

Digital Twins

Transforming stormwater
and flood management

 AUTODESK





Contents

01 Digital twins: What are they and why do you need one?

SWAN's way

Consult your digital partner

Building blocks of digital twins

Team building

The human element

02 Twin peaks: How digital twins are transforming storm and flood management

Planning

Design

Operations and maintenance

Joined-up thinking in action

03 Digital twins: Application and use cases

City of Fayetteville

Scottish Canals

InfoWorks ICM and Info360 Asset

Western Virginia Water Authority

GHD

Hinekōrako

Johnson County Wastewater

04 Conclusion: Low risk, high accuracy modeling & simulation for an unpredictable world

01

Digital twins: What are they and why do you need one?

Part 01

Digital twins are set to transform the end-to-end planning and operations of water infrastructure.

The technology is already delivering transformative value in many industries, including construction, manufacturing, and engineering. Civil engineers and water industry professionals are increasingly adopting their own digital twins, helping them to improve stormwater and flood management from rainfall to treatment plant.

SWAN's way

SWAN, the Smart Water Networks Forum, describes digital twins as:



A dynamic digital representation of real-world entity(s) and their behaviors, using models with static and dynamic data that enable insights and interactions to drive actionable and improved outcomes.



Consult your digital partner

With a digital twin as your virtual partner, you can create value throughout the asset and water lifecycle, from planning and design, through operations and maintenance. You can work with sophisticated simulations, using machine learning and AI to apply advanced analytics to tasks such as real-time monitoring of combined sewer overflows, helping to protect communities and optimize operational performance.

Benefits of digital twin

Unify data sources and overcome operational silos, driving organizational change.

Connect planning to operations for better decision making, with a holistic, real-time view of your asset performance.

Test and validate your professional instincts with real-time, dynamic insights for decision support.

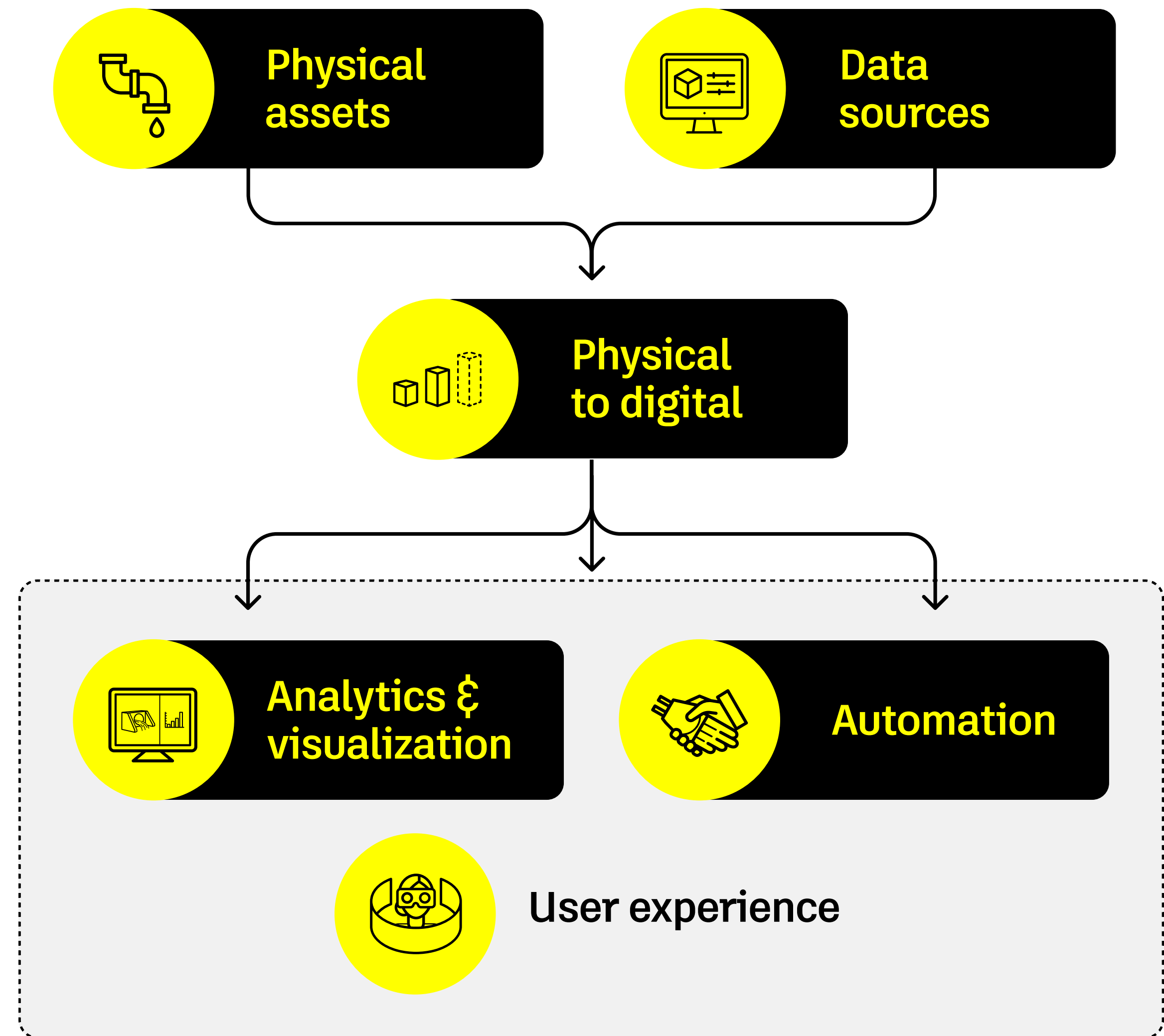
Build clear, robust business cases to secure budgets and accelerate approvals processes.

