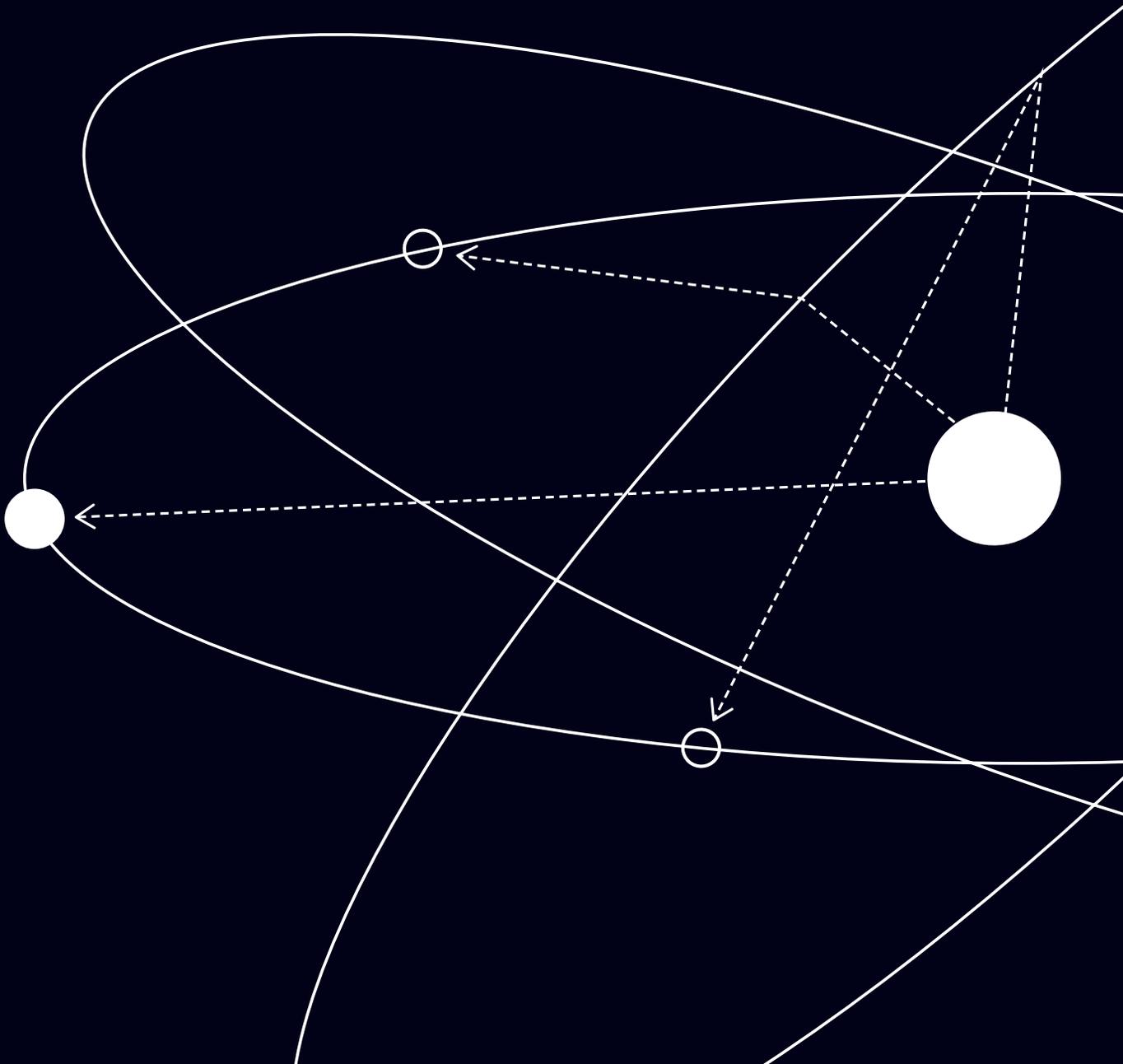




**BLACK & VEATCH**  
Building a world of difference.®

# 2015 STRATEGIC DIRECTIONS: U.S. WATER INDUSTRY REPORT

*Black & Veatch Insights Group*



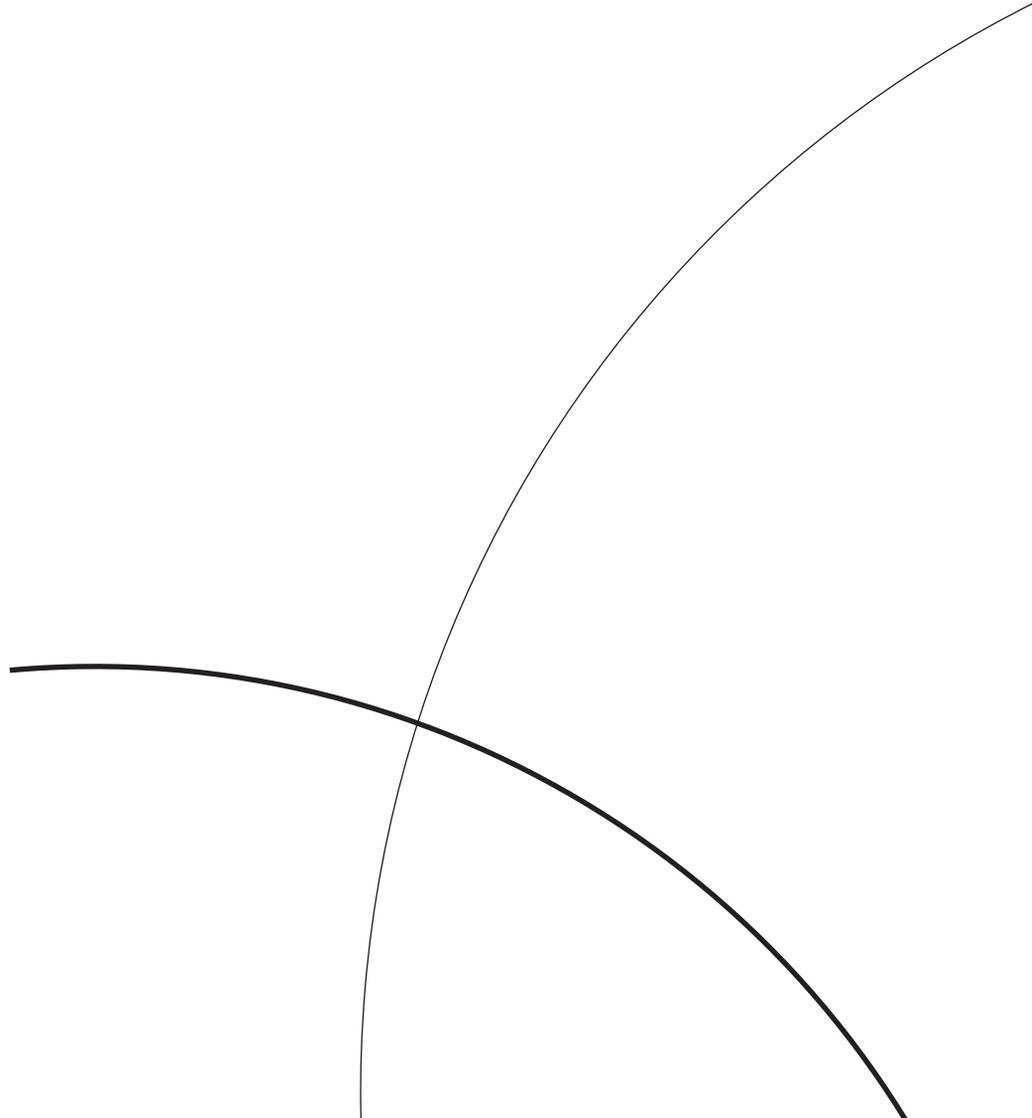
# A NOTE ABOUT DESIGN

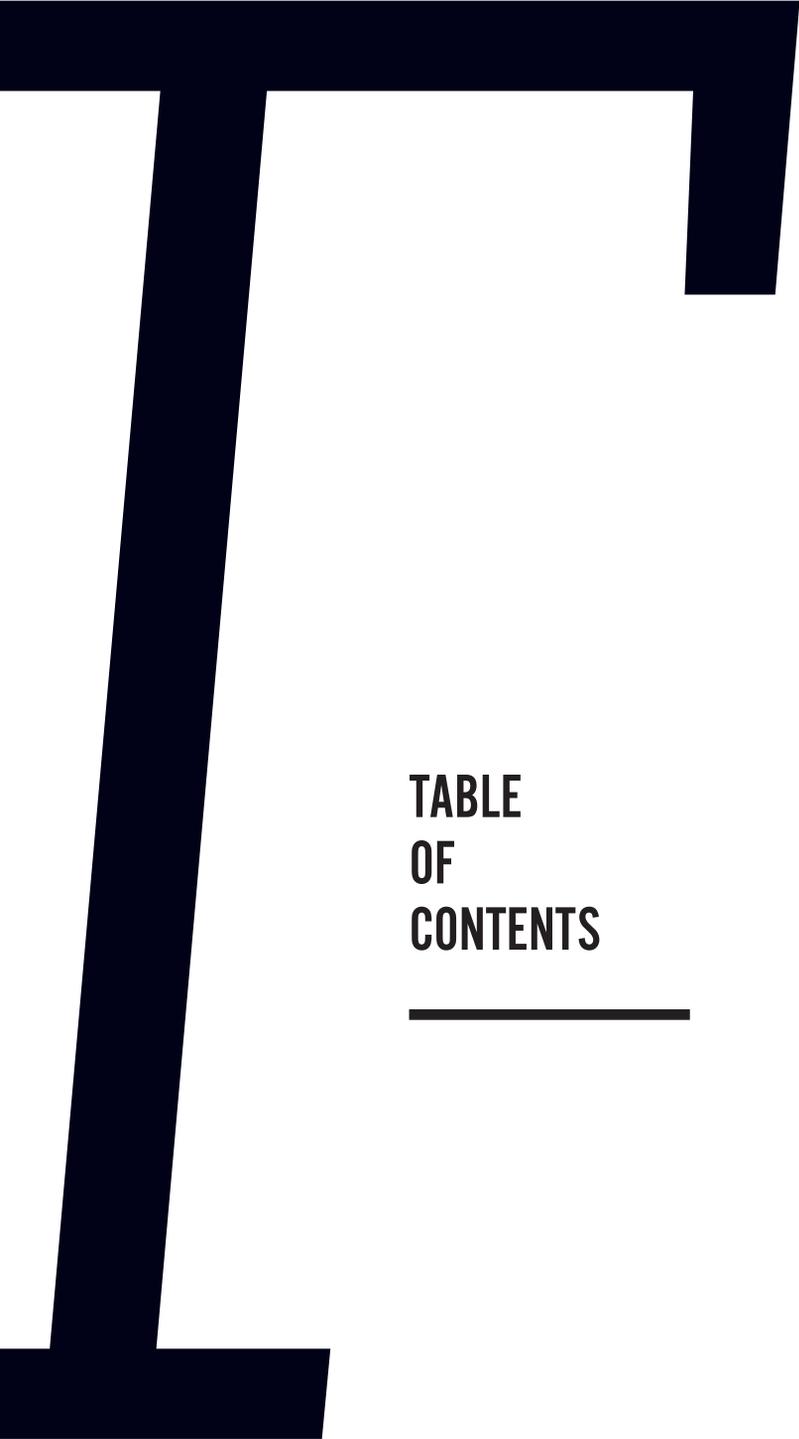
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The annual *Strategic Directions* report series captures Black & Veatch's global engineering and thought leadership expertise across key elements of the critical human infrastructure market. Just as advising our clients requires mastery of design, strategy development and project construction and execution, so too does selecting a report theme that reflects the dynamics of change across industries.

For 2015, the idea of the universe, which encompasses distinct yet overlapping galaxies, stood out as analogous to the continuous evolution of utility services. Interdependence and convergence, as illustrated by ongoing conversations about the energy/water nexus and consumer and utility technologies, are tangible examples.

From a design perspective, what you see reflected in the report's cover and in the graphic elements found throughout its pages, is purposeful art. Our aim is that this creative approach produces reports that are informative and engaging resources for its readers.





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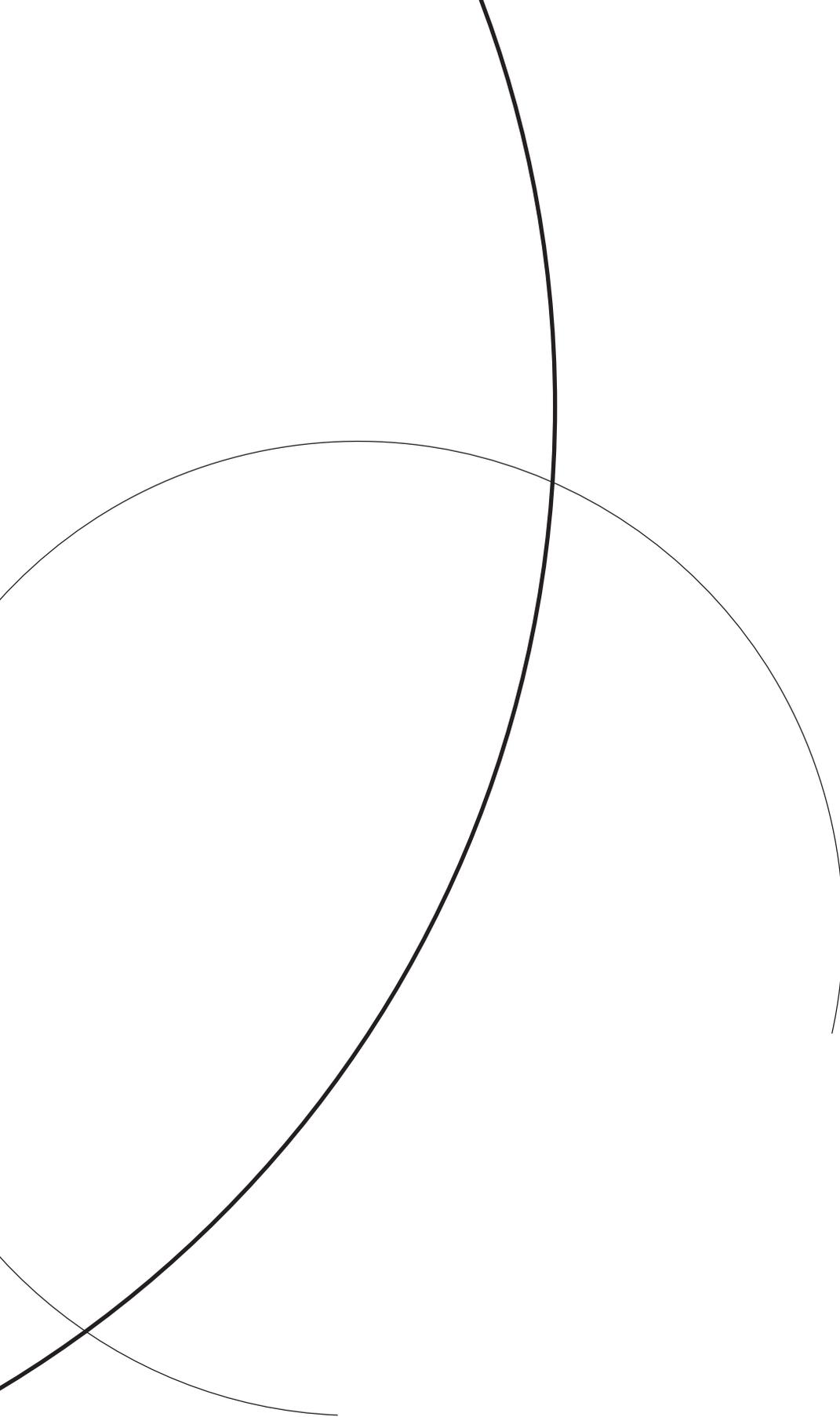
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# INTRODUCTION

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Welcome to Black & Veatch's 2015 *Strategic Directions: U.S. Water Industry* report. This report explores the concept of resilience from three perspectives — Strategic, Financial and Operational — as severe drought and other water infrastructure issues challenge service providers across the United States.

New this year is a focus on the application of asset management in resilience planning. Also, for the first time, the Black & Veatch 2015 *Strategic Directions: Water Industry* report also includes commentary from two external sources deeply concerned with the resilience of water infrastructure: Standard & Poor's and Willis Group.

While traditional issues such as rates, plant efficiency and sustainability remain key areas of discussion, advances in technology and the drive for sustainability fueled by fiscal and social pressures have emerged as key elements of the path forward. Managing demand, particularly in water scarce regions, will be essential to ensuring the viability of communities, businesses and agricultural concerns.

Report data and recommendations reflects the insight of city, county, municipal and investor-owned industry participants as they try to stabilize revenues and set paths towards operational security for decades to come.

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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## **The Black & Veatch Analysis Team**

### **EXECUTIVE SUMMARY**

*Ralph Eberts* is Executive Managing Director for Integrated Solutions in Black & Veatch's management consulting business. Eberts and his team drive Black & Veatch solutions that require expertise across energy, water and telecommunications services. Eberts was most recently the Executive Managing Director for Black & Veatch's Americas water business. Eberts is based in San Francisco.

### **FINANCIAL RESILIENCE**

*Mike Orth* is Executive Managing Director for the Americas in the company's water business. He is based in Kansas City, Missouri. Orth guides the company's growth efforts in supply, storage, treatment, conveyance and asset management, delivering projects for clients through both traditional methods and alternative solutions such as design-build and public-private partnerships.

*Blake Childress* is a Senior Vice President and Managing Director of the Americas Design-Build group in the water business. He has more than 40 years of water industry experience, including numerous design-build projects. He is based in Atlanta.

*Ann Bui* is the Managing Director for Black & Veatch's management consulting water practice. She has more than 25 years of experience assisting utilities nationwide with business advisory services including multi-tranche debt issuances, cost of service analyses, development of new rate structures, and back-office organizational efficiency studies. Bui is based in Los Angeles.

*Dr. Les Lampe* leads Black & Veatch's water resources practice focusing on financial evaluations for water utilities. With more than 40 years of experience at Black & Veatch, Dr. Lampe specializes in all aspects of finance for water supply. He leads water supply and economic evaluations for major utilities both domestically and internationally. Dr. Lampe is based in Kansas City, Missouri.

## **STRATEGIC RESILIENCE**

*Will Williams* is the Associate Vice President of Black & Veatch's Asset Management practice. He has more than 20 years of experience in asset management planning, including asset failure analysis, risk assessment, performance benchmarking, maintenance optimization and business change management, among other areas. Williams is based in Atlanta.

*James Strayer* is an Associate Vice President and Department Manager for Infrastructure Planning and Asset Management. He has more than 20 years of experience related to infrastructure planning, asset management and designing conveyance facilities for all types of water systems. Strayer is based in San Marcos, California.

*Martin Jones* is a Principal Consultant within Black & Veatch's Asset Management practice and has over 17 years of experience in the international water industry. Specializing in water utility asset management, Jones has undertaken a variety of asset management projects, including Publically Available Specification (PAS) 55 and International Organization for Standardization (ISO) 55001 maturity assessments and program implementations, strategy development and asset management planning. Jones is based in Atlanta.

*Jeffrey Stillman* is an Asset Management Practice Leader for Black & Veatch, specializing in asset management and system planning for water and wastewater systems. He is responsible for technical leadership on a variety of master planning and asset management projects throughout the United States and is based in Burlington, Massachusetts.

*Jeff Neemann, P.E.* is a Solution Lead for Smart Integrated Infrastructure and Director of Water Treatment Technology for Black & Veatch. He is involved in the development and application of advanced treatment technologies and how to use data to optimize operational performance. He is based in Kansas City, Missouri.

*Pam Kenel, P.E.* is a Solution Lead for Smart Integrated Infrastructure and a Practice Leader for Water Resources and Planning for Black & Veatch. She has over 30 years of experience working with water utilities on a broad range of water quality and supply issues, and she is involved in the development of intelligent water solutions that support a Smart City vision. She received a B.S. in Civil Engineering from Virginia Tech, an M.S. in Civil Engineering from the University of Maryland, and is a PhD candidate in Virginia Tech's Environmental Engineering program. She is based in the Washington DC region.

## **OPERATIONAL RESILIENCE**

*Dr. Andrew Shaw* is a Global Practice and Technology Leader in Sustainability and Wastewater for Black & Veatch. He has over 20 years of experience in wastewater treatment design, having worked in the UK, Australia, Asia and North America. His specialties include nutrient removal, computer modeling, instrumentation, process optimization and life cycle assessments. He is an active member and chair of several Water Environment Federation (WEF) and International Water Association (IWA) task groups and committees. Shaw is based in Kansas City, Missouri.

*Dr. James Barnard* is a Global Practice and Technology Leader in the Used Water Process Group of Black & Veatch. He has more than 50 years of experience during which he developed the basic biological nutrient removal processes still in use today. Barnard is an Honorary Board Certified Environmental Engineer and winner of a number of awards such as the Clarke Prize and the Singapore International Lee Kwan Yew Water Prize. He is a Distinguished Member of the American Society of Civil Engineers (ASCE) and a WEF Fellow. Barnard is based in Kansas City, Missouri.

*Julia Gass* is an aeration blower specialist and Lead Process Mechanical Engineer with 25 years of experience. She has specified aeration blowers totaling over 50,000 horsepower. In addition to being involved in aeration projects from design through construction and witnessing equipment performance tests, she serves on the American Society of Mechanical Engineers (ASME) PTC13 committee for "Wire-to-Air Performance Test Code for Blower Systems." Gass is based in Kansas City, Missouri.

## **PERSPECTIVES**

*Richard Hein* is the Chief Coastal Engineer with Black & Veatch and a specialist in coastal engineering, coastal management and flood risk. He has 18 years of experience with flood defense projects in the UK and internationally for clients ranging from central government organizations through local government to private clients. His experience includes the assessment of coastal processes and geomorphology, the supervision of numerical and physical modeling, the design and construction of maritime and coastal structures and the development of coastal strategy plans. He is based in England.

*James Currie* has more than 30 years of experience in the planning, study, design, construction supervision and management of diverse multidisciplinary water supply, water treatment, wastewater, environmental and infrastructure projects in Southeast Asia, Australia, and the UK. He has had business leadership roles for Black & Veatch in Singapore and Australia, and has participated at the committee level in several water industry associations. Currie is based in Melbourne, Australia.

## **CONCLUSION**

*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 technical and management leadership expertise to more than 100 projects around the globe. Wallis-Lage joined the Black & Veatch Board of Directors in 2012 and is currently on the Board of Directors for the WaterReuse Association. She is based in Kansas City, Missouri.

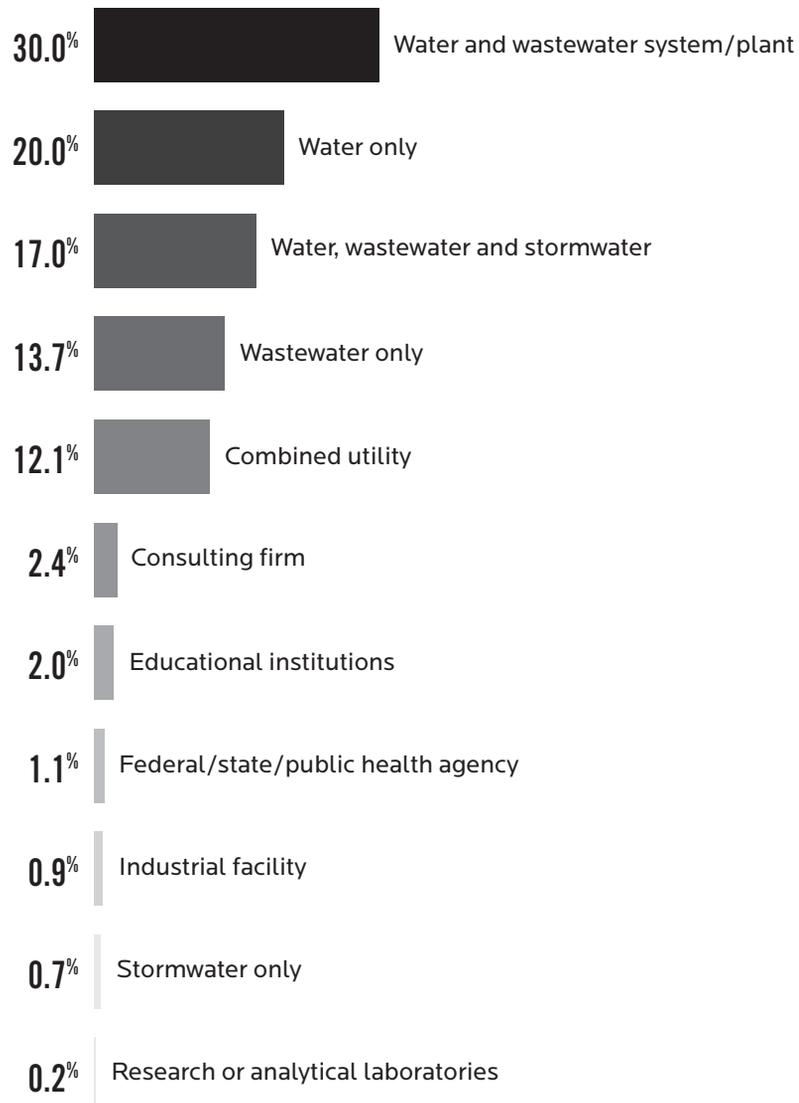
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## 2015 Report Background

The Black & Veatch 2015 *Strategic Directions: U.S. Water Industry* report is a compilation of data and analysis from an industry-wide survey. This year's survey was conducted from 6 March through 30 March 2015. The results of the online questionnaire reflect the input of 454 qualified utility, municipal, commercial, and community stakeholders.

