Harness the Power of Decision Intelligence

DRIVING PERFORMANCE IMPROVEMENT WITH SMARTER WATER

www.xylem.com

xylem
Let's Solve Water

WATER MANAGEMENT AT A CROSSROADS

For those entrusted with the responsibility of supplying vital water and wastewater services to their communities, it is both the **worst** and the **best of times**.

It is the worst of times because water challenges are intensifying, stressing infrastructure that is already badly in need of renewal. Around the world, the water system's vital signs, including leakage, main breaks, and wastewater overflows, reflect a system in urgent need of investment. Yet we cannot simply spend our way out of these challenges, regardless of how they are financed, without intensifying the burden on struggling ratepayers.

It is worth comparing the water sector's strategic situation to the health care system. Most of us can imagine what a world-class health care system might look like. It would emphasize preventative care, since good hygiene, diet, exercise and health monitoring improve personal health and prevent disease at very low cost. It would utilize powerful and efficient diagnostic processes, from the stethoscope to the CT scan, to screen for signs requiring further attention. It would target medical interventions – affecting only those areas that need it and leaving healthy tissue and systems intact.

By contrast, we all know what doesn't work: neglecting regular health maintenance and responding to health issues only when they erupt, often in the emergency room at moments of crisis. We've seen in too many countries that this model is both unsustainably expensive and does not improve long-term health.

These same truths apply to the water sector. Around the world, water and wastewater infrastructure suffers from long-deferred maintenance. Much of it is underground and out of sight and has never been inspected to assess its overall health. The interventions we do take, such as pipe replacement, are either reactive and driven by emergencies, or overly severe, ripping out serviceable assets every year at tremendous expense and disruption. This approach to managing water infrastructure is not always in the best interests of the system, or of the users who depend on it for affordable and reliable services.

The good news is that there is an emerging consensus around a better way. Advances in digital technologies are enabling better system hygiene, more efficient monitoring and diagnostics, more targeted investments, and a transition to a "primary care" model for system management. These solutions are poised to make this the best of times for utility managers who want to make a lasting difference in the lives of the communities they serve.

This new approach is called "Decision Intelligence." It leverages the power of data to inform better system-level choices today and make recommendations to improve future operations, maintenance and capital planning. These solutions scan, predict, recommend and prioritize actions and help utilities make dramatic progress on the problems that matter most to the communities they serve: water accessibility, environmental sustainability, resilience, and affordability.

DECISION INTELLIGENCE

describes the use of advanced data analytics to empower water system operators to make the best capital and operating decisions. This approach has three key principles:

01

APPLICATION-SPECIFIC

Decision intelligence is about solving problems, not about new technologies. Information only creates value when it helps decision-makers solve specific operational or financial challenges. Decision intelligence solutions help users address specific problem areas (or "applications") where better insights can reduce costs, improve cash flow, reduce risk, or improve community impact.

02

"FULL STACK"

Decision intelligence solutions provide users with an integrated package of sensors, models, and visualization tools to solve specific problems in a holistic way. Decision intelligence is not only about a unique sensor or communications protocol; it is about the orchestration of these technologies to answer a specific need.

03

OPEN ARCHITECTURE

Decision intelligence solutions process information from a wide variety of sources, including sensors, meters, and other enterprise data systems. They should be able to ingest information from a variety of systems and vendors, including systems the utility has already acquired, leveraging existing and future investments to answer new questions.

THE CASE FOR DECISION INTELLIGENCE

Against a backdrop of rising needs and insufficient resources, decision intelligence offers powerful new tools to help utility leaders achieve superior performance as they serve their communities. These solutions can help improve cash flow and service affordability, ensure compliance and operating performance, and build system resilience.

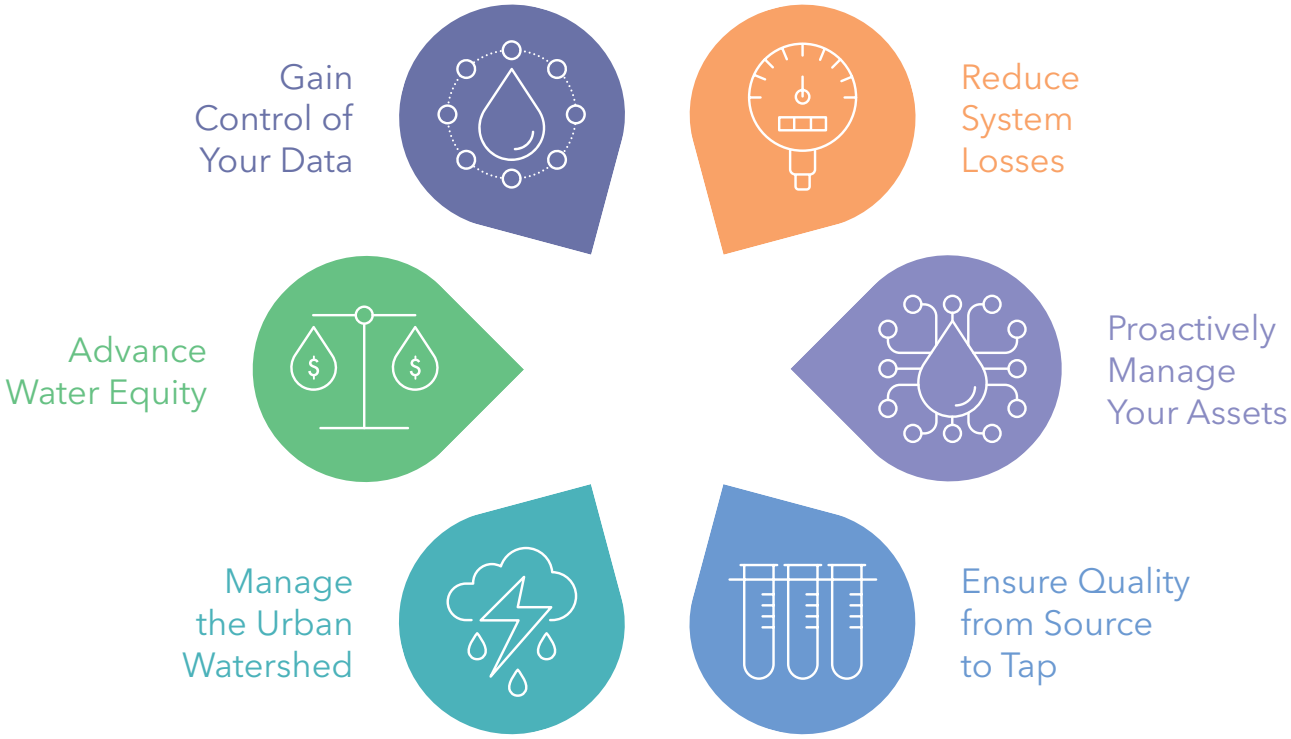
IMPROVE CASH FLOW AND SERVICE AFFORDABILITY
Decision intelligence can increase free cash flow by increasing revenues and decreasing non-payment events, lowering spend on inputs such as energy or chemicals, and lowering capital outlays – all while achieving equivalent or better operational performance. Recent implementations have helped clients avoid new debt issuance and rate increases that would have negatively impacted the community.

