

WHITE PAPER

Intelligent water, realized. Five ways to get ahead of the flow with digital twins and AI

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Executive summary:

Water and wastewater utilities face urgent challenges—aging infrastructure, extreme weather, contaminants, and cyber threats—calling for “Intelligent Water” solutions. By using digital twins and hybrid edge-to-cloud technologies, leaders can bridge OT and IT systems, harness real-time data and AI, and transform operations for greater resilience, efficiency, and smarter decision-making. Real-world applications have demonstrated significant advantages, such as a 25% reduction in water loss and deferring \$20 million in capital expenditures through enhanced pressure management.

This white paper outlines a practical path for CIOs, CTOs, operations, and maintenance leaders to harness these tools, turning data into resilience, efficiency, and smart decisions.

The dawn of intelligent water

Water and wastewater utilities face unprecedented challenges—but also a once-in-a-generation opportunity.

Aging pipes, extreme weather, “forever chemical” contaminants, and even cyber threats require new thinking.¹ “Intelligent Water” means leveraging digital twins and hybrid edge-to-cloud technologies to drive the convergence of operational technology (OT) and information technology (IT) to create a unified single-pane-of-glass view of your entire water network. Effectively transforming operations through real-time insights and AI-driven decision-making.

The new reality: Pressures on water utilities

Water and wastewater utilities stand at a crossroads, confronting urgent financial, infrastructure, and operational challenges. Financing capital improvements now tops the list of concerns, with only 41% of utilities confident they can cover essential costs through rates and fees.² Nearly 20% of U.S. households carry overdue water bills, and millions struggle with affordability, putting additional pressure on utilities.¹

Aging infrastructure intensifies these challenges. U.S. water networks break a main every two minutes and lose almost 20% of treated water to leaks, costing billions each year.³ Climate extremes like droughts, floods, and wildfires increasingly threaten water supplies and quality, prompting nearly 68% of utilities to implement loss control programs.¹

Utilities also act to address expensive compliance with contaminants like PFAS and to reinforce cybersecurity, with three-quarters prioritizing robust defense.¹ The sector faces a looming workforce gap as a third of its employees approach retirement, making talent recruitment and retention critical.² These converging pressures force utilities to innovate, invest strategically, and adopt advanced technologies to secure resilient, efficient, and equitable water services for the future.

These pressures demand new strategies—doing more with less by working smarter.

By the numbers: Water and wastewater²

41%	Only 41% of utilities feel confident they can cover capital improvement costs through rates and fees
40%	The world is projected to face a 40% shortfall in freshwater availability by 2030 if current consumption and management practices continue
17%	Water utilities in the U.S. are facing national water loss rates exceeding 17% annually due to leaks, breakages, and system inefficiencies.
2x	Utilities are doubling their investments in green infrastructure and treatment technologies in the next 1-3 years.

Utilities are responding: Despite these challenges, utilities are taking proactive steps: many are set to double investments in technologies and green infrastructure over the next 1–3 years,² reflecting a commitment to sustainability and resilience. However, with persistent leaks and financial insecurity, traditional solutions are falling short—underscoring the urgent need for innovative approaches to ensure reliable future water supplies.

While SCADA systems are instrumental in managing water and wastewater operations, executives must now look beyond SCADA to emerging technologies such as digital twins, AI, and advanced data analytics to ensure their organizations are future-ready and capable of meeting the evolving demands of the industry.

The following sections explore how digital twins and hybrid edge-to-cloud solutions directly address these challenges, enabling a more intelligent, efficient, and sustainable water future.

Nearly one in five gallons of treated water – about 19.5% – never reaches customers due to leaks and losses. That’s roughly 6.7 billion gallons wasted each day, costing utilities \$6.4 billion annually in lost revenue.⁴

Intelligence that works for water

Digital twins: A virtual path to resilience

A digital twin is a living digital replica of physical water infrastructure, from treatment plants to pipeline networks. By integrating live sensor data, historical records, and predictive models, a digital twin provides a 360° view of operations in real time. Overlaying design data from engineering digital twins can bring unique insights and drive efficiency across operations and maintenance (O&M) strategies. By fostering a culture where trusted data is accessible and actionable, teams gain heightened situational awareness—empowering them to rapidly interpret critical information, anticipate challenges, and make informed decisions in real time.

