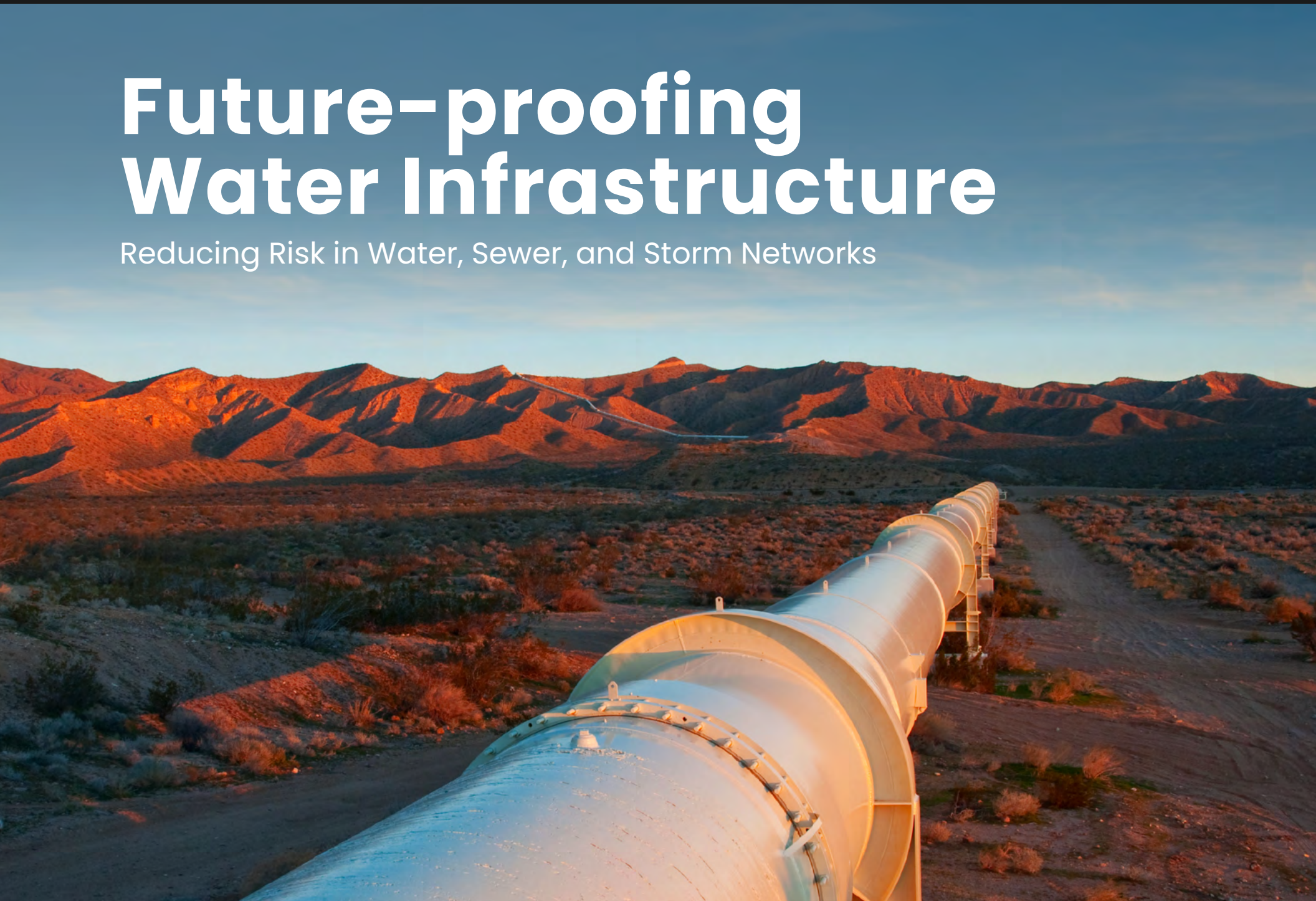
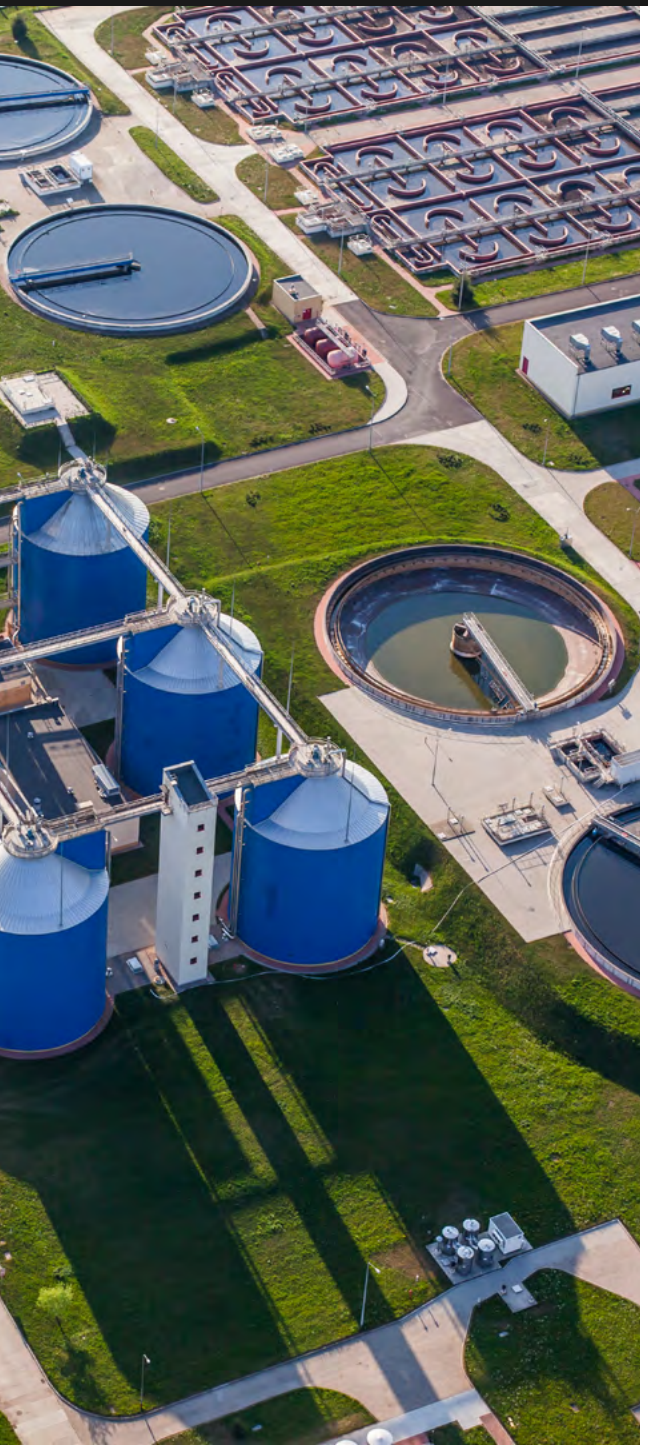
Future-proofing Water Infrastructure

