The Smarter Water Manager

SMART WATER SOLUTIONS FOR A RESILIENT WATER FUTURE

xylem
Let's Solve Water

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Authors

Xylem
Randolf Webb, *Vertical Marketing Manager – Europe*
Alexis de Kerchove, *Vertical Marketing Manager – Water Utilities, Europe*

The authors would also like to thank the following Xylem colleagues for their contributions to this paper: Joe Vesey, Al Cho, Kelly McAndrew, Ron Askin, Andy Fraher, Dan Iversen, Renee Peet, Sabrina Wolf and Silvia Spagnolo.

For more information on the contents in this report please email: smartwater@xyleminc.com

Letter from Xylem's President and CEO

As the global water crisis deepens, the challenges facing water and wastewater managers are intensifying. Climate change poses significant risks for water networks, from water stress to flooding. Aging infrastructure, suffering from a history of under-investment, is crumbling under a growing population. In Europe and US, non-revenue water accounts for 24 percent of supply on average [1-2]. In the US, the EPA estimates at least 23,000 - 75,000 combined sewer overflow events per year [3]. Rising global energy prices and an increasingly stringent regulatory environment add further complexity.

In short, water managers are under pressure to do more with less.

Faced with this mandate, managers cannot afford to stand still. Now is the time to act to get ahead of these complex water issues. The good news is that the solutions required to be successful in this effort are, in some cases, already available today, while other solutions are rapidly emerging. Smart water technologies offer the potential to enhance community welfare while transforming the economics of water and wastewater operations.

At Xylem, we are committed to accelerating this evolution. We have developed a platform of smart water solutions that addresses managers' most complex pain points. Our aim is to bring our global expertise and experience to bear to understand our customers' unique challenges and deliver solutions that add value to their operations.

This paper discusses the future of smart water and how smart water technologies can effectively address challenges met in the management of water.

We look forward to partnering with you as we strengthen our collective ability to achieve smarter, sustainable water management.

Patrick Decker
President and Chief Executive Officer
Xylem Inc.

Xylem Vision for the Future of Smart Water

The daily challenges of water management

Communities around the world are facing a growing storm. Complex challenges including water scarcity, changing demographics, extreme weather patterns, and aging or overly stressed infrastructure are colliding to threaten critical water, energy, transport, enterprise and health networks. The water industry is in the eye of the storm.

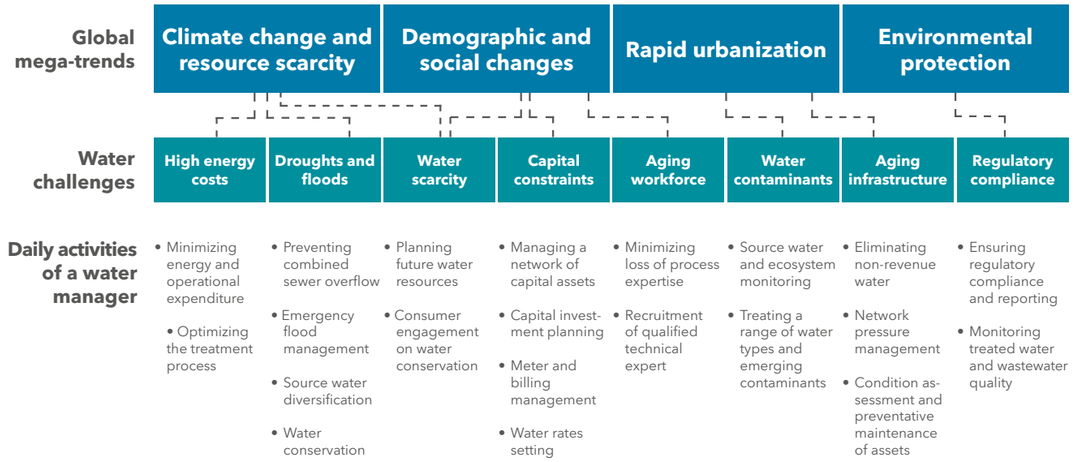
By 2025, more than 1.8 billion people worldwide will be living in areas of water scarcity, where more than two thirds of the world's population will face water-stressed conditions [4]. By 2050, it is expected that water demand will increase by 55 percent compared to 2015 levels [5]. Declining water quality due to human activity is compounding the situation.