The **Los Angeles Department of Water and Power (LADWP)**⁵ launched a “Water Information Network” project to use its vast data as a digital twin for 120+ operational use cases – from tracking pipeline integrity to managing reservoir levels under drought and flood conditions. This holistic approach is key to climate resiliency, allowing LADWP to proactively allocate water storage and monitor resources (like aquifer levels and aqueduct flows) in real time.

“We believe that data and data system integration is the key to achieve highly optimized workflow and truly realize a smart utility.” – Project Manager, LADWP

How digital twins tackle challenges: Digital twins enable water utilities to predict equipment failures, manage emergencies, and optimize resources efficiently. They aid compliance by simulating treatments and flagging assets for replacement, and also serve as safe virtual training tools, supporting resilient and sustainable operations amid aging infrastructure and climate risks.

Edge to cloud: Unifying IT and OT data, anywhere

Bridging the IT/OT divide is critical for digital transformation in water utilities. A fully integrated hybrid data infrastructure bridges the gap between traditionally siloed OT systems like SCADA, and IT systems such as analytics and business platforms. By securely integrating edge devices, on-premise operations and cloud-based data, organizations gain real-time visibility and predictive insights, streamline collaboration across all teams, and enable trusted partners to access relevant operational insights—all while maintaining robust security.

Data without borders

By adopting a hybrid architecture, Gwinnett County gave teams secure, universal access to operations data. Field crews, engineers, and managers now collaborate in real time, eliminating silos, and speeding decisions.

In practice, hybrid architectures break down data silos. For example, **Gwinnett County Department of Water Resources**⁶ developed a digital twin of its entire water network, centralizing data from six facilities and hundreds of assets, and bridging the IT/OT divide. Using AVEVA solutions, staff at all levels can access real-time information from any device, improving coordination and efficiency. This unified approach increased clean water delivery by 20%, identified inefficiencies, and saved 120 million gallons and \$35,000 annually by quickly fixing leaks. Cloud connectivity empowered every team member, ensuring reliable supply for over one million residents. “Now we have a solution that people at all levels can access... from anywhere,” said Gwinnett’s SCADA manager, underscoring how cloud connectivity and collaboration empowered every role.

Other utilities echo these benefits. The **Ontario Clean Water Agency (OCWA)**⁷, which manages dozens of facilities across a vast region, implemented a

standardized cloud-connected solution to simplify operations. Adding a new plant or customer connection now takes hours instead of days, thanks to centrally managed systems.

Meanwhile, at LADWP, integrating disparate sources (SCADA, maintenance databases, GIS mapping, even billing data) into a centralized AVEVA™ PI System™ data management solution has vastly improved oversight of their 7,000-mile pipeline network. This single source of truth provides enterprise-wide visibility and enables real-time alerts—a critical feature when you have to ensure dam safety or respond to a main break immediately. And by making data accessible through intuitive AVEVA™ PI Vision™ dashboards, LADWP ensures that everyone can get the information they need 24/7, rather than waiting on phone calls or outdated reports.

These results are not just for the big players. In Tennessee, the **White House Utility District (WHUD)**⁸ deployed the AVEVA PI System alongside GIS and within just 3.5 days pinpointed a massive hidden leak (147 million gallons per year) that was draining its system. Fixing that one leak saved WHUD over \$300,000 annually and helped them defer \$20 million in planned capital projects. Demonstrating how a well-implemented data infrastructure allows utilities of any size to do more with less – finding inefficiencies, protecting assets, and innovating faster using data they already collect. This cultural shift towards data-driven decision-making has resulted in modernized operations that are more agile, transparent and customer-centric.