Reducing Risk in Water, Sewer, and Storm Networks





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Designing for the future

Without water, our homes, cities, communities, and way of life would not exist as we know them. Maintaining clean, reliable water supplies—and the safe management of wastewater and stormwater—have been essential for human life from the earliest days of history. It would be hard to think of a more critical responsibility.

Today, the engineers tasked with the management of our water, wastewater, and stormwater systems must cope with aging infrastructure, extreme climate events, increasing regulations, and the expectations of ever-higher levels of quality and service.

But it is also difficult to think of another time when our water, sewer, and storm networks were under such pressure, or when the risks that they faced were so varied and complex.

At the same time, they must accommodate rising costs, act swiftly to prevent and address service disruptions, meet stringent regulatory requirements, and reduce the carbon footprint.

These pressures present a formidable task, and reducing risk is a major part of meeting it—the risk of old systems failing under the strain, of major weather events overwhelming storm networks, of water quality dropping below legal requirements, and of costs spiraling out of control.

Bentley's water, sewer, and storm network engineering solutions are designed to meet the critical business needs of infrastructure engineers, providing actionable insights so they can effectively plan, design, and operate water, wastewater, and stormwater infrastructure.

Water engineering professionals can use our solutions to plan and design smarter systems, predict demands more accurately, and modernize processes, improving outcomes and managing risk and compliance across the entire infrastructure lifecycle for years to come.

In this e-book, we will highlight our suite of solutions, their capabilities, the challenges they address, and the opportunities they present to water utilities and engineers to design reliable and resilient water, sewer, and storm networks that are risk-proof and ready for the future.

Smart infrastructure solutions

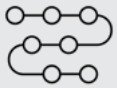
Together, Bentley solutions can help your engineering teams:

Plan, design, and analyze new water, sewer, and storm networks faster and more accurately.