Against this backdrop, water and wastewater managers are dealing with acute infrastructure challenges, including pipe leaks, main breaks, sewage overflows, storm water overflows, energy-intensive operations, and inefficient decision-making and asset management. Cities are expanding at a rapid pace, with a projected 70 percent of the world's population living in urban areas by 2050, putting water networks – already suffering from a historical lack of investment – under immense pressure. Water utilities throughout Europe are dealing with 3.5 million kilometers (km) of aging distribution networks [6] while in the US, the latest survey of 20-year needs estimates that $384.2 billion will need to be invested in water infrastructure between 2011 and 2030, with $247.5 billion of this figure attributed to pipe refurbishment and replacement [7].

This results in a water manager that is faced daily with a wide-range of interconnected challenges that must be addressed with limited resources, as captured in Figure 1. Among these challenges, three are of particular concern to utility operators when managing daily activities.

First, significant non-revenue water (NRW) volumes – due to operating inefficiencies, apparent losses, and physical leaks in the network – is a problem faced by utilities globally. An alarming 24 percent of countries analyzed as part of the Global Water Intelligence Global Water Market 2017 study cited NRW rates in excess of 40 percent [1]. Second, contaminants of emerging concern (CECs) in fresh water sources are creating a growing need to treat water to safeguard human health and protect against environmental risks. The significance of this threat is underscored by the introduction of legally binding regulations in Switzerland requiring wastewater treatment plants to implement an additional treatment process for the removal of CECs. Finally, rising energy costs cannot be ignored by an industry in which energy for water distribution and treatment alone accounts for more than 11 percent of operating expenses [8].

Figure 1. The challenges facing water managers



Turning crisis into opportunity

While the challenges of building resilient water infrastructure are complex, they are not insurmountable with the solutions we have today. Urban infrastructure relies on a number of distinct networks to supply city dwellers with food, water, energy, transportation, and other services. These interconnected infrastructure networks are vital to the life of modern cities, and when they are damaged, human health, welfare, and the economy are jeopardized.

Amid a "new normal" of increased natural hazards, weather volatility, and aging networks that threaten to impair and overwhelm this critical infrastructure, communities and their leaders can, and must, take a proactive approach to develop better strategies to anticipate, prepare for, respond to, and recover from external shocks. As explained in the section that follows, by creating robust, intelligent systems that are designed to withstand variability, water managers can more effectively and efficiently address their water challenges, and cities can proactively protect their communities for years to come.

The digital advantage for a more resilient water future

Smart water solutions – including physical equipment and treatment, wireless networks cloud analytics, mobile computing, powerful data modelling, and the internet of things – offer new ways to address the industry's challenges and opportunities. These are not prototypes being tested in a laboratory. These are proven solutions that are already delivering dramatic improvements in water productivity, quality and resilience. These intelligent solutions reduce energy consumption and costs, contribute to lower emissions, and improve operational efficiencies, all of which can help water managers better afford investments in clean water and wastewater infrastructure.

As smart water solutions are a relatively new phenomenon, work to quantify the full impact of these new solutions is ongoing. Even at this early stage, however, several studies involving qualitative research with global water utilities and economic analyses indicate that annual savings of $12.5 billion - $15 billion could be realized through reductions in capital and operational expenditure [9].

There are three primary solution categories driving the water sector's migration to smart infrastructure as seen in Figure 2.

Figure 2. The primary smart water technology categories

Intelligent Equipment

Intelligent equipment, including pumps, mixers, treatment and sensors, capable of self-optimization for enhanced performance. This enables water managers to decrease the time and effort needed to monitor and maintain their critical technologies.