Roslagsvatten⁹, a Swedish water utility, faced challenges with fragmented operations across its five municipalities. Disparate legacy systems made it difficult to access timely information for asset management and decision-making. Their strategic vision focused on open, layered digital solutions that allowed them to own their data and avoid vendor lock-in. The AVEVA PI System was crucial as the real-time data layer for visualizing contextualized, well-maintained data, empowering employees to make faster, informed decisions. AVEVA™ System Platform provides a unified SCADA layer, integrating diverse systems and leveraging template-based components for reusability. While AVEVA™ Asset Information Management streamlined documentation and puts critical asset information in the hands of the people who need it – when they need it. The transformation reduced handover costs by 40% and offered up to 20% savings in potential energy and operating expenses, advancing sustainability and operational efficiency.

Key takeaway: Hybrid data management and IT/OT integration lay the foundation for industrial intelligence. By enabling seamless data flow, edge-plant-cloud hybrid infrastructure solutions eliminate longstanding barriers between teams, allowing everyone from operators to executives to view and act on the same information. This unified access boosts daily efficiency and responsiveness to incidents, creating a secure foundation for organizations to leverage advanced analytics and AI-driven decision-making.

A trusted operations data management approach

The AVEVA PI System portfolio is the leading real-time data backbone for water utilities of all sizes, centralizing sensor, control, and business data into a unified, reliable source. With its no code, out-of-the-box capabilities, PI System is highly scalable and adaptable from on-prem to cloud. This enables utilities to build digital twins, gain operational insights, and foster collaboration across teams—so you can realize value from day one.

The AVEVA PI Data Infrastructure represents an innovative evolution, offering integrated, hybrid data management from edge-to-plant-to-cloud. With this flexibility, utilities orchestrate data effortlessly across analytics layers and AI platforms, enhancing decision-making and performance. PI Data Infrastructure also expands remote connectivity, allowing access to critical data from diverse assets and sites, which can be securely shared among operators, engineers, and stakeholders.

This trusted foundation bridges OT and IT, turning complex data streams into actionable intelligence for optimizing treatment, distribution, and asset management. In essence, AVEVA PI Data Infrastructure empowers utilities to make informed decisions, improve safety, and drive operational excellence across their organizations.

AI and Industrial Intelligence: From data to decisions

AI and advanced analytics enable predictive insights, optimizing asset performance, and supporting data-driven decisions that enhance resilience and service reliability. Industrial Intelligence means applying analytics—from simple dashboards to advanced machine learning algorithms—on unified data to uncover patterns, predict events, and prescribe optimal actions. Water utilities are leveraging these tools to solve problems proactively and automatically, delivering big gains in efficiency and reliability.

Consider these real-world use cases:

- **San Jose Water (California)**¹⁰ analyzed pump performance data across dozens of stations to reduce energy costs. By using AVEVA's analytics to run pumps during off-peak power hours, they saved \$143,000 in electricity annually and cut carbon emissions by 206 tons per year. Crucially, San Jose moved from reactive fixes to condition-based maintenance, preventing pump failures before they happen. The project paid for itself in under one year (ROI < 12 months).
- **Colorado Springs Utilities (Colorado)**¹¹ integrated water quality lab data with live operational data to enable proactive quality control. Instead of waiting weeks for reports, staff now get results in 15 minutes, allowing immediate adjustments to maintain compliance. By automating data collection and alerts, they also cut manual effort—overtime dropped 58% and driving to remote sites fell by 30%, improving safety and costs.
- **City of Salem (Oregon)**¹² transformed its water operations after a harmful green algae bloom in a water reservoir threatened drinking water quality. CONNECT enables City of Salem to consolidate diverse sources of information—such as algae levels, water depth, weather data, turbidity, satellite imagery and laboratory samples—into a unified, cloud-based platform. Combined with

the AVEVA PI System, this comprehensive data aggregation supports advanced analytics and machine learning, empowering the City and its trusted partners—such as the local University—to forecast harmful algae blooms and proactively prevent cyanotoxins from adversely affecting water quality.

- **EPCOR (Canada)**¹³ enabled dynamic management of Edmonton's stormwater systems during flood events by combining real-time data with geospatial data. Enhanced situational awareness and data context empowered EPCOR to discover process interdependencies and improve operational performance – cutting response times from days to minutes. Improved collaboration between teams also helps ensure public safety, avoid environmental releases and saves thousands in regulatory fines.