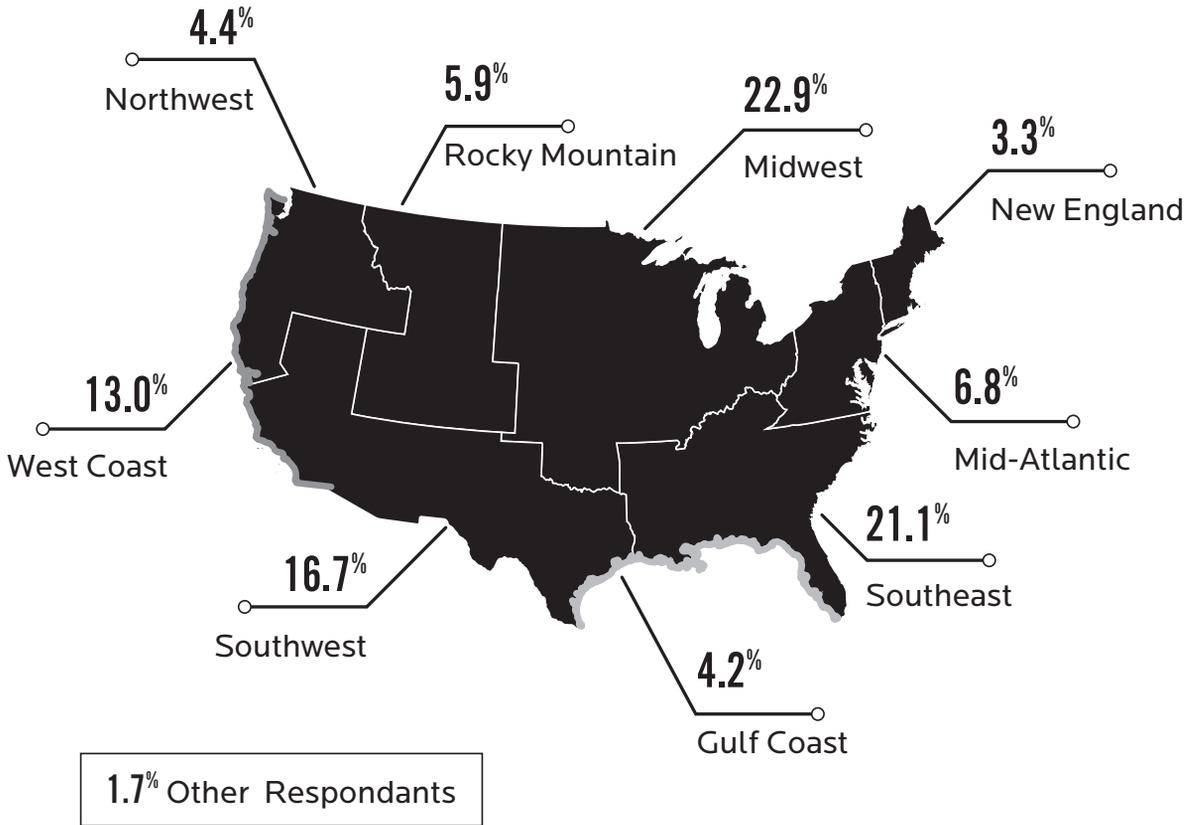
Statistical significance testing was completed on the final survey results. Represented data within this report have a precision of  $\pm 4.6\%$  at the 95 percent confidence level. The following figures provide additional detail on the participants in this year's survey.

### Industry Type



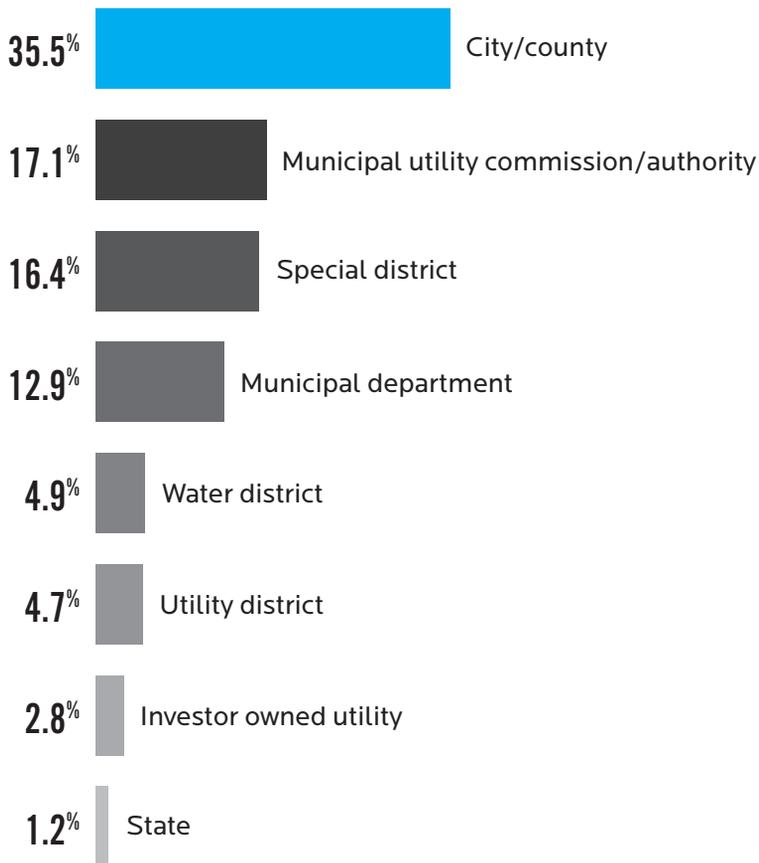
Source: Black & Veatch

Primary Business Region



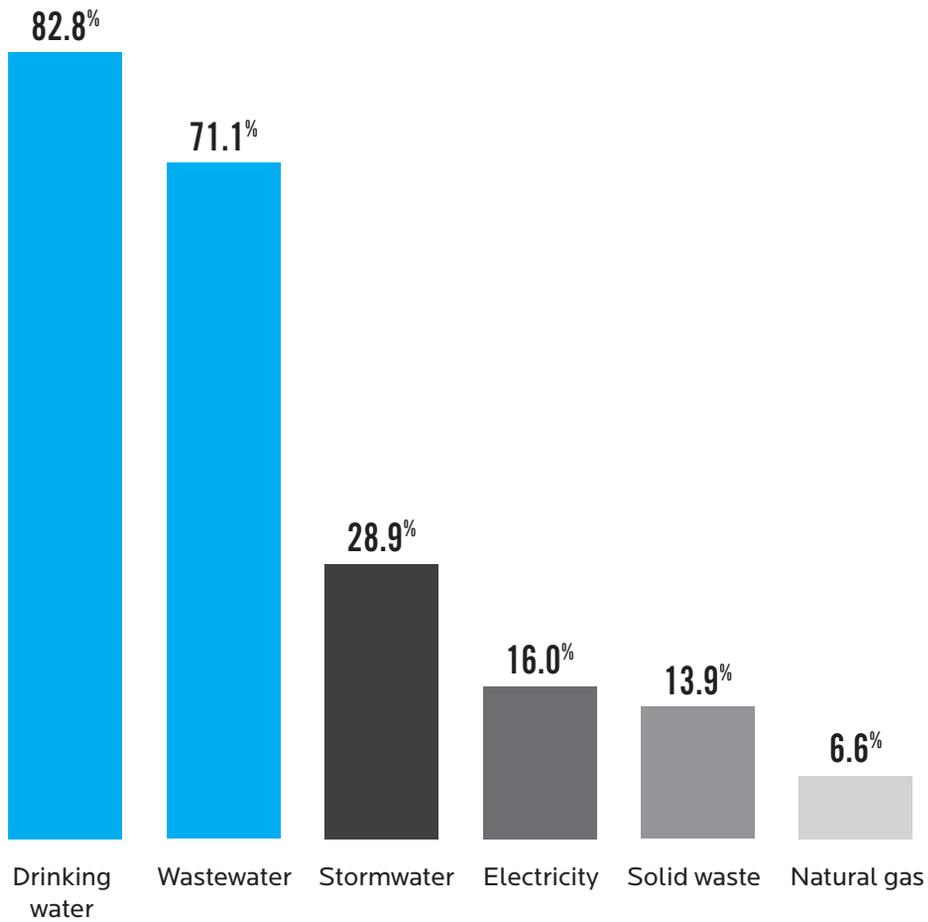
Source: Black & Veatch

**Utility Type**



Source: Black & Veatch

Utility Services Provided



Source: Black & Veatch



**12.5%**  
500,000-1,000,000

**13.2%**  
1,000,000-1,999,999

**12.8%**  
2,000,000 or more

**Population Served**

*Source: Black & Veatch*

# EXECUTIVE SUMMARY

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## *Resilience Questions Expose Gaps, Opportunity for Water Industry*

By Ralph Eberts

U.S. water service providers are uniquely accustomed to changing conditions. But rarely have so many competing pressures tested the industry as they do in 2015. Strained capital budgets, aging equipment and distribution systems, social pressures around sustainability and water scarcity are further impacting a sector that is already in the midst of a decade-long business model transformation. These pressures are also rewriting the rules for utilities that have been forced to prioritize “need to have” infrastructure investments at the expense of investments in their future.

The 2015 Black & Veatch *Strategic Directions: U.S. Water Industry* report frames the discussion by looking at financial, strategic, infrastructure and technological resilience in water utilities. It also contains perspectives from Asia and the UK where resilience is central to the planning cycle, albeit with varying degrees of success. The issues addressed within this report are complex and overlapping. Mitigating them will require deep assessment, integrated solutions and resolve.

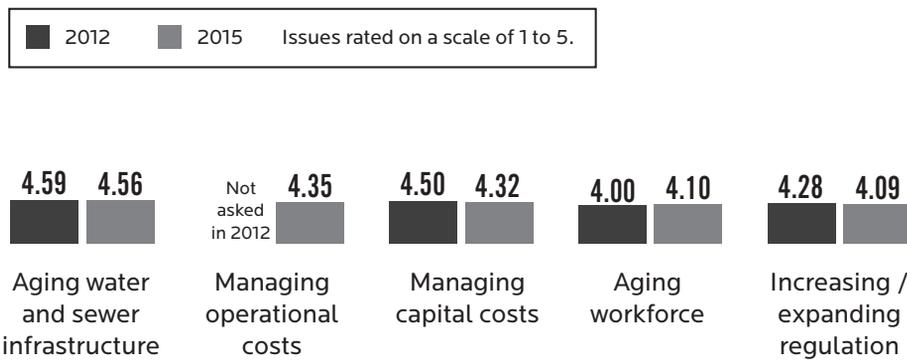
Achieving resilience – fiscal soundness, a diverse array of assets and the flexibility to respond and recover from system shocks and stresses — is at the top of the to-do list. The last two iterations of Black & Veatch’s *Strategic Directions: U.S. Water Industry* report reflected increasing urgency around these issues. However, this year’s report defines in stark terms the gaps that expose many U.S. utilities and what it means to be prepared for both anticipated and unexpected change. It examines what it means for water industry service providers to be resilient, connecting different elements that constitute readiness.

Survey data encouragingly suggest that some utilities, after years of immobility created by limited capital, are moving toward resilience. Many others, however, are not.

## KEY ISSUES IN 2015

When it comes to resilience, aging infrastructure continues to be a perennial concern for water utilities. It has ranked first among the top five water industry issues for the past four years (Figure 1). Managing operational costs, managing capital costs, and increasing/expanding regulation are also included among the top five water industry issues over this period. The consistent increase in concern over aging workforces should also be noted. The *Strategic Resilience* section of the report addresses how water utilities are incorporating asset management into resilience planning. It also discusses the impact of smart water and smart city programs, which often leverage data analytics to inform decision-making.

Figure 1  
**Ratings of water industry issues-trends over time**



Source: Black & Veatch

Externally, scientists have been discussing the specter of climate change for more than a quarter century; analysts have addressed the industry’s financial woes; and consumers and regulators have become more vocal about the importance of sustainable business practices. Yet development in water scarce regions, both residential and industrial, continues. So why act now? Motivating factors include immediate issues such as the drought in the southwestern United States; water main breaks and flooding in the east; emerging efficiency technologies; and decreasing revenue across the industry.

As organizations, water industry service providers know the looming operational and management challenges. Headlines focusing on drought, burst mains in winter and issues with waste management experienced by some utilities are hard to ignore. In fact, one could argue that the supply and sustainability challenges facing many utilities and communities are not caused by a lack of information, but by the lack of money to meet these challenges head-on.

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## When it comes to resilience, aging infrastructure continues to be a perennial concern for water utilities.

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Managing capital costs, while still maintaining its position as a top-five issue, experienced a steady decline in importance ratings from 2012 to 2015. Addressed in the *Financial Resilience* section of this report, this may be the result of capital becoming more readily available because of low interest rates. However, it could also be explained by the ongoing disconnect between operating cost coverage rankings and required annual rate increases. In addition to these issues, the *Financial Resilience* section also addresses the need for financial experimentation along with alternative delivery of key infrastructure projects.

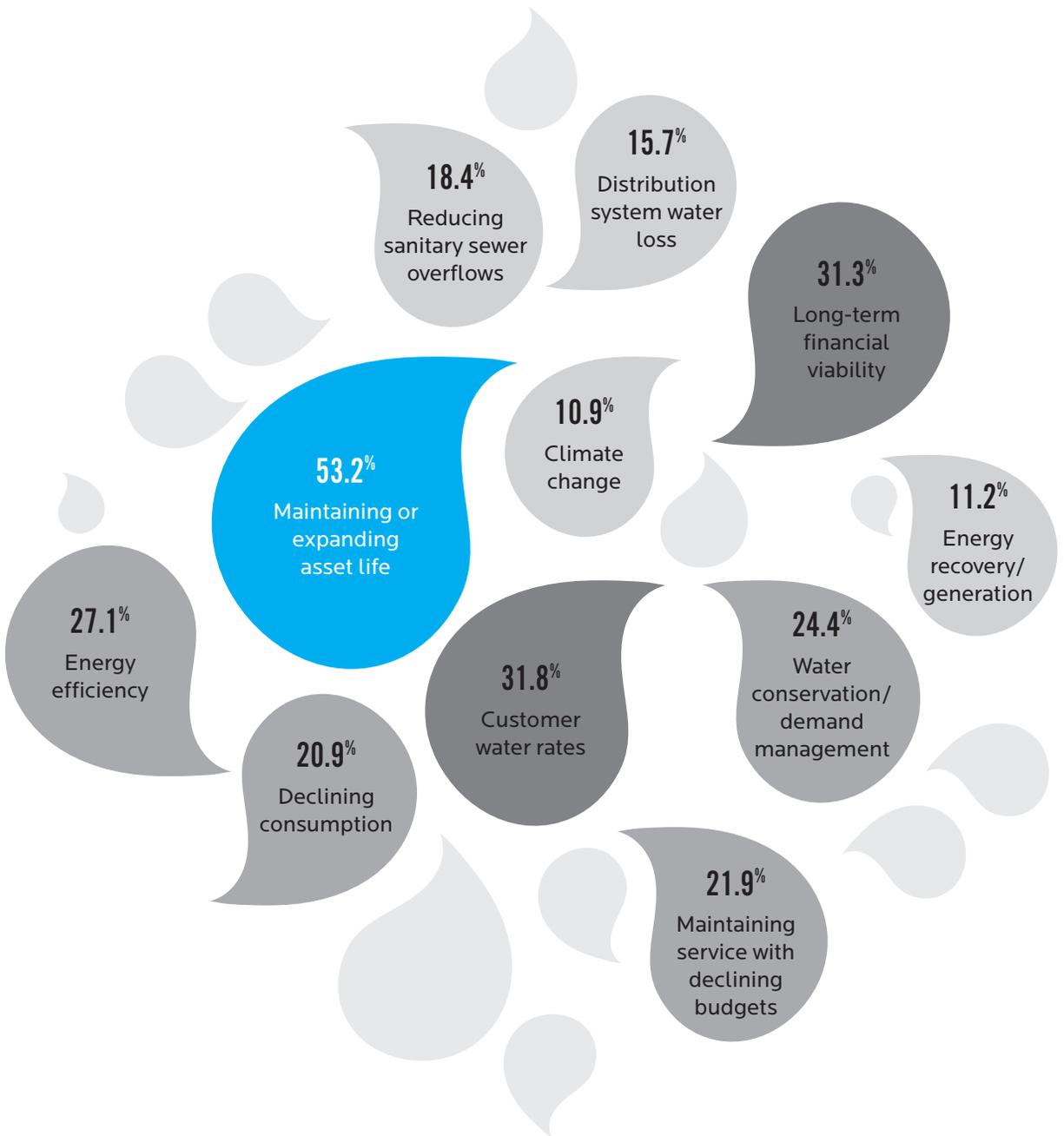
### **PUBLIC FOCUS ON SUSTAINABILITY DRIVES RESILIENCE**

Infrastructure maintenance, financial management, expanding regulation, and the proliferation of information technology (IT) are all occurring under the scrutiny of concerned regulators and information-hungry, technology savvy consumers. That same public is focused on sustainability for very real and human reasons. In some parts of the U.S., without eco-centric practices, such as water conservation and reuse, there will not be enough water to sustain the quality of life we know today.

Where utilities fail to act, regulatory pressures will continue to act as a catalyst for behavioral and operational change. The strategic benefits of sustainable and environmentally aware business practices also play a role in incentivizing resilience. The *Operational Resilience* section of the report delves into these benefits more deeply and focuses on sustainability through efficiency and resource recovery and innovation.

The most significant sustainability issue for water utilities was maintaining or expanding asset life. Respondents also felt customer water rates, long-term financial viability and energy efficiency were important sustainability issues (Figure 2).

Figure 2  
Most significant sustainability issues



Source: Black & Veatch

One cannot discuss sustainability without referencing climate change. Of note, the most significant climate issue for water utilities was water supply/scarcity. The voice of non-utility stakeholders, such as customers and elected officials/legislators, is sounding the call for action on climate change as well. They gave significantly higher ratings for climate change as a sustainability issue than did other survey respondents (Figure 3).

As environmental impacts are better understood and preserving our fragile eco systems becomes a higher priority, regulators continue to use consent decrees and effluent treatment mandates to force wastewater utilities to do more to address these issues. Though decreasing across the industry as a whole, this can be seen in wastewater utility survey respondents who gave significantly higher importance ratings for increasing/expanding regulation. The report delves more deeply into the new treatment technologies being deployed in the United States and the European Union to help meet some of the requirements.

Energy efficiency plays a large role in the sustainability effort. Here too, wastewater-only utility providers gave significantly higher ratings for energy efficiency and energy recovery/generation (Table 1). The reasoning behind this is part of a larger theme found throughout the report: increased efficiency lowers costs. In addition, with

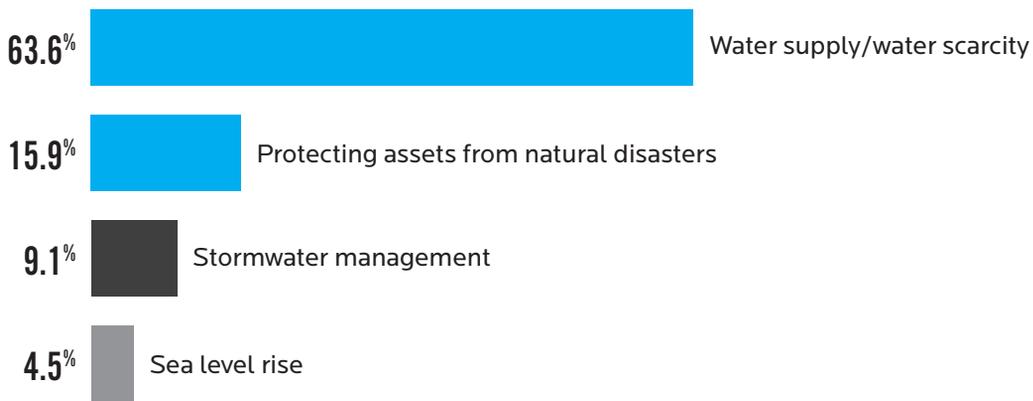
declining consumption ranking as a top issue for water-only utilities by a significant margin, the need to manage costs is top of mind.

Resilient water utilities consider and recognize the importance of the finance sector and risk-based investment decision-making. With this awareness in mind, the 2015 report includes two external perspectives. The first, from Standard & Poor's, focuses on the municipal bond/finance market. The second is from Willis Group. Here, the outlook of the insurance sector on strategic resilience is examined.

Among its conclusions, this report indicates that the most resilient service providers know that they need to act now if they are going to be ready to respond when the next big event hits them and their customers. In the coming years, it is expected that resilience will move up as a priority from its current eighth spot in the Top 10 list. As it rises, resilience can be interpreted as a reflection of how water utilities manage their current higher ranked issues.

Figure 3

**Most significant climate issue**



Source: Black & Veatch

Table 1

**Most significant sustainability issues-by organization type**

Most Significant Sustainability Issues for Water Utilities	By Organization Type					
	Water Only	Wastewater Only	Water or Wastewater	Water, Wastewater & Stormwater	Combined Utility	Non-Utility Water Stakeholder
Distribution system water loss	18.1%	0.0%	14.9%	17.9%	25.0%	20.0%
Energy efficiency	19.3%	47.3%	28.1%	14.9%	25.0%	32.0%
Energy recovery/generation	3.6%	30.9%	8.8%	13.4%	9.6%	4.0%
Water conservation/demand management	31.3%	7.3%	25.4%	20.9%	25.0%	44.0%
Declining consumption	32.5%	7.3%	28.1%	13.4%	19.2%	4.0%
Climate change	15.7%	3.6%	7.9%	11.9%	3.8%	40.0%
Customer water rates	43.4%	20.0%	35.1%	31.3%	32.7%	8.0%
Long-term financial viability	28.9%	29.1%	32.5%	32.8%	32.7%	24.0%
Maintaining levels of service with declining budgets	20.5%	16.4%	17.5%	32.8%	21.2%	32.0%
Maintaining or expanding asset life	57.8%	67.3%	48.2%	52.2%	53.8%	28.0%

Source: Black & Veatch

# STRATEGIC RESILIENCE

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## *The Role of Asset Management in Resilience Planning*

By Will Williams, James Strayer, Martin Jones and Jeffrey Stillman

Resilience has been put to the test over the past decade through significant events such as flooding, drought and financial strain – events that have tested the weak points in our critical human infrastructure and the organizations that manage it. The most fundamental test of resilience is dealing with unplanned events. These events test the ability to go from an optimized operating state to an operation that meets minimum service levels, then recover back to the optimal operating state. This cycle demonstrates the relationship between asset management and resilience. Upon close examination, both asset management and resilience strive to achieve the optimal balance between cost, risk and performance.

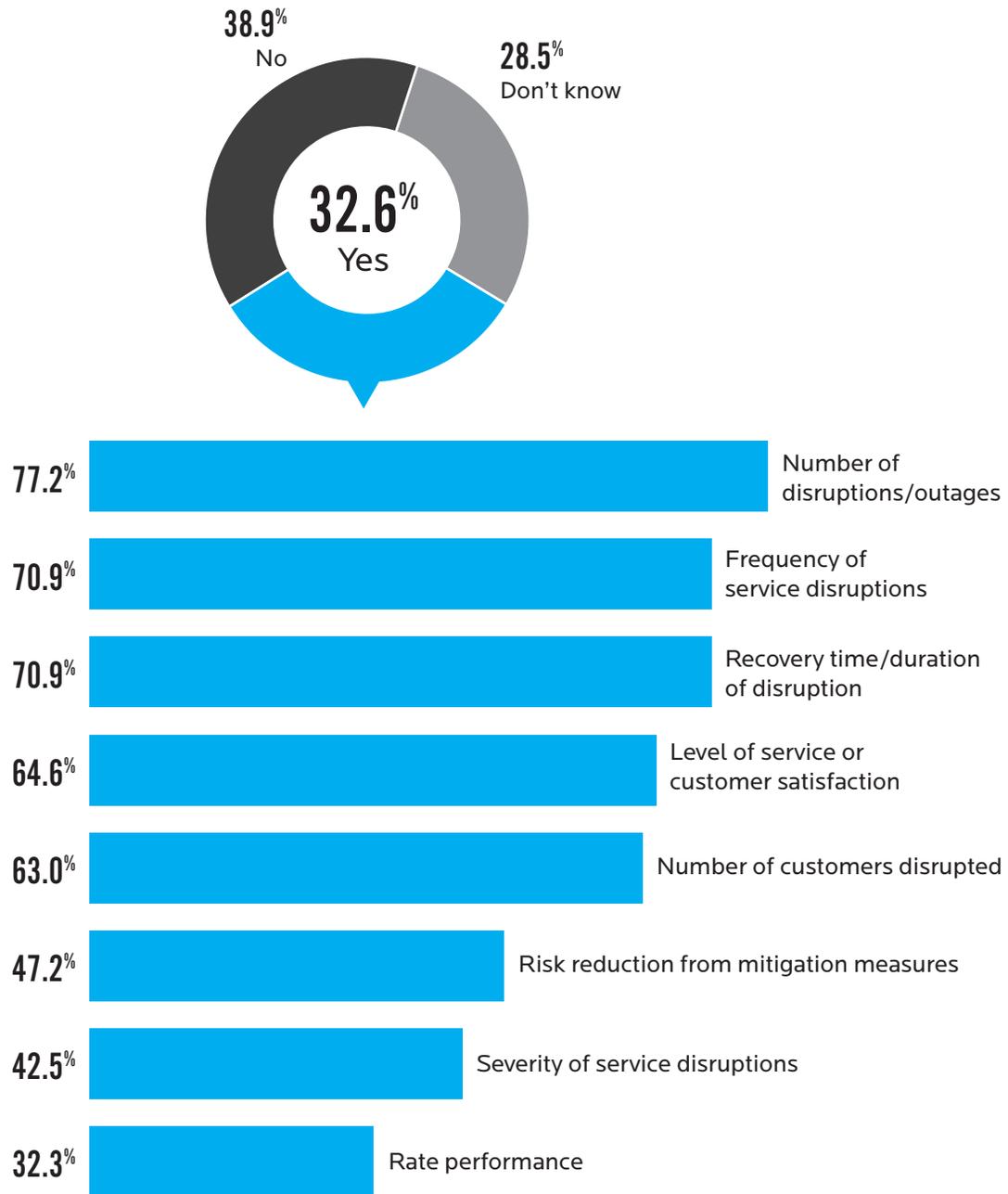
Resilient systems have well thought-out operational and maintenance schemes with dedicated and trained professionals servicing them. These systems achieve maximum performance for typical conditions, and have contingency plans involving the necessary labor and materials to deal with a multitude of possible scenarios. Resilient systems are also closely monitored and measured using asset and system performance metrics

(discussed later in the *Strategic Resilience* section). The operational plans and monitoring help determine appropriate mitigation and adaptation strategies, and lead to focused contingency plans. Resilient systems have also been assessed for a broad range of risks, from organizational elements such as staff succession planning and data security to infrastructure risks such as the likelihood and consequences of failures.