Smart Network

Smart networks collect information across a number of pieces of equipment to provide real-time reactive management of the system. This enables water managers to remotely and continuously monitor operations.

Digital Solution

Digital solutions combine real-time data from equipment with algorithmic decision support to provide proactive management of the system. This enables water managers to remotely and continuously monitor operations, and then make real-time adjustments to the operations based on data-driven decisions.

Reimagining the economics of water management

Collectively, these smart water solutions hold the potential to fundamentally shift the economics of water management. Capital-intensive water infrastructure – combined with pressure on water rates and quality that do not allow for full cost recovery – has created a sector in which the economics consistently challenge a utility operator's ability to maintain and improve the quality of service they strive to provide. These solutions drive step-changes in the management of water utilities by enabling an operator to confidently shift resources to data-driven preventative maintenance from far more expensive emergency interventions, such as infrastructure repairs, water quality alerts, or flood management. Unlocking these resources on a macro scale will enable water and wastewater managers to better meet the needs of their growing customer base.

The smart water future is resilient

The good news is that the adoption of smart water solutions has already begun, and the global evolution continues apace. Utilities are expected to spend $14 billion in investment in these technologies through 2024 as water managers continue to recognize how smart water solutions reduce energy consumption, mitigate unnecessary water losses and minimize the consumption of resources [10].

Although the cost of smart water has historically been a barrier in some regions, equipment cost is now at a point where water utilities are leveraging bulk orders to more quickly adopt these solutions and derive value in their operations. The development of consortia across municipalities to generate consolidated orders is growing and encouraged for smart metering installation. Approximately 260 smart water projects globally were announced in 2017, some in response to water scarcity situations, others driven by the need for operational efficiencies [9].

Let's build on this momentum and accelerate the water industry's migration to a smart, resource-efficient future. Let's embrace the smart technology opportunity. Let's solve water.

$12.5 - 15 billion could be realized through reductions in capital and operational expenditure

$14 billion in investment in smart technologies through 2024

260 smart water projects globally were announced in 2017

Current State of Smart Water in Europe

The opportunity in Europe

European water utilities' 3.5 million kilometers of distribution networks pose many challenges, not least the rehabilitation of large sections of water distribution networks requiring investments of €20 billion per year [11]. Within Northern European countries, the focus is predominantly on maintaining existing infrastructure, while Mediterranean states are seeking investment to comply with the EU Urban Wastewater Treatment Directive and better manage their water resources. Across the Balkans, EU funds are helping to expand wastewater treatment. Driven by operational efficiency rather than by water scarcity, countries such as the UK, France, Germany, Spain and Portugal are increasingly focused on employing smart leak detection and energy efficiency solutions. These states are early adopters leading the smart water revolution across the EU, seeking to address NRW and enhance sustainability through the implementation of advanced monitoring infrastructure.

The European Commission's Energy-related Products (ErP) Directive is progressing the adoption of high efficiency pumping equipment across Europe and it is anticipated that similar legislation could be extended to other water management technologies and/or jurisdictions. Xylem's Powering the Wastewater Renaissance report found that almost 50 percent of electricity-related emissions from the wastewater sector in Europe can be abated with existing technologies, including several readily-available smart water solutions. Nearly 95 percent of this abatement can be achieved at zero or negative cost, meaning that savings from energy efficiency would exceed spending on the abatement measure over the life of the equipment [12].

Smart water pilot projects are underway across the EU. The ICT4WATER cluster involves 30 EU funded projects, bringing together more than 300 institutions and businesses that collaborate and contribute to the development of the EU Digital Single Market Strategy. The SmartWater4Europe project contributes to the European Innovation Partnership on Water by accelerating demonstration and deployment of innovative smart water network technology solutions for upgrading the reliability, efficiency, quality control, sustainability and resiliency of metropolitan drinking water supply services. The post-trial adoption of smart water solutions has enabled major utilities to reduce NRW by more than 4 percent and improve their energy efficiency by more than 15 percent in three years (2013-2015) [8]. The return from the adoption of smart water delivers strong internal cost savings and supports states to reach 2020 sustainability targets set by the EU.

