projects.

Aside from supporting mission requirements, DoD facility managers also are faced with similar challenges to water utilities highlighted in this year's *Strategic Directions: Water Report* including limited funding, regulatory pressures and aging infrastructure. Fortunately that means that many bases can take lessons learned from industry leaders and adapt best practices to address budgetary restraints, meet compliance mandates and deliver long-term value.

Fort Leonard Wood Installs DoD's First Ultraviolet Water Purifying System

At Missouri's Fort Leonard Wood, a U.S. Army installation, a regulatory mandate to comply with Safe Drinking Act standards drove installation managers to find an economical technical solution to upgrade their water treatment system. Fort Leonard Wood's funding under the Sustainment, Restoration and Modernization (SRM) program limited the available funding for the modernization project. While their recently completed water infrastructure long-term capital investment plan (CIP) addressed the required investment to improve the water treatment plant, the plan needed adjustments to respond to the limited availability of funds.

Fort Leonard Wood's Director of Public Works staff and the U.S. Army Corps of Engineers' (USACE) Kansas City District worked in partnership with Black & Veatch to develop a CIP approach to provide an ultraviolet (UV) water treatment system in phases that could be implemented as SRM funds became available. The initial construction phase was limited to \$2 million in total cost.

The Black & Veatch team also maintains a working relationship with the Missouri Department of Natural Resources' Public Drinking Water Branch and Directorate of Public Works to ensure that all regulatory requirements are being met with this project to date. The innovative project was the first application of UV disinfectant technology for drinking water treatment in the DoD. The project included the design and construction of UV reactors that provide a clean and reliable water supply for the nearly 14,000 personnel living on base.

By applying state-of-the-art construction techniques and a streamlined technology option, as opposed to chemical treatment, costs were kept to a minimum and stringent project schedule requirements were met. Costs were further minimized by developing a limited occupancy facility and focusing on the industrial aspects of the project.

Smart Infrastructure Investments at Diego Garcia

U.S. Naval Support Facility Diego Garcia is on a small island in the British Indian Ocean and is home to military personnel that provide logistics support to operational forces deployed in the Indian Ocean and Persian Gulf. Like many small islands, freshwater aquifer purity and water distribution provide unique challenges for facility operators.

Diego Garcia's primary water treatment plant was designed and built prior to the adoption of current U.S.-based potable water quality standards. Interim filtration solutions were implemented but resulted in non-potable water to be distributed from the plant within the existing system, while potable water was delivered by tanker trucks to 300-500 gallon capacity tanks at public facilities and residential and industrial facilities. From there, potable water needed to be hand-carried to end users in each building.

To streamline treatment and distribution, the Naval Facilities Engineering Command (NAVFAC) Far East partnered with a design build firm to design and construct a new 1.2 million gallons per day (MGD) capacity water treatment plant and associated wells, pumping stations, and raw and treated water transmission mains. Black & Veatch was hired by the constructor to manage water treatment technology and design of the facility.

The following design and construction factors contributed to a smart, efficient and sustainable system:

- **Optimized Processes** - A low-pressure pump station conveys water from existing raw water storage tanks through the pre-filtration system to the nanofiltration (NF) membrane system inlet without the need for further transfer pumping. Redundant treatment units provide a high level of overall system reliability.
- **Instrumentation and Control** - Modifications to the existing SCADA system were made to control and monitor the existing well water systems and the new well water systems to help inform intelligent asset management decisions.
- **Civil/Site** - The new water treatment building's shape and orientation are based on an energy and sustainable design analysis approach. Further, the layout of new piping is optimized to directly connect to the existing system to minimize system loss.
- **Architecture/Structure** - Design and construction were coordinated to provide a Leadership in Energy and Environmental Design (LEED) Silver Certification. A 25 kilowatt (kW) solar photovoltaic panel array is provided on the roof. The building was designed as an essential facility, with applicable wind and seismic design criteria.

Procured under a design/build contract format, the new treatment plant and distribution system infrastructure provides potable water in compliance with all applicable water quality standards.

Collaboration with State Regulators Streamlines Project Development at Fort Carson

Colorado's Fort Carson seeks to be a strong community partner to manage water resources, which is vital in the arid western United States. Like many utilities across Colorado, the Fort Carson Wastewater Treatment Plant (FCWWTP) is facing stricter regulations, specifically to reduce nitrogen and phosphorus in its treated effluent discharge. The Colorado Department of Public Health and Environment (CDPHE) promulgated Regulation 85 to reduce loading of these nutrients in its waterways. The FCWWTP, which currently serves the base's soldiers, families and support personnel by treating an average of 1.5 MGD of wastewater daily, does not currently have capability for this level of treatment.

The FCWWTP team partnered with Black & Veatch to develop an innovative solution to treat nutrients by optimizing use of the biology at a wastewater treatment plant. Wastewater treatment, at its core, uses thousands of species of microorganisms purposefully grown in large aerated concrete basins to consume the "food" in the wastewater. These organisms then are removed via clarification, and the water is disinfected with UV light before being released into local waterways.

To save on capital expenditures, portions of the aerated basins will be converted to zones with low oxygen levels to naturally promote growth of microorganisms that consume nitrogen. Further, another basin will be converted to an anaerobic fermenter to grow phosphorus-consuming microorganisms.

This approach will save the facility in operations and maintenance costs otherwise required by traditional methods using chemicals to treat wastewater. The state-of-the-art fermenter process will support treating the base's wastewater to ensure that water being discharged is even cleaner than state mandates require, resulting in long-term value for Fort Carson and the local community alike. This also positions the facility well to meet anticipated stricter future-state requirements. To help navigate permitting for the project, Black & Veatch also leveraged existing relationships with the state of Colorado to provide early-stage permitting and design.