ENSURE COMPLIANCE AND ACHIEVE BEST-IN-CLASS OPERATIONAL PERFORMANCE
Decision intelligence can take the guesswork out of managing complex systems. With real-time data, real-time analysis, and real-time control, operators can ensure that systems function within critical parameters, delivering regulatory compliance and improving operating efficiency. Recent implementations have helped clients resolve regulatory issues in water and wastewater and improve progress on Board-level key performance indicators – all while reducing capital or operating costs.

BUILD SYSTEM RESILIENCE
Decision intelligence can position utilities to better weather changing future conditions. With a deeper understanding of how external factors influence operating parameters and the ability to analyze millions of potential scenarios in real time, utilities can manage the uncertainties inherent in planning for the future while operating in the present, ensuring that system risks are managed in the most cost-effective way.

By applying the power of decision intelligence in domains such as non-revenue water, proactive asset management, and the other connected strategies outlined in this document, utility leaders can move the needle in the areas that matter most for their community.

STRATEGIES POWERED BY *DECISION INTELLIGENCE*



Decision intelligence tools have proven their value and gained trust with utilities around the world. From Singapore to South Bend, Indiana, these solutions are providing unprecedented insight into capital and operational decisions, enabling a shift in resources from emergency response to proactive management, providing utilities protection against rapidly escalating water rates, and improving their environmental performance.

This document introduces specific components of a decision intelligence strategy that any utility can adopt, including examples where utility leaders have generated substantial benefits for their communities. It also provides brief and practical ideas of how to start their digital journey.

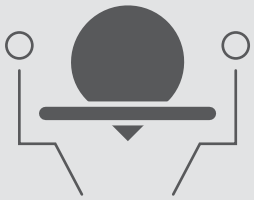
The importance of decision intelligence has little to do with technology and everything to do with public service. As public servants, utility leaders are constantly looking for ways to improve how they make use of limited resources to meet the community's needs. Thankfully, today's leaders are equipped like never before to solve long-standing community challenges at scale, using the same technologies that power our smartphones, empower our doctors, and connect our world. This is the opportunity of a lifetime to change the course of our sector, and we look forward to partnering with you and your team to seize it!

HOW WE CAN HELP

At Xylem, our vision is to help create a world in which water challenges are no longer a barrier to human health, environmental sustainability, or prosperity.

IDEATION WORKSHOPS

We can organize an ideation workshop with our experienced client engagement team to engage key stakeholders at your utility to assess how decision intelligence can help you address your most pressing challenges. We advise on format, agenda, and participation, and will assemble a team of relevant experts based on topics of greatest interest. In our ideation sessions, we do not restrict ourselves to Xylem solutions and frequently introduce third-party technologies and methodologies to our clients when it is in their best interest.



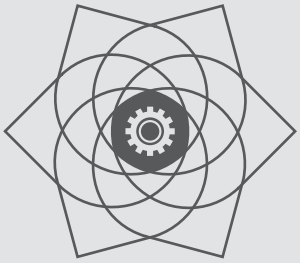
CONSULTATION/ BUSINESS CASE DEVELOPMENT

Based on our ideation workshop, if specific solutions are identified, we are happy to work with you to develop a tailored business case to identify cost savings, revenue generation opportunities and risk reduction impacts consistent with the format you require for discussion with internal and external stakeholders.

STAKEHOLDER COMMUNICATIONS

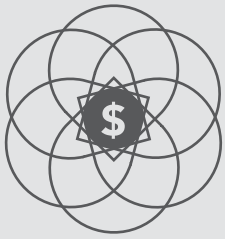
Our team can meet with internal or external stakeholders to provide our perspective on the rationale for adoption of decision intelligence solutions. Depending on the nature of the discussion, we can bring in national and international experts to address concerns and provide further information.

We advance this mission by working with our partners to address water accessibility, resilience, and affordability with powerful and trusted solutions, including our new portfolio of decision intelligence tools. We work with your team in the following ways:



LIMITED EFFORT INITIAL DEPLOYMENTS

Utilities often comment that management and field force bandwidth are obstacles in being able to execute initial deployments of solutions that are new to the utility. To support our partners, we offer "full stack," turn-key solutions that include physical equipment, installation and integration services, training, maintenance, and post-deployment support to help your organization implement solutions without distraction from daily work.



SUPPORT AND FINANCING

We work closely with clients to access external financing sources necessary to support initial deployments, including public sources (e.g. State Revolving Funds or WaterSMART grants in the United States; EU grant funding in Europe; development bank funding, export financing, and loan guarantees) and private sources (e.g. through third-party leasing companies). If requested, we work with you to identify appropriate financing solutions to help you fund recommended activities and can provide advice to complete relevant applications.

Reduce System Losses

Create comprehensive, lasting improvements in non-revenue water.

Non-revenue water (NRW) is becoming an urgent priority for our sector globally as water scarcity, regulation, and increasingly stringent targets call for tighter control of water from source to tap.

Utility managers are searching for proven and cost-effective solutions to identify and address sources of system loss, both real and apparent, in their transmission and distribution networks.

Current State

Most utilities have some form of a non-revenue water strategy. Many can identify major imbalances between production and consumption but have difficulty locating sources of loss. Common current practices include:

- Physical district metered areas (DMAs) to establish water mass balance
- Active leak surveys using acoustic techniques
- Basic metering infrastructure, often using meters with manual reading technologies

Today's approach has several limitations. District Metered Areas are costly to set up and maintain, and they can cause dead ends, hydraulic disruptions, and water quality issues. Manual leak surveys are labor intensive and decrease in accuracy when applied to larger pipelines, meaning they often produce false positives or worse: they misdiagnose failing pipe as good pipe. The accuracy of mechanical meters decays over time, and manual reads are slow, expensive, and do not support real-time system analytics. The reason non-revenue water remains such a persistent issue is that these approaches do not add up to a systematic, cost-effective solution.