€ 20 billion Annual capital expenditure to maintain Europe's water distribution networks

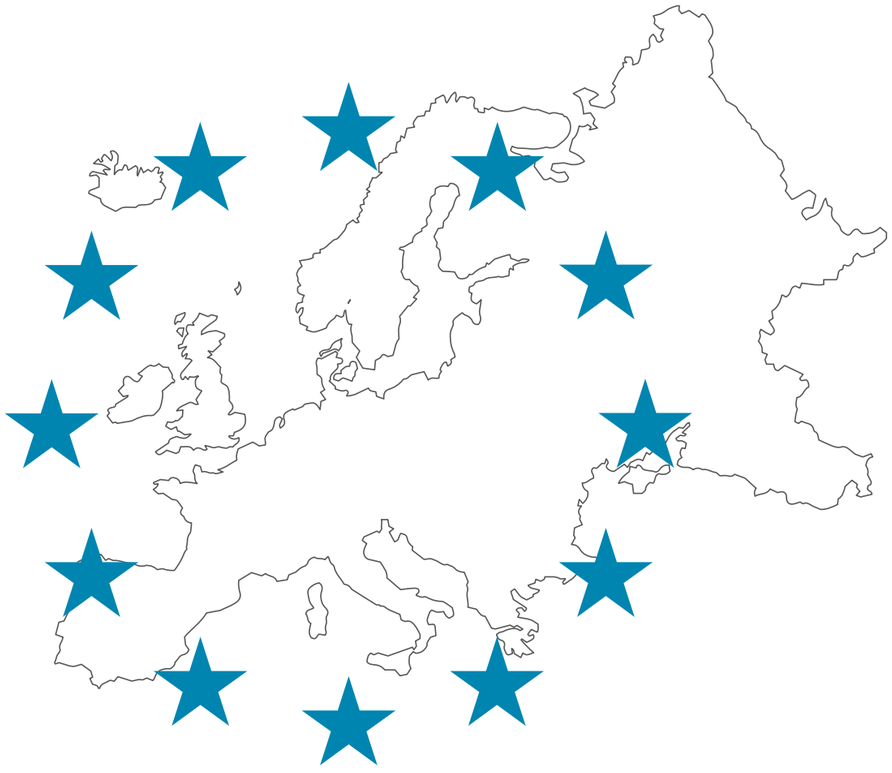
4%+ Improvement in non-revenue water by implementing smart water solutions

15%+ Improvement in energy efficiency over three years by implementing smart water solutions

Roadmap to Europe's smart water future

The EU Commission has laid out an ambitious vision for the future of smart water across the region in its Digital Single Market for Water Services Action Plan. This plan outlines the enablers to accelerate smart water adoption across Europe, detailing the governance system, policies and standards required, as well as the timeline for implementation between now and 2030.

It is envisaged that the plan will drive investment and create a level playing field, removing obstacles, deepening the single market, and ensuring favorable conditions for innovation and the involvement of all stakeholders. The Action Plan's vision sees utilities reinvented to become big-data related service providers, with high-quality forecasting and event diagnosis capabilities, using new data science methods and visualization applications to enable real-time knowledge, decision making, and customer engagement.



Xylem Smart Water & Wastewater Solutions Map

Advanced Water Treatment
A broad range of reliable treatment solutions including disinfection, oxidation and filtration

Treatment Process Optimization
Water quality sensors combined with advanced algorithms to optimize the treatment processes

Treated Water Quality Monitoring
Comprehensive real-time water monitoring and reporting solutions to support regulatory compliance

Preventative and Predictive Maintenance
Connected equipment and maintenance solutions to reduce downtime and failures of critical equipment

Ecosystem Monitoring
Remote sensor solutions to monitor and report on a variety of water resources parameters

Wastewater and Stormwater reuse

Integrated treatment to enable potable and non-potable reuse of wastewater and stormwater