Serve customers better, with responsive, proactive management and maintenance.

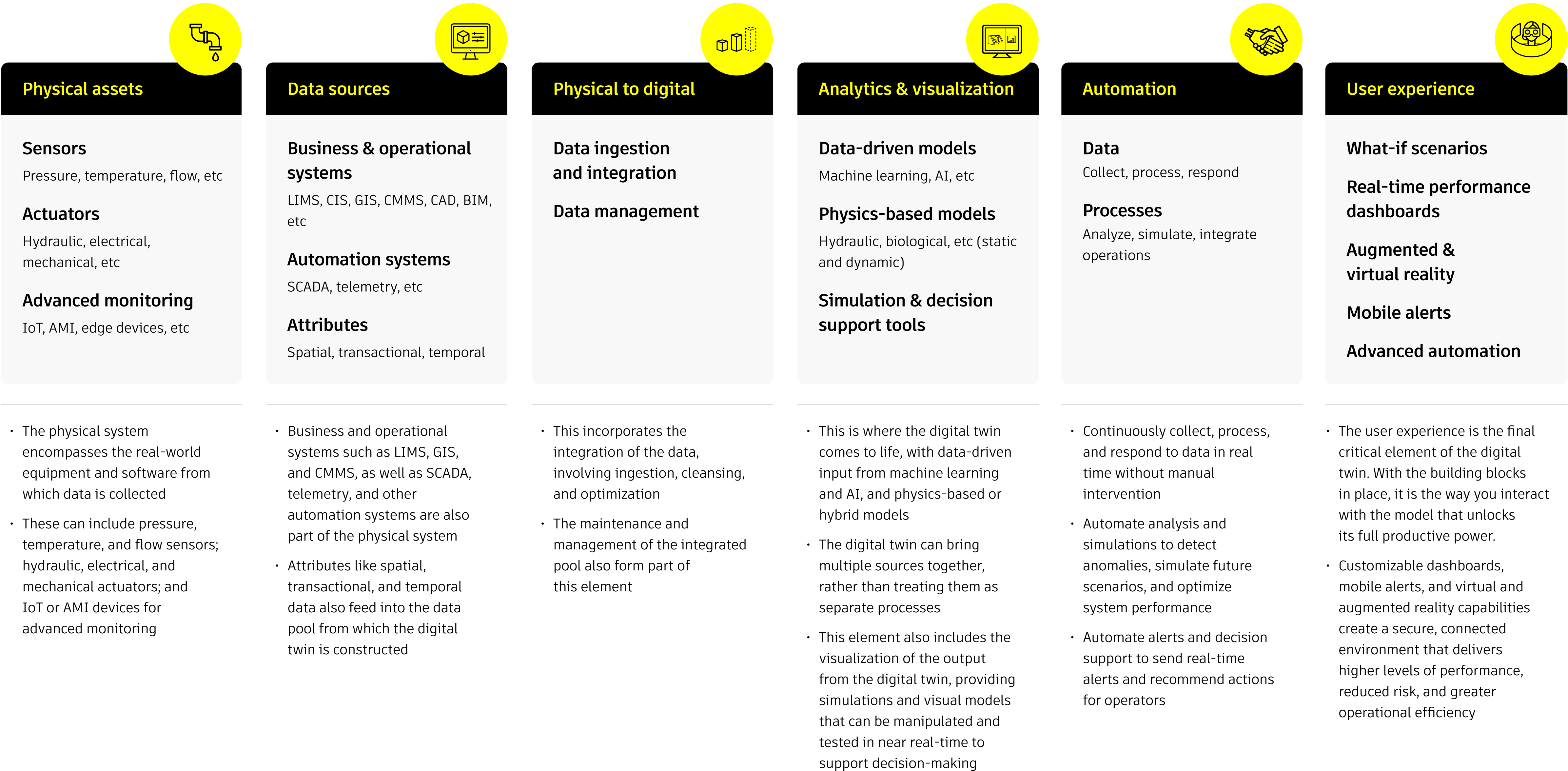
Building blocks of digital twins

A digital twin is not a single application. It is made from many elements, bringing together multiple applications and data sources. Breaking down these digital silos brings wider organizational benefits as well as overcoming technological barriers, because it calls for the buy-in of a diverse group of stakeholders. As a result, implementing a digital twin can have a transformative, unifying impact on an organization, extending far beyond the technology itself.

Note that creating a digital twin does not necessarily require all the components shown opposite. Digital twins only need the data sources and analytics relevant to their specific functions.



The building blocks of digital twins



Team building

Having worked together to contribute data sources to the pool, the teams involved in creating the digital twin can all benefit from the insights and simulations it provides. Operations teams, engineers, consultants, and all other specialist functions can create the dashboards and specify the outputs they need.

The digital twin opportunity



By using data, you can be proactive, rather than reactive. Think about it: You wouldn't call your utility unless something was wrong. But what if they actually called you and said, 'Hey, your water usage pattern doesn't look right. Can you go check?' That brings opportunities, as it not only improves customer experience and customer satisfaction, but it also helps the utility control water loss and champion sustainability.



Janice Lusco, National Discipline Lead,
Business Advisory Practice at Arcadis

The increasing pressures on aging infrastructure, the shortage of skilled labor, rising operating costs, and a multitude of other challenges are placing digital twins at the forefront of innovation in the industry. A digital twin deployment enables faster and better-informed decisions, and strategies that drive improved operational efficiency, greater resilience, and a better customer experience.

The human element

Most water utilities are still in the earlier stage of digital twin adoption. Advancing in your digital twin adoption journey requires input from subject matter experts and experienced operators who bring a deeper, more nuanced understanding of the data, models, and analytics. As utility teams get better at using these sophisticated analytical tools, they will be able to predict maintenance needs, optimize resource allocation, and improve overall system performance.

Moving through the digital twin adoption journey helps to build trust within the teams using the technology. As they gain confidence in the data, the value of using advanced analytics in managing and improving operational efficiency becomes clear.