Adding Value to Military Infrastructure Projects

Though many military facility managers are beginning to understand the value of proactive integrated planning, continued collaboration with industry leaders can help translate water utility best practices for use at DoD facilities. Shifting mindsets in how water is just as critical to supporting missions as physical, above-ground infrastructure will also be vital in adding value to future modernization efforts.

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Perspectives

CAPITAL MAINTENANCE COMES TO THE FOREFRONT IN THE UK

By [Scott Aitken](#)

Change is afoot for water utilities in England and Wales. For the past 30 years these private companies have favored capital investment for the creation of new assets as the best way to achieve their service, environmental and quality targets. Looking to the future, however, new assets are likely to be the solution of last, rather than first, resort.

Among the most significant reasons for this change is the decision by the water sector's economic regulator, Ofwat, that the weighted average cost of capital (WACC) in the next price review will be at the lowest level since the privatisation of water services in England and Wales, in 1989.

Because the water companies created by the privatisation process are natural monopolies, the government of the day sought to protect customers' interests by creating the economic regulator — Ofwat — to control water bills and set service levels. This was achieved through a system of 'comparative competition,' central to which is the five-yearly price review cycle.

WACC, the assumption that Ofwat makes on the cost water companies will incur in raising debt or equity to fund investment in assets, is one of the biggest building blocks in the price review. The next review will be completed in 2019 (PR19), and will cover prices from 2020 to 2025.



The need for resilience in the face of such things as climate change has added to the requirements placed upon the water companies in England and Wales.

Ofwat is predicting a WACC — in Retail Price Index (RPI) terms — of 2.4 percent for PR19. This is a reduction of 1.3 percent from the 2014 price review's WACC, and a record low for regulated utilities. Ofwat's WACC forecast for PR19 is driven by lower expectations of the market cost of debt and equity. The effect on customer bills could result in an average saving per customer of £15 to £25 per year from 2020 onwards.

Since privatisation demand for water and sewerage services has proliferated as population has grown, water quality and environmental standards have become increasingly stringent. In more recent years the need for resilience in the face of such things as climate change has added to the requirements placed upon the water companies in England and Wales.

Investing in new assets, or extending existing assets, has been the companies' favoured response with £130 billion invested since 1989; however, concerns about the regulatory framework creating the potential for a capital

expenditure (CAPEX) bias was among the reasons for Ofwat's shift to a total expenditure (TOTEX) price review, rather than using separate CAPEX and operating expense (OPEX), for the current price review.

With a regulatory determination that is likely to see customer bills reduce — and a low WACC — CAPEX investment will need to be carefully considered and targeted. Water companies will be required to fund resilient systems and ensure that business processes and structures are lean and efficient. At the same time there will be no decrease in the quality and service level demands placed upon them while public, customer, political and regulatory scrutiny is growing. This means the water companies will need to focus on the performance of their existing assets — to an unparalleled degree — to ensure regulatory compliance, while also meeting the expectations of owners and shareholders. However, there is good news for water companies that want to do things differently and embrace change. Significant efficiency opportunities exist for the water

companies that can capitalise on both data and technology. Advances in both these areas are significant, affordable, and offer substantial benefits.

Advances in data capture and analysis and the insights that are revealed, combined with an ability to utilise and integrate technologies, will enable asset optimisation and hence leverage cost efficiencies whilst giving greater assurance on compliance and service. Similarly, water companies that can move toward more proactive maintenance approaches and operate performance and condition-based maintenance programs will transition from paying a cost of asset failure to a lower cost based on optimum asset intervention. Behavioral change also will be required, and should not be underestimated or overlooked as water companies and their partners embark on these operational and delivery realignments.

In terms of asset management and operation, the sector is not short of data. The deployment of analytics tools can transform asset data into actionable information for smart decision making; for example, the application of tools that allow asset performance data to be combined with external data, such as weather and rainfall information. Such tools enable the identification of operating condition trends that facilitate the development of new system operating procedures and interventions to mitigate pollution risk.

More sophisticated analysis of asset performance data will enable water companies to get a better understanding of which are their most critical assets and when intervention is required to keep those assets delivering optimum performance.

An early example of how these capital maintenance programs might look is Yorkshire

Water's (YW's) Workstream 69 (WS9). In collaboration with YW, Black & Veatch has developed a Lean Reliability Centred Maintenance (LRCM) program covering the water company's process safety critical assets.

Central to WS69 is Failure Modes Effects and Criticality Analysis (FMECA), which is being used to produce a condition-based maintenance program. In collaboration with YW's O&M teams, failure mode responses have been developed for each asset category.

Mobile technology is used to capture live asset survey findings and piping and instrumentation diagram updates, and upload these to a dynamic asset database, improving data accuracy for the FMECA study. Mobile devices also allow O&M teams to access the condition-based maintenance programme in the field, providing information needed to complete their tasks and instant feedback of asset/process performance. This system ensures that asset condition and performance is under constant review and allows maintenance teams to assess probability of failure and take informed, proactive action.

The systems and processes are facilitating evidence-based decision making for operational improvements and risk-based investment planning, and helping to remove unnecessary planned maintenance from O&M programmes, reducing spares holdings and reducing reactive maintenance by 30 percent.

Water companies are not a homogenous group and, as we head toward PR19, they are at different points along the journey to make asset management and capital maintenance viable tools for delivering successful outcomes during the 2020 to 2025 price review period. Some have already begun to embed the necessary practices and data analytics tools; others are

less quick to adapt to what is likely to become the new normal.

Another change to make water companies assess large capital projects differently in the future is Ofwat's introduction of Direct Procurement for Customers (DPC).