Advanced Wastewater Treatment
A broad range of reliable treatment solutions including disinfection, oxidation, filtration, and biological treatment

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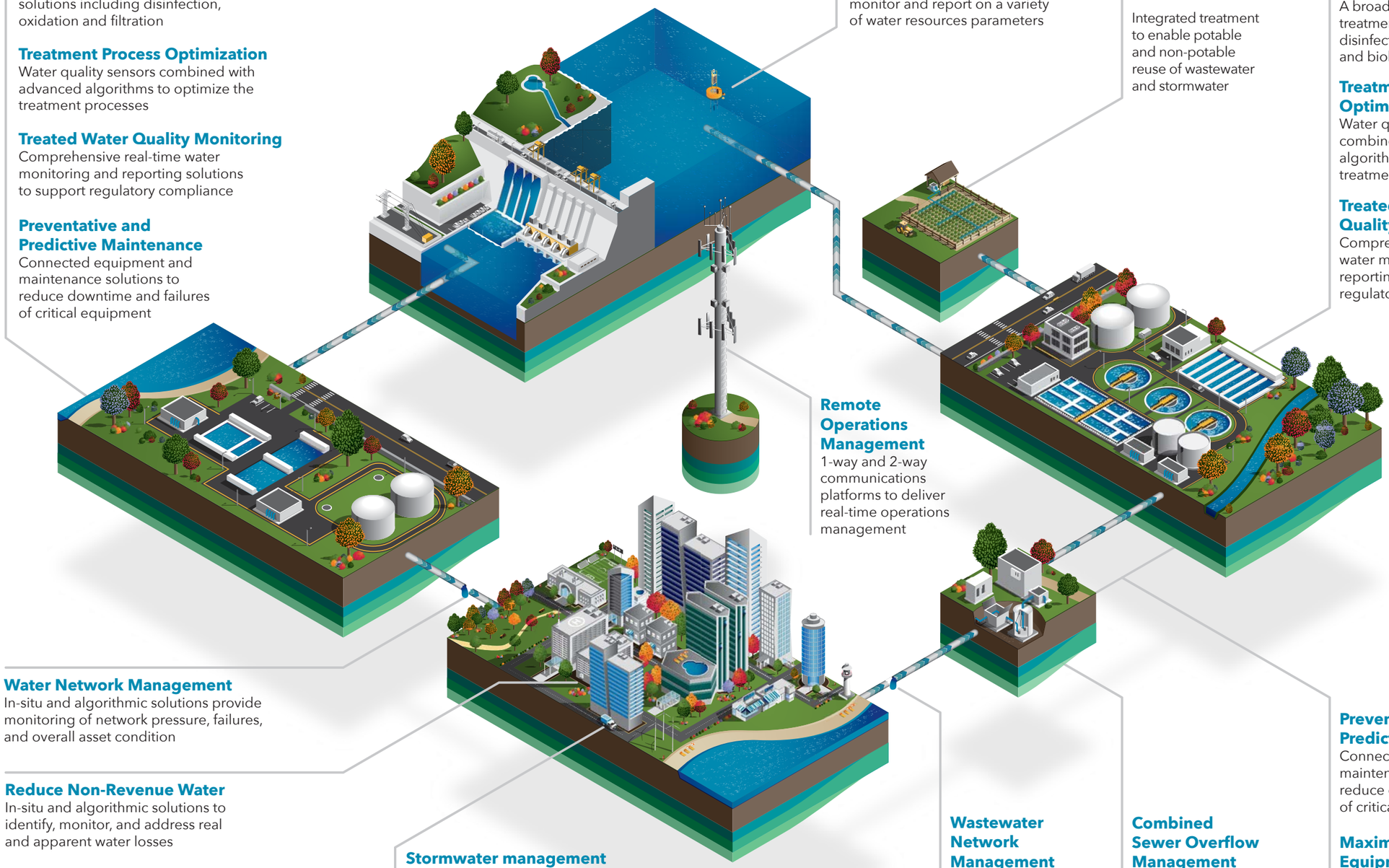