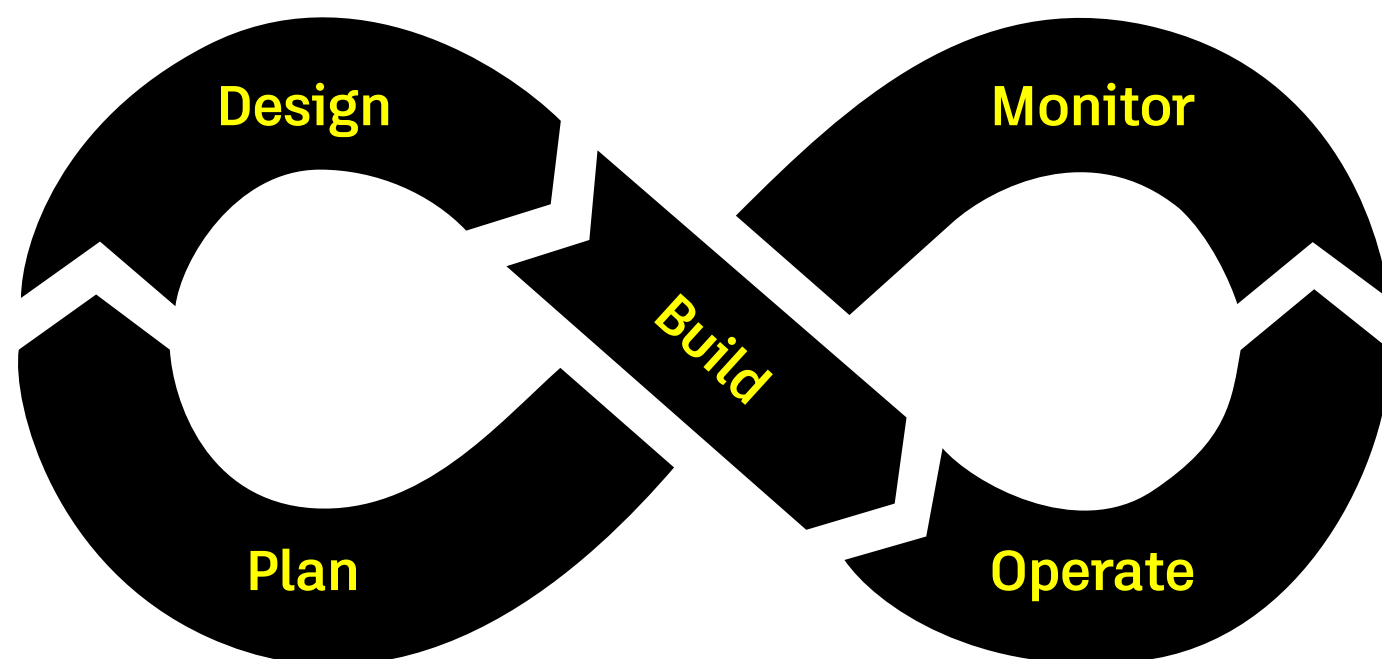


02

Twin peaks: How digital twins are transforming storm and flood management

Water industry professionals are already working with digital twins. They are using them to combine water models with real-time data and predictive analytics, so they can forecast storm behavior, and detect and resolve issues before they escalate.

Digital twins offer powerful, connected insights that support every stage of water management from *planning* and *design* to *operations and maintenance* (O&M), enabling smarter, faster, and more resilient decision-making across the full lifecycle of water infrastructure.



Planning

Digital twin technology offers live data analysis alongside historical trends. Real-time data analysis enables teams to assess risks, prioritize safety, and allocate resources efficiently, enabling workflows associated with performance, compliance, and improvement planning. Every preventive measure can be supported with up-to-date insights that enhance decision-making and reduce the risk of errors.

- **Early prediction of storm impacts**

What-if scenarios run in hydraulic models can be used to visualize where floods will occur in multiple conditions, helping to pinpoint vulnerable areas, and allowing the implementation of targeted interventions to improve resiliency for upcoming rainfalls

- **Optimizing field schedules**

Forecast data helps planners organize fieldwork during low-flow periods. Crews can work in safer, more manageable conditions, reducing risk and helping to improve productivity.

- **Maximizing resource use**

Digital twins can show where equipment and manpower will deliver the greatest impact, enabling teams to deploy resources directly to areas with the most need

Design

The comprehensive, real-time data that feeds a digital twin, including SCADA, GIS, and meteorological data, enables rich simulations of real storm events. Multiple scenarios can be tested in a risk-free environment, so that professionals can design to the most rigorous and effective standards.

- **Selecting materials and configurations**

Engineers and operations teams can experiment with a variety of pipe materials and layouts, to find the configurations that offer the greatest durability and cost efficiency before committing to any purchases

- **Enhancing system resilience**

Digital twin simulations can provide the closest possible models of drainage system performance under heavy flows. Teams can design with confidence for the real-world stresses of extreme weather events, minimizing the risk of overflow activations and flooding.

- **Integrating smart controls**

Unifying data silos simplifies the integration of sensors and control systems into the holistic digital twin model. The deeper insights allow the specification and installation of systems that are optimized for the dynamic conditions they will face.

Operations and maintenance

Proactive maintenance and real-time monitoring need reliable, smooth-running systems. Digital twin technology can provide immediate visual feedback through configurable dashboards, enabling teams to spot and fix issues before they turn into major failures. Risk assessments can be based on failure models incorporating asset details, condition data, work history, and proximity to spatial locations or GIS layer attributes.

- **Resolving issues quickly**

Teams can compare live sensor data with model predictions to detect deviations such as blockages, sediment buildup, or structural wear. They can address these issues immediately to prevent further damage, and protect communities from the impact of failures.

- **Scheduling proactive maintenance**

Live data allows teams to plan maintenance based on real-world conditions. Closer management of sanitary sewer networks, and user-defined network assets, helps to minimize the need for emergency repairs, while reducing costs, and extending asset life.