THE POWER OF DECISION INTELLIGENCE

New standards of practice combine remote sensing, real-time continuous monitoring, targeted use of high-resolution inspection tools, and advanced analytics to reduce real and apparent losses to economic levels. Modern tools include:

Advanced Metering Infrastructure to provide high-resolution consumption data in real time

Advanced data analytics applied to metering data to identify and reduce "apparent losses," including revenue lost from meter inaccuracy

"Virtual" District Metered Areas (vDMAs) that monitor network regions using real-time, connected flow meters to establish water balance without hydraulic disruption

Continuous, multi-parameter monitoring of the distribution network with high-frequency pressure transient and acoustic sensors supported by real-time data analytics to predict, identify, characterize and locate leak and burst events

Targeted use of high-resolution inline inspection tools that can identify both large and small leaks and pinpoint leak locations with a very high degree of accuracy and efficiency

Pressure management to reduce leakage rates.

Taken together, these approaches create a comprehensive, cost-effective strategy that help utilities gain control of leakage, with significant operational, financial, and community benefits.

Benefits of Decision Intelligence for Non-Revenue Water Management

OPERATIONAL BENEFITS

Avoidance of set-up and maintenance costs for physical DMAs, as well as associated water quality and hydraulic issues

Reduced main break rate from proactive leak detection and repair ("schedule your emergencies")

Reduced chemical and pumping cost associated with producing less water

Reduced need for new production assets in growing cities

FINANCIAL BENEFITS

Revenue growth without needing to replace all meters or raise rates

Lower cost of repairs and reduced resources devoted to emergency response

Lower volumes of water lost, reduced break rate, and subsequent reduction in treatment and energy costs as well as avoidance of investment in new supply infrastructure

COMMUNITY BENEFITS

Reduction in service disruptions, with proactive real-time customer communications when interruptions are unavoidable

Increased meter reading accuracy to ensure customers pay only for what they actually use

Environmental benefits from reduced water/energy consumption

Driving Impact

■ The City of Fountain Valley, California, sought to increase its drought resilience by deploying advanced metering infrastructure. The City selected Xylem's Sensus Smart Utility Network solution, which enabled their team to monitor high volume consumption and identify leaks, resulting in a 23% decrease in water consumption and the achievement of ambitious conservation goals.

■ Pengurusan Air Selangor Sdn Bhd, Malaysia, partnered with Xylem to proactively detect leaks and pipe bursts on over 3,725 miles of critical pipes. Data from high resolution pressure and acoustic sensors have enabled important insights into the operation of the network and the nature and distribution of leaks on the trunk mains. In the first year alone, 70 major leaks and bursts have been successfully detected and repaired.

■ JEA, Florida's largest public utility, faced an aging meter fleet across 25,000 commercial and industrial accounts. Working with Xylem, the team developed a phased change-out program that included advanced meter testing, valve maintenance, and targeted replacement of legacy meters with Sensus OMNI™ meters, increasing accuracy, service life, and flow range. Since first addressing the issue, JEA has seen an overall gain of one billion gallons of measurable water.

■ Clayton County Water Authority (CCWA) in Georgia was finding it difficult to quantify the effects of apparent loss on their bottom line. By implementing Xylem's Hidden Revenue Locator™ advanced analytics to continuously identify problem meters in their system, the Authority has solved the issue and optimized its meter replacement program. CCWA has identified over $1 million in annual lost revenue and avoided unnecessary investment in fully functional meters.

■ Dallas Water Utilities (DWU) in Texas aimed to reduce non-revenue water to meet state conservation regulations. By implementing a comprehensive leak detection program combining traditional leak surveying and high precision inspection tools like SmartBall® and Sahara® Leak Detection technologies, DWU has located and repaired over 120 leaks, leading to a 17% decrease in main breaks and an estimated water savings of 7.2 million gallons per day, with a programmatic cost of 20% below the cost of new water resource development.

■ A water authority serving the United Arab Emirates experienced significant water losses in their distribution network, with little to no visibility on the root causes. The utility worked with Xylem to create virtual District Metered Areas (vDMAs) to bring structure to its complex network while maintaining redundancy and avoiding hydraulic disruption. Xylem's View™ platform also helped the client visualize the source of losses and to identify specific vDMAs where adopting advanced metering technology could most effectively reduce apparent losses.

Proactively Manage Your Assets

Multiply the impact of your capital investments and lower the risks of system failure.

Water and wastewater are the most capital-intensive utility services, with buried infrastructure accounting for a majority of the asset value of most utilities. Capital spending to renew or replace these assets is typically the single biggest line item in a utility's budget. However, research demonstrates that because these spending programs are based on limited information on actual condition or criticality, much of this spending is wasted on replacing assets with significant remaining useful life, resulting in little impact to level of service.

Utility managers are turning to a new approach that uses decision intelligence to focus limited resources on the assets that need the greatest attention and will provide the biggest return for their communities, dramatically improving the productivity of asset management spending.

Current State

Utility managers must decide where to invest limited resources to maintain their aging infrastructure and face significant political pressure to reduce the rate of pipeline failures. Most utilities have asset management strategies that include some or all of the following elements:

- An annual plan to replace 0.5% to 1% of pipeline assets each year, prioritizing areas based on assessment of age, type of pipe and failure history
- Emergency response plans to mobilize crews to isolate failed pipelines and rapidly replace broken sections trying to minimize damage
- Limited system control (valve) maintenance (typically only visiting critical control points when needed for emergency response) and replacement of those found to be inoperable
- Visibility on actual asset condition is limited by complex, disconnected and inefficient data collection practices and applications

Today's approach has serious limitations. Pipe condition is only weakly correlated with pipeline age. The US EPA has found that 70-90% of replaced pipe has significant remaining useful life.[1] That means billions of dollars are spent on replacing assets that do not need replacement while leaving higher-risk assets in the ground — often in areas where failure would have severe consequences. Moreover, a lack of comprehensive valve management in most communities means that up to 33% of critical valves in a system are not locatable, accessible or operable, so service outages affect far more people than necessary during emergencies.[2] In sum, current asset management practices leave many utilities spending scarce resources on activities with little "risk-return on investment."