Remote Operations Management
1-way and 2-way communications platforms to deliver real-time operations management

Water Network Management
In-situ and algorithmic solutions provide monitoring of network pressure, failures, and overall asset condition

Reduce Non-Revenue Water
In-situ and algorithmic solutions to identify, monitor, and address real and apparent water losses

Meter and Billing Management
Smart metering solutions to improve billing accuracy and enhance customer service

Stormwater management and flood relief
Comprehensive range of dewatering solutions for all stormwater and wastewater flood events

Wastewater Network Management
In-situ and algorithmic solutions provide monitoring of network pressure, failures, and overall asset condition

Combined Sewer Overflow Management
Intelligent equipment and real-time analytics to prepare for and prevent sewage and stormwater overflows

Preventative and Predictive Maintenance
Connected equipment and maintenance solutions to reduce downtime and failures of critical equipment

Maximize Equipment Efficiency
Intelligent pumping and mixing equipment adapts to conditions for maximum reliability and operations efficiency

Intelligent Equipment

Smart Network

Digital Solution

EXAMPLE XYLEM BRANDS

Water manager daily challenges	Xylem's solution	Monitor	Treat	Transport	Decide
Ecosystem monitoring	Remote sensor solutions to monitor and report on a variety of water resources parameters	● ●			
Remote operations management	1-way and 2-way communications platforms to deliver real-time operations management	● ●	●	● ●	● ● ●
Preventative and predictive maintenance	Connected equipment and maintenance solutions to reduce downtime and failures of critical equipment	● ●	●	● ● ●	● ● ●
Treatment process optimization	Water quality sensors combined with advanced algorithms to optimize the treatment processes	● ●	● ●	● ●	
Treated water and wastewater quality monitoring	Comprehensive real-time water monitoring and reporting solutions to support regulatory compliance	● ●	● ●	●	
Advanced water and wastewater treatment	A broad range of reliable treatment solutions including disinfection, oxidation, filtration, and biological treatment		●	●	
Wastewater and stormwater reuse	Integrated treatment to enable potable and non-potable reuse of wastewater and stormwater		●	●	
Maximize equipment efficiency	Intelligent pumping and mixing equipment adapts to conditions for maximum reliability and operations efficiency		● ●	● ●	
Stormwater management and flood relief	Comprehensive range of dewatering solutions for all stormwater and wastewater flood events			● ● ●	
Combined sewer overflow management	Intelligent equipment and real-time analytics to prepare for and prevent sewage and stormwater overflows			● ● ●	● ● ●
Reduce non-revenue water	In-situ and algorithmic solutions to identify, monitor, and address real and apparent water losses			●	● ● ●
Water and wastewater network management	In-situ and algorithmic solutions provide monitoring of network pressure, failures, and overall asset condition			● ● ●	● ● ●
Meter and billing management	Smart metering solutions to improve billing accuracy and enhance customer service				● ● ●

The Future of Xylem Smart Products and Services

Addressing the daily challenges of water management

In recent years Xylem has expanded its portfolio of solutions to become a leading provider of intelligent solutions that address the water industry's most persistent problems. Adding the Sensus, Pure Technologies, Emnet and Valor Water Analytics brands to our comprehensive portfolio of cutting-edge water and wastewater solutions has significantly strengthened the Company's smart infrastructure assessment and management capabilities. These advanced technologies and expertise enable Xylem to better partner with our customers to address their infrastructure pain points – NRW, aging infrastructure, operational efficiency, water conservation, and improved life-cycle costs – while significantly enhancing the economics of their water and wastewater operations.

The building blocks of Xylem's smart water future

Customers need a partner who can effectively assess and understand their unique challenges, and propose smart solutions that add value to their business in a safe and reliable manner. Collectively, Xylem's advanced infrastructure analytics capabilities allow us to be that vital partner and solutions provider, as well as a supplier of unmatched products and services.