This Black & Veatch 2015 *Strategic Directions: U.S. Water Industry* report shows that roughly one-third of utilities (32.6 percent) are measuring resilience (Figure 4 and 5). The main measures being used include the number and frequency of service disruptions and the time taken to recover from the disruptions. The survey results show that more work needs to be done. However, the agencies that are monitoring these elements are developing a beneficial understanding of the level of service provided to customers and how resilient their assets are in providing that level of service.

Figure 4

**Does your utility have any tools to measure resilience? Please select all of the ways your utility is measuring resiliency.**



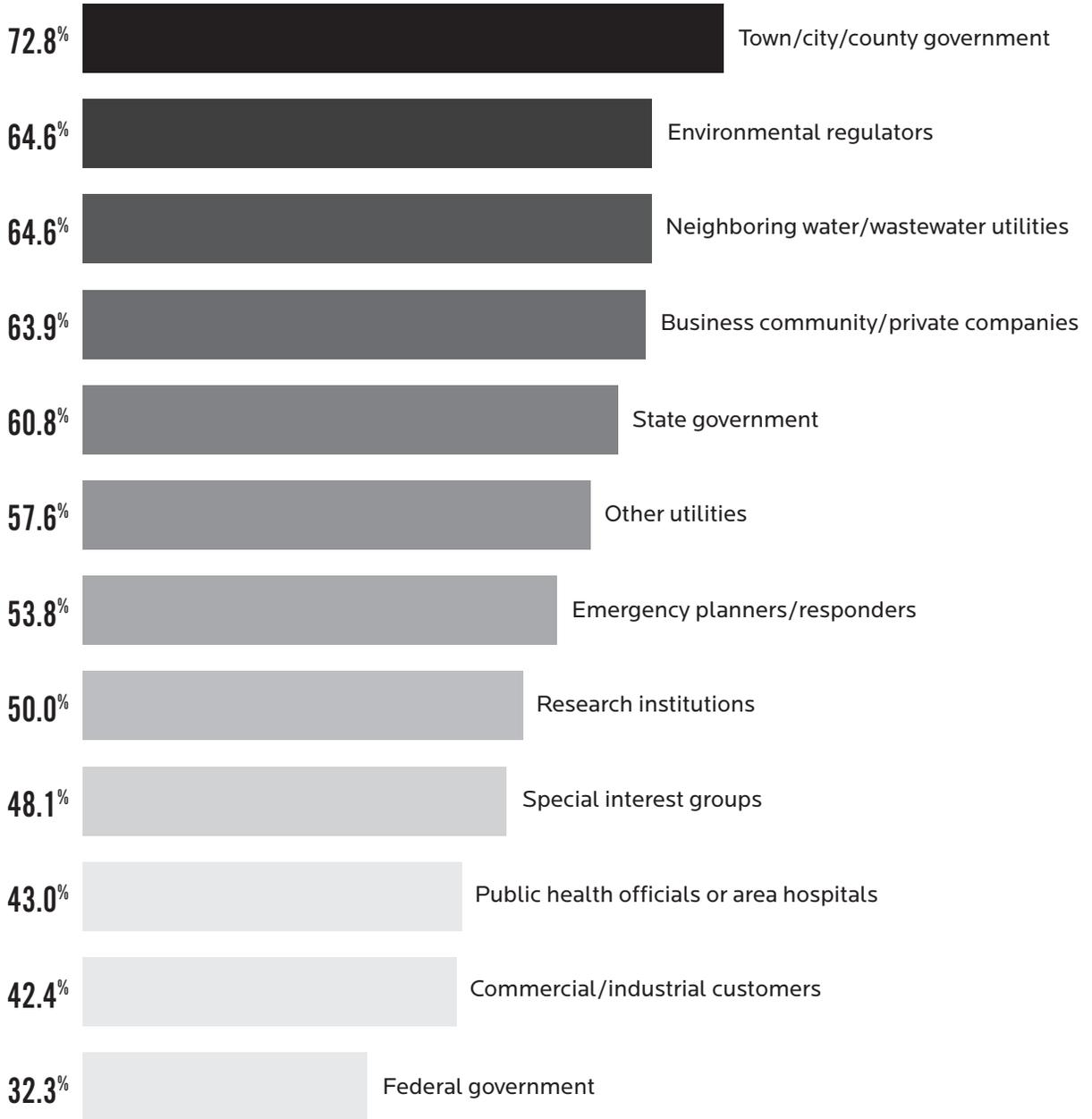
Source: Black & Veatch

## STAKEHOLDER CONSULTATION

Stakeholders may not always fully appreciate (or even want to know) the behind-the-scenes activities required to manage assets and maintain reliable service. But they will passionately engage the utility when the level of service is not being met or when they do not see value when their rates go up. Asset management and the related resilience components are therefore improved by engaging stakeholders with regular two-way communication. The survey indicated that 47 percent of respondents are providing public education and have two-way conversations with residential customers, while 41 percent are engaging with non-utility stakeholder groups. While this represents a good effort by nearly half of the survey participants, it leaves room for improvement – especially given the impact these challenges have relating to utility financing, potential lifestyle disruptions and other social concerns. It was encouraging that a wide range of stakeholders were being consulted related to resilience.

Figure 5

What non-utility stakeholder groups is your organization collaborating with to build resilience in strategic planning?

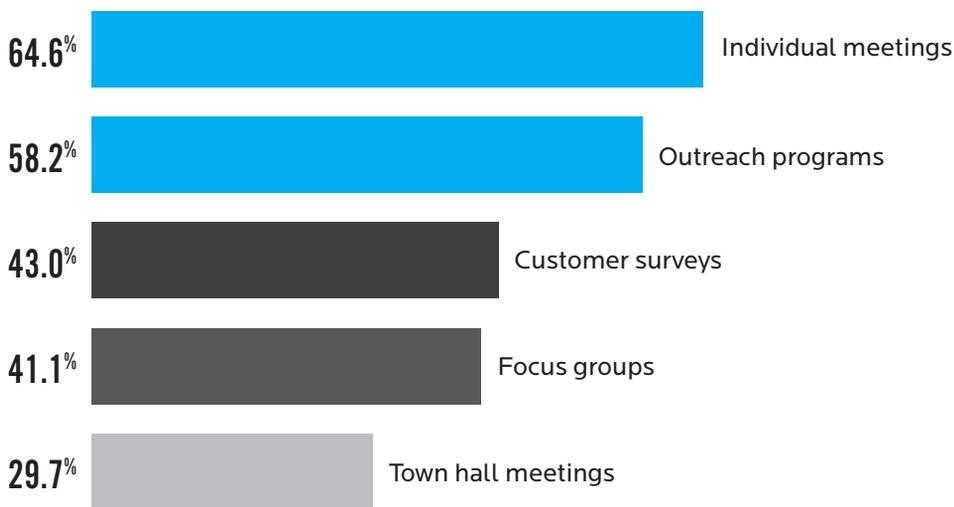


Source: Black & Veatch

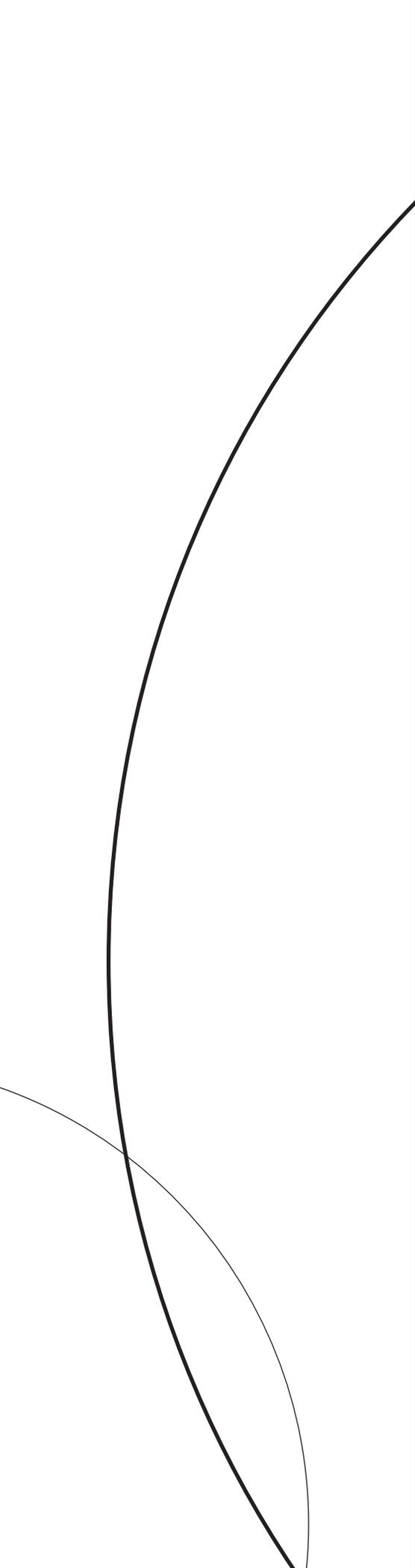
Stakeholders are consulted primarily through individual meetings (64.6 percent) and outreach programs (58.2 percent), but it is interesting to see that 22.8 percent are using stakeholder or customer review panels. A review panel is typically made up of representatives of a utility's customer base and, in some cases, other stakeholders who work collaboratively with the utility in developing the strategy, providing input and ensuring that stakeholder needs are taken into account. It is believed this approach will continue to increase in popularity among utilities. Only a small percentage of utilities (3.8 percent) are using willingness-to-pay surveys. This is an approach used by more mature industries to evaluate what levels of service customers value the most, and it asks what they might be willing to pay for an improved service, or if they want to pay less for a reduced level of service. This analysis can be used to calculate the cost/benefit of capital improvement projects and influence rate setting and is routinely used in the UK and Australian water industries.

Figure 6

**How are non-utility stakeholders consulted as part of the strategic planning process? (Select all that apply)**



Source: Black & Veatch



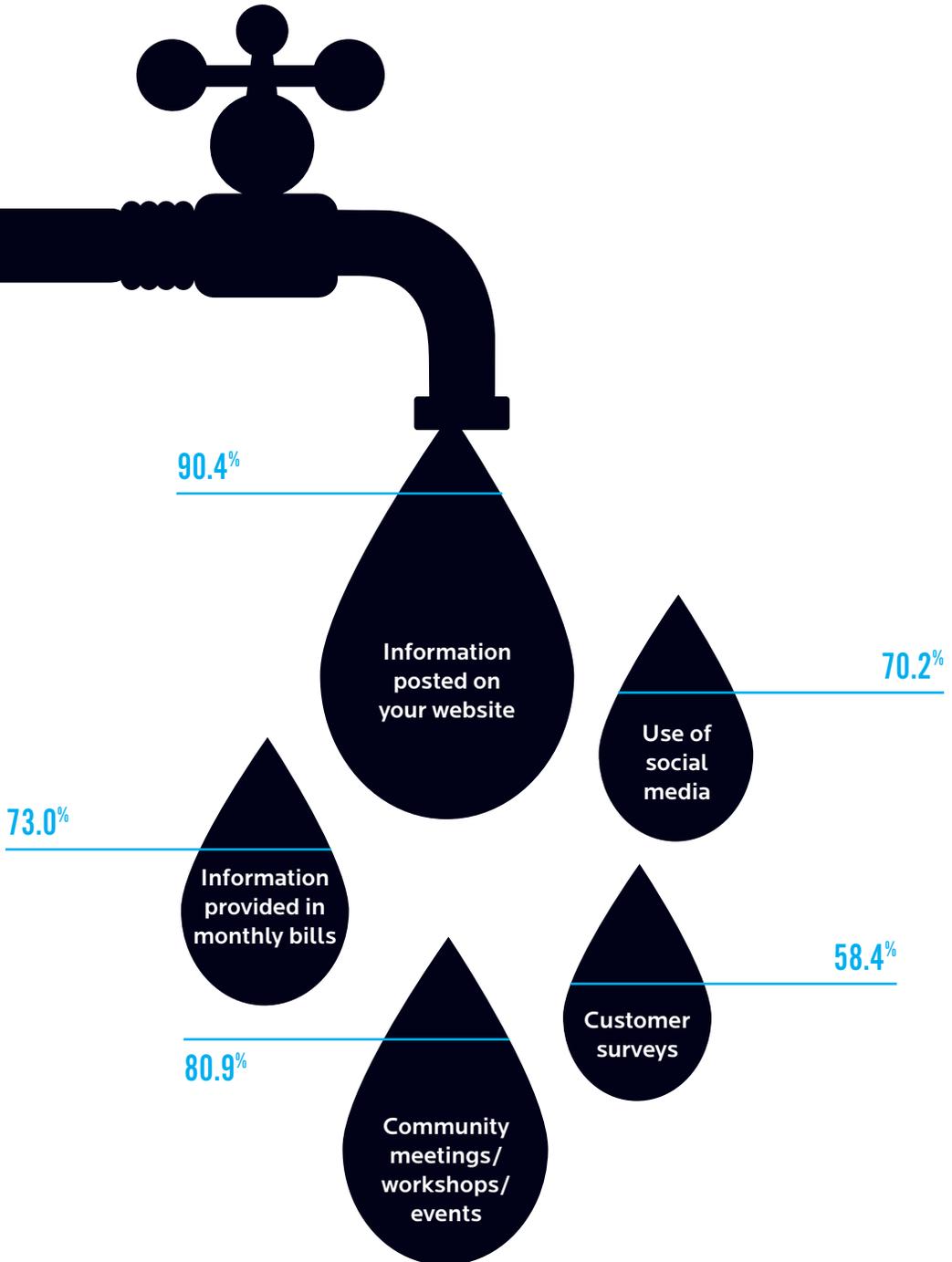
## USE OF CUSTOMER REVIEW PANELS AND WILLINGNESS-TO-PAY SURVEYS – LEADING INTERNATIONAL PRACTICE

In the last round of water company asset management planning in England and Wales (referred to as PR14), the utility regulator Ofwat required close collaboration between water companies and their stakeholders in developing the 5-year asset management plans for 2015-2019. Customer challenge groups consisting of customer representative organizations, businesses, and environmental regulators were formed to scrutinize each company's plans and customer engagement activity in developing the plans and to report back to Ofwat. Water companies had to engage with customers to obtain their opinions on service levels and rate increases (known as willingness-to-pay surveys) through telephone interviews, focus groups and face-to-face interviews.

Respondents were also asked what is included in their public education/community outreach programs (Figure 7). The utility's website was the most widely used (90.4 percent), followed by community meetings (80.9 percent). Use of social media such as Facebook, Twitter and Instagram also scored highly (70.2 percent) as utilities are increasingly using technology to connect with their customers.

Figure 7

**Which of the following does your utility include in its public education/community outreach programs?**

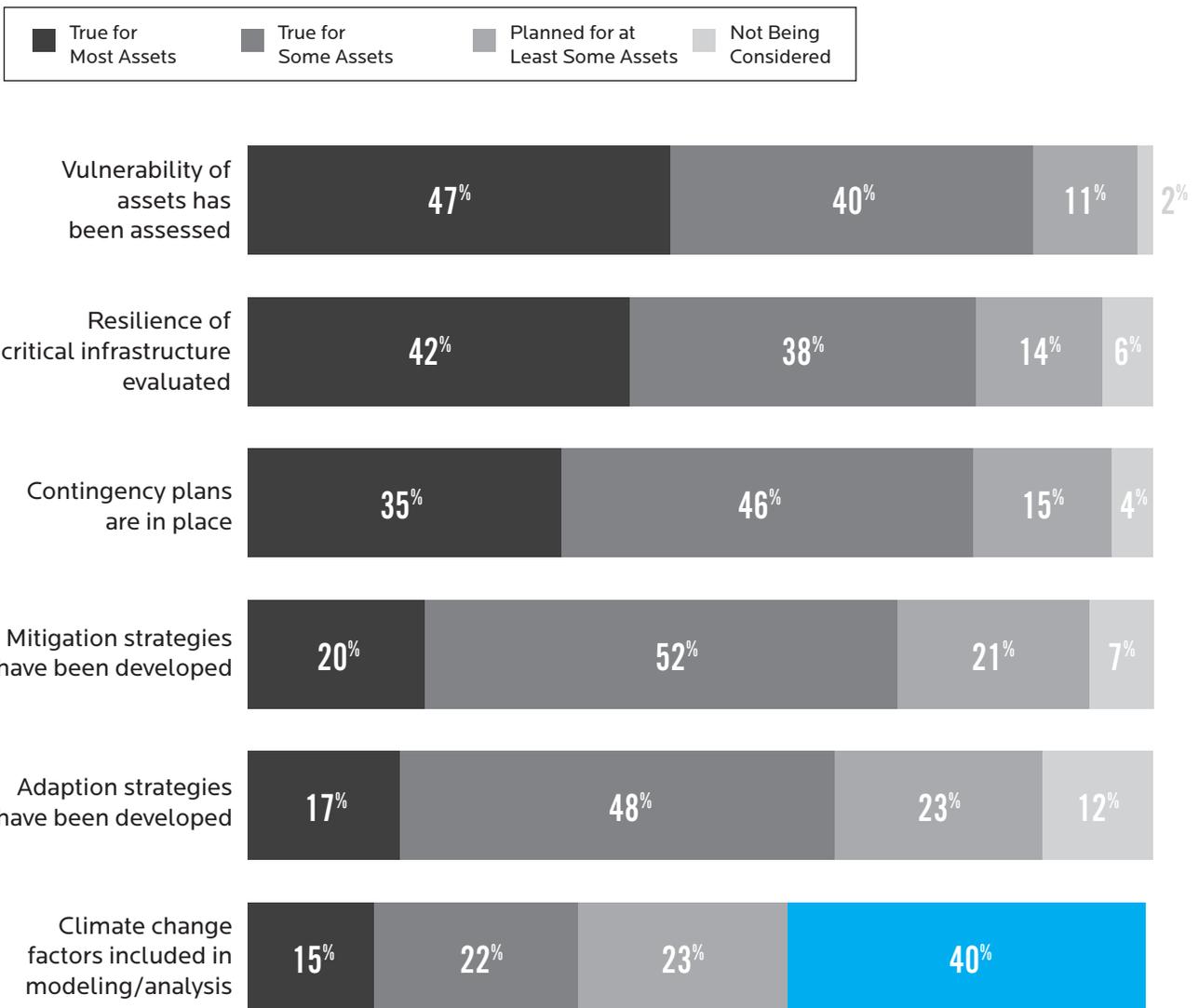


Source: Black & Veatch

## PLANNING FOR RESILIENCE

Incorporating resilience into asset management planning is becoming increasingly important. Planning for asset resilience starts with an assessment of the vulnerability of assets, followed by an evaluation of the resilience of the most vulnerable or critical assets. Forty-seven percent of respondents have assessed the vulnerability of most of their assets and 42 percent have evaluated the resilience of most of their critical assets (Figure 8). This is good progress, coupled with the results that most utilities reported assessing risk and vulnerabilities for at least “some” of their infrastructure. But it is also important to note that over half of the utilities surveyed may have major blind spots in regards to risk depending on the extent to which their critical assets fall under the category labeled “some” assets.

Figure 8  
**How is resilience addressed as part of your capital investment planning?**



Source: Black & Veatch

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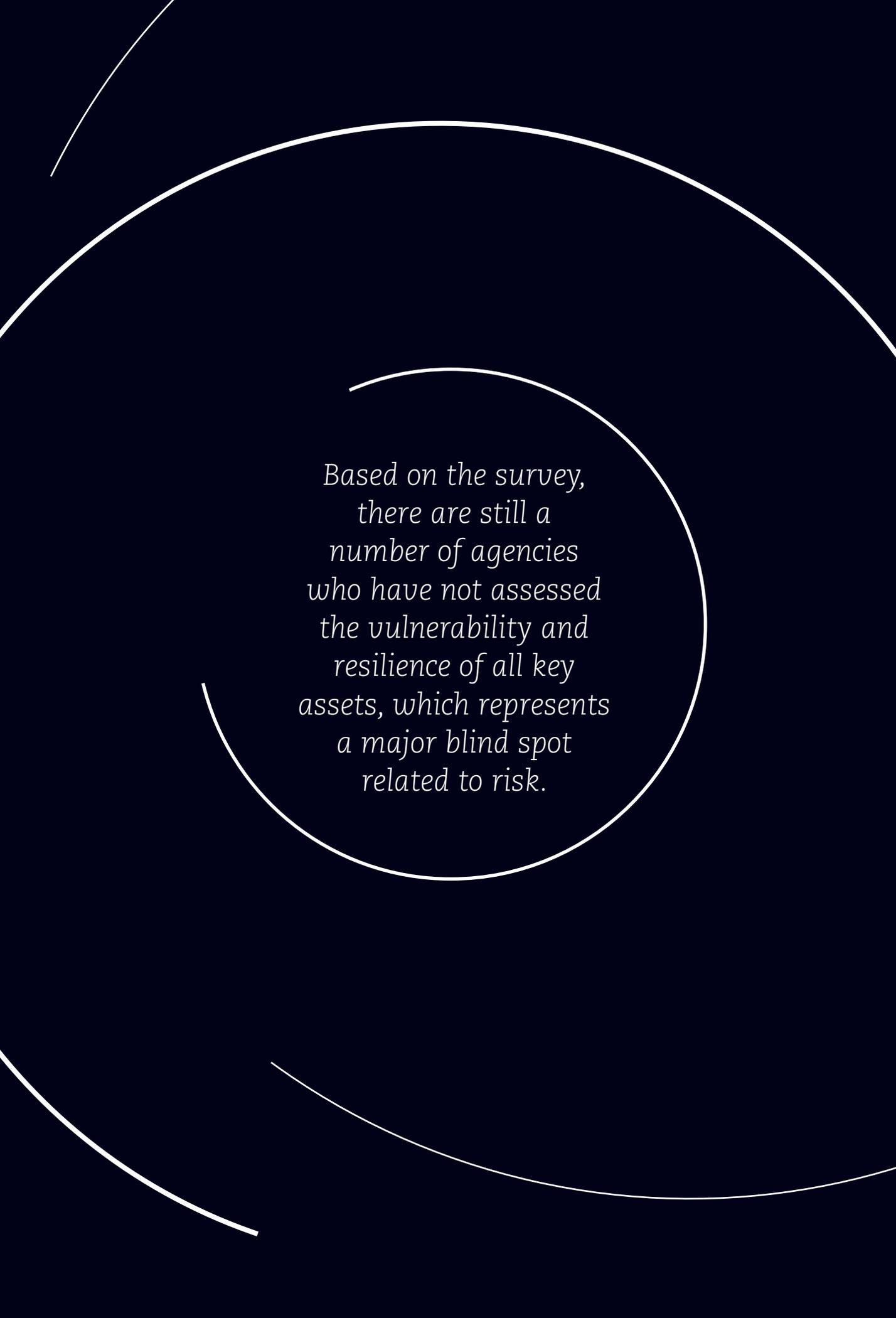
*Emerging trend – scenario planning is a growing trend that mitigates risks in both master planning and asset management processes. Scenario planning includes developing multiple future scenarios (for both expected and unexpected/adaptable conditions). By considering all these scenarios and their related risks, mitigation measures and adaptable strategies can be developed. The application has been applied to a wide range of needs – from specific facilities to multi-state watersheds.*

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The next steps for those utilities that have identified risks and vulnerability include contingency planning, setting up mitigation strategies and evaluating how future conditions may change and impact the organization. Thirty-five percent of respondents reported that contingency plans are in place for most assets, which is only slightly lower than the percentage of respondents who reported that they have assessed vulnerabilities and resilience. A larger drop-off occurred related to developing mitigation strategies and adaptation strategies. Only 20 percent have developed mitigation strategies, and only 17 percent have developed adaptation strategies for most assets. There is an important distinction between having contingency plans (which sit ready to deal with predicted events) and taking mitigating actions or adaptive strategies (that are more proactive in reducing future risks and the consequences of vulnerabilities).

***A focus on mitigation measures and adaptable strategies offers the biggest opportunities for those utilities that have assessed their risks and vulnerabilities but have not advanced past the contingency planning step as part of their overall asset management/resilience planning.***

Respondents were also asked to gauge the level of climate change activities specific to modeling for resilience. Planning for climate change involves considering climate change factors to analyze system performance and resilience, which is most often done using models. However, 40 percent of respondents are not including these factors in their modeling. Because of the low response rate on this question, further climate change survey questions were included to draw conclusions related to climate change and resilience.



*Based on the survey,  
there are still a  
number of agencies  
who have not assessed  
the vulnerability and  
resilience of all key  
assets, which represents  
a major blind spot  
related to risk.*

## **CLIMATE CHANGE RELATED TO RESILIENCE PLANNING**

Utilities were asked how they are considering climate change in relation to resilience. The first and third rows of the survey results to the right specifically called out whether climate change elements were included (Table 2). The results show approximately 30 percent of small- and medium-sized utilities consider climate change, and approximately 60 percent of larger utilities do (with larger utilities defined as those serving a population of 1,000,000 or more). When adding in resilience in general (the second row of Table 2), the totals jump to approximately 50 percent for small- and medium-sized utilities and 80 percent for larger utilities. The lower response rate of small- and medium-sized utilities is of interest. This may be reflective of the belief among some U.S. utilities that climate change is less of an issue to their operations or the value is not there to spend limited dollars analyzing it. The differing opinions on climate change show up in a related survey question which asked respondents what the most significant sustainability issues are. Climate change was third from bottom of the list. However, 40 percent of non-utility respondents to the survey identified climate change as the most significant sustainability issue after water conservation.