< *1. EPA Advanced Concepts, Techniques, and Tools in Infrastructure, Asset Management, 2010* | *2. Wachs Water Services 2019* >

THE POWER OF DECISION INTELLIGENCE

New standards of best practice combine real-time sensing and condition data with advanced analytics to optimize asset management spending. Every dollar of investment is rigorously prioritized and spent to ensure the community sees the greatest possible reduction in risk. Modern tools include:

Risk-based asset prioritization that leverages condition data and advanced algorithms to estimate the probability of failure of each asset, while incorporating socioeconomic data to estimate the consequence of failure, identifying the projects that minimize the community's total risk exposure

Comprehensive condition assessment to provide actionable information on the condition of critical assets, including environmental, operational, and other risks to structural integrity

Hazard reduction through the identification, localization, and mitigation of pressure activity that may damage pipeline integrity or potentially cause water quality issues

System control assessments that collect information on the condition, location, and position of control valves across the system, including regular measures to maintain operability, and rehabilitation services that restore system control at a fraction of the cost of replacement programs

Flexible field applications to engage and enable field staff to access and input critical data, empowering decision makers with timely insights to improve operational processes and address issues as they arise.

Taken together, these approaches enable a powerful, cost-effective strategy for asset management with significant operational, financial, and community benefits.

Benefits of Decision Intelligence for Asset Management

OPERATIONAL BENEFITS

Reduction in asset failures from risk-based prioritization and pressure management

Increased system resilience through proactive repair of individual critical assets

Better system control through locating, operating, and repairing valves

Reduced operational risks and safety concerns associated with unplanned/emergency action

Increased efficiency supported by coordination of real time, integrated awareness of field activity

FINANCIAL BENEFITS

Reduction in waste by focusing resources to truly high risk areas

Better cash flow through targeted evaluation and rehabilitation programs

Lower system liability and costs associated with unexpected asset failures

Reduction in unnecessary truck rolls and errors from improved real-time field activity data

COMMUNITY BENEFITS

Reduction in expensive, inconvenient, and dangerous disruptions from asset failures

Reduced community vulnerability from prioritized mitigation strategies reflecting consequence of failure

Faster utility response to customer issues through integrated and accessible data

Reduced rate pressures through increased productivity of capital and operational spending

Driving Impact

■ Howard County, Maryland was looking to optimize their capital program to reduce leaks and main breaks. Partnering with Xylem, the team implemented an artificial intelligence-supported risk model that prioritized the riskiest pipes and recommended appropriate management strategies to minimize risk. Since beginning the program, the County has achieved planned levels of service at 75% of the cost of conventional methods.

■ A private utility in Singapore was experiencing leaks and breaks on approximately 9 miles of new steel trunk main and was not able to determine the cause. By implementing high sampling rate pressure sensors and advanced analytics, large magnitude, damaging pressure transients were quickly detected, located and mitigated, eliminating the issue and generating approximately $15 million in savings.

■ The City of Grand Rapids, Michigan was experiencing issues with isolating its system due to failing control valves. Working with Xylem, the team implemented a robust valve management program that evaluated and restored critical valves to fully functional assets for an estimated 10% of the cost of replacement, saving nearly $1 million.

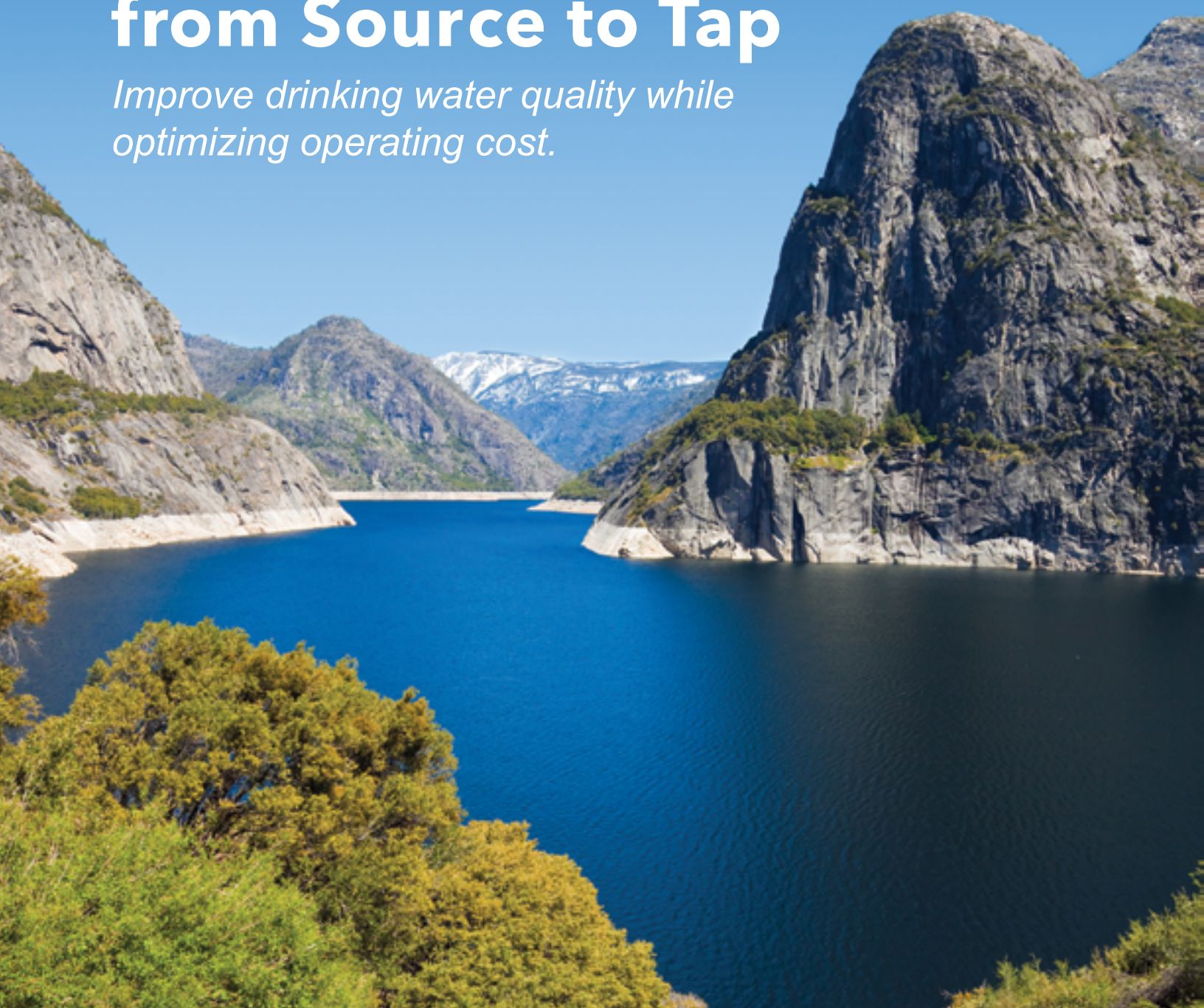
■ Baltimore County, Maryland, was looking to ensure the fidelity of its system controls before embarking on a significant capacity upgrade at a suburban pumping station. Before construction a specialized Xylem field team was tasked with ensuring that the 45 division valves responsible for maintaining the pressure integrity of the service area were in the intended closed position. When 5 of the 45 division valves were found in the incorrect position and subsequently closed, pumping demand fell from 10.2 MGD to 5.5 MGD, eliminating the need for the planned $1 million + in capacity upgrades.