Establish a complete and comprehensive picture of existing conditions to mitigate risk.

Create strategies to improve emergency response and mitigate the risk of catastrophic events.

Transform into a digitally proficient organization by integrating and leveraging data to make better decisions.



Be better prepared, and plan more effectively, for the increasing demands of a rising population.

Predict and solve network problems and make better decisions for maintaining aging infrastructure.

Drivers of change

Shaping the future of the water industry

- **The shift to digital and AI.** AI is becoming a crucial risk-reducing ally in areas, such as predicting demand, detecting leaks, water quality monitoring, optimizing operations, and overall improving infrastructure resilience. Adoption is increasing across the industry. Organizations are applying AI abilities across the full scale of their operations, from boosting productivity by automating repetitive tasks to implementing a full digital twin of their facilities for more accurate analysis.
- **The rising impact of climate change and energy transition.** Extreme weather events are pushing water infrastructure to its limits, necessitating upgrades and operational efficiencies. Older, combined sewer systems run a greater risk of overflows in wet weather conditions, creating environmental and public health risks. Emergency planning is becoming more complex. Meanwhile, the transition of the water sector to sustainable and efficient energy use is a complicated and long-term journey.
- **Rapid urbanization and population growth.** Expanding cities are driving up the need for more extensive water and drainage networks, treatment facilities, and environmental protection. By 2050, 68% of the world's population is expected to live in a city, compared to 55% today. Water infrastructure engineers will need to demonstrate exceptional innovation and problem-solving skills to address the increasing demands for water and sanitation services cost-effectively. Water utilities must also take a closer look at their operations and future strategies that advance water equity.
- **A push for resiliency and sustainability.** Water utilities must be able to survive the stresses of climate events, which are testing networks far more frequently than past predictions have suggested. Existing infrastructure will need to be adapted and strengthened. Future planning will have to take the increased frequency of such events into account, but also ensure that water is supplied sustainably, without impacting future generations.

Around 60% of utilities are actively pursuing digital transformation projects.*

Many critical water infrastructure assets are nearing the end of their service and are prone to breaks and collapses.

At Bentley, we specialize in providing purpose-built solutions to design, build, and operate more efficient and resilient infrastructure.

Professionals can factor in risk and regulatory considerations during the delivery phase of new water infrastructure and stay compliant during the performance phase of their assets.