***With the potentially significant impacts that changing weather patterns have on water supplies, flooding, and agency finances, utilities should be considering climate change in their planning processes. Small- and medium-sized utilities have the most room to advance in this area.***

Respondents who indicated they are considering climate change in their resilience planning were also asked what mitigation strategies were used to address risks and vulnerabilities. The top mitigation strategies currently being implemented by water utilities are: energy management (71.0 percent), water conservation/demand management (67.2 percent) and protecting vulnerable facilities (60.9 percent). It is interesting that energy management was the top strategy being used, because in itself, energy management does not directly provide a new water supply or reduce flooding. It does help optimize agency finances and promotes agencies doing their part to curb emissions linked to climate change – so there is absolutely a tie to mitigating these key vulnerabilities. The other elements offer a menu of strategies commonly used to address climate change risks. Their application is dependent on the utility's specific circumstances and assets.

## **RESILIENCE CONCLUSIONS**

Overall, identifying the need to improve resilience is just part of the equation. A core challenge for U.S. utilities is balancing the overall budget in the context of increasing pressure not to increase rates. Having a common approach to prioritize investments that will improve environmental, customer, health and safety, financial and resilience as investment drivers is essential. Increasingly, risk-based investment planning is being adopted to achieve this balance between system performance, cost and risk. Resilience and asset management are therefore inextricably linked, and building the foundation for resilience through asset management is both timely and essential for the success of modern infrastructure systems and organizations.

Table 2

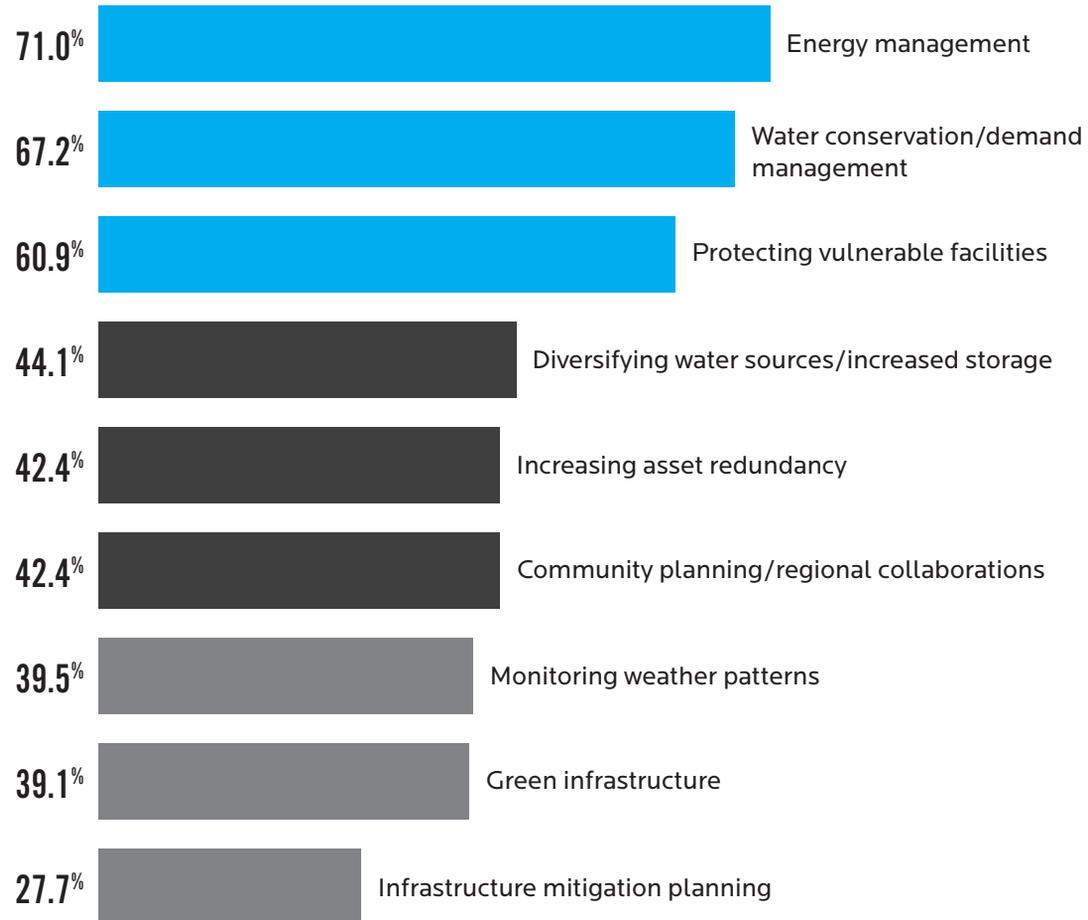
How has climate change and the need for a resilient infrastructure been considered?

Consideration of Climate Change and a Resilient Infrastructure in Planning	By Population Served		
	Under 100,000	100,000-999,999	1,000,000 or More
Our strategy considers the impacts of climate change	11.3%	5.4%	24.3%
Our strategy recognizes the need for asset resilience	21.39%	27.9%	18.4%
Our strategy considers climate change and the need for asset resilience	20.0%	24.0%	35.9%
We recognize these issues, but they are not considered in our strategic plan	22.5%	22.5%	10.7%
We do not recognize these as issues	11.3%	8.8%	2.9%

Source: Black & Veatch

Figure 9

What mitigation strategies is your organization taking to address climate change and infrastructure resilience?



Source: Black & Veatch

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**Uncertainty Around  
Smart City Concept  
May Hide Golden  
Opportunity**

By Jeff Neemann and  
Pamela Kenel

“Smart City” initiatives and technologies have already captured the imagination of the water industry. Now, they are starting to capture their investment dollars.

Data sensors, intelligent metering and cloud-based analytics software offer utility managers unprecedented access to real-time information about consumption, system demand and pressure points allowing service providers to apply predictive analytics that can sense anomalies before they occur. Advanced metering systems not only optimize systems but carry potential for building partnerships with customers by offering data about their consumption. This information can influence behaviors as customers consider environmental factors, such as drought, or seek efficiency gains in light of tiered-rate structures.

The current environment is ripe for delivering on the promise of smart systems. Water scarcity in the Southwest, aging equipment in major cities (particularly along the Eastern Seaboard and Midwest) and an increasingly conservation-minded customer base have stoked high levels of interest in water-related smart city initiatives. But, the Black & Veatch 2015 *Strategic Directions: U.S. Water Industry* report finds an industry in which aspiration is outpacing tangible progress. Siloed communication, cost-recovery concerns and cloudy perceptions of water providers’ roles in an integrated smart city plan are slowing wide adoption (Figure 10).

Figure 10

What are the top three barriers to integrating water utility systems with other systems?



Source: Black & Veatch

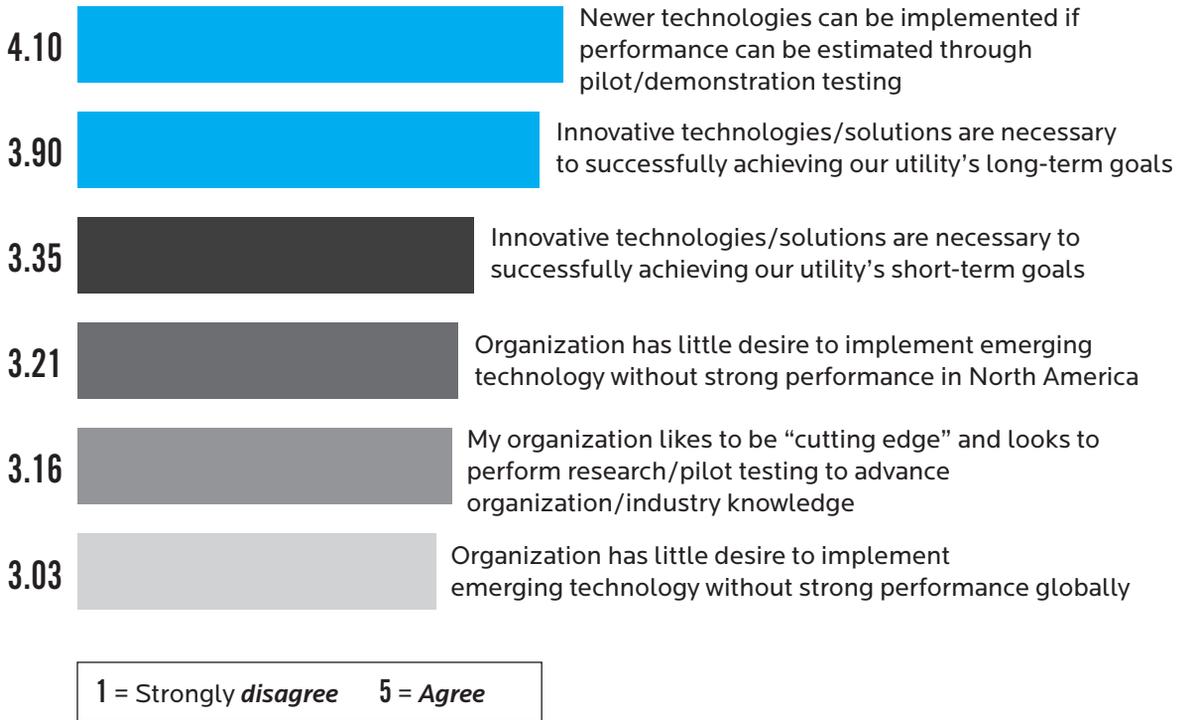
## **PROGRESS CONSTRAINED BY FAMILIAR FACTORS**

Research for this report and conversations with clients across the industry indicate new levels of executive focus toward integrating water into larger smart city solutions. Mayors, city managers and civic groups are approaching local utilities to begin the hard work of preparing strategies and building customer support for them. For instance, Kansas City, Missouri, has started a Smart + Connected City initiative with Cisco, Sprint and other leading technology vendors that will focus on improving the efficiency of the water system. Survey data suggest organizations believe strongly that new technologies (in general) can be implemented if performance is successfully demonstrated through pilot testing. Data also indicates that innovative technology is crucial to achieving utilities' short- and long-term goals (Figure 11).

But that buzz is struggling to produce broad and tangible integration efforts among water providers. Just over 11 percent of respondents indicated their organization was planning or participating in a Smart City initiative. About half said no plan was in place or being considered, and nearly 40 percent didn't know (Figure 12). The fact that a high percentage do not know suggests, in some cases, that the water system is being left out of the conversations.

Figure 11

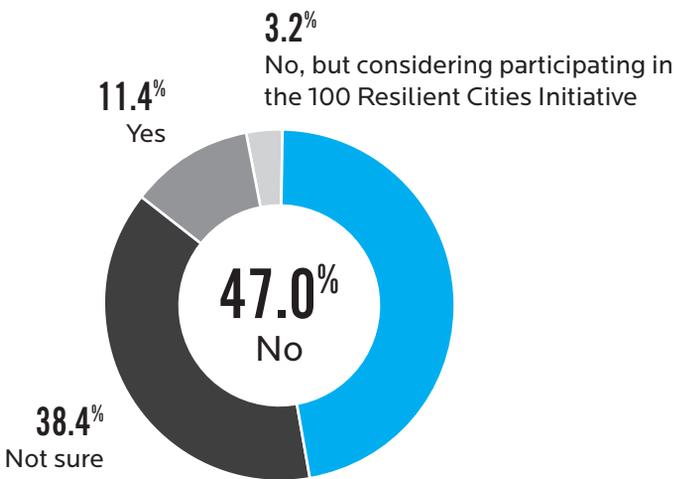
**Agreement with statements related to the implementation of new technology**



Source: Black & Veatch

Figure 12

**Smart city initiatives currently in place or planned**



Source: Black & Veatch

## MEASURE, MOVE AND MANAGE

Earlier this year, responses across the water, electric and natural gas utilities contained in Black & Veatch's 2015 *Strategic Directions: Smart Utility* report suggested the term "smart" in a utility context was less than definitive. Many see it as a buzzphrase that carries different meanings to different utility sectors.

The specificities of a smart city system, and a water utility's role within it, depend on a community's needs and the missions of its various stakeholders. But the foundation of any plan can benefit from simple, higher order concepts common to smart city plans: measure, move and manage.

Hardware measures data and habits, with automatic meter readers (AMR) and advanced metering infrastructure (AMI) playing prominent roles by informing utility operators about consumption and system strain. High-speed data networks move supply and information related to consumption and infrastructure details. Systems manage the flow of it all (Table 3).

***Confusion persists about the smart city concept itself and the role of the water system in an integrated strategy***

Table 3

***What approaches or tools is your utility using to increase the accuracy of demand forecasting?***

Tools Being Used to Increase the Accuracy of Demand Forecasting	By Organization Type				
	Water Only	Wastewater Only	Water or Wastewater	Water, Wastewater and Stormwater	Combined Utility
Shifting rate recovery to fixed charges to reduce dependence on usage	32.5%	12.2%	17.7%	18.8%	17.0%
Identifying and reducing water loss	47.5%	10.2%	59.3%	50.0%	61.7%
Implementing AMR/AMI	48.8%	4.1%	58.4%	43.8%	51.1%
Looking at time of use rates	5.0%	4.1%	12.4%	7.8%	8.5%
Using weather normalization techniques to improve estimate of baseline demand	16.3%	6.1%	13.3%	17.2%	10.6%
Comparisons with other utilities	21.3%	34.7%	30.1%	26.6%	31.9%
Increased detail in monitoring and modeling water use	36.3%	22.4%	47.8%	40.6%	38.3%

Source: Black & Veatch

Common features of any smart system include an automation technology that uses a centralized location to remotely control and adjust devices, along with two-way communication that sends information between a customer's meter and the utility.

For instance, the Washington Suburban Sanitary Commission recently began deploying acoustic leak detection technology and sensors to measure pipeline condition and proactively repair leaks and other anomalies. Customer-use patterns are established and give operators actionable data that can lead to behavioral change. Automation and data analytics carry an extra advantage by producing systems that rely less on human intervention, thus helping to offset the effects of aging or reduced workforces.

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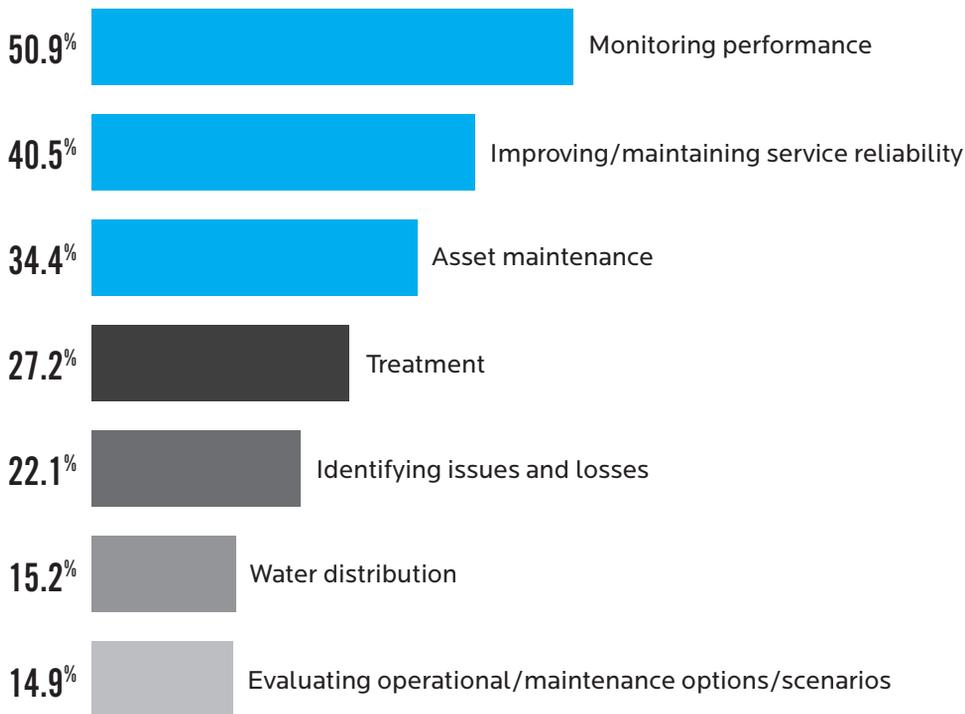
*Intelligent devices, deployed along utility systems, gather consumption information in real-time and detect leaks or other abnormalities to enable quick response times.*

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Among utilities actively using data analytics, nearly half of those responding said they use dashboards that display consumption, equipment data and other metrics. Performance monitoring, service reliability, asset management and treatment were seen as areas that would gain the most from an analytics strategy (Figure 13). Cloud-based systems with greater cost-efficiencies are making analytics available to smaller utilities. These often subscription-based services host the analytics, IT information and customer data that combine to deliver actionable intelligence about consumption and infrastructure.

Figure 13

**What three operational areas do you feel that data analytics will help improve most at your organization?**



Source: Black & Veatch

**MAKING THE CASE**

Responses to the survey suggest smart city plans are seen as a solution reserved for big-city utilities (Table 4). But while scale and costs are different, the core concepts and technologies of smart city solutions bring similar benefits to smaller communities.

Black & Veatch expects providers to set high bars that analytics and automation plans must meet before adoption. Any smart city plan and its efficiency and reliability gains must be easily, and robustly, explained to citizens to engage buy-in through rate cases. Water providers will be challenged to show stakeholders the dangers of sitting out the advances, which may only exacerbate the effects of drought and outdated equipment.

Table 4  
**Smart city initiatives currently in place or planned?**

Smart City Initiatives Currently in Place or Planned	By Population Served		
	Under 100,000	100,000-999,999	1,000,000 or More
Smart city initiatives currently in place or planned	8.6%	8.8%	18.8%
No, but they are participating or considering participation in the 100 Resilient Cities initiative being pioneered by the Rockefeller Foundation	1.2%	3.9%	3.1%
No, none of the above	63.0%	50.5%	26.0%
Not sure	27.2%	36.8%	52.1%

Source: Black & Veatch



## **INDUSTRY PERSPECTIVE: WILLIS GROUP**

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*Analytics: Enhancing Certainty in  
an Increasingly Risky World*

By Jessica Rasulo, Willis Group



In light of the increased risks of a changing environment, many businesses and communities are working to ensure that they are making the best decisions possible to protect their resources.

During a recent panel discussion dealing with coastal risk and resilience and drawing experts from across the United States, several macro pressures affecting regions across the globe were discussed at length:

1. Urbanization is rapidly increasing pressure on existing infrastructure
  - Today, 54 percent of the world's population lives in urban areas compared to 35 percent in 1963. By 2030 60 percent of the world's population will live in cities.
  - There is an emergence of new megacities (those cities with a population of more than 10 million people). There are projected to be 23 megacities in 2015.
2. Frequent severe weather patterns are escalating the risk to our assets.
  - Many of these megacities are coastal, and, thus, more prone to extreme weather flooding etc.
  - Global flood damage for coastal cities could cost \$1 trillion a year if nothing is done to harden assets.
3. Globally we suffer from aging and often overburdened infrastructure resulting from investment failing to keep pace with population and economic growth.
  - \$57 trillion of infrastructure investments will be needed between now and 2030; 60 percent more than what was spent between 1995 and 2013.

That combination of risk factors presents a bleak picture. But as the risks of climate change and the need for resilience grow, so do the tools available to governments, industry and insurers to jointly assess and address them. Vastly expanded data sets and meaningful analytics allow for preparation for risk in a multitude of ways:

### **QUANTIFYING AND PLANNING FOR MID- TO LONG-TERM RISK**

As longer term models become more accurate and reliable, insurers are better able to underwrite the actual risks faced and quantify both the likelihood and severity of exposure. New models allow us to understand how actions taken now are likely to impact exposure to loss in the event of a loss event.

### **PREPARING FOR IMPENDING RISK**

More detailed and accurate weather forecasts allow us to plan for impending weather events and more effectively align resources to deal with storm-related infrastructure challenges.

### **DETERMINING THE MOST EFFICIENT MEANS OF FINANCING RISK**

Risk financing, like all major decisions involving expenditure of corporate capital, faces increased scrutiny. Increasingly, making insurance purchasing decisions regarding structure, retention levels and limits using subjective judgments, benchmarking and other more qualitative information is not the answer.

As previously mentioned, the gains in the ability to utilize analytics in risk-financing decisions allow for the transition away from subjective criteria and the creation of a scientific approach to financing risks. In some respects, this analysis is the antithesis of benchmarking. The focus is inward in terms of examining the specifics of a risk profile.

The starting point is to quantify the risk in the absence of any insurance structure, relying often on the models discussed in the mid- to long-term risk section. This produces an uninsured (unhedged) loss distribution curve. Once the curve is established, it is possible to overlay different combinations of premium, limit and retention to measure the economic value of a given insurance program.

Value is objectively determined by a metric that captures premium, expected retained loss and the cost of volatility retained on the risk. The Cost of Volatility is equal to Risk Capital x Opportunity Cost of diverting this capital from elsewhere within the organization.

All capital has a cost associated with it. Because the financial strength of an organization and the amount of capital required will influence the cost of capital, this analysis should consider the cost of using different capital sources. Examples include the drawing down of an existing line of credit, issuing new debt or equities, selling common stocks, or in the most severe case, filing for bankruptcy or asset liquidation.

The program that delivers the highest value in terms of reducing the cost of risk represents the most efficient combination of premium, limit and retention for that risk.

This analysis allows for the most efficient allocation of capital, purchasing insurance when it proves to be the most efficient means of financing risk. It is critical to note that almost all construction undertakings require insurance. Utilities purchase insurance for both their operations and any construction/renovation/maintenance work they take on. This includes public-private partnerships (PPPs) or other projects where multiple interested parties and expectations for profit exist.

Design-Build and Integrated Project Delivery agreements can further complicate the purchase and put higher scrutiny on the transaction. When this is not the case, the funds that would have been spent on insurance can be invested otherwise – to mitigate risk or provide other means of future capital that can be utilized in the event of a loss.

Community and water utility leaders have much work to do. They face multiple challenges to developing and relying on models in long-term infrastructure planning:

Mega projects shift the risk dynamics. This is challenging because we don't have the actuarial history to predict future performance.

- **Example:** Greater project scopes with multiple parties increases risk exponentially due to the interconnectivities.

As climate changes, catastrophe modeling must also evolve.

- **Example:** Federal Emergency Management Agency maps are used as the standard for flood risk assessment in the United States. As sea levels rise, the maps lose validity and must be updated. Often it is not until after a catastrophe that these updates are made.

Models are inherently imperfect predictors because they are based on past experience.

- **Example:** If one took the lessons learned from Hurricane Katrina and tried to apply them to Sandy, the results will be imperfect. This misalignment is inherent and must be considered when relying on models.

Given the potential challenges facing coastal communities and the dramatic impacts of water scarcity issues that have plagued much of Texas, California and the Southwest, it is clear we must move toward exploiting the promise of technology to gather, analyze and act on data from a diverse array of inputs in a prompt and meaningful way.

## HERE LIES OUR GLIMMER OF HOPE:

As technology allows us to more effectively gather and analyze data, insurance shifts from a relationship business in which coverage is purchased to satisfy requirements of various interested parties to becoming a scientific means of assessing and transferring risk to a third party. We are more capable of making informed decisions about the use of our capital and the efficiency of various risk mitigation tools and investing our limited capital effectively. These strategies aim at a single goal: limiting the impact of the increased risks we face.

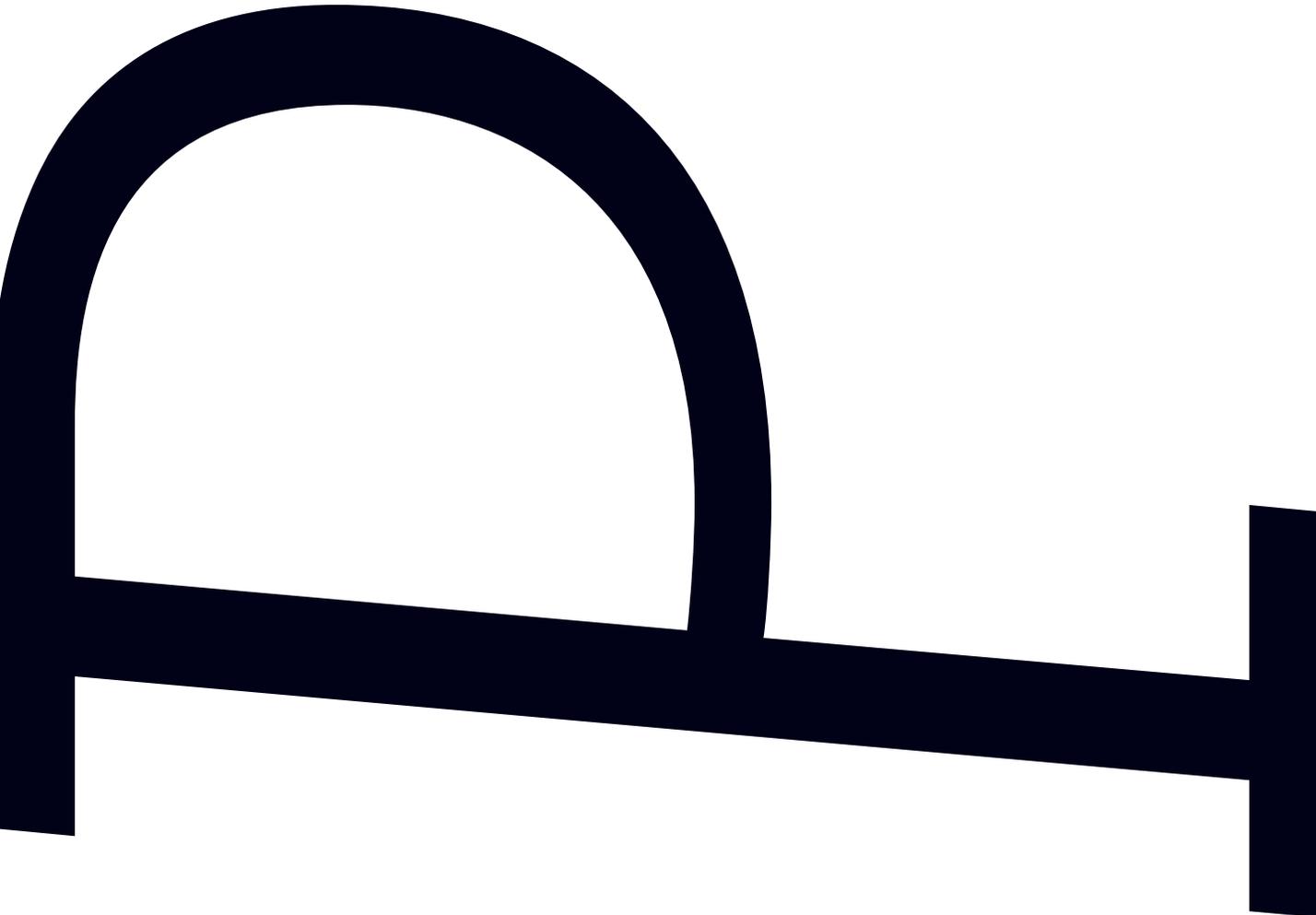
*Jessica Rasulo is Senior Vice President, with the Construction Practice of Willis North America. Willis Group Holdings plc is a leading global risk advisor, insurance and reinsurance broker. Willis operates today on every continent with more than 18,000 employees in over 400 offices. Willis offers its clients superior expertise, teamwork, innovation and market-leading products and professional services in risk management and transfer. Our experts rank among the world's leading authorities on analytics, modelling and mitigation strategies at the intersection of global commerce and extreme events. Information regarding "Determining the Most Efficient Means of Financing Risk" is based on Willis' proprietary tool CCoRSM – Comprehensive Cost of Risk. Find more information at our website, [www.Willis.com](http://www.Willis.com), our leadership journal, Resilience, or our up-to-the-minute blog on breaking news, WillisWire. Across geographies, industries and specialisms, Willis provides its local and multinational clients with resilience for a risky world.*

# PERSPECTIVE: STRATEGIC RESILIENCE

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*A UK Perspective on Flood Management*

By Richard Hein





Major weather events such as the 2011 tsunami in Japan, 2012's Superstorm Sandy in the United States and the UK floods of 2014, have raised concern over the resilience of key infrastructure to headline news status. This increasing public awareness of the risks to critical infrastructure assets is no longer limited to specialty publications such as *New Civil Engineer* in the UK, but can also dominate mainstream media. As water service providers, and the customers they serve, become more aware of the need to plan for resilience, there is a greater demand for assistance in the planning, implementation and management of resilience projects.