Under DPC water companies are expected to competitively tender services for discrete, large-scale projects with an anticipated whole-life TOTEX of more than £100 million. This differs from current procurement norms in that the tenders cover more aspects of service, for instance operations and — in a significant departure — project finance. The change is intended to deliver reduced total costs for larger capital projects, including the cost of operations and financing, over a potential 15 to 25 year timeframe that will span numerous price review periods. Ofwat is also expecting this approach to foster innovation and reduce customer bills by pushing down CAPEX and OPEX.

The number of projects likely to meet the DPC cost and guidance requirements is uncertain, but numerous large CAPEX projects should be less likely. Under the current price review period, projects such as Thames Tideway with an estimated capital cost of £4.2 billion, or Severn Trent's £300 million Birmingham water supply resilience scheme are cited as examples that would have met the new criteria, but these are rare projects.

Looking to future programmes, Thames Water's £1 billion Abingdon Reservoir project may potentially meet the DPC criteria. It remains to be seen, however, whether third parties are able to raise the finance and deliver such a project more cheaply than Thames Water could. Assets delivered by DPC would not contribute to a water company's Regulatory Capital Value

(RCV) – a measure of the company's capital base and major component the regulatory price limit formula. This creates a potential disincentive for water companies, as a larger RCV typically results in the ability to charge customers more.

Water companies' re-evaluation of CAPEX investment began with the 2015 price review's shift from separate CAPEX and OPEX reporting to a TOTEX assessment. The move away from CAPEX will be given significantly more impetus in PR19 with the reduced WACC and introduction of DPC. As capital programmes continue to change and be re-shaped the future will be characterized by increasingly sophisticated asset management strategies and capital maintenance regimes, with smart data analytics as a key enabler.

Geoffrey Piggott is the Project Director of Singapore's Integrated Waste Management Facility leading a multi-disciplinary consultancy team of Black & Veatch and AECOM, in association with Ramboll. Until recently he was part of the Black & Veatch and AECOM joint venture that continues to programme manage the delivery of the Deep Tunnel Sewerage System Phase 2, serving as the initial Project Director for three-plus years. He has more than 40 years of global experience supporting major infrastructure projects in water, wastewater and solid waste management.

Perspectives

INTEGRATED PLANNING FOR LONG-TERM SUSTAINABILITY IN SINGAPORE

By [Geoffrey Piggott](#)

On reclaimed land at the southwestern tip of Singapore, the co-location of two major utility infrastructure facilities are set to establish new standards in how we harness water, waste and energy resources. They serve as potential blueprints on how, under the right conditions, utilities can work together to realize and meet advanced sustainability goals.

The two co-located facilities are part of the master planning behind Singapore's multi-billion dollar Integrated Waste Management Facility and Deep Tunnel Sewerage System (DTSS) Phase 2. National Environment Agency (NEA) and PUB, Singapore's national water agency are planning a world's first: never before have two large scale advanced solid waste management and water reclamation facilities been planned from the ground up on a co-located basis.

The design and operation of the Integrated Waste Management Facility (IWMF) and the Tuas Water Reclamation Plant (TWRP) will realize various synergies as compared to building two standalone plants.

For example, sludge generated at the TWRP will be sent next door to the IWMF to be incinerated. In return, the amount of electricity produced at the IWMF will be sufficient to power both the operations of the IWMF as well as the TWRP with excess electricity exported to the grid.

Below are some more details on what's been planned and what resources will be optimized and shared between the facilities.



IWMF

The IWMF is an integral part of NEA's long term plan to meet Singapore's solid waste management needs. The waste-to-energy (WTE) facility within the IWMF will be designed with an incineration capacity of 5,800 tonnes per day (tpd) making it one of the largest in the world (Figure 29). In addition to the treatment of incinerable waste, the IWMF will also process source-segregated food waste, household recyclables collected from the National Recycling Programme (NRP) and dewatered sludge from the adjacent TWRP.

The plan is to develop IWMF in two phases. The first phase comprising a WTE Facility (capacity: 2,900tpd), a Materials Recovery Facility (MRF) (capacity: 250tpd), food waste treatment facility (capacity: 400tpd) and a sludge incineration facility (capacity: 800tpd) will be completed in 2024.

The incineration capacity of the IWMF will increase to 5,800tpd when the 2,900tpd WTE facility under the second phase is developed in 2027. The highly energy efficient processes at IWMF will maximise resource recovery and electricity production while meeting stringent environmental standards.

DTSS Phase 2

A superhighway for used water management, the DTSS is a core water infrastructure which provides a cost effective and sustainable solution to support Singapore's continued growth and meet its long term needs for used water collection, treatment, reclamation and disposal. DTSS uses deep tunnels to convey used water by gravity to centralized water reclamation plants (WRPs) located at the coastal areas in Singapore.

With Phase 1 completed in 2008, the detailed design and construction of Phase 2 is underway

and expected to be complete by 2025. Forty kilometers of deep tunnels and 60 kilometers of link sewers will cover the western and southern parts of Singapore.

A highlight of DTSS Phase 2 will be the new TWRP, which will contribute to Singapore's long-term goal of increasing the NEWater supply to meet up to 55 percent of total water demand, further strengthening water sustainability and resilience for Singapore. In addition, the TWRP will treat 800,000 cubic meters of used water per day, making it the largest membrane bioreactor facility in the world.