These examples barely scratch the surface. Armed with AI, utilities can balance water distribution in real time, optimize chemical usage, identify leaks, detect equipment anomalies, and even automate routine decisions. The Los Angeles DWP plans to deploy AI to automate water treatment adjustments – making manual sampling “a thing of the past” and ensuring optimal water quality continuously. In wastewater operations, advanced process control is anticipating variability (like surges in ammonia at South Platte Renew, CO¹⁴) and adjusting aeration blowers on the fly, yielding a 30% energy reduction while meeting strict environmental targets.

Bottom line: Data by itself has limited value – it is the insights and actions derived from that data that create real value. By combining contextualized data with AI and analytics, water executives can shift from firefighting to foresight. Problems that once blindsided operations (pump failures, regulatory breaches, inefficient energy use) can now be predicted and averted. The result is greater reliability, safety, and cost-effectiveness – exactly what stakeholders and communities demand.

Industrial intelligence in the cloud

CONNECT is a secure, vendor-neutral, cloud-native platform that brings together industrial data, applications, and users—enabling water and wastewater utilities to accelerate digital transformation without starting from scratch. Built to support rapid deployment, CONNECT offers:

- Pre-configured templates through the Industry Accelerator for water, including predictive insights, dashboards for asset performance, energy and water loss optimization.
- Scalable architecture that integrates with existing systems and grows with your utility's needs.
- Real-time access to operational data from anywhere, empowering teams to collaborate and respond faster.
- Contextual insights from visualizing your data and applying AI to improve operations.
- Secure data management with built-in governance and cybersecurity features.

Whether you're launching a digital twin, centralizing operations, or applying AI to improve reliability, CONNECT helps utilities get going quickly—with proven tools and industrial intelligence designed for the water sector.

Roadmap: Five practical steps to realizing intelligent water

Digital twins, hybrid architecture, and AI can each deliver value independently—but when combined, they offer utility leaders a powerful framework: contextual insight from digital twins, seamless data access via hybrid architecture, and intelligent decision-making through AI—driving smarter, more resilient operations.

Ready to embark on your own transformation? **Here's how water leaders can put these concepts into practice** in five manageable steps:

Step 1: Unify and visualize your data

First, bring together all your operational and business information—whether it's data from SCADA systems, IoT sensors, GIS maps, asset databases, or customer billing. AVEVA PI System serves as a powerful starting point, easily consolidating disparate sources into a single, real-time data management hub. This unified view instantly reveals inefficiencies and opportunities, providing the foundation for smarter decisions. With AVEVA Unified Operations Center, you can visualize key performance indicators on customizable dashboards, enabling faster response and improved collaboration across teams. Most importantly, these open solutions can be implemented without costly system overhauls, as they are designed to integrate seamlessly with your current infrastructure and prior investments.

Step 2: Start small with off-the-shelf solutions

Choose a focused, high-impact area to start—such as leak detection, energy usage, or asset performance. Deploy AVEVA's preconfigured templates and Industry Accelerator for water in CONNECT to create a digital twin of your plant or network segment, with minimal setup and no need for complex custom coding. Ready-to-deploy use cases include smart water leak detection, mains break prediction, predicted water demand forecasting, pump performance and energy optimization, flow equalization and UV optimization. These ready-made solutions allow you to simulate real-world scenarios, monitor assets in real time, and quickly identify quick wins. Early results—such as reduced energy costs or improved water quality—build trust and momentum for wider transformation.

Step 3: Bridge IT/OT and empower your teams

Integrate your operational technology (OT) with enterprise IT analytics using CONNECT, AVEVA's secure industrial intelligence platform. This approach ensures data flows smoothly from remote sites and field devices to decision-makers on any device, anywhere. CONNECT's role-based data visualizations and built-in governance make it easy for field crews, operators, managers, and even trusted third parties to access the right information, collaborate in real time, and act confidently on shared insights. By automating data collection and reporting, your teams spend less time wrangling spreadsheets and more time delivering value.