In the UK, the Environment Agency, local authorities and other asset owners are planning for and implementing the future resilience of communities and vital infrastructure assets. For example, Black & Veatch carried out the design and environmental assessment for the award-winning £50 million (US \$78.3 million) Nottingham Left Bank scheme, the largest inland flood defence scheme in the UK. Major flood resilience projects also include the emergency response to flooding on the Somerset Levels, the business case and outline design of the £300 million (US \$469 million) River Thames Scheme near London, wave overtopping analysis and determination of economic damages for the Hull Humber Frontages project, and the £11 million (US \$17.2 million) Phase 1 of Derby City Council's £390 million (US \$610 million) Our City Our River scheme. The skills honed on these projects are also being sought for coastal infrastructure projects in the United States, Canada, Mexico, South America, Southeast Asia and Australia.

When considering resilience projects, some of the key requirements needed to successfully plan flexible, long-term solutions include quality data and strategic planning resources. Each component can benefit from the rapid proliferation of edge processing, cloud computing and increased computing power that allows project teams to model a range of complex scenarios to arrive at the best solution.

A strategic approach ensures that the most cost-effective solutions are developed, and that solutions can manage and protect our coastlines and coastal infrastructure in a proactive way. For communities, as well as infrastructure owners and operators, this may mean new ways of thinking about risk, and adopting new methods for dealing with that risk, such as designing structures that allow a certain degree of flooding to take place without major impacts on the structure's ability to perform its primary function.

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*When considering resilience projects, some of the key requirements needed to successfully plan flexible, long-term solutions include quality data and strategic planning resources.*

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In terms of residential and commercial properties, this may require the development of structures that are resilient to flooding of the lower levels (water-resistant floors and walls, raised electricity points, etc.) with high value items only stored on the upper floors. Similar solutions may be appropriate to harden key infrastructure assets, but many other options are also available.

Increased computing power enables service providers to find new and innovative ways of assessing and developing solutions to their challenges. One example, the Hull Humber Flood Defence Project, uses calculated wave overtopping flows at five-minute intervals throughout a full tidal cycle as a key data input to determine flood extent and depth during storms. Thousands of calculations are collected for each location, whereas just a few years ago the data would have been limited to the peak value, with estimates for the remainder of the tidal cycle.

Greater computational power and more advanced numerical models also allow resilience planners to create flood models with increasingly small grid cells, allowing finer, more localized detail to be examined. Black & Veatch's own Flood Damage Economic Model (FDEM) uses a geographic information system (GIS) to link flood risk, property values and economic damages to provide a quick and reliable means of valuing the economic benefits of flood risk management options.

But neither strategic planning nor computer power can be fully utilized without good quality data on which to base asset management decisions. With this in mind, the development of regional/national monitoring frameworks to collect regular data is a vital element of successfully managing our coastlines to improve our resilience against extreme events.



To highlight the essential nature of data in planning decisions, Black & Veatch is currently working to relocate a sewage treatment works in the north of the country that is close to an eroding cliff line. Though constructed less than 20 years ago, with a predicted design life of 60 years, because of accelerated erosion rates it will be unlikely to operate in its current location for more than five years.

Using regular Lidar surveys (now available), the project team has been able to make accurate and reliable predictions with regard to the remaining life of the structure. This has enabled the facility owner to consider a range of options and make business decisions about the future of the plant based on sound technical information. Given the significant role that environmental conditions play on asset performance and longevity, and the increasing variability of environmental conditions, it is critical to use the best information available to understand and predict such changes.

With the inseparable relationship between power generation and water resources, most of the UK's critical infrastructure (power plants, water supply, transport links, etc.) is by necessity located at or near the coast. Yet, many of these critical assets are in locations that could be affected, or are already affected, by coastal processes, flooding, and climate change. This makes steps to protect and build resiliency increasingly important.

The extreme climate events of the decade have already demonstrated that many critical infrastructure assets such as power, water and telecommunications service are vulnerable. It also requires that governments, utilities and their stakeholders measure their systems' ability to bounce back.

*Climate events have already demonstrated that many critical infrastructure assets such as power, water and telecommunications service are vulnerable.*

# FINANCIAL RESILIENCE

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## *Securing Revenue Streams Are Key to Sustainability*

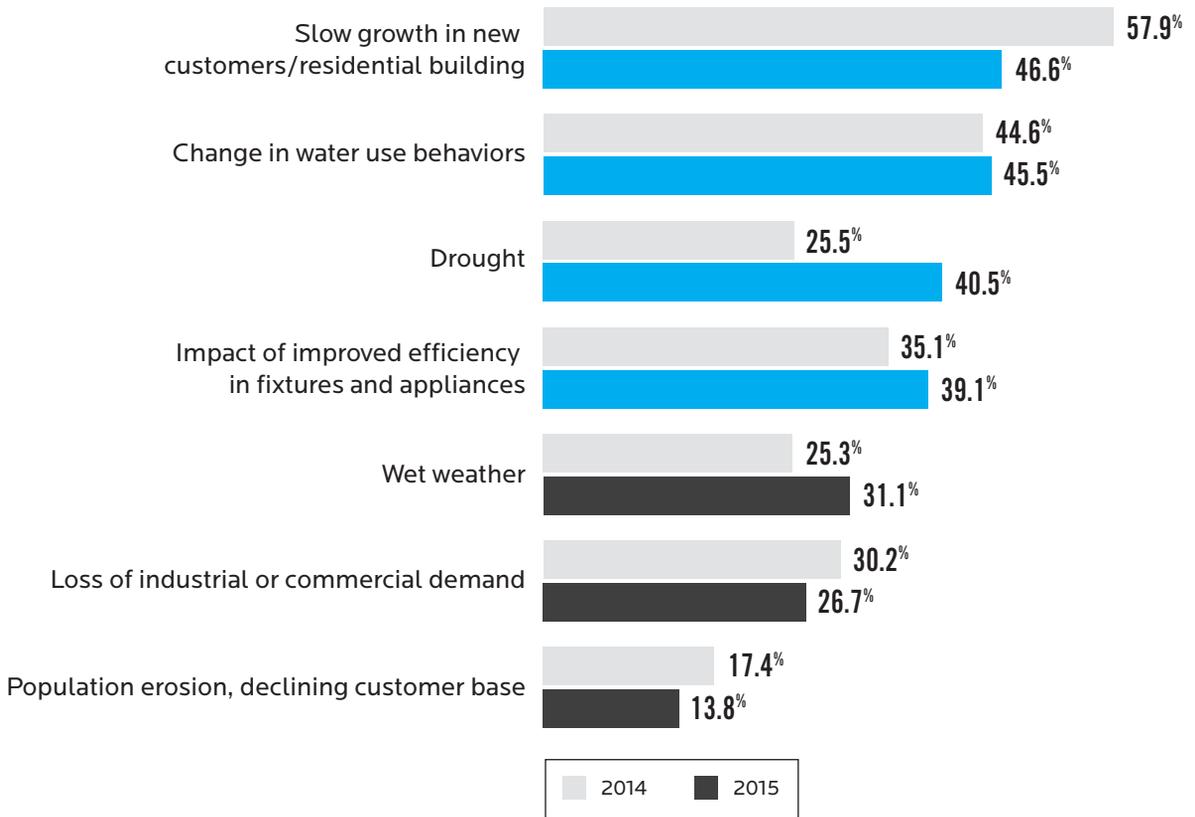
By Ann Bui

For much of the United States, 2015 is yet another challenging financial year for water service providers. Drought across the Southwest and California has reached near crisis levels in many areas with some communities resorting to trucked and bottled water supplies for their residents. In other parts of the country, extended cold temperatures and historic levels of snowfall once again battered aging infrastructure systems with burst mains and leaking pipes. While the impacts and dramatic steps proposed to address California's drought (in particular) garner nationwide headlines, across the United States, all water service providers are dealing with a range of issues affecting their financial resilience.

Despite broad indicators that the overall pace of economic recovery is tempering water utility concerns toward financial issues, the slow pace of new customer additions and residential building remains the top issue this year (Figure 14). Nearly 47 percent of respondents cited slow growth as the leading factor negatively affecting revenue during the past five years — down from nearly 60 percent in 2014. New customers provide many water utilities with a steady stream of capital. Unfortunately, the influx of financial resources fueled by the rapid pace of construction during the housing boom of the mid 2000s often masked a range of underlying financial challenges. As this revenue stream disappeared during the Great Recession, the full brunt of water utility financial issues became apparent, particularly in flat or declining population zones.

Figure 14

Select all items that negatively impacted utility revenue streams during the last five years



Source: Black & Veatch

## SLOW GROWTH/CHANGING BEHAVIORS AREN'T JUST REGIONAL ISSUES

The continuing multiyear drought has impacted customer behavior and compounded revenue issues brought on by the greater adoption of water/energy efficient appliances, the slow pace of the housing market and manufacturing process improvements that reduce water use. The trend toward declining customer consumption manifests as falling revenues in volume-based pricing systems and is the second most pressing revenue issue (45.5 percent) identified. It is also noted that survey data show that the concerns vary widely across geographies (Table 5).

In fact, it is interesting to note that within the geographic data cut, the most dramatic negative impacts to revenue are water conservation resulting in decreased demand in the Gulf Coast (75 percent) and drought concerns from West Coast respondents (67 percent). With slow growth, the combination creates a quandary for water utilities encouraging conservation while at the same time struggling to service high fixed costs.

Table 5

**Regional View: Items that negatively impacted utility revenue streams during the last five years**

Items That Negatively Impacted Utility Revenue Streams During the Last 5 Years	By Primary Business Region							
	North-east	Mid-west	South-east	Gulf Coast*	West Coast	Rocky Mountain	Northwest/Southwest	Other Countries*
Drought – water conservation results in decrease in demand	23.3%	25.3%	27.6%	75.0%	67.4%	45.5%	55.7%	21.4%
Wet weather – decrease in demand for irrigation purposes	30.0%	49.4%	50.0%	8.3%**	8.7%	45.5%	10.1%	28.6%
Population erosion, declining customer base	33.3%	23.0%	9.2%	0.0%	4.3%	90.1%	11.4%	0.0%
Slow growth in new customers/residential building	56.7%	46.0%	55.3%	33.3%	30.4%	50.0%	50.6%	28.6%
Loss of industrial or commercial demand	26.7%	44.87%	27.6%	8.3%**	15.2%	4.5%**	13.9%	21.4%
Impact of improved efficiency in fixtures and appliances	63.3%	43.7%	60.5%	8.3%**	21.7%	40.9%	24.1%	21.4%
Change in water use behaviors – non-fixture conservation measures by customers	53.3%	49.4%	50.0%	50.0%	34.8%	54.5%	36.7%	50.0%

\*Small samples sizes, under 30 respondents.

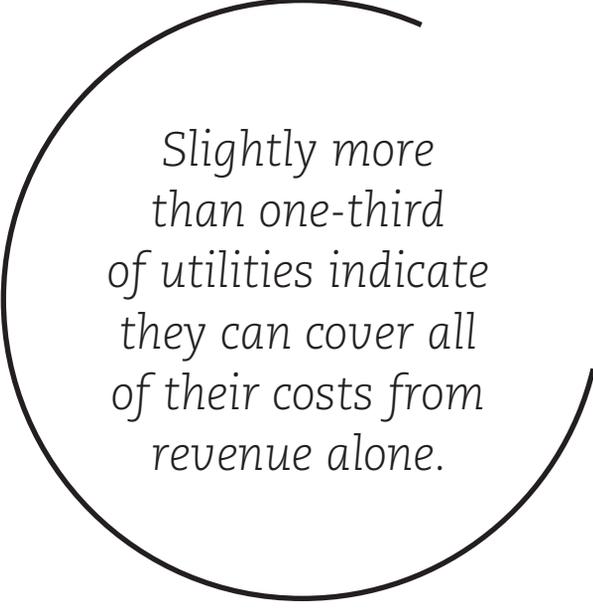
\*\*Excluded from significance testing because too few respondents.

Source: Black & Veatch

With scarcity concerns in much of Texas and the Western United States, security of supply becomes an increasingly large factor in the financial resilience of a water utility. This is particularly true for drought-impacted service providers as drought may actually cause water utilities to increase their operating costs. This is due to the challenges of obtaining and treating marginal sources of supply.

For example, desalinated ocean water, a recent component of California's water costs, may add a significant increment of additional cost given its high energy cost of production. Other water utilities are being forced to obtain supply from resources further afield as traditional sources restrict allocations or sales. Likewise, other California water utilities are being forced to purchase water from new suppliers, in this case agricultural interests, at rates of \$700 per acre-foot to replace sources that were previously obtained at a near zero cost basis.

While the United States continues to recover from the Great Recession, municipal recovery typically lags the broader economy by about two years. The slow recovery, coupled with the ongoing urban exodus from major Northeast cities such as Detroit, Cleveland and Buffalo continues to plague utilities in the Northeast as their customer base shrinks and those remaining struggle to pay increasing costs.



*Slightly more than one-third of utilities indicate they can cover all of their costs from revenue alone.*

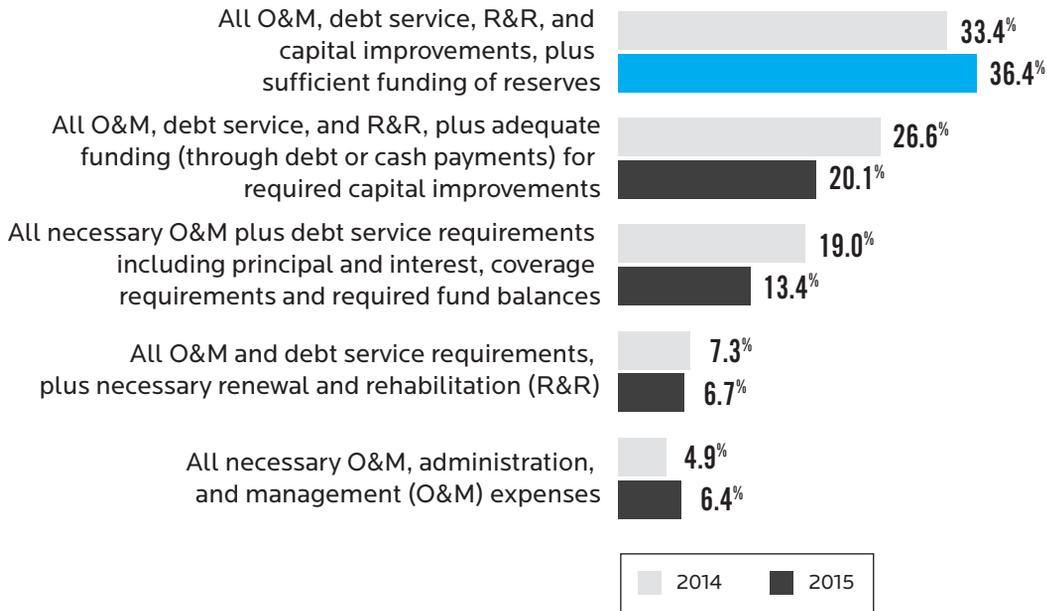
#### **UNDERSTANDING FINANCIAL RESILIENCE**

Declining revenue represents just one aspect of the overall financial resilience challenges facing water utilities. The percentage of water utilities reporting sufficient revenues covering all financial obligations (36 percent in 2015 versus 33 percent in 2014) shows marginal year-over-year improvement. Slight improvements are also seen across most categories measuring financial strength. However, the fact remains that slightly more than one-third of utilities indicate they can cover all of their costs from revenue alone, leaving a significant number of utilities that cannot. This discrepancy demonstrates the instability of the overall U.S. water infrastructure system (Figure 15).

Black & Veatch's analysis also notes the ongoing disconnect between those utility executives/directors and managers reporting comprehensive financial resilience and the ability to address all operational, capital planning, and debt service considerations. Approximately 55 percent of respondents indicated the need for annual rate increases of at least 5 percent or more annually for 10 years to fully cover funding, far outpacing the less than 2 percent inflation rate of the past few years. Their concerns also include deferred maintenance and capital activities during the Great Recession that now require them to "catch up." The frequency of water main breaks on both the East and West coasts of the United States is increasing which also results in economic impacts to the community. These impacts include road closures and business interruption.

Figure 15

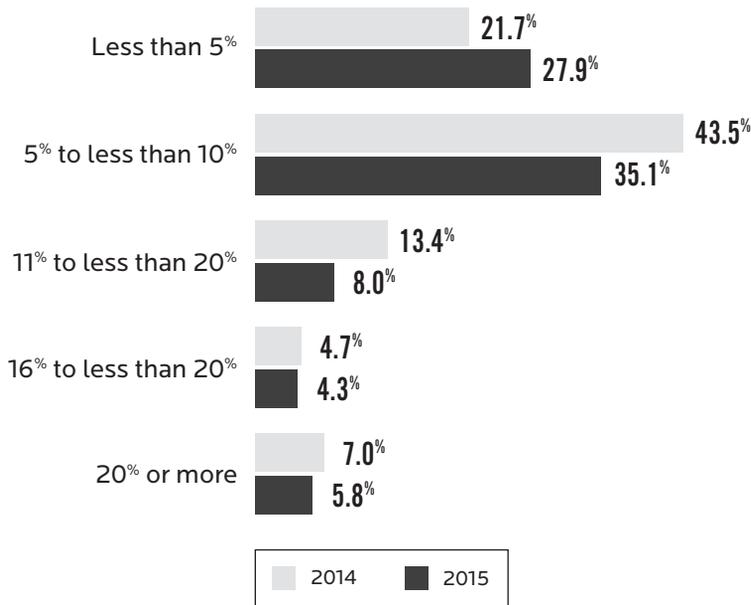
**Current Revenue Coverage**



Source: Black & Veatch

Figure 16

**Annual rate increase needed to fully cover services and provide funding over the next 10 years, including O&M, debt service, R&R and capital improvements and provide sufficient funding of reserves**



Source: Black & Veatch

## CLOSING GAPS

Water utilities provide an essential service and today's providers face more conflicting demands than ever. They must fix/maintain/improve infrastructure and maintain service levels without raising rates (or as little as possible). This must be accomplished in the face of reduced water consumption.

The most common solution for trying to stabilize revenues in times of unpredictable demand (60 percent) is to shift from highly variable use-based rates to a structure that recovers a greater percentage of fees through fixed costs. While this can be a way to moderate cyclical utility finances, any resulting increase in water rates may affect low-usage customers (such as fixed income and seniors) more dramatically.

Working with our clients, it is evident that the political process will play a role in addressing these gaps. Public entities, as providers of water services through municipal, state and regional entities, must find a clear balance between customer affordability and the financial viability

of the service provider. Nevertheless, this latter point is critical to strengthening the financial resilience of water utilities as they plan for a range of future extreme weather events and the ongoing challenges of aging infrastructure.

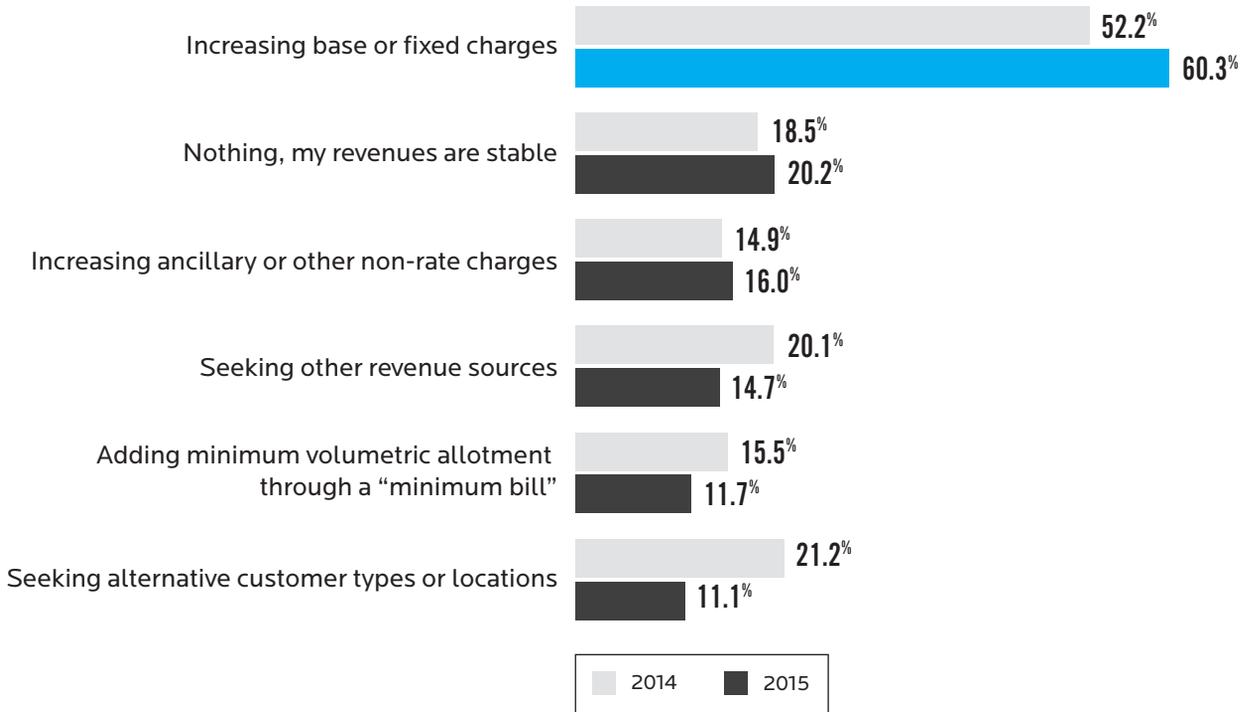
## RESEARCH NOTE:

### IN-FILL VERSUS NEW DEVELOPMENT

*During our analysis, an interesting footnote emerged regarding the global trend toward urbanization versus urbanization/gentrification in the United States. In certain cities that have experienced population loss or those with areas that are experiencing gentrification in historically blighted areas, the data indicate that an influx of residents doesn't necessarily bolster water utilities' financial conditions in the same manner that new construction can. This is because in-fill within a city is not the same as growth in new accounts; it generates some new revenue, but doesn't replace new development. That said, innovative approaches to revitalizing neighborhoods in cities with declining populations can help stabilize revenues as areas that had once been unlivable are converted to mixed-use residential/commercial zones that draw new customers to areas previously abandoned.*

Figure 17

What is your utility currently doing, planning to do or considering in order to stabilize its revenues?  
(Select all that apply).



Source: Black & Veatch

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## Viability Questions Forcing Financial Experimentation

By Dr. Les Lampe

For centuries, providing efficient water services typically involved large up-front investments, high fixed costs and ideally, predictable revenue. Driven by a range of factors, the costs of providing water, wastewater and stormwater services are rising and impacting the financial resilience of service providers and municipalities across the nation. Today, aging assets, higher operational costs, compliance with federal mandates and the impacts of decades of conservation practices are creating fundamental questions for more than 30 percent of the respondents in the Black & Veatch 2105 *Strategic Directions: U.S. Water Industry* report.

In many regions of the country, raw water costs are going up. In California and the Southwest new supplies must be located, drilled for or otherwise contracted for as drought impacts traditional sources. In other parts of the country, non-revenue water is a significant issue for water utilities with extensive deferred maintenance backlogs and leaking pipes, issues common to the Midwest and Northeast. In the Southeast, a mix of drought, seawater intrusion, and rapidly rising demand are straining operators.

In the current operating environment, where the substantial fixed hookup fees for new customers are a fraction of their mid-2000s peak, many service providers are exploring methods to shore up revenue. Financial experimentation is the result of trying to address the large funding gap between infrastructure needs, ability to raise rates (affordability), and grants. Federal funding is fragmented and decreasing; infrastructure needs are increasing and mandated at times (e.g. consent decrees), and the ability to raise rates is hampered by lack of political will and continued pressure that undervalues the price of water.