FIGURE 29

Key IWMF-TWRP Synergies in Deep Tunnel Sewerage Systems

Material Handling

1. Food waste from IWMF to TWRP
For co-digestion with used water sludge
2. Dewatered sludge from TWRP to IWMF
For treatment and electricity production
3. Grit from TWRP to IWMF for treatment

Energy

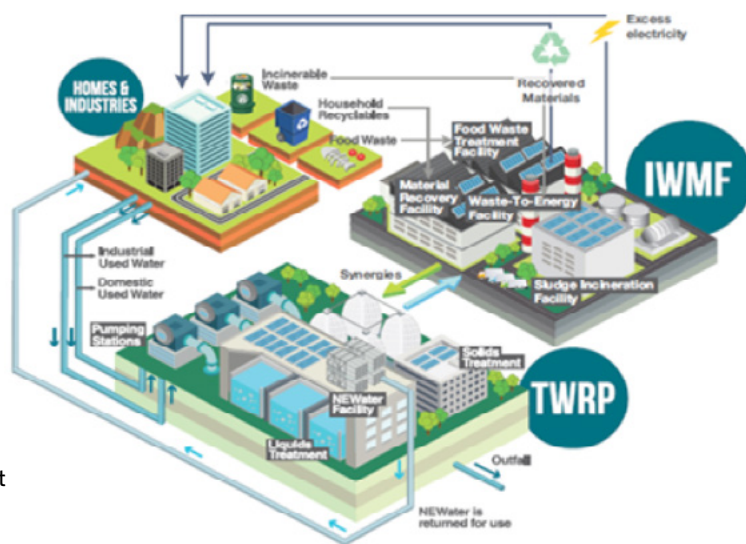
4. Power supply from IWMF to TWRP
5. Biogas from TWRP to IWMF
For higher overall plant thermal efficiency at IWMF
6. Steam from IWMF to TWRP
For sludge thermal hydrolysis and greasy waste treatment

Water

7. Water from TWRP to IWMF for process use
8. Used water from IWMF to TWRP for treatment

Others

9. Foul exhaust air from TWRP to IWMF
for combustion



* A joint venture between Black & Veatch and AECOM is the Lead Consultant to PUB and is programme managing the delivery of DTSS Phase 2. For NEA, a multi-disciplinary consultancy team led by Black & Veatch and AECOM, in association with Ramboll, is the Owner's Engineer for the preparation of engineering plans and design specifications and for the supervision and management of the works.

** Image is courtesy of PUB and NEA.

Bruce Allender is Chief Operating Officer of infraManagement Group LLC (iMG), a wholly owned subsidiary of Black & Veatch. He has more than 25 years of experience in the water and wastewater sector and has been part of teams that have proposed and implemented public-private partnerships in North America, Australia and Asia Pacific for the water and wastewater municipal and industrial marketplace.

Greg Cannito serves as the Partnership Innovator for Corvias, and applies their innovative public-private partnership (P3) model to challenges faced by public sector institutions nationwide. He has nearly two decades of experience with structured financing, development and management of P3 implementation. Cannito helped develop The Clean Water Partnership, a first-of-its-kind P3 pilot program addressing federal environmental regulatory requirements for stormwater management in Prince George's County.

Troy Hunt is Corvias' Partnership Implementer. As a licensed civil engineer, he develops and establishes operational frameworks for the company's community based P3s, including the Clean Water Partnership. He has 27 years of experience in technical design, project and program management, financial and business operations, and regional leadership.

Francesca McCann is a leader in the U.S. water industry with expertise in investments, public-private partnerships and project development. Before joining iMG, McCann served as CEO for Abengoa Water, where she successfully led the \$3.4 billion Vista Ridge Project in San Antonio, Texas. McCann also founded a consulting company, Global Water Strategies, and started her water career in 2003, covering the water sector for Wall Street.

Perspectives

A NEW MODEL FOR STORMWATER: COMMUNITY-BASED P3S

By Bruce Allender, Greg Cannito, Troy Hunt and Francesca McCann

The need for innovative, efficient solutions and models to help communities across the United States meet their stormwater regulatory requirements is growing, and community-based public-private partnerships (CBP3s) may hold the key. Recognizing the challenges of funding large-scale stormwater management infrastructure projects, Region 3 of the U.S. Environmental Protection Agency (EPA) developed the CBP3 framework to assist communities in these efforts. Black & Veatch's *2018 Strategic Directions: Water Report* survey found that there is a strong receptivity to better understanding the role the private sector can play in a community-based P3 structure and consideration of such a partnership.

What is a CBP3?

A CBP3 is a partnership between a local government and a private partner that agrees to a performance-based approach to build infrastructure and deliver on broader policy goals and objectives, such as established community-centered metrics, incentivized redevelopment and workforce development initiatives. CBP3s span the full life cycle of assets, including a maintenance period for the assets that lasts 20 to 30 years, to ensure asset sustainability and increased economic and social impact for a community.

Examples of social/economic community benefits include disadvantaged (e.g., minority-, woman- or veteran-owned) business-entity participation, education, faith-based initiatives and local business participation that provide job creation and positive economic impact for the community. Twenty-nine percent of respondents said they would consider a partnership with the private sector that combines the construction and long-term O&M of stormwater and yields community benefits (e.g., job creation, economic development, etc.).

Local governments and private partners both benefit when the agreed key performance indicators (KPIs) that are associated with social/economic and delivery performance outcomes of the contract are met. In this way, the partnership aligns goals and metrics to create a true alliance and accountability between the two entities.

CBP3s address a delivery need that transfers greater risk and accountability to the private sector and are “financing agnostic.”

Program Benefits

Employing a CBP3 approach enables local governments to incentivize a greater volume of shovel-ready projects to the marketplace to access a greater array of tax-exempt and/or taxable capital sources; however, the CBP3 in and of itself does not represent a new source of funding, but instead the framework to aggregate projects for greater scale. It better leverages existing available funding to maximize the amount of infrastructure and community impact delivered and does so through a turnkey delivery model whereby the partnership can efficiently deliver projects, inspection services, maintenance services or other infrastructure installations in a timely manner. A CBP3 delivers community benefits through agreed performance outcomes, with greater risk transfer than traditional design-bid-build (DBB) approaches.