■ The Washington Suburban Sanitary Commission (WSSC), Maryland, wanted increased visibility on the condition and associated risk of their critical water mains. In partnership with Xylem, WSSC developed a pipeline management program, using high-resolution inspection technologies like SmartBall®, PureRobotics™, and PipeDiver®, advanced structural and life-cycle evaluation techniques and continuous condition monitoring with SoundPrint® AFO. WSSC has reduced their failure rate by over 73%, avoided 27 potential failure events through AFO-informed interventions, and safely managed their system for 6.6% of the cost of replacement.

■ The Honolulu Board of Water Supply's field teams in Hawaii were struggling to collect useful field data with difficult-to-use legacy applications. Working with Xylem, the utility implemented the Kona™ mobile work management system, offering seamless integration to GIS, existing enterprise asset management systems, and customer information and billing systems for meter endpoint management. Kona™'s flexible and integrated platform has simplified data-driven asset management, generating significant operational savings.

Ensure Quality from Source to Tap

Improve drinking water quality while optimizing operating cost.



Managing the quality of water from source to tap is a core responsibility of the drinking water operator. Public health and regulatory compliance are of paramount concern, with customer complaints about taste and odor growing in importance and emerging quality issues informing new key performance indicators. Drinking water operators not only need to "keep the tanks full," they also need to manage complex interactions between hydraulics, chemistry, and energy consumption. Until recently, utilities have not had the tools to proactively manage water quality from source to the end user.

With concern rising about the safety of drinking water, utility managers are taking bold steps by adopting decision intelligence tools to gain visibility and control over water quality to ensure compliance, customer confidence, and public health.

Current State

Water quality management today has evolved around achieving compliance with key drinking water legislation. Elements of quality control strategies include:

- Water treatment interventions, including organics removal and disinfection
- Required testing of treated water as it leaves the treatment plant
- Required sampling in the distribution system and testing for regulated constituents
- Flushing programs to reduce discolored water complaints
- Reactive response to customer complaints about taste and odor, including spot flushing
- Infrequent (e.g. annual) reporting of compliance to end-users, often by physical mail

Today's approach has serious limitations. While many utilities have achieved compliance with existing regulations, more information is required to optimize operations. The quality of water delivered to the customer may differ substantially from that leaving the treatment plant, but most operators lack visibility into these changes. In many networks, valves are in the wrong position, creating unidentified dead zones, and network configuration is constantly evolving with valve closures, storage operations, or pumping activity. Uncertainty about the network leads to inefficient process interventions to create a "safety buffer" around compliance, ranging from excess disinfectant dosing to maintain residuals, to inadequate dosing to control disinfection by-products, to opportunistic flushing to keep water moving – approaches that do not address the underlying issues of water quality challenges in the network.

THE POWER OF DECISION INTELLIGENCE

Today's best practices create real-time awareness of water quality from source to tap and suggest optimal control mechanisms to ensure the efficient delivery of high-quality water to the end user, reducing the risk of compliance violations and customer complaints:

A real-time source-to-tap digital twin, powered by online monitoring of source waters, drinking water treatment plants, and data-driven hydraulic and water quality models

Decision support to optimize trade-offs between supply reliability, quality, and energy consumption, with daily operational guidance to meet operators' objectives

Simulation tools to let operators test-drive operational scenarios before they are put into practice

System control assessments to ensure that valves are in the right position so that the network is flowing as expected and dead zones are addressed

Optimized flushing regimes to support more effective maintenance of water quality while minimizing waste and inconvenience.

Benefits of Decision Intelligence for Water Quality

OPERATIONAL BENEFITS

More efficient and effective treatment operations informed by real-time source water information

Real-time visibility into how operational changes affect future water quality

Fewer compliance violations resulting from network water quality issues

Increase in efficiency, effectiveness, and predictability of flushing operations

FINANCIAL BENEFITS

Reduction in costs from optimized treatment and energy efficient delivery

Reduction in wasted water through optimized and targeted flushing

Reduction in labor costs and potential liabilities associated with compliance violations

Reduction in chemical costs due to overtreatment of water

COMMUNITY BENEFITS

Consistent delivery of high-quality water everywhere and at all times

Reduction in taste and odor complaints

Reduction of disinfection byproducts

Reduced inconvenience, waste, and negative publicity from unnecessary flushing

Timely and targeted feedback about potential water quality issues

Increased trust of the utility by the community

Driving Impact

- Thames Water in the United Kingdom wanted to understand the nature of their source water to support treatment optimization. Using Xylem's automated systems, they were able to generate vertical profiles of water quality at key locations in their drinking water reservoirs. This visibility allowed them to optimize intake selection and mixing protocols to mitigate taste and odor problems and reduce the release of potential cyanotoxins, reducing treatment requirements and costs and customer complaints.

- Langenau Waterworks of Germany was looking to optimize chemical inputs and avoid operational stressors at a critical treatment plant. By implementing Xylem's BLU-X™ Treatment solution they were able to optimize the amount of coagulants and flocculants while maintaining regulatory requirements, stabilizing the process and generating meaningful input cost savings.