On the wastewater side, the increasing number of federal consent decrees — occasionally resulting in mandatory billion-dollar remediation projects — has significant impacts on municipalities' ability to access traditional bond financing markets. Black & Veatch notes that among Municipal Department respondents, 30 percent identified reducing sanitary sewer overflows and/or combined sewer overflow occurrences as important financial issues (Table 6). Though these large capital projects can be amortized over 20 to 30 years, the sheer scale of the project costs is a tremendous figure for ratepayers to contemplate.

Table 6

Which items represent the most significant sustainability issues for your utility/water utilities?

Most Significant Sustainability Issues for Water Utilities	By Utility Type					
	City, County or State	Special District	Municipal Department	Municipal Utility Commission or Authority	Utility or Water District	Other
Distribution system water loss	17.6%	1.7%	18.0%	10.6%	11.4%	40.0%
Energy efficiency	23.7%	31.7%	26.0%	19.7%	28.6%	42.9%
Energy recovery/generation	13.7%	13.3%	10.0%	10.6%	11.4%	5.7%
Water conservation/demand management	22.1%	30.0%	22.0%	18.2%	28.6%	20.0%
Declining consumption	18.3%	10.0%	20.0%	37.9%	17.1%	34.3%
Climate change	5.3%	13.3%	10.0%	9.1%	17.1%	5.7%
Customer water rates	32.1%	30.0%	32.0%	45.5%	34.3%	22.9%
Long-term financial viability	31.3%	36.7%	24.0%	36.4%	31.4%	28.6%
Maintaining levels of service with declining budgets	33.6%	11.7%	22.0%	15.2%	11.4%	11.4%
Maintaining or expanding asset life	49.6%	61.7%	54.0%	62.1%	57.1%	48.6%
Reducing sanitary sewer overflows and/or combined sewer overflow occurrences within the system	19.8%	18.3%	30.0%	12.1%	14.3%	14.3%

Source: Black & Veatch

Despite these headwinds, (and as previously noted in the *Financial Resilience* section) there is less concern toward the financial health of water utilities versus one year ago. Unfortunately, this does not mask the fact that, for most, current revenues simply do not cover all financial obligations.

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*A movement is afoot across all regions to shift from a traditionally volumetric-based revenue model to one in which base or fixed charges play a larger role.*

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#### **SHORING UP REVENUE THROUGH PRICING EXPERIMENTS**

While no two regions of the United States are the same, a movement is afoot across all regions to shift from a traditionally volumetric-based revenue model to one in which base or fixed charges play a larger role (Table 7).

By increasing fixed costs, service providers shift a greater portion of their revenue stream to charges to “access” the water system. Even if the actual commodity charge remains the same, customers would typically pay more for using the same amount of water. This increase in revenue certainty insulates providers from decreasing revenues as consumption habits change.

Black & Veatch notes that raising fixed costs also draws a parallel to the electric utility industry. The growing proliferation of rooftop solar systems in some regions is creating a situation where the maintenance costs of the electric grid are being spread across a smaller number of customers, many who cannot avail themselves to the benefits of rooftop solar. Electricity service providers, mandated to ensure system reliability, are exploring increasing fixed charges as a means to spread the costs.

Other locales, including those regions typically not regarded as water stressed, are exploring tiered-rating structures based on consumption. Use of tiered rates is not new though in much of the Western United States. In the Rocky Mountain region alone, more than 40 percent of respondents identified raising rates for use above the amount covered by the fixed charge as a means of stabilizing revenue.

***Black & Veatch is now seeing conservation pricing/ideas starting to appear in areas such as Indiana where access to previously “unlimited” water sources might get threatened.***

In addition to its revenue impacts, the practice also encourages conservation as pricing can increase dramatically at each consumption tier.

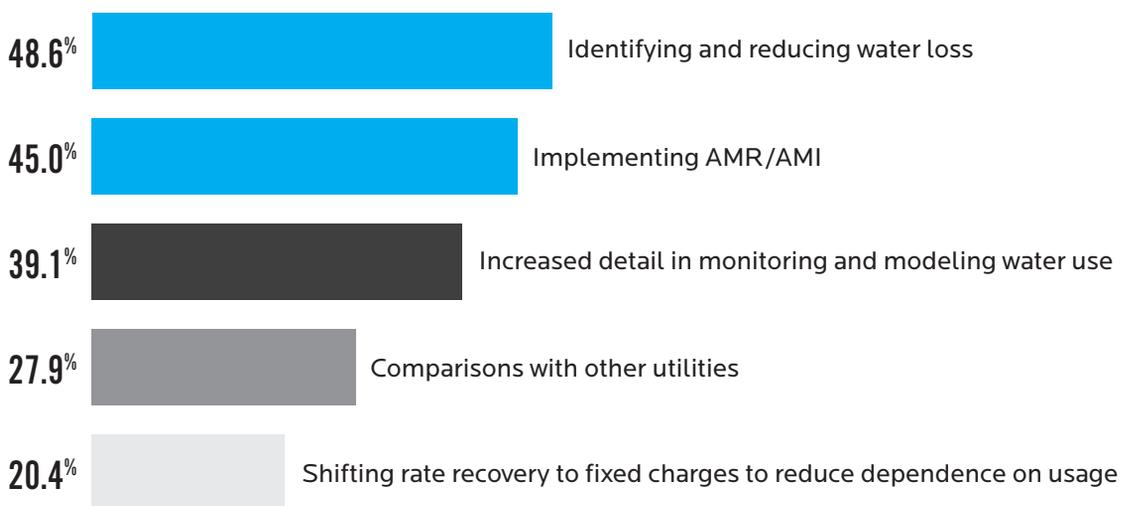
In addition to fixed fees and tiered rate structures, water utilities are turning to tools, technology and analysis to identify water loss (Figure 18). Similarly, there is increasing adoption of, and enthusiasm for, the role of automated metering infrastructure (AMI) in improving utility efficiency through greater understanding of system infrastructure and usage through data analytics. Technology is even playing a role in improved weather normalization forecasts. In Texas, several years of drought led to intensive efforts to promote water conservation. The immediate positive response from water users has led to longer term adoption of water efficiency measures that has resulted in difficulty in forecasting demands. This, in turn, has led to lower revenues and significant budget shortfalls.

Table 7  
 Water utility plans to stabilize revenues

Water Utility Plans to Stabilize Revenues	North-east	Mid-west	South-east	Gulf Coast	West Coast	Rocky Mountain	Northwest/Southwest
Increasing base or fixed charges	43.8%	56.8%	52.5%	30.8%	40.4%	54.5%	46.4%
Increasing base charges by adding a minimum volumetric allotment through a “minimum bill”	15.6%	11.4%	7.5%	15.4%	10.6%	18.2%	4.8%
Increasing ancillary or other non-rate charges	25.0%	11.4%	21.3%	7.7%	10.6%	13.6%	9.5%
Increasing rates for use above that covered by the base charge	34.4%	28.4%	25.0%	15.4%	27.7%	40.9%	25.0%
Seeking other revenue sources such as service contracts	12.5%	5.7%	16.3%	0.0%	10.6%	4.5%	8.3%
Seeking alternative customer types or locations, such as through wholesale agreements	28.1%	12.5%	12.5%	0.0%	10.6%	0.0%	1.2%
Nothing, my revenues are stable	12.5%	6.8%	17.5%	30.8%	12.8%	18.2%	21.4%

Source: Black & Veatch

Figure 18  
 What approaches or tools is your utility using to increase the accuracy of demand forecasting?



Source: Black & Veatch

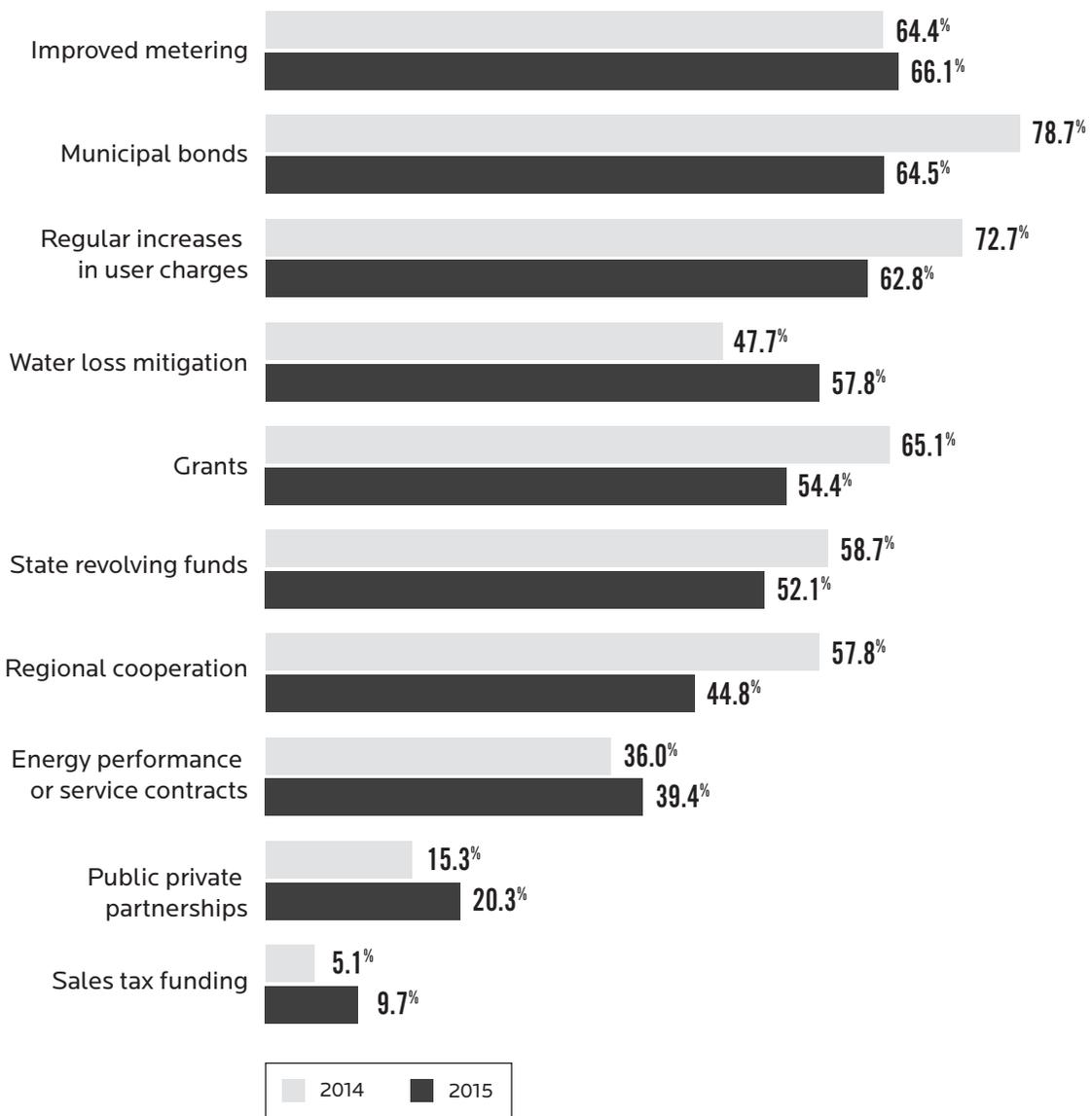
### **EVOLUTION OF PUBLIC-PRIVATE-PARTNERSHIPS?**

Alternative financing methods were discussed at length in previous Strategic Directions reports. Unlike Australia and the United Kingdom, public-private partnerships (PPP) remain elusive in the U.S. water industry. PPPs are of great interest as a means of providing much needed capital. However, the checkered history of PPPs, in which some simply did not work financially, has created as many doubters as advocates for the PPP delivery process. Yet it is clear that alternative financing will have to play a role because of the sheer volume of capital requirements. Maintaining an overall sound financial footing will require some municipalities to find new sources of funding beyond the municipal bond market (Figure 19).

Black & Veatch notes that recently, and unlike previous approaches to increasing private participation in the market through PPPs or outright privatization, there is rising interest in taking on equity partners on a specific project basis that could help provide needed capital. In these cases, private capital might finance a treatment facility, conveyance project or other element of the overall system in return for a guaranteed rate of return. Given the sensitivities of PPPs, it is an exciting evolution in the market.

Figure 19

**Strategies and tactics to help finance and/or deliver services and major capital programs**



Source: Black & Veatch

# END-TO-END DESIGN-BUILD SOLUTIONS GROWING IN FAVOR

By Mike Orth and Blake Childress

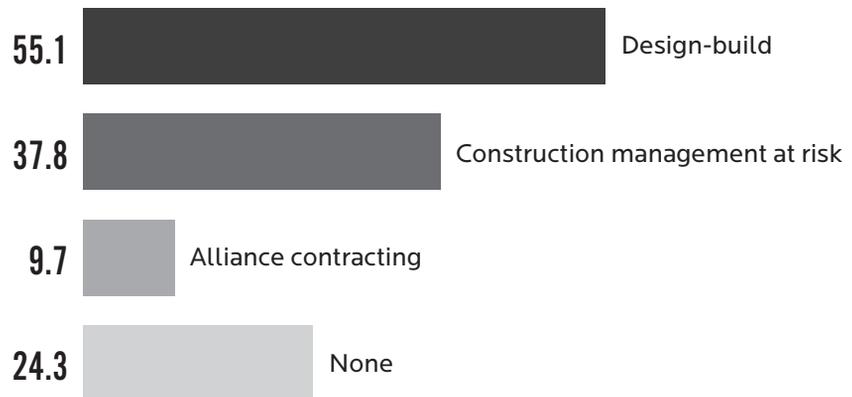
For years, design-build strategies have served as an alternative to traditional water utility project delivery methods, tempting utilities as an end-to-end solution for delivering new, expanded, and modified facilities and other key projects. In 2015, design-build has become a nearly mainstream method of choice for project owners.

The traditional delivery model known as “design-bid-build” sees design and construction services split into separate jobs requiring separate contracts being held by the utility owner, multiple contractors and sometimes vastly different completion timelines. Design-build streamlines project delivery by placing all services under one contract governing both design and construction, giving the owner a single point of contact and greater control over project scheduling and costs.

More than half of the utilities responding to Black & Veatch’s 2015 *Strategic Directions: Water Industry* report survey said they were either using or considering design-build as the path toward implementing capital programs (Figure 20).

Figure 20

**Has your utility used or considered any of the following alternative delivery methods for implementing capital programs?**



Source: Black & Veatch

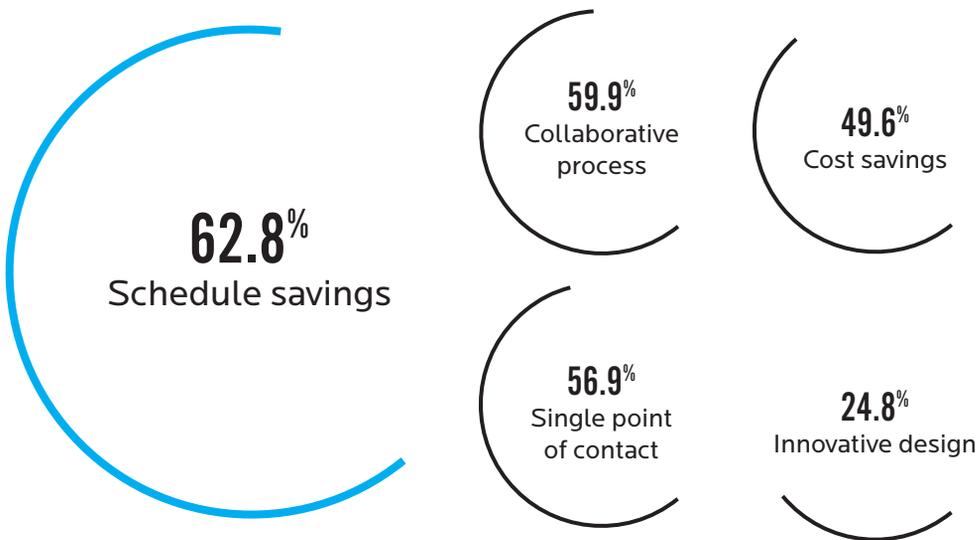
## DESIGN-BUILD ADVANTAGES DRIVE ACCEPTANCE

Survey responses confirm design-build's key advantages: speed and certainty of scheduling and cost. Under design-bid-build processes, time and resources devoted to the management of multiple contracts and projects – and their frequently competing timelines – often add months to a project. Design-build shortens the timeframe of the bidding process and confines the design-builder's obligations inside a single contract, a speed component that is a key for utilities eager to quickly bring capital projects online to meet demand or even consent decrees.

The approach was a crucial one for the Midland County Fresh Water Supply District No. 1, which recently partnered with Black & Veatch to design and build a well field project to deliver desperately needed water to drought-stricken west Texas. (A small number of U.S. states, including New York, prohibit government entities from entering into design-build contracts, largely out of concerns that the method removes competitive bidding and thus lower-priced options from the construction process. Industry advocates are working to ease those rules.)

Project delivery timelines are often negotiated between the design-builder and the project owner, resulting in a shorter delivery schedule because both design and construction can proceed simultaneously rather than sequentially. Schedule and cost savings were key drivers for utilities that explored and employed design-build for their projects (Figures 21 and 22).

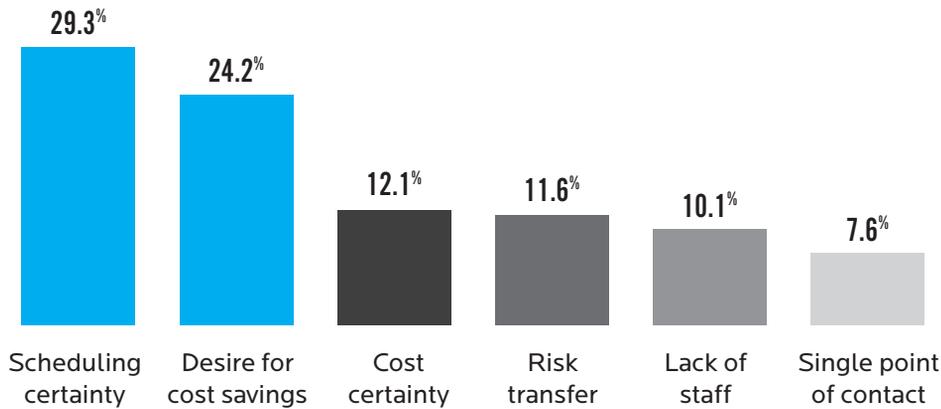
Figure 21  
*What water utilities liked about using the design-build method?*



Source: Black & Veatch

Figure 22

**What was the primary reason for looking into design-build as an alternative solution?**



Source: Black & Veatch

### VERSIONS OF DESIGN-BUILD

Within the design-build principle are several project delivery approaches that can meet the varying needs of utilities. They include lump sum design-build, construction management at-risk (CMAR) and progressive design-build, just to name a few. Lump sum design-build sets a project's cost from the outset, an option for owners who must meet restricted cost budgets and who seek innovative and alternative ideas (Table 8). Lump sum design-build contracting requires the owner to spend a significant amount of time, effort and cost to adequately describe the project to the depth required to price the work.

Advocates of design-build and other approaches fight perceptions that they remove control from a project owner. Control issues were a significant issue for organizations considering design-build (Figure 23).

In fact, selecting the appropriate design-build approach can give the owners as much involvement as they desire. Successful design-build scenarios see project owners maintaining control via the design-builder selection process and by acting in a close, collaborative role during project design and construction. Experience is key. More than 80 percent of utilities indicated experience was the primary factor in picking a design-build team.

Nearly a third of utilities cited the design-builder's willingness to accept responsibility and risk as a benefit for design-build delivery. In traditional models, the designer is only on the hook for the cost of the design while the general contractor can point back to the design team when trouble arises. In design-build, there is no confusion related to the coordination between the designer and the contractor as they are the same entity.

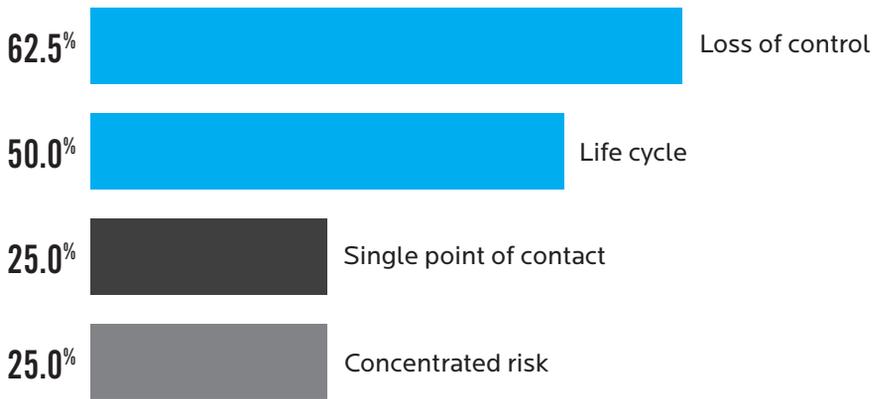
Black & Veatch believes these strategies will become more prevalent in the water industry as utilities exploit their efficiencies and project-timeline advantages.

Table 8  
 Specific types of design build approaches used or considered

Specific Types of Design-Build Approaches Used or Considered	By Organization Type				
	Water Only	Wastewater Only	Water or Wastewater	Water, Wastewater & Stormwater	Combined Utility
Design Build Operate (DBO)	17.2%	16.1%	19.7%	22.2%	14.3%
Design Build Operate Finance (DBOF)	10.3%	6.5%	7.6%	2.8%	0.0%
Hard bid/lump sum design-build	58.6%	41.9%	37.9%	41.7%	39.3%
Negotiated guaranteed maximum price	48.3%	41.9%	33.3%	38.9%	67.9%
Progressive Design-Build	24.1%	16.1%	13.6%	16.7%	17.9%
Converted Design Services Contract into Design-Build	13.8%	6.5%	7.6%	5.6%	7.1%
Best Value Based Design-Build	10.3%	12.9%	22.7%	16.7%	17.9%
Construction Manager-at-Risk (CMAR)	27.6%	22.6%	30.3%	36.1%	46.4%

Source: Black & Veatch

Figure 23  
 Elements of the design-build approach that were a concern



Source: Black & Veatch



**INDUSTRY  
PERSPECTIVE:  
STANDARD &  
POORS**

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*Liquid Gold: Water  
Utilities and Users  
Must Revalue the Cost  
of Their Aquatic Assets*

By Geoffrey Buswick



California takes pride in its reputation for innovation, but Governor Jerry Brown's recent decision to restrict urban water usage breaks new frontiers even for the resourceful Golden State. The proposed usage constraints are a necessary response to the state's ongoing drought — the worst in over a millennium, according to scientists — but restricting the water supply may only provide a limited solution to a growing problem.

The interaction of water sources and the utility systems that deliver them to our homes and businesses are complex and sometimes contradictory. Water utilities are largely self-reliant and user-funded, which makes the sector one of the most stable asset classes we assess at Standard & Poor's Ratings Services. Roughly 98 percent of the public water systems we rate are in the 'A' category or higher, indicating that they have a strong capacity to meet their financial obligations.

Bubbling underneath this surface of fiscal stability, however, are our concerns about the longer-term threats to water infrastructure. As a wave of cities from Sao Paulo to San Diego confront the likelihood of a shrinking water supply and growing service costs, we believe that these challenges are likely to produce an upward pressure on the rates consumers pay for water in coming years.

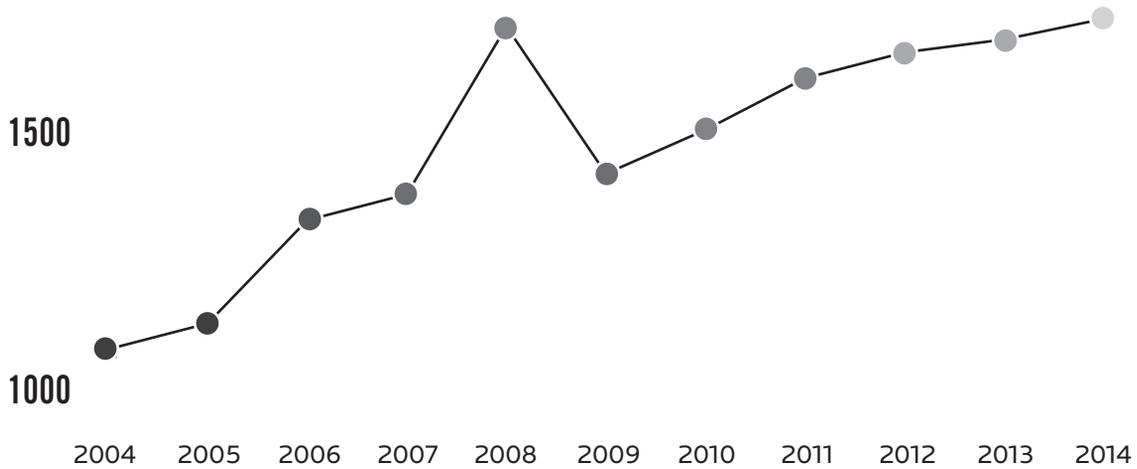
In the past, this imbalance between demand and supply may have resulted in new investments and sweeping regulatory changes. Yet, capital spending in the sector remains largely inadequate and the gap between demand and supply, as California's case illustrates, is widening.

These difficulties threaten both municipal water agencies and their investor-owned counterparts. In the United States, investor-owned water utilities have responded in part through new investment. In fact, we estimate that privately-owned water utilities will devote more than \$2 billion to capital expenditure every year by 2020. This represents a significant investment when you consider that there are only nine publicly-traded water companies in the country (seven of which are rated by S&P).

Figure 24  
**Annual capital spending for all U.S. publicly traded water companies**

(Mil. \$)

2000



Source: Standard & Poors

Municipally-owned water utilities are the dominant model in the U.S., however, and they account for more than 85 percent of all water service providers. These agencies increased their per capita spending by 60 percent between 2001 and 2010, according to the U.S. Conference of Mayors. It's clear to us that the majority of the nearly 1,600 municipal and quasi-public water systems rated by Standard & Poor's around the country are attempting to confront the quiet crisis.