The community is able to greatly increase efficiency; expedite the delivery of needed infrastructure improvements across the community at scale; deliver quantifiable community and economic impact metrics; accomplish greater inclusion and outreach with the local community; meet regulatory requirements; and create a measured return on investment for stormwater ratepayers in the community.

CBP3s address a delivery need that transfers greater risk and accountability to the private sector and are “financing agnostic.” A CBP3 is a collaborative effort driven by project goals and deliverables rather than a specific financing approach. CBP3s address bottom-line efficiency and exist to provide greater output, value and risk transfer than the traditional DBB delivery approach. The DBB approach requires a great

deal of involvement and risk on the part of local governments to contract design services, procure and inspect construction, and maintain assets.

The private partner provides services and risk transfer that varies from one CBP3 to another, but typical services include planning, design, procurement, construction management, capital structuring, financing, regulatory submittals, public involvement and long-term maintenance. With a CBP3, these services are wrapped into a single contract that provides commercial guarantees to the public entity for agreed performance outcome.

Community Benefits

Another CBP3 driver is community and economic impact. CBP3s drive community and economic impact through the inclusion of KPIs that center on broad policy goals and objectives for the community. The private partner adopts accountability for these goals and objectives as part of the delivery plan. For example, stormwater infrastructure is pervasive throughout a community, and investing in stormwater infrastructure can create opportunities for other strategic infrastructure investments while delivering stormwater projects such as sidewalks, recreation parks, community areas, bus stops and street improvements. Investment in stormwater infrastructure through a CBP3 framework can also be a catalyst for other development through strategic land reclamation.

In addition, stormwater development has a lot of low barrier to entry activities and responsibilities across design, construction and maintenance operations that create tremendous opportunities for coordinated local subcontractor development, workforce training

and employment. A community can achieve almost triple its local return on investment of every dollar spent on a stormwater program delivered through a CBP3. Based on Esri economic development models, communities that have employed a CBP3 have almost tripled the amount of each dollar invested to reflect over \$2.5 billion dollars returned in economic stimulus in the community.

Leveraging Other Trends

The CBP3 model is evolving in parallel with other trends in the stormwater field that complement the use of CBP3s. One is the application of asset management techniques and principles for stormwater systems. The water and wastewater sectors have used asset management for many years. Some stormwater utilities and/or system managers are beginning to seek ways to capture the benefits of asset management frameworks that link assets to business planning and budgeting for the life cycle of the assets.

The application of asset management to stormwater-management programs helps program providers move from reactive to predictive management practices, efficiently apply limited resources and quickly and confidently communicate the value of the system and future improvement plans. Incorporating a CBP3 approach to improve stormwater assets encourages managers to look at their stormwater systems as managed infrastructure, which naturally dovetails well with asset management techniques and practices. Asset management programs can be capital-intensive, so incorporating a CBP3 approach can help lower costs and provide an overall economic benefit to the community.

Case Study: Prince George's County Clean Water Partnership

The Clean Water Partnership (CWP) between Prince George's County, Maryland and Corvias is a leading example of the benefits of a CBP3. CWP is a three-year, \$100 million program that initially retrofits 2,000 acres of stormwater infrastructure and is endorsed by both the Maryland Department of the Environment (MDE) and EPA, and meets their regulatory Municipal Separate Storm Sewer System (MS4) permitting, total maximum daily load (TMDL) and Clean Water Act compliance requirements. The economic impact is estimated to be \$210 million, with economic impact of local expenditures of \$132 million based on a Regional Economic Studies Institute study conducted by Towson University.

Throughout this 30-year, \$100-million partnership, Prince George's County retains control of assets, investments and prioritization for the full program of work. Together, the county, along with its private partner, Corvias, is better able to build local capacity and buy-in, and achieve social, economic and infrastructure benefits that go well beyond the industry's standard measurement of cost per acre.

Cindy Wallis-Lage is President of Black & Veatch's water business, leading the company's efforts to address billions of dollars in water infrastructure needs around the world. Wallis-Lage joined the company in 1987 and has provided leadership and project expertise to more than 100 municipal and industrial facilities throughout the United States, the U.K. and Asia Pacific. Wallis-Lage joined the Black & Veatch Board of Directors in 2012. A licensed professional engineer, she earned a Bachelor of Science in Civil Engineering from Kansas State University in 1985 and her Master of Science in Environmental Health Engineering from the University of Kansas.

Closing Commentary

DIGITAL WATER IS SMARTER WATER

By Cindy Wallis-Lage

Recently, a long-time client and Midwestern city utilities manager posed a fundamental challenge to Black & Veatch's water leadership team: "Help me understand, explain and implement a digital water program."

At first glance, we believed this would be a simple exercise drawing upon our experience as a comprehensive global water solutions provider. Over the past decade, investments in two-way electronic meters, system monitoring equipment and other technologies have created a wealth of data – the "digital" in digital water. But as we explored this client's individual needs, and compared them to clients across the United States, United Kingdom and Asia, we realized that for many water utilities, identifying the components of a digital water program is one thing. Implementing a holistic solution is quite another.

Many water utilities lack a granular understanding of the cost to operate each of their various processes, so there is no way to determine which treatment processes or operational strategies would result in the most efficient outcome.

Built in the 1950s and renovated occasionally in the following decades, our client's 10 million-gallon-per-day treatment plant was becoming costlier to operate and maintain. This, at a time when public demand to do more with less is a constant drumbeat, and historic funding streams have been limited despite population growth placing additional demand on their system.

To manage these competing forces, many of our clients have looked to technology to provide greater efficiency and network intelligence. Distributed metering and sensing technology deployed across service territories are pushing the Internet of Things (IoT) deeper into client organizations and creating vast amounts of data. Yet too frequently the presence of multiple data management systems creates silos that prevent operators from drawing actionable insights from the constant stream of information.