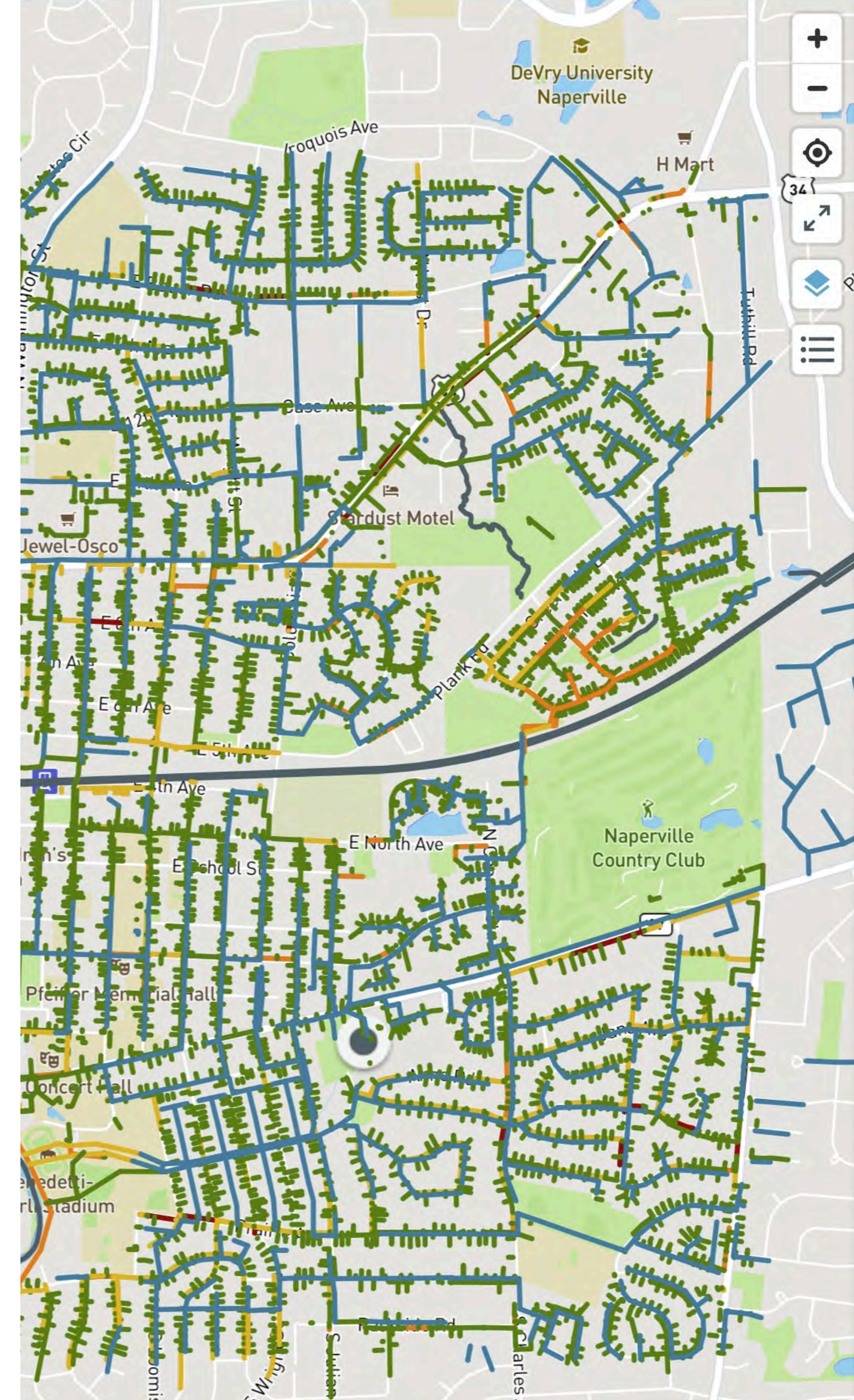
- **Enhancing safety and efficiency**

Digital twins can give crews the flexibility to adjust field operations on the fly. Accurate, real-time insights allow pumping schedules aligned with the true conditions, reducing risk for workers and keeping operations efficient and secure.

Joined-up thinking in action

Digital twin technology fosters a joined-up approach across planning, design, and operations. For instance, hydraulic models of stormwater can be directly integrated with asset performance dashboards. This allows operational teams to monitor how drainage systems are responding under different weather conditions and adjust maintenance schedules accordingly.