As impressive as these numbers seem, the estimated investment needs suggest that these funds are only a drop in the proverbial bucket. Public water systems require an estimated \$335 billion in investment over the next two decades, according to the Environmental Protection Agency, the bulk of which will be spent on developing transmission and distribution capabilities. The EPA's numbers, however, do not include most water supply projects or any projects driven solely by climate change, meaning the number is probably too low. Other estimates suggest that the need might approach \$1 trillion.

There's clearly an unfulfilled need for new water investment domestically and internationally. To successfully combat the long-term supply challenges currently facing California and other regions under pressure, we believe utilities must strengthen their management of water demand, develop more stable water sources, and devise rate structures to generate stable revenues.

In California's case, we anticipate that the state's Department of Water Resources will assume significant capital spending plans to develop the capacity to provide reliable service. These plans include massive public works projects like the Bay Delta Conservation Plan's (BDCP) \$14.6 billion-twin tunnel conveyance facility.

The Bay Delta's role as the largest estuary on the West Coast makes the outlet an essential aspect of the state's water supply reliability plans. The 50-year BDCP conservation plan intends to balance the twin demands of ecological preservation and urban water supply by constructing two 30-mile-long tunnels more than 150 feet below ground to move water through the area.

The project will include three intakes, construction of a new forebay and enhancements to an existing forebay at the end of the new tunnels. State and federal water supply contractors are expected to fund roughly two-thirds of the cost of the colossal development, while state, federal and other sources will cover the remainder.

While the contractors and various tiers of government will provide this up-front funding, these costs will ultimately show up on the bills of consumers. The Metropolitan Water District of Southern California (MWD) has already estimated that the new Bay Delta project will increase the average household water bill in Southern California by \$5 a month. Simply put, the 18 million customers served by MWD through its 18 member agencies may be the testing ground for a revaluation of water. Pressure on local rates will continue as affordability becomes the 'third rail' discussion among utility providers.

California's drought may be an anomaly, or it may foreshadow a future of climate change-induced water shortages around the globe. What is certain is that the problem of scarce water will confront many utilities and their end users in the near future. Water utility systems are among the least visible aspects of our metropolitan infrastructure, and they have often been among the least-discussed. This needs to change. Our anecdotal and analytical experience with water scarcity in recent years suggest that as rates increase and more stringent policies are introduced, consumers will need to be less complacent about what happens when we turn the tap. We continue to believe that water is not yet priced like a commodity, but well could be within our lifetimes.

*Geoffrey E. Buswick* is a Managing Director and the Lead Analytical Manager for United States Public Finance (USPF) Infrastructure Ratings at Standard & Poor's Ratings Services. The USPF Infrastructure group rates obligations secured by revenues generated from water & sewer, solid waste, transportation, public power, electric cooperatives and municipal pools. Based in Boston, Geoff heads a team located in six offices.

From 2005 through September 2010, Geoff served as the Boston office head for Standard & Poor's Ratings Services. In this role, Geoff was responsible for strategic planning and the day-to-day operations of the regional office serving New England. He also oversaw regional investor relations activities and managed corporate and government client relations.

Geoff serves on the Board of Governors of the National Federation of Municipal Analysts (NFMA), and is the co-chair for the 2012 and 2013 NFMA Annual Conferences. Currently, Geoff also chairs his town's Finance Committee. In 2010, he served as the President of the Boston Municipal Analysts Forum.

Geoff holds a bachelor's degree in Political Science and a master of public administration degree from the University of Massachusetts at Amherst.

# OPERATIONAL RESILIENCE

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## *Sustainability a Growing Priority for Wastewater Treatment Providers*

By Dr. Andrew Shaw and Dr. James Barnard

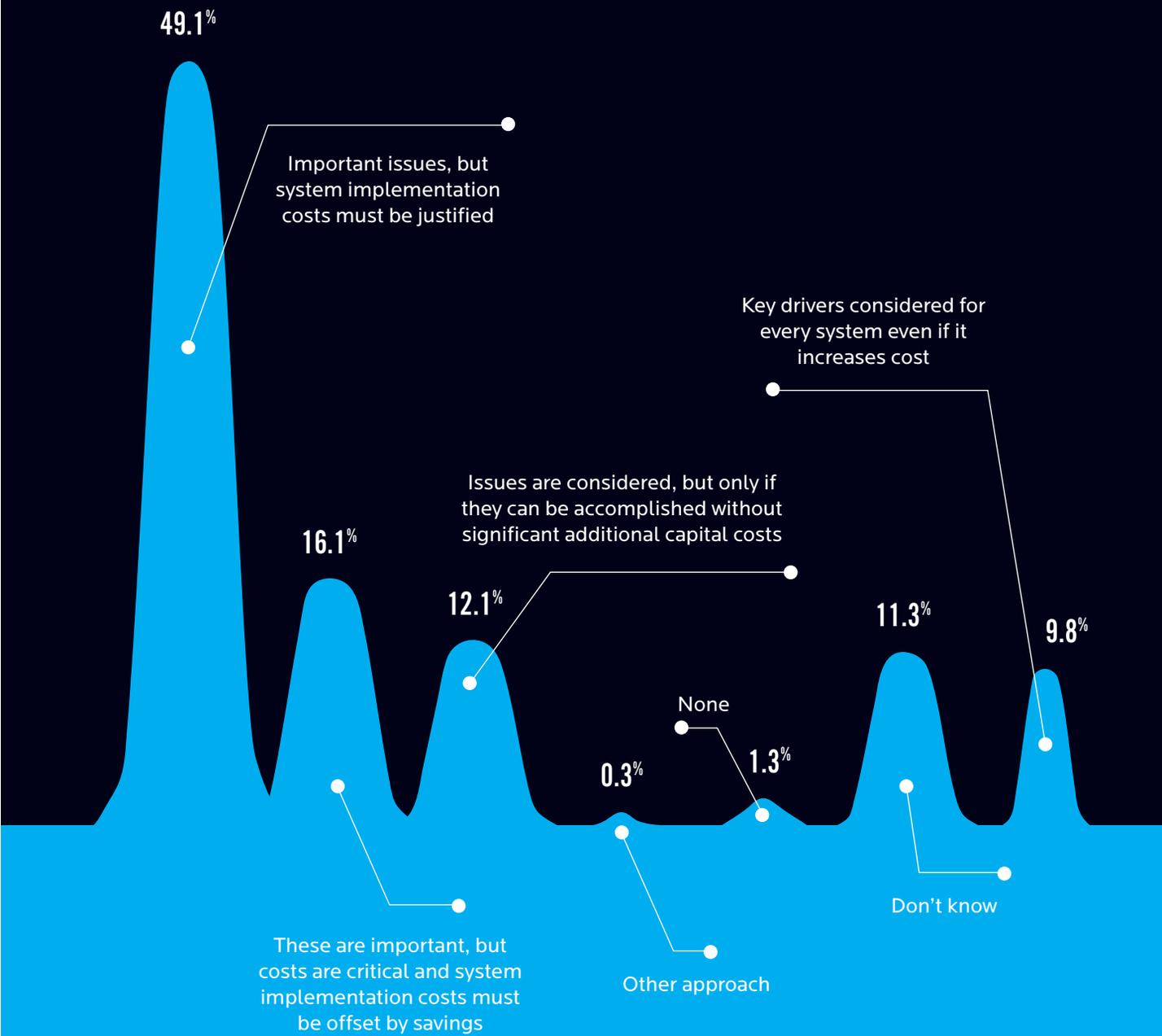
Extreme climate conditions, aging and increasingly outdated infrastructure and social demands on utilities to reduce their environmental impacts are combining to test the operational resilience of today's wastewater treatment facilities. From water-inundated regions in the east to tapped-out areas in the West and Southwest, utilities are under extraordinary pressure to streamline operations, increase efficiency and reduce costs.

But the Black & Veatch 2015 *Strategic Directions: U.S. Water Industry* report finds increased use of advanced treatment processes that combine efficiency with energy recovery in ways that can position utilities to thrive.

Sustainability and resource recovery are receiving significant attention by utilities as they consider treatment technology upgrades. Providers are smartly setting tough standards for holding down implementation costs and maximizing savings, but survey responses suggest utilities are approaching new systems with environmental impacts in mind. (Figure 24)

Figure 25

What is your organization's approach to implementing systems for sustainability/resource recovery?



## HOPES FOR A RESILIENT, ENERGY NEUTRAL FUTURE

Financial and social pressures are driving utilities to explore solutions that are simultaneously sustainable and cost-effective. They also propel capital planning and management decisions: Maintaining or expanding asset life is by far the top sustainability issue among survey respondents across most geographic regions and by all utility types. Large plants, in particular, are considering climate change and resilience in their planning strategies (Table 9).

Table 9  
*Consideration of climate change and a resilient infrastructure in planning*

Consideration of Climate Change and a Resilient Infrastructure in Planning	By Population Served		
	Under 100,000	100,000-999,999	1,000,000 or More
<b>Our strategy considers the impacts of climate change</b>	11.3%	5.4%	24.3%
<b>Our strategy recognizes the need for asset resilience</b>	21.39%	27.9%	18.4%
<b>Our strategy considers climate change and the need for asset resilience</b>	20.0%	24.0%	35.9%
<b>We recognize these issues, but they are not considered in our strategic plan</b>	22.5%	22.5%	10.7%
<b>We do not recognize these as issues</b>	11.3%	8.8%	2.9%

Source: Black & Veatch

Particularly intriguing for utilities is the notion of sustainable systems that also produce substantial resource paybacks. Many utilities indicated that they hope to eventually produce, onsite, all the energy needed to meet or exceed the energy required to operate their facility. Nearly a quarter of respondents said they were either currently energy neutral or positive or plan to be in coming years (Figure 25). Internal combustion engine generators, microturbines and digester gas production are driving energy recovery plans.

Figure 26

Does your utility have plans to become energy neutral or positive?



Source: Black & Veatch

Traditional processes such as high rate activated sludge or trickling filters continue to be used for secondary treatment in some cases. But with the trend toward nitrogen removal, energy demand increases. Combined- or separate-stage nitrification and denitrification is widely used and is seen as more energy-efficient than nitrification only. About 40 percent of water utilities reported they employ either combined- or separate-stage nitrification and denitrification as a secondary treatment in their plants (Figure 26).

Wastewater treatment plants employing simultaneous nitrification and denitrification can realize a 40 percent energy savings. The process was largely pioneered and perfected in Europe. Though once seldom used in the United States, domestic utilities are taking notice. The development of granular activated sludge, which allows for simultaneous nitrification and denitrification and biological phosphorus removal in the same basin, has been brought to the market in the Netherlands and is creating significant interest. A Leawood, Kansas, facility is currently testing its use as a secondary process. The process needs only a fraction of the footprint of conventional activated sludge and about 60 percent of the energy.

Deammonification is a process in which ammonia is removed mostly from return streams and can result in a 60 percent energy savings compared to nitrification/denitrification. The two-step process involves anaerobic ammonia oxidation (Anammox), which reduces the amount of energy required for aeration. Deployment is common in Europe with a number of pilots at various plants. Full-scale plants are either planned or under construction in Washington, D.C., Chicago and at the Hampton Roads Sanitation District in Virginia.

The United States is also investing in phosphorus recovery, whose sustainability is catalyzing its increased adoption, particularly in Europe. As an essential ingredient to agriculture, phosphorus' decreasing global supply has spurred strong efforts to recover it. While phosphorus recovery in the United States is still opportunistic and voluntary, Sweden's Committee on Environmental Objectives studying sustainable development proposed

a goal for returning 75 percent of waste- and wastewater-borne phosphorus to the ecosystem. The Swedish Environmental Protection Agency further refined the goal, proposing that at least 60 percent of wastewater phosphorus be restored to productive soil – half of which should be returned to arable land – by 2015. A goal of 70 percent recovery is now set for other plants in Europe.

### **ENERGY COSTS SPUR NEW SOLUTIONS**

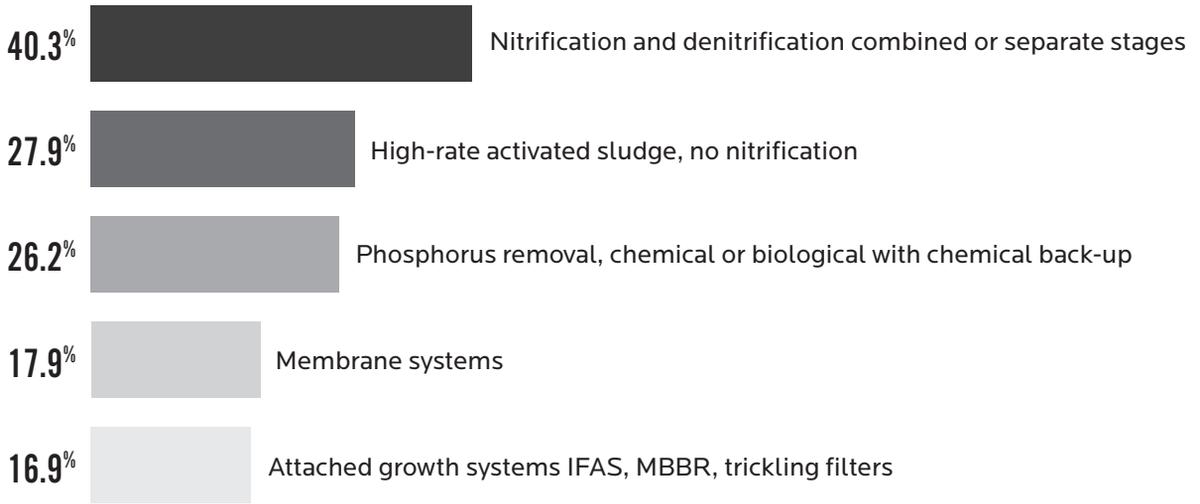
The United States lacks a formal national recovery policy, but Black & Veatch sees opportunities for wastewater plants to embrace sustainability and resource recovery goals. For example, Black & Veatch is currently advising the Metropolitan Water Reclamation District of Greater Chicago on phosphorus removal methods at their seven conventional plants.

Advances overseas offer encouraging guidance for U.S. utilities, which are increasingly open to implementing new technology if performance can be demonstrated (Figure 27). In Europe, decades of high-cost energy motivated industry and communities alike to seek efficient means of operations. In the United States, cost-recovery needs combined with historically low interest rates are stoking investments that can deliver efficiency and streamline operations.

2015 is an opportune time for the wastewater treatment industry. Technology is advancing to meet social demands that are helping to shape policy, and there is strong support from utilities to implement these advances. Black & Veatch is optimistic that the outcome will be a more sustainable and resilient future.

Figure 27

**Types of secondary treatments used in plants**



Source: Black & Veatch

Figure 28

**Agreement with statements related to the implementation of new technology**



1 = Strongly *disagree*    5 = *Agree*

Source: Black & Veatch

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## ***In the Drive to Be More Sustainable, Efficiency is Key***

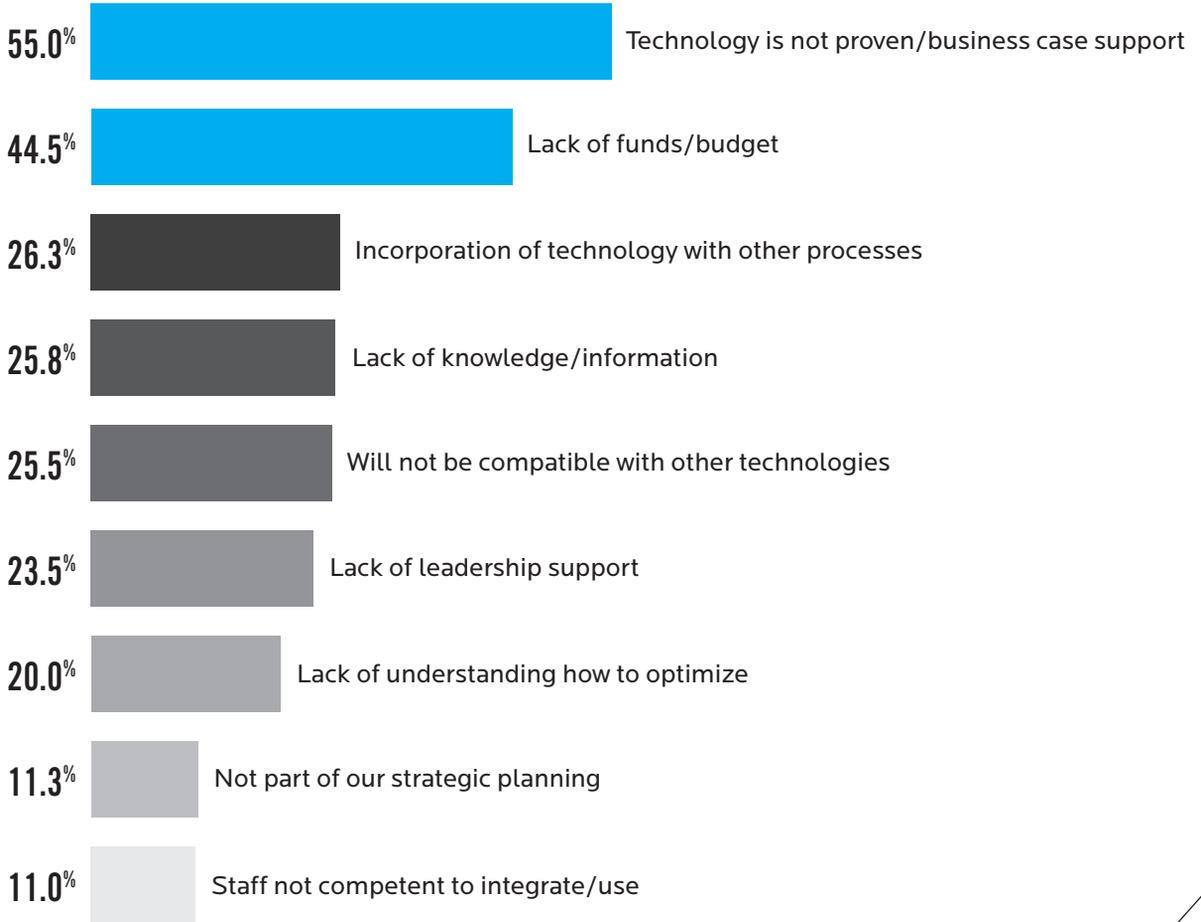
By Julia Gass

New equipment technologies offer the promise of significant energy savings and resource management when wastewater utilities may need them the most. A universal worry comes with aging infrastructure, especially in larger cities, where energy inefficiencies drag on bottom lines and create capital investment uncertainties.

Implementing technological innovation for wastewater service providers – from the deployment of highly advanced blower technologies to aeration control valves that can slash energy costs at plants – requires a system-wide commitment that starts at the executive level. Yet, Black & Veatch's 2015 *Strategic Directions: U.S. Water Industry* report shows a curious disconnect. Many utilities are confident new technologies can reduce energy costs and deliver more efficient systems, but they either lack the leadership support necessary to adopt and deploy the technology or believe the advancements are too expensive or won't integrate well with existing systems (Figure 28). The result may be a utility that misses opportunities to shore up limited capital during an already challenging time for wastewater utilities.

Figure 29

**Most significant barriers to technological innovation**



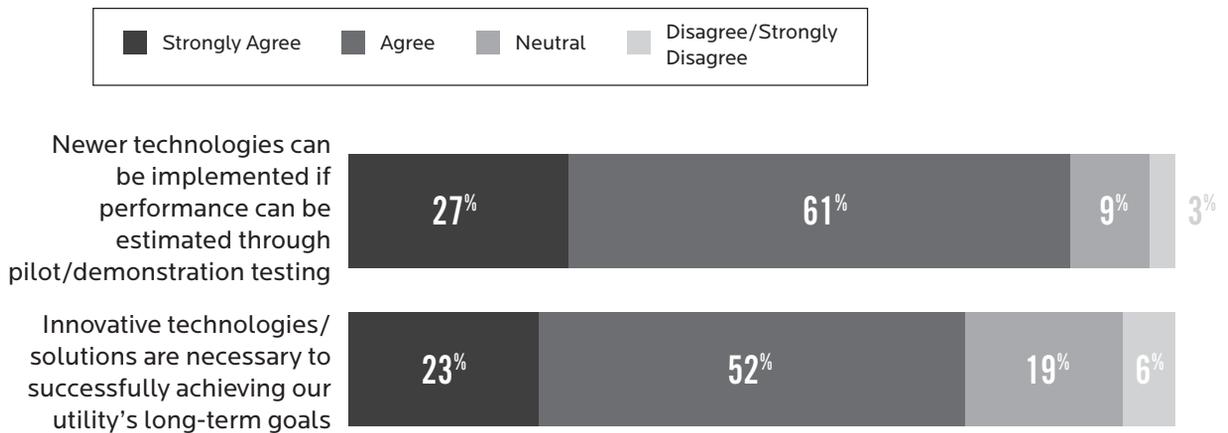
Source: Black & Veatch

### FACTORS HOLDING BACK INNOVATION, TECHNOLOGY

Innovation and new technology are highly valued, if not universally adopted, among water utilities. More than 80 percent of respondents agreed that newer technologies can be implemented if performance can be demonstrated through pilots or other testing (Figure 29), while 75 percent see innovative technology as necessary to achieving the utility's long-term goals.

Several factors are holding back utilities from fully embracing these advancements: available capital, lack of technical understanding and a perceived apathy at the upper levels of the organization.

Figure 30  
**Agreement with statements related to the implementation of new technology**



Source: Black & Veatch

For smaller utilities, a lack of knowledge about available technology was rated as a significantly higher barrier to technological innovation (Table 10). Among utilities serving populations up to 1 million people, lack of funds and the perception that new technologies remain unproven were seen as the tallest barriers to entry. Utility engineers tended to agree that proof-of-concept concerns were sidelining upgrades in their organizations.

However, 43 percent of engineers also saw lacking engagement from utility leadership as a barrier to adopting new technologies. The notion that many technologies remain unproven is often a signal that utilities would rather let other organizations provide the base case. But, suggestions by engineers that innovation lacks institutional support signals the potential for a systemwide stasis that can keep organizations from implementing cost-reduction and resource-recovery initiatives.

Table 10

**What are the three most significant barriers to technological innovation at your water utility?**

Most Significant Barriers to Technological Innovation	By Population Served		
	Under 100,000	100,000-999,999	1,000,000 or More
Lack of knowledge or information about what new technologies are available	40.0%	21.4%	23.8%
Lack of funds/budget to implement new technology	54.1%	47.1%	30.7%
Lack of leadership to support new technology or not a priority in our organization	12.9%	25.2%	29.7%
Not part of our strategic planning	11.8%	11.4%	9.9%
Technology is not proven/not enough business case support	42.4%	57.1%	61.4%
Concern of how the technology will be incorporated into our organization's work processes	23.5%	26.2%	29.7%
Technology will not be compatible with other technologies currently implemented	23.5%	23.3%	32.7%
Staff is not competent to integrate/use new technology	14.1%	7.6%	13.9%
Lack of understanding how to optimize the new technology	24.7%	16.7%	23.8%

Source: Black & Veatch

### **FROM A POWER HOG, AN OPPORTUNITY**

Wastewater treatment is a huge cost center for utilities, led by aeration blowers, whose energy needs dwarf the power required for pumps, lighting, clarifiers and other equipment.

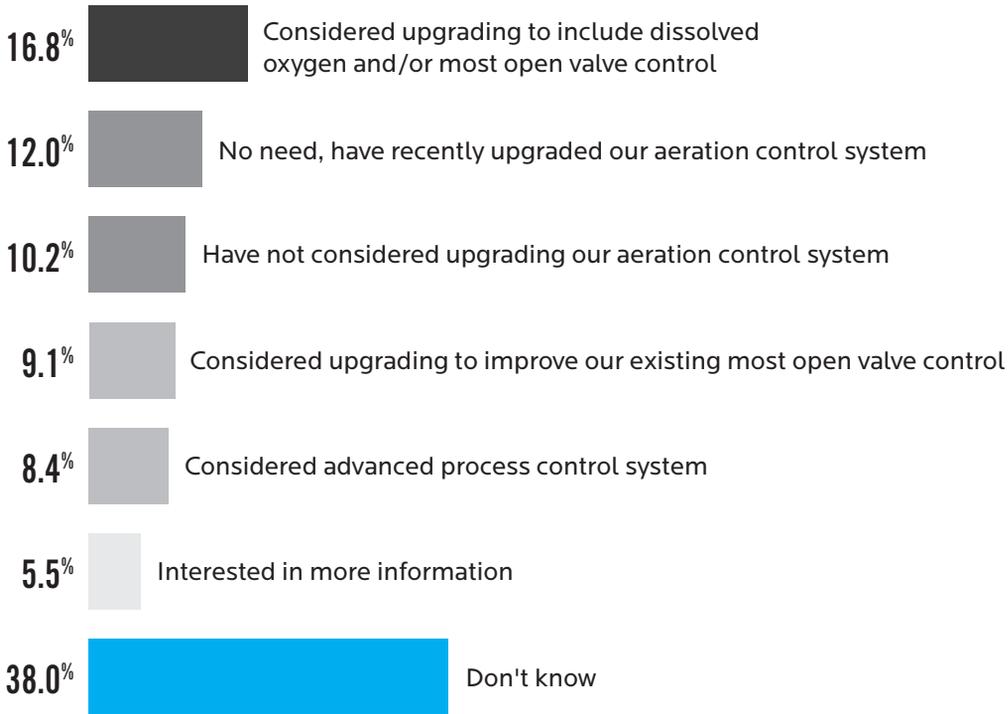
Despite the aeration system's outsized energy requirements, system upgrades and control valve replacement rank as surprisingly low priorities for treatment facilities (Figures 30 and 31). Among smaller utilities, a quarter of respondents said they were not considering valve replacement or control upgrades as an efficiency strategy, and about one-third said they didn't know of such plans. That number jumps to nearly 60 percent among wastewater utilities serving populations of 1 million or more, a potentially troublesome data point considering the problems of aging or outdated water infrastructure in many major U.S. cities. Such moves reduce the amount of energy required for production, which demands water. For water-stressed regions, reducing energy demand can support stretching a limited supply.