What this means is that data capture, while a critical process, must have corresponding software applications that can harness information to improve operations. Analysis that drives decision-making, recognizes and adapts to changing conditions and, critically, helps match demand with the supply resources at hand is the heart of a digital water program.

To move from data harvesting towards data science, our client began a three-month pilot

of ASSET360[®], and quickly the platform began providing actionable intelligence to plant operators. Through comparisons of condition data and flow rates, the cost of operating conventional versus high-rate treatment during wet weather events could now be quantified, as well as the energy savings associated with tighter dissolved oxygen control. Real-time process calculations saved plant operators valuable time from manipulating spreadsheets, and remote monitoring by Black & Veatch process engineers provided them with added confidence and support for their decision-making process. The pilot was later expanded to include the city's two wastewater treatment plants and two water treatment plants.

From treatment plant operations to customer consumption at the tap, this is just one example of how global water leaders are learning that digital water is smarter water. Just as the ubiquity of smart phones and intelligent devices has redefined our understanding of connectivity, the power of data to increase system effectiveness is changing our understanding of water infrastructure. The same technology that speeds voice and video services to our smartphones, tablets and laptops is altering how we manage operational maintenance, think about system safety and security and how we plan for future resilience.

Big Data Can Form Sustainable Systems

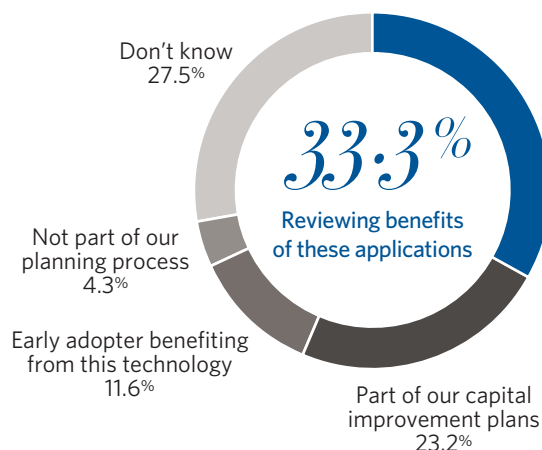
Our *2018 Strategic Directions: Water Report* shows room for growth among water utilities that are collecting robust amounts of data from their systems. For instance, the report finds that only 14 percent of respondents are using their SCADA device data to predict asset failure, monitor system health, and for other operational purposes. Just over one-third of respondents reported using SCADA for operational purposes only, and less than half stated said they are using SCADA to monitor both system health and operational purposes.

The true value of a digital water program emerges when operators can move from archiving and analysis of historical data to forward-looking predictive and prescriptive analytics. For example, the algorithms can comb through data sets to identify previously undetectable changes in vibrations on a pump or changes in water pressure within a system and schedule preemptive maintenance to maximize uptime. This can help organizations anticipate leaks or asset failures and inform the roadmap of capital investments. Accordingly, significant numbers of utilities are moving toward the adoption of data-driven strategies, but much room remains (Figure 30).

In resource-conscious regions, there is growing urgency around the use of data to help sustain and secure supply. Black & Veatch recently joined Thames Water's eight20 alliance to deliver innovative, sustainable solutions to water customers in the UK with data analytics services enhancing and enabling the alliance's effort. Apart from the eight20 alliance and using a combination of data, subject matter expertise and analytics tools, Black & Veatch provided a proactive solution to help Thames Water avoid sewage spills.

FIGURE 30

Where would you say you are on the spectrum for adapting smart technologies in your water development plan? (Select one choice)



Source: Black & Veatch

In the Thames Water control center, multiple disparate data sets were accessed via SCADA control through alarms, asset performance and weather data. Using algorithms to analyze conditions in network and pumping systems, Thames Water could predict with high probability up to seven days in advance that a pollution event was possible, then take steps to prevent system spillage. Thames Water hasn't had a discharge of untreated water since the new method of analysis was implemented.

In Hong Kong's Happy Valley, frequent flooding of the city's cultural, economic and entertainment center required government officials to explore a solution that combined both heavy hardware and large doses of data. Working with the Drainage Services Department (DSD) of the Government of the Hong Kong Special Administrative Region, an underground storage strategy was developed that leveraged a large tank to store stormwater runoff during severe rainfall events.

At the center of the SCADA system is a network of sensors to capture tidal levels in Victoria Harbor and water levels at several strategic locations, including the storage tank and upstream and downstream of the culvert. With the adjustable dams and SCADA system, the tank remains dry most of the time as stormwater flows along the culvert adjacent to the storage tank straight to the downstream drainage network. During heavy rain, the water level rises and SCADA triggers the adjustable dam system in which excess runoff enters the storage tank. After a rainfall event when the water level in the culvert drops, the movable dams can be further lowered to drain the stored stormwater to the downstream drainage network by gravity.

Secure Networks

As IoT expands through a range of connected devices and artificial intelligence (AI) propels further system automation, the complexity of interactions on utility networks increases. Higher risk follows.

Recent cybersecurity cases underscore the threats. Earlier this year, it was reported that the water treatment plant system of a European utility was compromised by malware aimed at mining cryptocurrency. Ransomware incidents, as well as larger hacking disruptions like the recent incident that shut down the City of Atlanta's online systems, reveal the conundrum for organizations considering the transition to a more robust use of data: How can we make our systems smarter but also safer?

Webs of connected devices have opened new entry points for hackers to disable critical infrastructure or release personal information. Interestingly, physical and cybersecurity threats rank comparatively low among survey respondents' challenges and even dropped in importance from 2017 (Figure 31). How utilities manage and safeguard both customer data and behind-the-fence data transport will be crucial.