- The City of Melbourne, Florida, was looking to improve the efficiency of their flushing efforts. The City partnered with Xylem to develop and execute a prioritized uni-directional flushing program that helped to reduce iron concentration by 77% and turbidity by 57%, while increasing chlorine residual by 15%. Consequently, customer complaints were reduced by 92% year over year.

- The City of Houston, Texas, wanted to assess and maintain its 100,000 distribution system valves to establish and ensure system control. Together, Xylem and the City established a robust valve assessment program. To date, 4,700 valves have been found in the incorrect position, creating over 8,000 "dead-ends," which often increase water age in distribution systems. Correcting this issue has improved water quality, increased fire flows, eliminated nearly 200 miles of "dead-ends," and enhanced the accuracy of the City's GIS.

- A city in Michigan was facing water quality challenges and wanted greater visibility on water age throughout their distribution network. Working with Xylem, the City developed a real-time water quality map of their network that identified water storage operations as the cause of the water quality challenges. This map has helped the City optimize water age throughout the system by altering pertinent hydraulic operations.

Manage the Urban Watershed

Reduce the cost of safely reclaiming wastewater.

The key imperatives of wastewater and storm water management include ensuring compliance with environmental regulations at the lowest total cost. This task is becoming more difficult with stronger and more variable wet weather incidents, deteriorating infrastructure, intensifying inflow and infiltration issues, and more complex constituents in wastewater (e.g. wet wipes, microbeads) requiring new mitigation measures. At the same time, the wastewater treatment process remains extremely energy intensive and vulnerable to shifting volumes and concentration of wastewater influent.

In an effort to deal with these dynamic issues in an affordable way, utility managers are challenging traditional mitigation strategies that rely only on building expensive new infrastructure, and instead leveraging the power of decision intelligence to optimize the use of existing assets.

Current State

Wastewater management has improved over the years but continues to rely on incremental improvements in technologies that are decades old and often highly inefficient. Key approaches to addressing emerging challenges include:

- Combined sewer separation or the construction of tanks and deep tunnels to manage wet weather flows
- Scheduled sewer cleaning; gravity sewer CCTV inspection to assess sources of inflow and infiltration and identify blockages
- Regular maintenance schedules for wastewater pumps at lift stations
- Aeration to saturation in secondary wastewater treatment to ensure proper digestion or control logic based on dissolved oxygen set points

This approach has serious limitations. Sewer separation and deep tunnel construction are massive capital investments that have a very low return on investment, with only episodic benefit during peak flow events. Routine sewer inspection and cleaning can help reduce infiltration and blockages, but current methods are labor intensive and result in crews spending most of their time cleaning sewers that do not require attention while neglecting hotspots – both known and unknown. Regular maintenance of lift station pumps can help reduce overflows and outages caused by lift station challenges, but pump clogging, power failures and other malfunctions still lead to periodic violations. Finally, most secondary treatment approaches leave money on the table with respect to energy savings, with Xylem research indicating that 50% of electricity consumption could be eliminated with effectively zero or negative costs incurred.[1]

< *1. Powering the Wastewater Renaissance, Energy Efficiency and Emissions Reduction in Wastewater Management, Xylem Inc. 2015* >

THE POWER OF DECISION INTELLIGENCE

New standards of best practice leverage assessment technologies, real-time monitoring, data analytics, and system modeling to minimize the cost of maintaining compliance, both through capital optimization and energy efficiency:

A real-time digital twin of the wastewater collection system enables real-time management of wastewater from toilet to treatment plant. By optimizing capacity utilization of the network using coordinated real-time control of gates, valves, pumps, and tanks, the total effective capacity of the system can be increased with little or no construction of additional infrastructure (e.g. eliminating tanks, tunnels and/or sewer separation). Digital twins can also identify, locate, and characterize I&I to prioritize mitigation efforts, and can optimize sewer cleaning schedules to address blockages in order of importance.

Critical force main assessment and ongoing monitoring can identify defects and risks of failure in these essential assets, lowering the risk of leakage and compliance violations in this part of the collection system.

Risk-based asset prioritization reduces the risk of failure by leveraging condition assessment data and machine learning tools to evaluate each asset's probability of failure, while also incorporating multi-disciplinary socioeconomic data to estimate the consequence of failure. This approach ensures that dollars can be targeted at the right assets to minimize the community's total risk exposure.

Intelligent pumping systems provide real-time visibility into current conditions, enable proactive maintenance programs that ensure uptime, and dramatically reduce the risk of clogging and backups at the lift station.

Digital twins of the treatment plant enable process optimization, decreasing energy consumption and increasing process stability, throughput rate and effluent water quality. Coupled with real-time control of sewer networks, these twins can stabilize flows into the plant, generating even greater performance improvement.

Taken together, these approaches significantly reduce the capital and operating costs of collecting and treating wastewater in compliance with environmental regulations.

Benefits of Decision Intelligence for Managing the Urban Watershed

OPERATIONAL BENEFITS

Rapid response and proactive mitigation facilitated by advanced warning of real-time network capacity issues

Reduced numbers of call-outs to address infrastructure failures or overflows

Optimization of operator efforts during critical procedures using predictive decision support systems

Minimization of surcharge conditions, basement backups, street flooding and overflows

Expanded operational agency over legacy infrastructure and treatment facilities

FINANCIAL BENEFITS

Reduction or avoidance of new capital investment in the sewer network and optimization of renewal and rehabilitation programs

Reduction in energy costs from substantial efficiencies

Avoidance of significant fines associated with non-compliance

COMMUNITY BENEFITS

Reduction in risk of dangerous sewage overflows into environmentally sensitive waterways

Avoidance of large capital investments that would require rate increases or new debt

Increased support for economic development and expansion

Driving Impact

■ The City of South Bend, Indiana, faced a billion-dollar consent decree for combined sewer overflows. The city implemented Xylem's BLU-X™ intelligent sewer solution, utilizing a combination of sensors and artificial intelligence to provide real-time decision support and coordinated real time system control. As a result, the City has reduced combined sewer overflow volumes by over 70%, reduced E. coli concentrations in the St. Joseph River by 50% and is expected to reduce capital required to comply with the consent decree by more than $500 million.