*The 2023 Global Water Intelligence Report

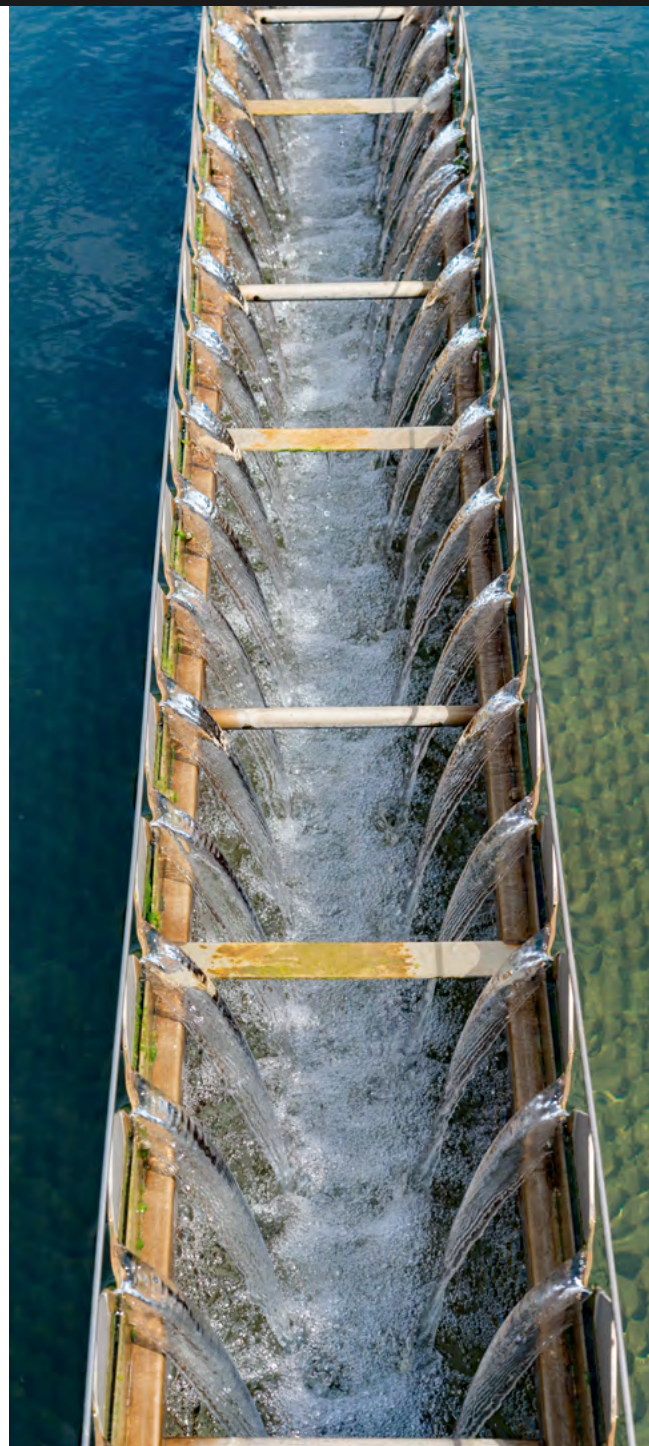
Water networks

Keeping water supplies flowing is a serious responsibility that is complicated by multiple challenges. Advanced hydraulic analysis software can help engineers design better networks, improve their performance, and prepare for the future with more confidence—while reducing costs.

Water supply networks have a ssimple, yet vital, purpose—to deliver safe and reliable water to people and industries. But behind that plainly stated task sits a complex, hydraulically engineered system with a vast number of connections buried deep underground, as well as a unique set of challenges.

The management of all these systems will reside with water utilities, whose responsibilities span the planning and designing of sustainable water distribution through to its operation and maintenance. Their end goal is to deliver a safe, robust, reliable, and affordable service, ensuring water security.

There are key hurdles to overcome to reach that goal, but comprehensive hydraulic analysis software can make a major contribution, supporting water network providers to optimize system performance. Interoperable and AI-enabled, these solutions facilitate seamless data sharing across design engineering and operations teams, providing a clearer picture of the network and helping identify weaknesses that need to be addressed. Most importantly, they help engineers analyze and understand system hydraulic behavior so they can make better decisions and that improve performance, reduce costs, aid more effective maintenance, and mitigate risks.



Five challenges water networks face

1. **Hydraulic performance optimization.** Water distribution systems must supply high quality water at adequate pressure—cost-effectively—and meet water demand, including fire flow requirements. At the same time, water networks must also be designed to perform under emergency and extreme conditions. The hydraulic analysis calculations needed to achieve this level of optimization, while controlling costs, require efficient analysis and problem solving.

2. **Water hammer.** The hydraulic shocks that surge through a system when the water flow stops or changes direction must be reduced to avoid damage to pipes. Such damage can be immediate, such as the rupturing or collapse of a pipe, or long term, contributing to the shortening of the system's lifetime. Aging networks—and that will include many across the world—can be especially at risk.

3. **Water quality** must be maintained. As water quality regulations continue to evolve and become more stringent, the risks associated with a drop in quality can be considerable—from public safety to penalties and long-term reputational damage.

4. **Identifying and reducing water losses.** Lost water means lost revenue, as replacing it comes with additional supply, energy, and treatment costs. Therefore, leaks must be identified quickly to enable fast remedial action and prevent the problem from worsening.

5. **Controlling energy costs.** Optimizing pump performance and minimizing energy costs will play a key part in supporting water utilities to work more efficiently and profitably. The complex interconnectedness of a water network must be considered to ensure that a reduction in pumping in one area does not lead to issues in another.

How Bentley solutions can help

Bentley offers a reliable and interoperable hydraulic analysis solution with AI-enabled optimization capabilities. It is specifically designed to help organizations, and their engineering and operation teams, easily understand the behavior of their water distribution systems, make better decisions, mitigate risks, and meet growing population needs.

Our software empowers agile and optimized water system design and assists the water sector in its move to a digital future.

Bentley's Water Network Engineering solution supports digital processes by helping engineering teams at utilities and consulting firms plan, design, and analyze sustainable water systems, as well as solve both everyday and long-term engineering challenges in operations and maintenance.