Recent cybersecurity cases reveal the conundrum for organizations considering the transition to a more robust use of data: How can we make our systems smarter, but also safer?

FIGURE 31

Please rate the importance of each of the following challenges to water/wastewater/stormwater industry.
(Select one choice per row)

% Answering Very Important or Important	Year					
	2013	2014	2015	2016	2017	2018
Aging water and wastewater infrastructure	97.2%	95.7%	94.0%	94.3%	96.1%	92.1%
System resilience	Not Asked	Not Asked	78.8%	82.2%	92.6%	90.4%
Managing capital costs	94.9%	96.2%	93.9%	92.6%	91.5%	90.2%
Managing operational costs	94.4%	91.8%	93.7%	90.9%	93.6%	89.3%
Data collection and management	Not Asked	Not Asked	Not Asked	Not Asked	85.8%	84.2%
Justifying CIPs and/or rate requirements	Not Asked	91.3%	78.5%	89.1%	89.6%	83.3%
Information technology	84.3%	78.5%	80.1%	85.4%	81.7%	82.3%
Condition assessment capabilities	Not Asked	Not Asked	Not Asked	Not Asked	83.5%	80.1%
Treatment technology	80.3%	77.7%	72.4%	80.2%	78.4%	79.8%
Integrated water planning	Not Asked	Not Asked	68.9%	77.2%	80.4%	78.1%
Water conservation	Not Asked	Not Asked	61.9%	66.9%	73.5%	77.7%
Increasing/expanding regulation	85.9%	81.0%	80.2%	77.0%	75.9%	77.3%
Aging workforce	78.5%	78.0%	79.0%	78.1%	76.4%	73.6%
Recruiting employees for specialized fields	Not Asked	76.1%	61.4%	70.3%	75.8%	72.9%
Water scarcity or availability	71.2%	68.5%	54.5%	63.0%	72.4%	71.7%
Availability of funding in the marketplace	Not Asked	64.1%	52.1%	61.8%	68.0%	69.4%
Physical and/or cybersecurity threats	Not Asked	Not Asked	68.1%	70.6%	79.2%	69.1%
Water loss (non-revenue water)	64.3%	61.7%	65.5%	62.9%	65.3%	66.5%
Political will to establish a sustainable rates	Not Asked	65.5%	45.1%	57.8%	57.5%	58.5%

Source: Black & Veatch

Data for the Road Ahead

The amount of data moving across networks is staggering and defies an accurate count; it's always growing. And the demand curve for data-hungry applications will continue to rise so long as things like regulatory compliance, the planning of future investments and predicting asset failure rely on them.

Moving to digital water will test the comfort levels of many leaders within our industry, who've long resisted technologies that are disrupting the power and telecommunications sectors. Their concerns are real: Will too much reliance on automation and data override human intuition and control? Can we adequately protect our systems against hacks and privacy intrusions? And even if the benefits of data are clear, how do we convince skeptical stakeholders that the payoffs are worth the investment? After all, projects — now more than ever — must be hard-wired to performance and the bottom line.

Data performs because it informs. It gives us keen insights about asset health. It reports and predicts customer consumption and equipment failure. It forecasts how flood control systems will fare under load and much, much more. Putting this information to work requires two crucial components: the decision to embrace data, and to finding experienced partners who can help water and treatment providers manage and act on that data.

We marvel at the way smartphones and data-rich applications have reshaped how we chat with loved ones, listen to music or even turn on the lights. Let's fully turn that technology toward the critical job of safeguarding our world's most precious resource.

The amount of data moving across networks is staggering and defies an accurate count; it's always growing.

The true value of digital water emerges when we move from data harvesting to data science. Collecting information is good. Using data to make better decisions and plan for a safe and abundant supply is game-changing.

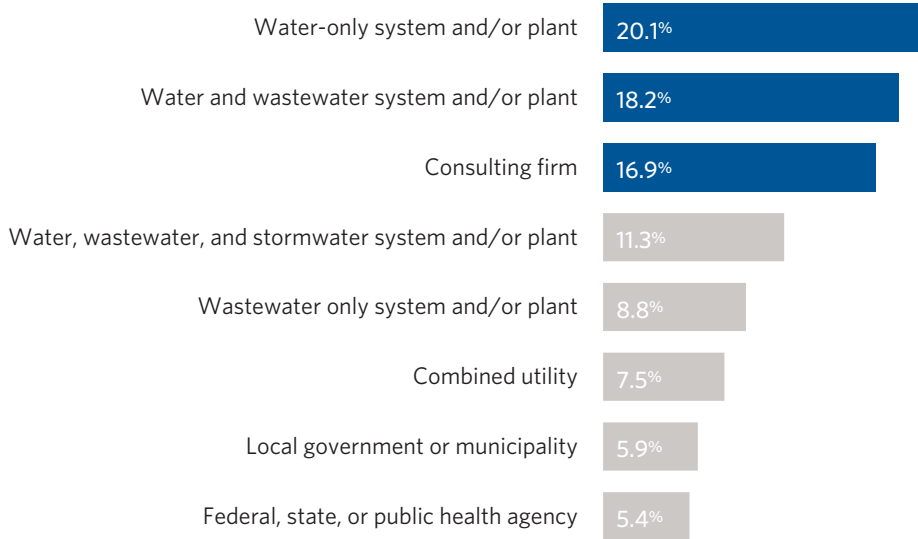
2018 Report Background

The Black & Veatch *2018 Strategic Directions: Water Report* is a compilation of data and analysis from an industrywide survey. This year's survey was conducted online from 26 February 2018 through 18 March 2018. A total of 517 qualified utility, municipal, commercial and community stakeholders completed a majority of the survey.

Because the survey was administered online, the amount of self-selection bias is unknown; therefore, no estimates of sampling error have been calculated. The following figures provide additional details on the participants in this year's survey.