■ Baltimore County, Maryland, was looking to use data to manage their critical force mains. Working with Xylem, they implemented a comprehensive force main assessment program using a combination of SmartBall®, PipeDiver®, and PureRobotics™ inspection technologies. These assessments determined that 3.5% of pipes showed signs of deterioration, with only 0.5% requiring repair. The program has empowered the County to safely and cost effectively manage its system while avoiding unnecessary replacements.

■ A large municipal WWTP in Cuxhaven, Germany, wanted to optimize their energy consumption. Using Xylem's BLU-X™ Treatment solution, an optimization strategy based on artificial neural networks was developed to predict the best setpoints to operate the aerators of five parallel biological treatment tanks. Following system commissioning, results showed a 26% reduction in aeration energy usage, corresponding to ~1.1 million kWh annually. In addition, all plant effluent concentrations continue to maintain regulatory compliance.

■ Genesee County, Michigan, sought to employ smart technologies to address operational issues at their lift stations. Following the deployment of Xylem's Flygt Concertor® system, an artificial intelligence-powered wastewater pumping system, the County was able to significantly reduce energy consumption, eliminate the need for scheduled de-ragging and lift station cleaning, and ultimately reduce maintenance call-outs to zero.

■ The City of Muncie, Indiana, wanted to reduce energy consumption and improve the process stability at its wastewater treatment plant. By installing Xylem's aeration control technologies, which optimize the treatment process with real-time sensors and controls, the City was able to reduce energy usage in the plant by over 20%, ensure more stable effluent quality, and increase operator efficiency.

Advance Water Equity

Sustainably align system operation with stakeholder policy objectives.

For a majority of the world, water rates are increasing rapidly to keep pace with the need for continued investment in water systems. These rate increases routinely outpace the rate of local inflation, and economically disadvantaged populations and families on fixed incomes can struggle with the affordability of water and wastewater services. Given that many water utilities are either directly supervised by local governments or are contracted to them, the affordability of water services, and the equitable distribution of cost recovery across various segments of the population, are critical policy issues for utility leaders.

In response, utility managers are developing strategies for water equity by optimizing capital and operational spending, and by targeting customer engagement and affordability as a strategic policy objective to secure the utility's social license to operate as a valued partner to the community.

Current State

Affordability and water equity programs typically include some or all of the following elements:

- Engagement of a consultant to develop rate structures that allocate cost recovery across consumers consistent with state and local regulations and policy objectives
- A voluntary surcharge that funds a community assistance program for ratepayers in distress
- Disconnect and/or reconnect fees for users that have fallen into arrears on payment
- Hardship programs that are often underfunded and struggle to reach participants in need

This approach has serious limitations. Service suspensions are expensive, disruptive, and inconvenient for the utility and its customers alike. They sour relations between the community, the utility, and local political leadership, produce cash flow and balance sheet inefficiencies, and put field workers in difficult and sometimes unsafe situations. Many of them can be prevented with proactive management. Moreover, although rate structures are developed to ensure equitable distribution of utility costs across ratepayers, metering systems decay over time, generating apparent losses from meter under-registration that routinely favor larger, principally commercial and industrial customers. This results in relatively more favorable treatment for larger customers who are typically better able to pay than the average consumer, forcing lower income customers to foot a larger percentage of the cost of service over time, potentially introducing a regressive form of cross-subsidization.

THE POWER OF DECISION INTELLIGENCE

New standards of best practice combine modeling, data analytics, modern communications, intelligent hardware, and an "open architecture for affordability" to address the water equity challenge in a systematic way. Decision intelligence tools can reduce regressive cross-subsidization, bill shocks, and service suspensions in an economically viable way that supports all members of the community:

Apparent loss reduction utilizing advanced data analytics enables utilities to identify meters in the network that are contributing significantly to revenue loss through under-registration.

Bill shock reduction is enabled by decision intelligence applications that can identify leaks on the customer side of the meter, empowering customers to respond quickly before costs mount to unaffordable levels.

Service management is facilitated by data analytics, remote shut off meters, and customer service applications to enable better customer engagement, lower field costs, and more effective account management.

Reduction in service suspensions is enabled by data-driven tools that can identify clients who are in danger of non-payment and target communications and other interventions (e.g. reminders, information about community assistance programs) to support on-time payment.

Remote flow reduction tools enable utilities to reduce flow through a remotely actuated valve for customers who do not pay on time, ensuring these customers are able to meet essential needs while creating an incentive to pay to eliminate the inconvenience of reduced flow. This also avoids the costs and risks associated with onsite service suspensions.

Taken together, these approaches enable a powerful, cost-effective strategy for water equity with significant operational, financial and community benefits.

Benefits of Decision Intelligence for Water Equity

OPERATIONAL BENEFITS

Targeted identification of faulty meters enables more effective replacement strategies

Reduction in the cost and risk associated with conducting service suspensions in the field

Reduced call center volumes related to service suspensions

FINANCIAL BENEFITS

Targeted identification of faulty meters to optimize revenue collection in a capital-efficient way

Reduction of service suspensions from non-payment improves cash flow

COMMUNITY BENEFITS

Reduction in regressive cross-subsidization improves long-term affordability of rate structure

Bill shock reduction places fewer individuals at risk of non-payment

Reduction in service suspensions improves relations with community and alignment with local policy objectives

Driving Impact

- In Clayton County, Georgia, utility leaders were looking to identify and quantify apparent losses across their meter network. Utilizing Xylem's Hidden Revenue Locator™, the County was able to achieve a four-fold improvement in locating meter registration gaps and identified over $1 million in annual lost revenue. On a per-meter basis, the solution flagged revenue losses of $6 for the average residential meter and $67 per non-residential meter.

- Newport Beach, California, was looking for an approach to tackle their apparent loss issues. Through the implementation of Xylem's Hidden Revenue Locator™, the City identified over 1 billion gallons of apparent water loss which summed to over $4 million in historical revenue losses. These data analytics also helped the City to detect leaks, support meter right-sizing, and ensure billing accuracy.

- Another city in Georgia aimed to reduce service suspensions in a sustainable way. Using Xylem's Cutoff Analyzer™, the community was able to apply data analytics and targeted customer interventions to reduce suspensions by 30% in a one-year period, and 50% for chronically (3 or more/year) suspended customers. This success meant 700 households that had been suspended the previous year, maintained constant water service that year. This solution also decreased arrears from suspended customers by over 50% in a one-year period.