Engineers and operations teams can make timely, better-informed decisions, working with clear, actionable insights from their digital twins. They can plan and prioritize capital investments more accurately, and allocate resources more effectively. At the same time, they can ensure regulatory compliance, and deliver reliable and sustainable services for the communities they serve.



03

Digital twins: Application and use cases

City of Fayetteville: Taking on climate change with digital twins

After four major storms in successive years, the City of Fayetteville, North Carolina, set up an urgent program of city-wide stormwater improvement. Insights from digital twins helped to prioritize tasks, secure the necessary project funding, and deliver substantial capital and operational savings.

Elements of digital twin employed

Physical assets

- Comprehensive survey of stormwater assets, including city-owned and maintained assets, drainage on state rights-of-way, and outfalls on private property

Data sources

- Citizen flood alerts and in-house local knowledge quantified and captured
- ‘Worst-first’ planning, evaluating, scoring, and ranking sub-basins to prioritize work that could be started quickly

Physical to digital

- Unification of files in diverse formats, including Excel and shapefile, into a uniform ESRI geodatabase
- 1D and 2D models unified with InfoWorks ICM, enabling visualization of inundation and depth from 2-year to 100-year storms

Analytics & visualization

Successful business case developed to show:

- 100-year flood plain reduced by 136 acres
- Three-and-a-half miles of impacted lane length eliminated
- More than 144 structures prevented from flooding

[Read full story](#)

Solution and key benefits

Autodesk InfoWorks ICM enabled the Fayetteville team to unify previously isolated models and gain deeper insights into the effects of flooding across the city.

- **200 proposed solutions** in four watersheds delivered in Phase 1
- **\$25M benefit** in flood risk and property damage reduction

Featured product



[Learn more](#) →

Scottish Canals: Turning Glasgow into a sponge city

The 38-mile waterway in North Glasgow managed by Scottish Canals is a thriving natural ecosystem and a focal point for urban regeneration. But with increasing pressure from extreme weather and unpredictable rainfall, the challenge has been to balance recreational water levels with emergency storage needs, all while complying with regulatory requirements.

Elements of digital twin employed

Physical assets

- Sluices, watercourses, and natural and constructed ponds and features

Data sources

- Water quality, flow, and level data
- Live and forecast weather data from the UK Met Office

Physical to digital

- Unification of data into an integrated control system
- Hydrological modeling, setting levels to accommodate the predicted runoff
- Hydraulic modeling, using monitored flows and levels

Analytics & visualization

- Modeling optimum sluice positions at three discharge points
- Modeling recommended timings for activation

Automation

- Integrated SCADA system issues commands to site PLCs when drawdown is required

[Read full story](#)

Solution and key benefits

Scottish Canals implemented a digital twin solution using Autodesk InfoWorks ICM and ICMLive, to ensure effective, adaptive flood management along the entire canal.

- 110 hectares of land unlocked for investment, regeneration, and development
- Up to 55,000 m³ of natural storage, with safe, regulated restoration post-storm
- 5,000 tons of capital carbon avoided, with 500 tons eliminated annually

Featured products



[Learn more](#) →



[Learn more](#) →

InfoWorks ICM and Info360 Asset: Streamline planning for better asset management

Connecting planning to operations and maintenance through digital solutions delivers more visibility and accurate decision making. You can benefit from this integration through bringing hydraulic models built in Autodesk InfoWorks ICM into Info360 Asset, enabling asset managers to use digital twins in the assessment of system capacity issues. Digital twins can be used to evaluate Likelihood of Failure (LoF) and Consequences of Failure (CoF), and to help identify critical storm durations that impact the sewer and drainage network.

This joined-up, data-driven approach enables better risk analysis and helps prioritize capital investment planning more effectively, focusing on areas with the highest risk and potential impact.

Learn more


Solution and key benefits

- Identify areas with a higher consequence of failure if surcharging or flooding is anticipated
- Use digital twins to help prioritize areas for investment
- Use return period data to assess the likelihood of pipe surcharge and manhole flooding

Featured products

 InfoWorks ICM

Learn more →

 Info360 Asset

Learn more →

Western Virginia Water Authority: Making management software work for everyone

Western Virginia Water Authority has an Asset Management Program covering around 1,000 miles of wastewater infrastructure, serving over 200,000 people in a region about 240 miles southwest of Washington DC. Having implemented new asset management software, the next key step was to introduce quality control for the acquisition and maintenance of data across the networks.