ORGANIZATION TYPE

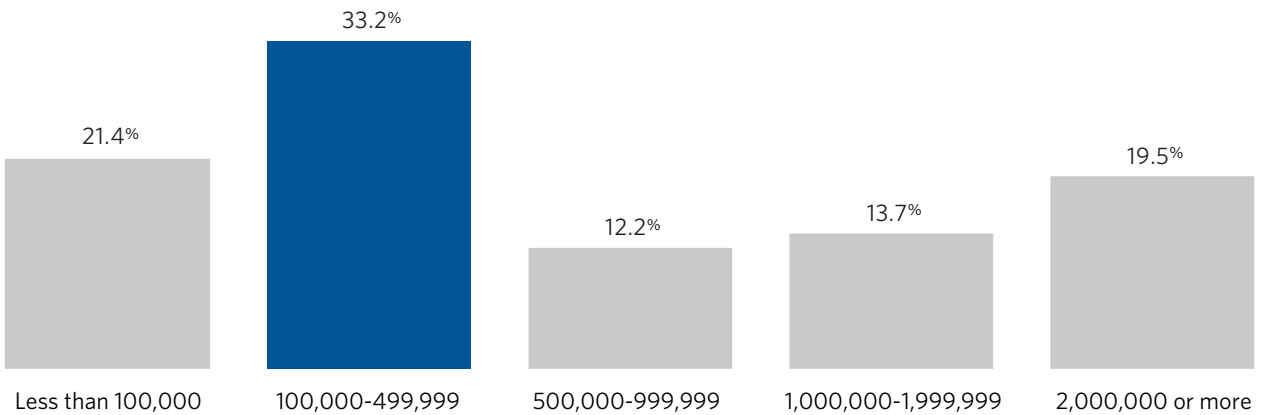
Which of the following **BEST** describes your organization?



Source: Black & Veatch

POPULATION SERVED

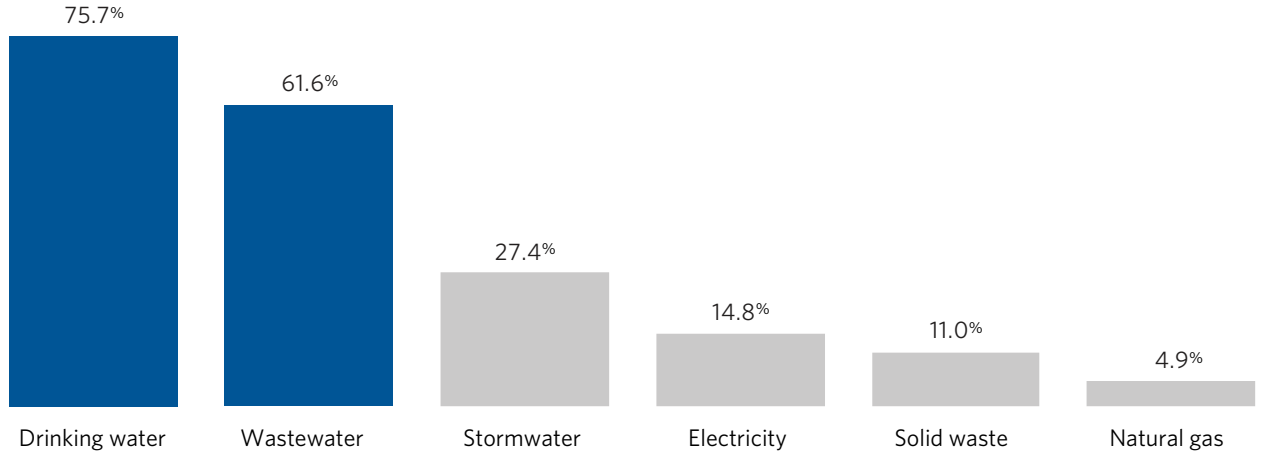
What is the estimated population served by your organization? (Select one)



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UTILITY TYPE

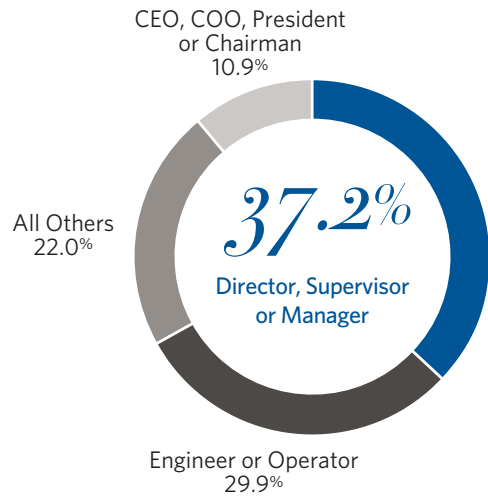
Please identify all of the services provided by your utility (Select all that apply)



Source: Black & Veatch

JOB FUNCTION

Which of the following best describes the position you currently hold within your company? (Select one)



Source: Black & Veatch

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Which items represent the most significant sustainability issues for water utilities? (Select top three choices)
- 6 **FIGURE 2**
Which of the following statements **BEST** represents your community's overall impression of desalination and water reuse? (Select one choice for each)
- 7 **FIGURE 3**
What is your organization's current level of usage and future plans for the following types of non-potable industrial reuse? (Select one choice per row).
- 10 **FIGURE 4**
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How interested are you in implementing the following integrated planning techniques and technologies moving forward?

- 21** **FIGURE 10**
Which of the following do you feel are most beneficial in helping your organization overcome the barriers that prevent you from having stormwater/integrated planning programs? (Select top three choices)
- 23** **FIGURE 11**
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Please rate the importance of each of the following challenges to water/wastewater/stormwater industry. (Select one choice per row)

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