Xylem's current and future success in smart water is built on four main pillars:

Our people – we have established dedicated teams within Xylem who use their expertise and passion towards developing the next generation of water technologies, leveraging disruptive technologies such as artificial intelligence, virtual reality, and mobile applications.

Our products – we continue to commercialize on a global scale a number of leading smart water technologies that are best in class in performance and total cost of ownership.

Our partners – we have long-established partnerships with a number of leading venture capital firms, and academic research institutions such as Massachusetts Institute of Technology and the IVL Swedish Environmental Research Institute to scout the next wave of technology.

Our customers – we continue to partner with our customers, such as the DC Water and Sewer Authority, to develop, pilot, and implement at scale our latest smart water technologies worldwide.

We see a bright future for our customers and partners as we continue to advance our ability to bring systems intelligence solutions to communities across the world. We stand ready to partner with water and wastewater managers worldwide as we look to a smart and resilient water future.

Case Studies

Thames Water smart network reduces water consumption by 13%. United Kingdom

The challenge:
Thames Water is the largest water and wastewater services provider in the UK serving 15 million customers across London and the Thames Valley, every day. It is forecast that by 2020, 133 million liters of water will be consumed daily by Thames Water customers, while by 2040, with a population increase of 2 million expected in London alone, that number will rise significantly to 414 million. As London and the South East of England are already severely water-stressed areas, the utility wished to prevent a predicted shortfall in water supply by investing in smart water technologies that would enhance the productivity of its operations.

The solution:
A smart network was installed, delivering comprehensive, accurate daily data reads across the entire network. This data helps Thames Water address water loss and identify supply issues such as continuous use which can indicate non-revenue water (NRW) or wastage. The smart network, based on actual usage, empowers Thames Water customers to more easily manage their water use.

The result:
The smart network delivered multiple benefits including: more equitable billing as customers only pay for what they use; prompt identification of issues as leaks and pipe ruptures can be located and remedied quickly; and an enhanced customer experience as pressure and temperature are monitored to give Thames Water a better understanding of the overall network performance. Above all, water meters have strengthened water conservation by enabling customers to better understand their water consumption via an online usage report. According to Thames Water a customer using a meter uses 13 percent less water.

Smart network saves $260 thousands of water losses to Borough of Monaco, PA. United States

The challenge:
The Borough of Monaca located just 25 miles northwest of Pittsburgh, in Pennsylvania, US, was operating a leak-prone, aging water system that required significant structural upgrade works as well as smart water technology that would help to increase productivity, minimize water loss, and improve billing accuracy.

The solution:
The Borough began by upgrading approximately 20,000 feet of water lines to prevent mains breaks and improve water quality and pressure. The town's water managers also decided to incorporate a smart network which involved replacing 2,438 water meters and deploying

a fixed base communication network with an advanced metering infrastructure (AMI) system.

The result:
The smart network delivered many benefits to the community including a more efficient and sustainable water supply network as well as significant cost savings. Within just eight days of being installed, the system's leak detection function helped water managers to discover that a landmark waterfall was in fact a long-standing rupture buried underground, and not a natural spring! With the leak spilling more than 200,000 gallons of water per day, the Borough had lost approximately 1.46 billion gallons of water over two decades.
Since the meters were installed through to 2026, the new water lines and smart network are expected to save the Borough $2.6 million by minimizing water loss and supporting more sustainable water use by customers.

Digital solution at Milan municipality finds and fixes previously undetected leaks. Italy

The challenge:
Metropolitana Milanese (MM) manages the integrated water services for the City of Milan, Italy, which has a network of over 1,430 miles of pipeline. The Assiano Linate Transmission main, a 48 inch steel transmission main situated in the heart of the city, was installed in 1982. When MM identified the main as a priority for inspection as part of an effort to reduce NRW, the task was not without its risks; a rupture would prove costly and disruptive to the city, and MM had no prior condition information on the main's integrity.