Elements of digital twin employed

Physical assets

- Geometric and physical characteristics of assets—GPS surveys, manhole surveys, CCTV surveys

Data sources

- Repair work orders, as-built drawings, development plans

Physical to digital

- Flow monitoring, hydraulic modeling, capacity report

Analytics & visualization

- Scheduling of proactive inspection work, including acoustic monitoring, CCTV, smoke tests, and manhole surveys.
- Recommendation and scheduling of interventions such as pipe cleans, chemical root treatment, and pipe and manhole renewals



In our system, there is no bad project. Over the years, we have developed analytics using the InfoAsset data to quickly identify areas of concern and come up with solutions. I like to keep things simple, understandable and defensible. If I feel that I wouldn't be able to explain a methodology to a Roman engineer from 2,000 years ago, I'm over-complicating matters.



Jim O'Dowd, PE, AECOM

[Read full story](#)

Solution and key benefits

The Western Virginia team uses InfoAsset Manager for asset management and work ordering and InfoWorks ICM sewer hydraulic modeling. The integration of these two softwares provides support for key business objectives, such as overflow mitigation, reduction of inflow and infiltration, as well as the creation of defensible capital improvement and maintenance plans.

- **Descriptive and diagnostic** analytics for data mining, showing what happened and why
- **Predictive and prescriptive** analytics help anticipate issues and recommend remedies
- **Timely** recording of blockages and overflows, as well as interventions such as pipe cleans and repairs

Featured products



[Learn more](#) →



[Learn more](#) →

GHD: Unifying GIS and CCTV for Aqua America

Aqua Pennsylvania provides water and wastewater services to 32 counties across Pennsylvania and operates more than 50 wastewater systems. With an aging infrastructure, they turned to GHD to help unify the high volumes of GIS and CCTV data needed for their pipe rehabilitation and Capital Improvement Planning (CIP) programs.

Elements of digital twin employed

Physical assets

- Pipe attributes

Data sources

- GIS, CCTV footage, inspection data

Physical to digital

- Integration of Esri GIS data with Info360 Asset
- Customized dashboards and web maps updated with results direct from Info360 Asset

Analytics & visualization

- Decision trees, organizing assets “according to condition, risk, cost-based analysis and other attributes
- LoF drawing on asset age, material, or current condition
- CoF including public health, environmental, or economic consequences
- Tabular and spatial reporting formats



Autodesk and Esri are bringing the pieces of the puzzle together, providing my clients with powerful tools and collaborative interfaces to analyze the important data needed for making informed decisions about the assets they manage.



Todd Plank, GHD Associate

[Read full story](#)

Solution and key benefits

GHD implemented Esri's ArcGIS Online platform, integrated with Autodesk Info360 Asset. The solution enables users with little experience of GIS set up risk models and decision trees, and to generate results.

- Cloud storage and management enables close **team collaboration** and integrated workflows, with maximum data visibility and accessibility
- Management of high volumes of CCTV inspection data, for **risk assessment** and proactive, prioritized sewer **rehabilitation planning**
- Deploy integrated CCTV and GIS data for **capital improvement planning** at state, regional, and local level

Featured product



Info360 Asset

[Learn more](#) →

Hinekōrako: A web-based portal for near real-time tracking of water quality

Hinekōrako (it means ‘lunar rainbow’), is a web-based portal established by New Zealand’s water regulator. It enables water providers to report their compliance, facilitates data sharing between laboratories, and offers citizens transparency in water quality records.

Elements of digital twin employed

Data sources

- Raw data from various sources, such as laboratory results and sensors

Analytics & visualization

- User-built analytics embed your compliance rules into an automated data process
- View results in digital workspaces and output to your reports
- Use Info360 Plant to generate compliance scores or values
- Track water quality compliance and dig down into specific historical analytics

Info360 Plant helps water professionals to generate accurate compliance reports with ease, making electronic submission more efficient. Even where providers are still required to use conventional spreadsheet formats, Info360 Plant helps to enhance data accessibility, and enables real-time process improvements.

[Read full story](#)

Solution and key benefits

The portal relies on Info360 Plant to help standardize and unify data from diverse sources, including field reports, giving users near real-time insight into processes and infrastructure status.

- Automation allows **compliant** processing of raw data, tracking water quality in real-time and alerting instances of non-compliance
- Analysis of historical data allows past performance data to inform predictive analytics and enable **operational efficiencies**
- **Unification of data** avoids internal silos and duplicated effort, as well as streamlining version control and audit processes

Featured product



[Learn more](#) →

Johnson County Wastewater: Bringing BIM into digital twins

Johnson County Wastewater serves more than half a million residents across its fast-growing suburban communities. Increasingly fragmented paper-based and digital workflows made it difficult to operate and maintain the utility's diverse network of treatment facilities and assets. There was an urgent need to improve tracking of maintenance schedules, ensure operational efficiency, and optimize return on investment for asset upgrade projects.