Step 4: Accelerate insights with analytics and AI

Leverage AVEVA's analytics and machine learning tools to turn your unified data into actionable intelligence. Start with simple rule-based alerts for anomalies—like sudden pressure drops or pump vibration spikes—and then evolve to predictive models for maintenance, energy optimization, and compliance. AVEVA Asset Information Management and AVEVA PI Vision make advanced analytics results accessible to all staff, empowering everyone to contribute insights. Because these tools are designed for ease of use, operators can explain, adjust, and trust AI recommendations, driving broad adoption and improved outcomes.

Step 5: Scale up and sustain value

Once your initial phase proves its worth, use AVEVA's modular solutions to expand digital twins, analytics, and dashboards across other plants, assets, or entire regions. Prioritize based on business goals — whether it's minimizing energy costs, improving water quality, or enhancing customer service. Continue upskilling your workforce through AVEVA's training resources and foster a culture of innovation by capturing best practices and institutional knowledge in your digital systems. Regularly review outcomes, refresh your roadmap, and celebrate wins to maintain support and keep evolving.

- Start small, learn fast: AVEVA's off-the-shelf products and templates let any utility deploy powerful solutions with minimal IT overhead.
- Scale confidently: Modular architecture and robust cybersecurity features ensure you can grow and adapt as needs change.
- Achieve tangible value: From operational savings to improved compliance and customer service, intelligent water delivers real-world impact.

By following these steps—and leveraging AVEVA's proven technologies—water leaders of any size can transform their operations, unlock new insights, and build a future-ready organization. The technology is ready, the benefits are proven, and the journey is more accessible than ever.

5 simple steps to realizing intelligent water



5. Scale up and sustain
Expand digital solutions across the organization and maintain long-term value



4. Accelerate insights
Utilize analytics and AI to transform data into actionable intelligence



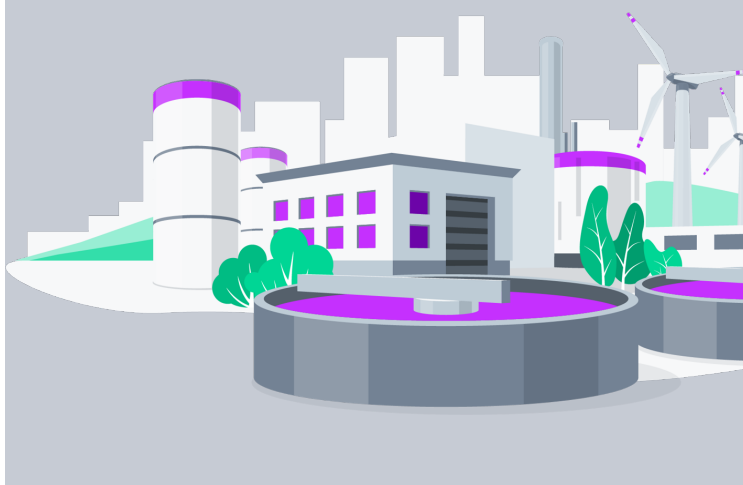
3. Bridge IT/OT
Integrate operational technology with analytics for seamless data flow



2. Start small and iterate
Deploy preconfigured solutions to test and validate digital transformation benefits



1. Unify your data
Consolidate diverse data sources into a single hub for real-time insights





Conclusion

For today's water utility leaders, the message is clear: digital transformation is not just possible—it's essential. Whether it's financial savings, water conservation, risk reduction, or service improvement, the intelligence gained by bridging IT/OT and applying analytics translates into real-world impact. Importantly, these successes involve the whole organization—technology and people together. By harnessing integrated data, digital twins, and AI-driven analytics, you can unlock operational efficiency, increase resilience, and safeguard your community's most precious resource long into the future. Now is the time to lead boldly, setting your utility apart as an innovator in a rapidly evolving industry. The tools are proven, the benefits substantial—the next move is yours.

About the author

Fiona Stratton is the Senior Industry Marketing Manager for Critical Infrastructure at AVEVA. With over 18 years of industry experience, Fiona is a passionate advocate for digital transformation and the role of technology in delivering a better, more sustainable quality of life for all. Fiona's expertise spans across various facets of marketing and infrastructure, making her a key player in driving innovative solutions and strategies within the industry.

For more information, please contact your local representative or visit: <https://www.aveva.com/en/industries/infrastructure/water-wastewater/>

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