The solution:
A digital solution – a smart leak detection tool – was deployed to proactively assess a 5.5 mile section of the Assiano Linate Transmission main without the need to dig up large sections of the pipeline. The technology, a free-flowing leak detection platform that operates while the pipeline remains in service, was chosen to allow continuous operation of the networks served by the main. The digital solution is capable of completing long inspections in a single deployment and is equipped with an acoustic sensor that identifies acoustic anomalies associated with leaks and air pockets.

The result:
The digital solution identified 23 large leaks across the 5.5 mile section. Because the overall flow of the main is high, the leakage was undetectable with traditional metering equipment. In metallic pipe materials, a catastrophic failure is often preceded by a period of leakage, so identifying and repairing leaks can help to reduce water main failures. The inspection identified a targeted area for repairs and enabled MM to gain a better understanding of its condition and the factors that might be causing leakage.

Focused repair works will allow the utility to extend the life of the pipeline and reduce water loss, thus improving the overall service to its customers. The expected savings in water loss from repairing the leaks will pay back the costs of the project in approximately three years, including the cost of repair to the damaged section.

Smart water solution fulfills wastewater collection needs in Westland Municipality. Netherlands

The challenge:
The low-lying Westland province in the Netherlands is one of the most important regions in the world for greenhouse horticulture. In 1980, new regulations were introduced to enhance the sustainability of wastewater management in the area, including connecting horticulture operations to the municipal wastewater system. The success of the hybrid network relied on balancing the flow of household and industrial wastewater across its 2,500 pumping stations. In spite of buffers to capture the industrial wastewater, volatility in flow was putting the system under pressure and a solution was required to better manage demand across the network.

The solution:
A customized digital solution – a SCADA system – was developed to address this challenge. The solution enables operators to monitor and control pumping systems across the network, allowing them to coordinate discharge needs and better distribute flow. Any pump station failures are recorded and the data is used to support preventive maintenance.

The result:
Westland province's horticulture industry is now supported by a sustainable and reliable wastewater management system. The digital solution means that the network's operators have 24/7 visibility of its 2,500 pumping stations, with the capacity to monitor and control each station allowing them to effectively handle manmade and natural peak flows. Data from across the network is used to optimize the operation of all pumping stations and treatment plants, and to inform preventive maintenance.

By investing in its infrastructure, the province of Westland has permitted its horticultural industry to flourish and its economy to grow.

Industrial facility minimizes non-revenue water through real-time detection of pipe burst. Singapore

The challenge:
Singapore is one of the most water-stressed cities in the world and as such, addressing NRW is a top priority for water managers. An industrial facility water to several industrial consumers in Singapore was experiencing large-scale leakages as a consequence of pressure variations in the network. This was an unusual phenomenon given the network's steel pipelines were less than five years old and laid above ground. The operators were anxious to find a solution.

The solution:
A new digital solution was installed to collect real-time data about damaging pressure surges across the pipe network. Data from wireless pressure monitoring devices is automatically transmitted to, and analyzed within, a smart water platform using artificial intelligence. The solution enables the operators to detect burst pipes in real-time and identify areas at risk of leakage, as well as the source of pressure surges.

The result:
Large pressure surges were revealed to be a product of pump changeovers within the network and customer consumption activities. Armed with this insight, the network operator identified a series of interventions, including reducing the pump changeover frequency, utilizing speed controllers to slow down the intake valves' opening speed, and installing hydraulic accumulators to absorb consumption related surges.

The digital solution provides actionable information that allows the customer to identify problems and their causes, and stage appropriate interventions. The operators have been able to significantly reduce damaging pressure surges, thereby optimizing performance and extending pipe lifetime. Ultimately, the solution is supporting Singapore's goal of reducing water system losses.

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Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services settings. Xylem also provides a leading portfolio of smart metering, network technologies and advanced analytics solutions for water, electric and gas utilities. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xylem.com

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Xylem Europe GmbH

Bleicheplatz 6, 8200 Schaffhausen,
Switzerland
Tel +41(0)52.644.52.00
Fax +41(0)52.644.52.01
www.xylem.com