Elements of digital twin employed

Physical assets

- Wastewater treatment facilities, pump stations, clarifiers

Data sources

- Revit BIM models
- Azure IoT sensor data

Physical to digital

- Standardized data import via reusable templates, classification systems, and attribute mapping

Analytics & visualization

- Real-time dashboards integrated with Power BI
- Spatial data aggregation
- Model-based predictive analytics

Automation

- Integration with CMMS systems for efficient maintenance execution



Tandem creates a foundation for continued innovation, where we can create and deliver a better product. We can set up clients like Johnson County Wastewater to add value across their operations, with more and new information.



Brian Melton, Technology Innovation Lead,
Black & Veatch

[Read full story](#)

Solution and key benefits

Johnson County partnered with Black & Veatch for its digital transformation journey, implementing a digital twin solution powered by Autodesk Tandem.

This initiative unified design, operations, and maintenance data, enabling a real-time, integrated view of the entire wastewater network.

- Consolidation of BIM data, enabling **enhanced asset tracking** and **predictive maintenance** for critical infrastructure
- **Reduced downtime** through targeted visualization of valves, pumps, and other components
- **Improved collaboration and training** to extend value and benefits to more staff

Featured product



[Learn more](#) →

04

**Conclusion:
Low risk, high
accuracy modeling
and simulation for an
unpredictable world**

Part 04

Right now, the last thing the water industry needs is risky innovation. Economic and political uncertainty are combining with extreme climate events to heighten risk across the board in stormwater and flood engineering and operations management. If new tools are to be adopted, they must be proven and readily adaptable to the specialist needs of storm and flood management professionals.

Digital twins are both proven and adaptable. They are widely used in other engineering sectors and, as our case studies show, they are already achieving remarkable results in some of the most challenging environments around the world.

Focused adoption

The first move towards adoption need not be on a dauntingly grand scale. Many organizations are implementing digital twins in highly specialized areas, where smaller pools of data are sufficient for the creation of a viable and valuable digital twin. Overflow activations, localized flooding, new developments and other specific tasks can all benefit from digital twins that do not require input from across the entire organization in order to function.

Securing the future

To realize the full benefit of digital twins, it is essential to tie data analytics to your organization's strategic goals. When these analytics align with long-term objectives, the full operational, financial, and cultural benefits begin to flow.

We can help you get started with your digital twin.

[Talk to us](#)



Autodesk technologies deliver versatile, scalable digital twins

InfoWorks ICM

Integrated catchment modeling solution used by stormwater and wastewater professionals to plan, design, and manage capacity improvements, network operations, and emergency weather scenarios such as flooding. It provides a collaborative space for the modeling of hydraulic and hydrologic network elements quickly and accurately, locally or in the cloud.

[Learn more](#)

Info360 Asset

Cloud-based application for condition and performance monitoring and assessment. It delivers connected assets together with historic and current inspections, in an easy-to-use, easy-to-access web application. Asset intervention plans can be based on simple or complex decision queries by using asset, condition, and risk data, and supporting external data.

[Learn more](#)

ICMLive

Live modeling solution that integrates with InfoWorks ICM to create an operational digital twin. It combines hydraulic models, SCADA histories, GIS data, and weather forecast databases to predict real-time network performance, providing advanced flood warnings and enabling actions to prevent flooding and sewer overflow events.

[Learn more](#)

Info360 Plant

Cloud-based operational analytics solution within the Info360 platform, designed specifically for water and wastewater treatment plants. It helps to improve real-time data analysis, and to enable workflows for performance, compliance, and improvement planning.

[Learn more](#)

InfoAsset Manager

Comprehensive asset management suite that helps integrate, manage, and optimize wastewater assets. It provides robust visualization, reporting, and risk-based prioritization capabilities to support operational decisions, proactive maintenance, and efficient emergency response.

[Learn more](#)

Tandem

Creates a data-rich digital twin that connects facility data with an accurate virtual model, allowing operators to monitor and optimize system performance in near real-time. Tandem supports collaboration across teams and provides actionable insights to improve asset management, reduce downtime, and enhance operational efficiency in wastewater facilities.

[Learn more](#)