Bentley's Water Network Engineering solution

OpenFlows™ Water, part of Bentley's Water Network Engineering solution, is intuitive, hydraulic modeling software used by thousands of engineers to improve the design and understanding of their water distribution network. It helps them create the best designs and extract the maximum performance from their systems—balancing capital cost, energy use and reliability—to achieve a capable, high-quality, resilient network.

With it, you can perform multiple hydraulic modeling scenarios using alternative data sets to simulate the system under a variety of what-if conditions, including different demands, master planning horizons, operational strategies, or possible designs. In master planning, you can easily configure model runs to include only assets that will be in service in a selected year. This enables you to predict and solve problems in the existing network system, and better plan and implement rehabilitation strategies and expansions beyond it.

OpenFlows Water embraces operation and maintenance, such as improving pump modeling or analyzing water quality, while also enabling more informed and agile decision-making, ready to anticipate and meet population demands.

Mitigate risks, better prepare for failures and critical events, detect leaks and decrease non-revenue water faster, and become more confident that your system fully complies with regulations.

Transient pressures can cause catastrophic damage to pipes and equipment, endanger operators, introduce dangerous contaminants into the system, and interrupt service to customers. With OpenFlows Water, engineers can use water hammer and hydraulic analysis software to identify, manage, and lessen the risks associated with transients.

Key benefits

Bentley's Water Network Engineering solution can help engineering teams:

Reduce design and operational costs

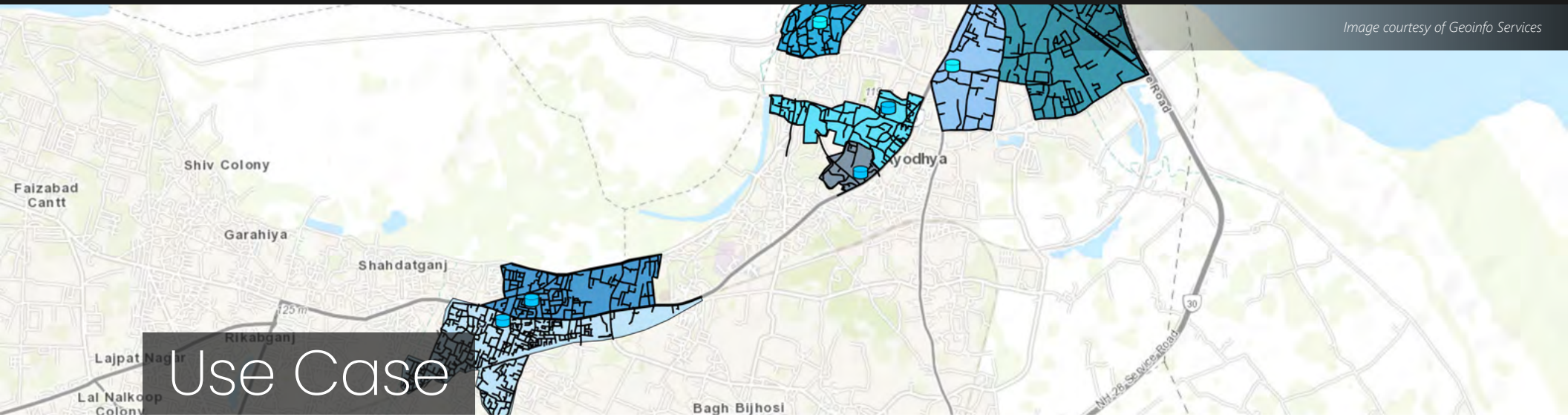
- Give engineers a better and more detailed understanding of their system and its challenges.
- Make it easier to analyze and optimize network design to deliver the best performance at the most economic cost.
- Integrate and analyze a range of data to gain the insights that support effective maintenance and capital plans.

Achieve better business outcomes and ROI

- Plan more efficiently and cost-effectively for growing population demands.
- Lower cost and risk.
- Reduce water losses.
- Control energy costs.

Be compliant and mitigate risk

- Ensure a safe, high-quality water supply for customers and meet regulations.
- Improve network monitoring and identify critical points in the system to protect facilities and assets.
- Reduce the risk of catastrophic pipe failure and failure in supply.



Designing a 24/7 pressurized water network to provide clean reliable drinking water

The objective

In Ayodha, one of India's most sacred pilgrimage sites, there was an urgent need for a sustainable solution to clean water provision for a population that sometimes reached 24 million. An urban pressurized water supply system was essential to replace the existing, and failing, gravity-fed network.