These upgrades are an opportunity for cost savings. Multiple valve solutions exist on the market, and Black & Veatch believes utilities should explore their potential, as in many cases new valves can return their investment costs within five years. Large plants could see significant savings with an investment in updated most open valve (MOV) controls.

Such replacements offer a high-return solution that doesn't require a complete overhaul of an existing asset. While the services industry rightly will try to sell the most advanced solution to a problem, service providers are making it clear that financing large-scale overhauls can be tougher to pull off than an effective tweak to a system.

Figure 31

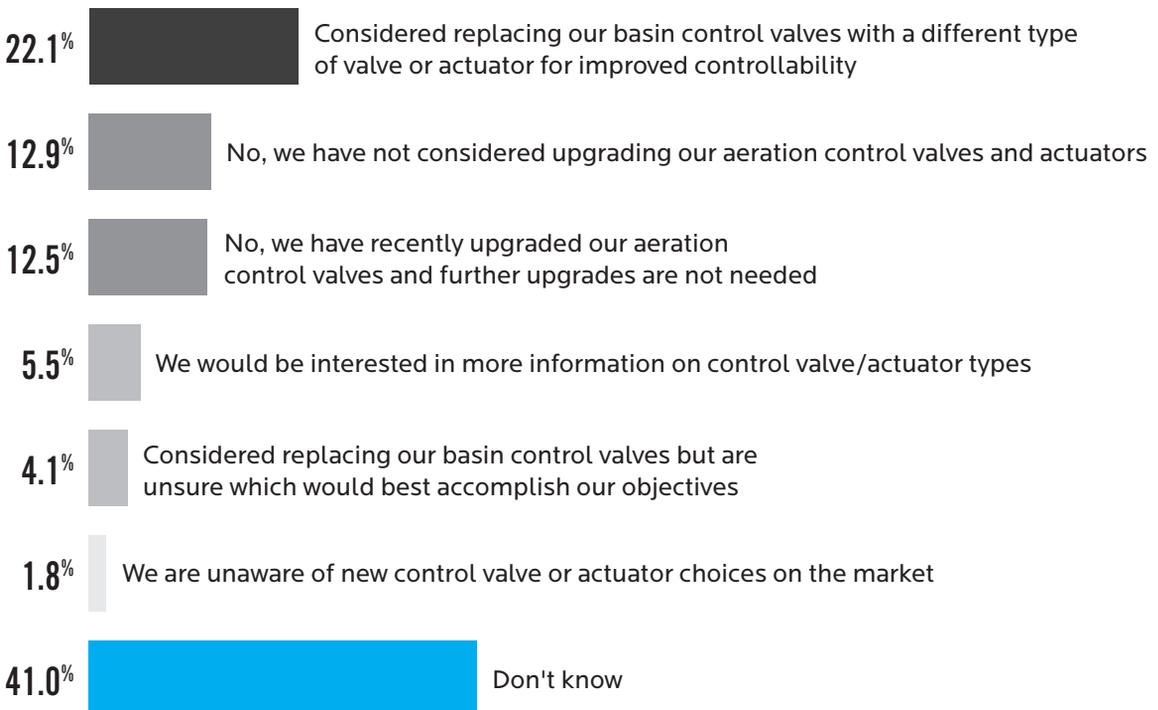
**Consideration of upgrading aeration control systems**



Source: Black & Veatch

Figure 32

**Consideration of aeration basin control valves and/or valve actuators**



Source: Black & Veatch

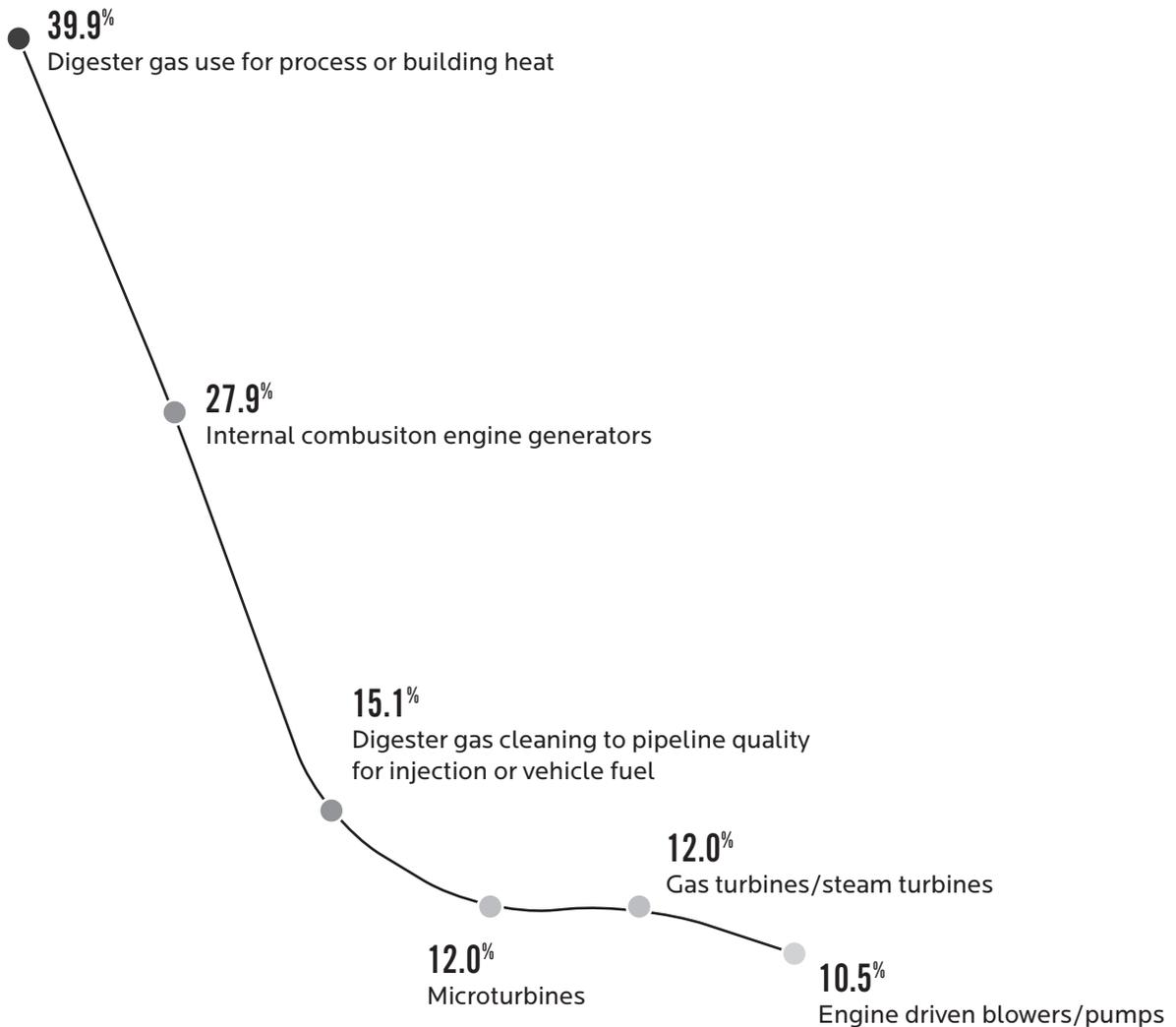
## ENERGY RECOVERY FROM WASTEWATER

While new technologies are being developed to help utilities, focus is being put on moves by utilities to adopt so-called “add-ons” that offset energy costs by extracting the considerable energy contained in wastewater.

Wastewater holds nearly five times the energy required to treat it, according to the Water Environment Research Foundation. Recent studies suggest that energy recovered from wastewater biosolids could be enough to meet up to 12 percent of domestic electricity demand in the United States.

Energy recovery is a clear focal point for wastewater plant operators, and digester gas used for process or building heat leads the way with 40 percent of respondents indicating the method is used to recover energy (Figure 32). Other recovery methods include internal combustion engine generators and microturbines.

Figure 33  
*Energy recovery technologies being used or considered*



Source: Black & Veatch

However, roughly one-fifth of wastewater respondents said their organizations had no energy recovery methods in play, suggesting a sizeable number of wastewater treatment plants are passing up these potential gains. Because energy prices heavily influence the economics of recovery strategies, it was not surprising to see wide fluctuations in recovery practices based on geography. Utilities in the Rocky Mountain region, other countries (primarily Canada), Northeast and Midwest regions were most likely to employ some type of recovery regimen, with the Northwest/Southwest and Southeast least likely (Table 11).

Table 11  
**What energy recovery technologies are you considering or have you implemented?**

Items That Negatively Impacted Utility Revenue Streams During the Last 5 Years	By Primary Business Region							
	North-east	Mid-west	South-east	Gulf Coast*	West Coast	Rocky Mountain	Northwest/Southwest	Other Countries*
Reported their utility was considering or implementing at least one or more of the energy recovery technologies listed	70.8%	67.3%	58.5%	50.0%	59.3%	83.3%	62.9%	76.5%

\*Small samples sizes, under 30 respondents.

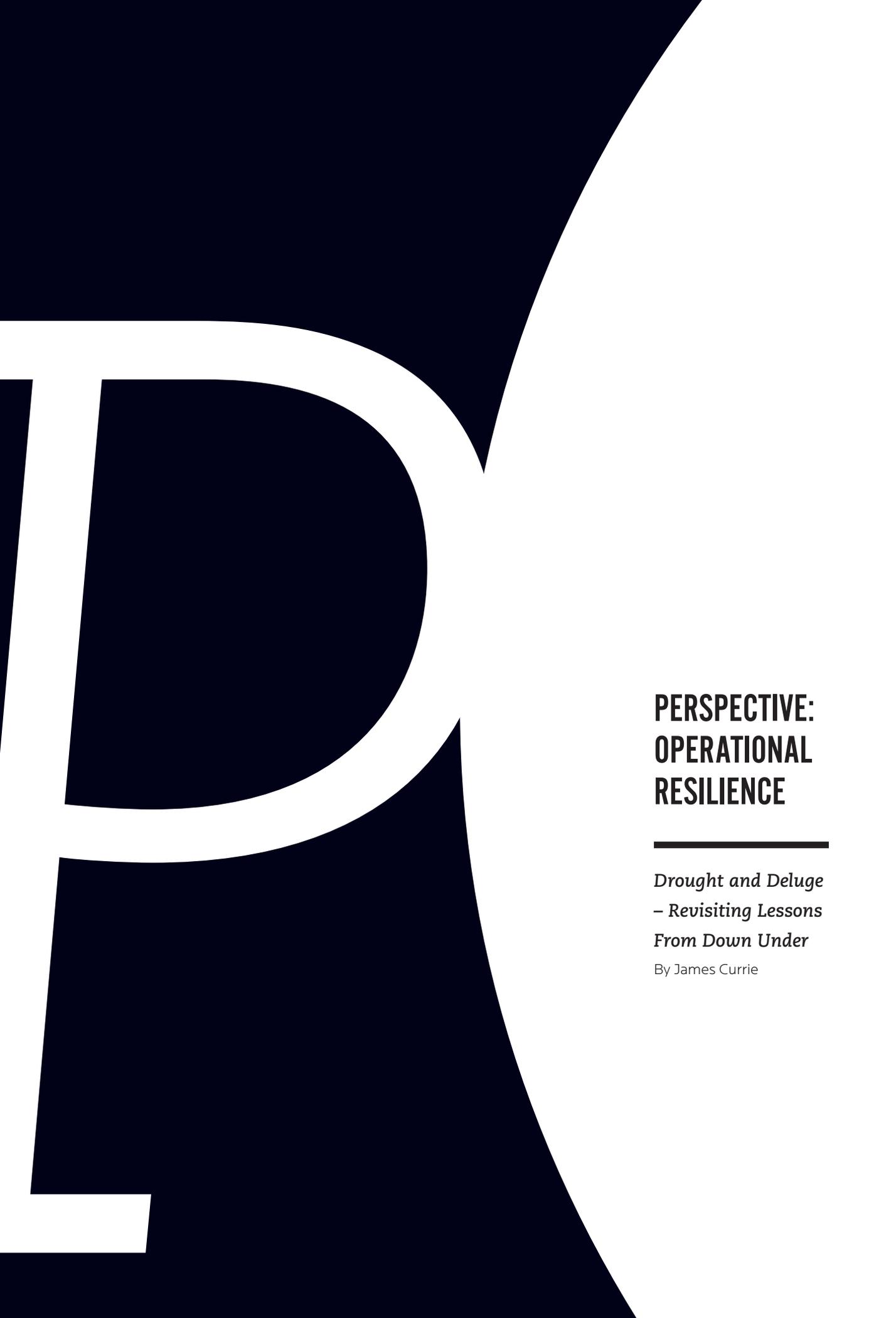
\*\*Excluded from significance testing because too few respondents.

Source: Black & Veatch

**EXECUTIVE SUPPORT REQUIRED**

The array of efficiency solutions includes everything from specific equipment upgrades (the aeration blowers themselves are a candidate due to the many new energy efficient blower technologies on the market) to scientifically complex extraction methods to extract energy from wastewater. Though capital costs are an inhibitor, help is seen through electric utility rebates and energy performance contracts (EPCs), which involve third-party financing to use money saved through reduced energy consumption to repay the cost of installing more energy efficient equipment.

Regardless of size and scope, Black & Veatch believes the success of any such effort depends on the full engagement of an organization’s leadership. Utility executives must explore these and other avenues at a time when supply is increasingly constrained by climate and aging systems.



## **PERSPECTIVE: OPERATIONAL RESILIENCE**

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*Drought and Deluge  
– Revisiting Lessons  
From Down Under*

By James Currie



As the world's driest inhabited continent, subjected to a 'boom and bust' of floods and drought conditions as well as ever-changing climate change patterns, Australia has had to plan and manage its water resources more than most nations. Recognized by water industry leaders for some of the most advanced water resilience planning, the question remains whether Australia missed its opportunity to embrace potable reuse as part of an integrated water portfolio.

Australia's journey through the Millennium Drought (circa 2001 to 2009) was remarkable, made even more so as it coincided with a period of sustained economic growth in spite of the water crisis. Today, in contrast, Australia's economy is shrinking, propelled by falling commodity prices and a sharp decline in mining investments. Budget cuts are already underway, highlighted by the disbandment of the National Water Commission (NWC) in December 2014. For more than 10 years, NWC played an important role in spearheading the national water agenda and its closure underscores fears that Australia's technology leadership may be lost.

#### **QUEENSLAND'S MISSED OPPORTUNITY FOR EDUCATION AND PUBLIC ACCEPTANCE**

During the worst period of the drought, the Wivenhoe Dam was running at only 18 percent capacity. In response, the Queensland State Government embarked on the Western Corridor Recycled Water Project. The AUD\$2.5 billion water recycling scheme was the largest undertaking of its kind in the Southern Hemisphere. Three advanced wastewater treatment facilities, including the award winning Bundamba Advanced Water Treatment Plant, formed the core of the scheme.

Against the backdrop of a crisis, the decision to implement indirect potable reuse (IPR) for potable applications was taken. As part of a fast-track program, Black & Veatch and its joint-venture partner designed and built the first stage of Bundamba AWTP on a fast track timeline of 10 months.

The plant was targeted to produce 66 million liters per day (ML/d) of high quality treated water, adhering to the highest standards of sampling and testing. The treated water would be directed into reservoirs where it would be mixed and again treated with fresh water before reaching consumers' taps. The plant would also provide cooling water for the Tarong and Swanbank Power Stations. However, soon after commissioning, the rains returned to Queensland.

Looking back, the urgency created by the crisis outweighed public skepticism towards supplementing communities' water supplies with purified recycled water. Consequently, when it rained again and the reservoirs were recharged, public disfavor towards IPR returned, leading to the rejection of the plan. So, despite investing billions and having built three world-class, advanced treatment facilities, each of the plants of the Western Corridor Scheme lie dormant, as large-scale, planned IPR was never introduced.

By not adopting a long-term view and tackling public resistance at that juncture, Australia appears to have missed a major opportunity to educate the public on a technologically advanced water source that is not tied to Australia's ever-changing weather patterns. Further, as government budgets are trimmed, IPR remains a more cost-effective solution when compared to some other measures such as desalination.

### **INDIRECT POTABLE RECYCLING IN SINGAPORE**

Nearby Singapore clearly shows that when implemented as part of a long-term solution, IPR can flourish. Over the past 15 years, PUB, the national water agency, leveraged technological innovations and strong public education programmes to make its ultra-clean, high-grade reclaimed water – NEWater – initiative a success. With limited land to collect and store rainwater on its island, Singapore's national water agency PUB has driven the message of NEWater's importance in building a sustainable and resilient water management strategy. Their multi-decade long-term planning approach demonstrated that when it comes to IPR there is no such thing as an overnight success.

In another example of their phased approach to educating the public about water reuse as a source of water supply, NEWater is also used to top up the raw water reservoirs during dry months. During prolonged dry spells, such as in 2014, PUB increased NEWater production and the amount pumped into reservoirs. The well-communicated move was welcomed by the public as it ensured water reserves were maintained at a healthy level during these dry periods. Singaporeans' strong support for NEWater can also be attributed to their understanding and acceptance of the technology used to produce NEWater as demonstrated in the NEWater Visitor Centre, a state-of-the-art water museum that serves as the focal point of public education on NEWater.

### **ENGAGING THE PUBLIC IN WESTERN AUSTRALIA**

If Queensland has missed out, Western Australia, a State where a drying climate prevails, has continued to plan and address the challenge of integrating recycled water for drinking water use. The State's water utility, Water Corporation, steered a successful Groundwater Replenishment Trial that was a first-of-its-kind for Australia. Groundwater replenishment is the process where treated wastewater is further treated to drinking water standards and then recharged into an aquifer for later use as a drinking water source. The trial examined the efficacy of groundwater replenishment across a range of factors including technical feasibility, policy and regulation as well as, critically, community acceptance. Research was undertaken to monitor community support for groundwater replenishment which demonstrated that public support remained steady at around 73 percent. From conception to completion the trial took several years of planning and coordination but it was a path that brought the public on board to accept groundwater replenishment. The construction of the subsequent full-scale Groundwater Replenishment Scheme started at the end of 2014 and is on track to be completed by the end of 2016.

Other important water management initiatives are also underway in Australia. For example, 60,000 residents in select New South Wales (NSW) areas receive potable supply sourced from a mix of high grade recycled water, storm water and river-water. In 2012, the NSW government announced that it will examine the viability of adding recycled water to drinking water in a review of its water plan. In order to reverse the negative "toilet-to-tap" perception, the Federal Government along with the Australian Water Recycling Centre of Excellence embarked on an engagement campaign called the National Demonstration, Education & Engagement Program (NDEEP) in 2013. Using a mix of education programs, social media engagements and demonstration projects, the public is able to experience firsthand how wastewater is treated to potable quality using advanced treatment processes. Black & Veatch led one sub-team of NDEEP focused on mechanical resilience of recycled water plants and the program recently won the 2014 WaterReuse International Award.



### **LESSONS FROM DOWN UNDER**

Best practices and several completed projects worldwide show that the technology is available to support the safe application of IPR to augment drinking water supplies. Meaningful public initiatives in Israel, Spain, Singapore, Western Australia and the west coast of the United States also clearly show that water-scarce communities can understand and accept the approach of using multiple technological barriers for safe water recycling.

With a tremendous amount of international focus on the agricultural impact of the drought in California both the unsuccessful and successful examples of introducing IPR to the public clearly show that planning, timing and politics are vital ingredients in increasing the likelihood of its acceptance. But doing so can greatly enhance the resilience of water supplies and augment other potable drinking water sources safely, economically and reliably.

# CLOSING COMMENTARY

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## *Be the Change*

By Cindy Wallis-Lage

All the water we will ever have, we have right now; thus, the world must survive on a finite resource. Yet the demand is not finite. Increased population in combination with greater urbanization and a rising middle class in developing countries put significant strain on water supplies and water infrastructure. Changing weather patterns complicate the demographic challenges creating extreme conditions of water stress/scarcity as well as flooding in various communities. Lack of adequate investment has resulted in frailties within the water system including buried infrastructure as well as many treatment systems. The solution is not simple nor is it universal, but it is clear: Our governments, communities and water system providers must rethink how they plan, invest and maintain their water infrastructure. It's not just a matter of building more, but of building in more flexibility and resilience.

### **RESILIENT AND HOLISTIC WATER PLANNING**

The traditional models and approaches used in the water industry need to evolve to efficiently cope with change and manage an overall more sustainable water system. An all-encompassing approach is required to identify actionable plans that incorporate competing water demands for human consumption, industry and agriculture with existing infrastructure capacity/condition. When it comes to planning water resources and the required system infrastructure, the industry must ask itself challenging questions such as, how to account for unexpected or unplanned events?

Utilities must be able to supply water, wastewater and stormwater services regardless of changing circumstances, such as climatic shifts or population growth. This does not necessarily lead to redundancy; redundant systems are not always the most resilient due to the cost and challenge of managing excess capacity.

Planners and the public need to change their current way of thinking about the service level and supply opportunities, as well as funding requirements and availability.

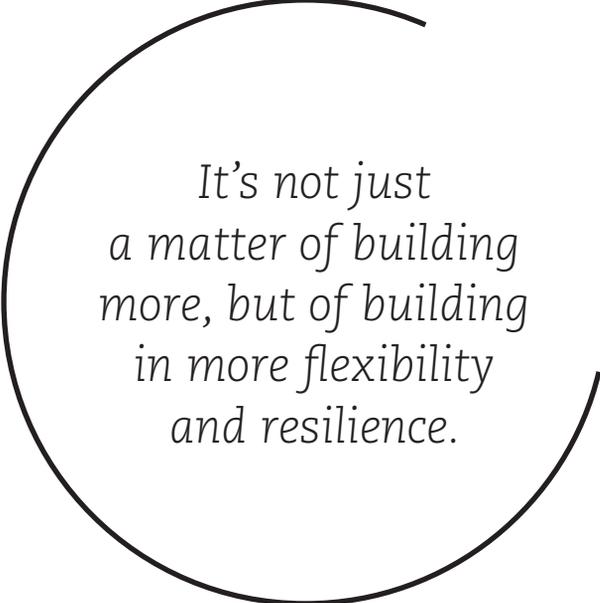
Hurricane Sandy was a loud wake-up call that crystalized “resilience” as a concept. Other significant events such as earthquakes, tsunamis, prolonged drought and industrial accidents have all served to raise water’s profile as a global concern. These events have altered worldwide supply chains, recast insurance markets and recalculated how system resilience is factored into planning the world’s critical infrastructure.

***Water crisis has taken the top spot for the risk with the highest impact.***

The critical importance of water is highlighted in the *World Economic Forum’s 10th Global Risk 2015 Report*, which ranked water crisis as taking the top spot for the risk with the highest impact. This is a measure of potential devastation. Water crisis also ranked 8th among the risks identified for the likelihood of occurring within 10 years. The Global Risk 2015 Report is an annual survey of approximately 900 leaders in politics, business, and civic life about the world’s most critical issues. For reference, water ranked third on impact in the 2014 report.

The devastation that can be caused by a lack of water has been clearly demonstrated in many communities in the state of Texas over the past several years. Industry shutdowns, reduction in agriculture production, relocation of livestock and a complete alteration to the lifestyle of the residents that remain illustrate how devastating drought can be.

The growing water crisis in California provides further evidence of the critical role water plays in maintaining sustainable communities. As the world’s fifth largest economy and largest domestic producer of fruits and vegetables, California’s water supply issues impact consumers around the world. In addition, the emergency regulation to reduce potable water usage by 25 percent implemented in May 2015 will invoke significant changes to business/industrial sector as well as the lifestyle of residents in the state. With the global media focus on California, they are the perfect illustration of the need to implement resilient and holistic water planning.



*It’s not just  
a matter of building  
more, but of building  
in more flexibility  
and resilience.*

## **DO MORE WITH LESS**

Understanding existing asset conditions and performance affords utilities the opportunity to unlock hidden capacity and do more with the assets in place. In addition, a strong asset management program allows optimal capital spending via risk-based planning and proactive prioritization of needs.

Whether actively pursued, every utility collects significant data. The question is whether the data actively drives smarter decision making or is merely a passive database. Optimally, utilities can use data to identify performance challenges, detect pending asset failure, and drive the appropriate repair actions before a failure becomes potentially catastrophic. Data collected in regions suffering from sustained and severe drought conditions can be the backbone of information to monitor usage and enforce water rationing, as well as to quickly identify resource-wasting leaks. Advances in data analytics can provide significant cost benefits in terms of how a utility or a specific asset is managed. At the end of the day, a strong asset management system creates a more predictable scenario for financial investment.

## **EVOLVING THE WAY WE WORK**

Water is complex. It is emotive. Access to water is a human right, yet the cost to provide water services – both the infrastructure and operation – is considerable and must be accommodated by the end users to drive the appropriate behaviors both in quantity and quality. Evolving the operating model for utilities to operate as sustainable businesses which can recapitalize assets and generate sufficient revenue is crucial. Further, a goal of water service providers and their customers must be greater integration with their communities and other utilities, i.e. water, wastewater, stormwater to deliver sustainable systems that recognize water as an economic resource.

Significant changes in technology over the past several decades, as well as evolving technologies – especially as they relate to resource recovery and energy efficiency – provide the opportunity to significantly reduce operating costs, gain additional capacity of fixed assets and move toward revenue generation.

## **INTERCONNECTION AND AWARENESS KEY TO RESILIENCE**

Coordination among municipalities and service providers will be essential to improving the use of limited water resources and leveraging advances in technology to solve supply and distribution problems. Resilience and successful water management requires more than just a focus on supply. It requires coordination with business, industry, residents and a strong embrace of technology and be the agents of change needed to ensure the sustainability of communities around the globe. Citizens must gain a deeper understanding of their water footprint and how consumption habits of agricultural products and manufactured goods affect water demand. Both supply and demand must be efficient, and water-scarce regions must explore alternative sources where possible.

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