Gain Control of Your Data

Empower your teams to extract real value from smarter water systems.

Utilities around the world have been working to improve their operations by making investments in distributed sensor networks and data acquisition systems, ranging from smart pumps, level sensing and flow metering devices, to supervisory control and data acquisition (SCADA) systems and advanced metering infrastructure (AMI). The proliferation of sensors, data streams, and applications is as challenging as it is exciting.

Many utilities complain of a "data deluge" that is making it difficult to realize the benefits of their investments. Utility managers are working to unlock the value of their data by focusing on usability, interoperability and application development – moving from "data swamped" to "data smart."

Current State

Water and wastewater utility managers have implemented steps to improve the visibility into and operation of their systems by increasing the data they are collecting about their networks. Key characteristics of the current state include:

- Installation of sensors and telemetry to measure performance of existing assets and equipment to backhaul the data in real time to the cloud or an on-premise server
- Increasingly intelligent equipment with integrated control from a range of vendors
- Implementation of purpose-built networks and systems for specific processes in the utility (e.g. SCADA for operations and AMI for revenue collection)
- Field staff, disconnected from existing data sets, are left to make decisions lacking available information and insights

This approach has serious limitations. Each new device and system produces massive quantities of data that are rarely presented in ways that offer actionable insights. Data formats are inconsistent across devices and vendors, and separate purpose-built systems rarely share data, making it difficult to generate system-level insights related to the performance of the overall network. Internal and external development teams routinely introduce new applications that make it harder for operators to maintain a single, common operating picture. The proliferation of data, communication modes, and applications can result in data security and privacy concerns. The end result is a messy patchwork of incompatible sub-systems that do not support integrated operational decision-making, limiting (and sometimes negating) the return on investment to the utility from "smart water" systems.

THE POWER OF DECISION INTELLIGENCE

Today's best practices leverage data integration, analytics and visualization capabilities to help utility managers gain control of the intelligent systems they have installed and unlock the value of their data:

A flexible cross-enterprise integration layer can make data from multiple purpose-built systems and devices available in a single, secure environment.

A modular applications architecture can enable utilities to select and add new software applications à la carte to solve specific problems in their systems while also leveraging the existing investments they have made in technology, thus unlocking the utility's valuable data and better serving every information consumer, including utility leadership, engineering, operations, regulatory compliance, and external stakeholders.

A data security framework ensures that data in transit as well as at rest are encrypted and anonymized where necessary to ensure only systems and personnel authorised to use the data are granted access in a suitable format.

A modular integrated presentation interface that is user-friendly and purpose-built for interoperability can help users pull in information from multiple applications from multiple vendors into a single interactive and configurable dashboard that makes it easy for users to draw insights and extract value from the systems they have installed.

Taken together, these approaches enable a utility to access the full power of their data for short- and long-term decision making.

Benefits of Decision Intelligence for Managing the Data Deluge

OPERATIONAL BENEFITS

Better decisions can be made faster as users have access to integrated data streams

Cross-department collaboration enabled by the integration of multiple applications into a single presentation layer (e.g. between operations, engineering, customer service)

FINANCIAL BENEFITS

Elimination of the need for major system overhauls as new capabilities can be added quickly and incrementally

Preservation of value invested in existing systems through the implementation of interoperable and open architectures

Elimination of the need for costly middleware through the implementation of a flexible integration platform

COMMUNITY BENEFITS

Improved service as data is more effectively used to address challenges

Minimized impact of water shutdowns from real-time customer alerts

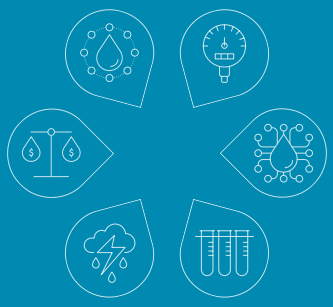
Driving Impact

- Denver Water in Colorado faced the challenge of integrating information between their Customer Billing System, Computerized Maintenance Management System (CMMS), and GIS to support their 300+ field staff. Xylem's Kona™ solution provided a flexible mobile front-end where dispatch and field staff can see all work being conducted in one view, powered by a robust and seamless back end integration platform. This implementation enabled information to flow between major back office systems while preserving the source system data structures and removing the need for expensive middleware. Over the course of 10 years, Denver Water has saved over $20 million by increasing staff efficiency across dispatch and field functions and IT integration costs.

- The city of Grand Rapids, Michigan, set out to certify the performance of their newly separated sanitary sewer system. After building one of the largest distributed sensor networks of any storm water and wastewater utility in the country, the city utilized Xylem's BLU-X™ visualization and analytics tools to assess planned I&I mitigation projects. By linking these to a common framework, the City found many of these projects were not necessary and has reduced capital infrastructure program needs from over $1 billion to less than $50 million.

- A Southeast Asian National Utilities Board deals with a massive amount of data from multiple sources (with hundreds of distributed water quality, flow, and pressure sensors installed across the system), and was looking to derive more insight from multiple data streams. By implementing Xylem's View™ platform, the utility has been able to integrate data streams, apply advanced analytics, and display operational insights through a comprehensive and accessible interface that informs decision-making and streamlines operations.

- A major water utility in Australia wanted to reduce pipe breaks in its dense urban center and avoid disruptions to public life. The utility adopted an open architecture approach to building a smart water network, using Xylem's View™ platform to "crunch" data coming from thousands of sensing points in order to deliver the right information to the right business units at the right time. Since implementation, they have prevented 50% of the breaks through early intervention.



It would be our distinct pleasure to partner with you in capturing the opportunity of a lifetime to serve your community even more effectively through the power of decision intelligence. Please do not hesitate to contact **decisionintelligence@xyleminc.com** with any questions. We will respond within 24 hours.

United States
8920 State Route 108, Suite D
Columbia, Maryland USA 21045
Tel: +1 (443) 766-7873

Canada
5055 Satellite Drive Unit #7
Mississauga, Ontario
Canada L4W 5K7
Tel: +1 (905) 624-1040

Europe
Edificio de escritórios JONOBRAS,
EN 247, Sala 3, 2º Piso.
Ribamar, Santo Isidoro
Portugal 2640-027
Tel: +351 (261) 863-159

Asia Pacific
3A International Business Park Rd.
08-14 Tower B, ICON@IBP
Singapore 609935
Tel: +65 8292 8392