The challenge

Conventional, constant speed pumps would mean high energy consumption and cost. Variable frequency drive pumps would be more economic to serve a population that varied in size throughout the year. But the haphazard layout of the existing system, as well as the almost total lack of legacy data, made planning the new network and deciding how best to implement the pumps hugely challenging.

The solution

Geoinfo Services, tasked to carry out the analysis, discovered that traditional software could not cope with a system of more than 400 pipes, or carry out scenario modelling that could incorporate the constantly shifting number of pilgrims. They turned to OpenFlows Water to create 3D models of the city's 24-hour supply, as it could allow for an unlimited number of pipes and calculate the variable frequency drive pumps necessary to deliver the right pressure at the right time. As a result, Geoinfo Services was able to save USD 1.5 million in annual operating costs, while eliminating 347 tons of carbon emissions.

Sewer networks

Climate change is just one of many issues pushing sewer systems to their limits and beyond. But there are ways to improve their resilience and performance under extreme conditions and reduce the risk of their failure.

Growing populations, expanding cities, and climate change are all placing pressure on our sewage networks. Shifting climate conditions are making it more difficult to manage stormwater—an issue complicated by older networks and combined sewer systems. Communities now expect a higher quality of service. Regulations also are becoming stricter, and environmental goals more demanding.

Through all the challenges, it is the responsibility of utilities to ensure that sewer networks manage the transportation and storage of wastewater safely and reliably, however challenging the circumstances.

Sewer engineering projects must ensure their designs are optimized to handle sewage capacity, prevent overflows, and deliver it to wastewater treatment plants (WWTPs). Accurate calculations are critical if these systems are to work correctly and avoid the danger of WWTPs becoming overloaded.

But smart and efficient sewer network design, aided by the right hydraulic analysis software, can play a major part in combating these problems. For example, it can eliminate the need for additional pumping stations, thereby bringing down maintenance, energy and staff costs.

A well-optimized design can also mitigate environmental impacts and health risks. Perceptive analysis can help you to understand the flaws of aging networks, account for them, and extend their lifetime. Rapid, easy sharing and integration of data can support teams to make the right decision, at the right time, whether that be for a here-and-now problem, or planning for the long term.

Five challenges sewer networks face

1. **Planning, designing and analyzing sewer networks.** There is a need to meet growing population demands and the increasing pressures they place on the system. As systems expand, hydraulic analysis calculations become more complex and must integrate the entire system.
2. **Optimizing design for capacity and overflow prevention.** Operators must ensure collection systems can provide sufficient capacity so that all wastewater reaches its destination without overflows.
3. **Managing combined sewers and stormwater.** Optimal management means analyzing, understanding, and addressing the challenges that aging infrastructure can bring. With this insight, you can ensure that the system performs under emergencies and extreme conditions.
4. **Regulatory compliance and environmental goals.** Networks must stay compliant with the increasing regulation around the treatment, overflows, and stormwater discharge of WWTPs.
5. **Energy and cost efficiency.** To meet both budgetary and environmental targets, sewer networks must reduce the need for energy as much as possible.

How Bentley solutions can help

Bentley's comprehensive hydraulic analysis software provides wastewater engineers with simulation, modeling, and operational software that can help them tackle all these challenges.

Bentley's Sewer Network Engineering solution enables engineers to efficiently design and analyze new sewers, expand existing sewer and stormwater systems to meet future population growth, renew aging or problematic wastewater infrastructure, or perform comprehensive analysis of all aspects of stormwater systems to ensure regulatory compliance.

AI-enabled and automated features make the analysis of gravity flow, overflows, flow splits/diversions, pump stations, and pressurized force mains quicker and easier.

These enhancements lead to better project delivery and system performance, and a sewer network less exposed to risk.

Bentley’s Sewer Network Engineering solution

OpenFlows Sewer, part of Bentley’s Sewer Network Engineering solution, is a comprehensive hydraulic analysis application that enables engineers to design and analyze sanitary, stormwater, and combined sewer systems using built-in hydraulic and hydrologic capabilities. These detailed insights into your sewer and storm systems will support swifter, more accurate, and more informed decision making.

With OpenFlows Sewer, you can complete comprehensive analysis of all aspects of sewer and storm systems. Implement strategies for design, operations, sanitary loading, and network topology. Create steady-state simulations, including peak flow, as well as long-term continuous simulations. Integrate data across multiple platforms with the power of real-time SCADA analysis.

Sewer network engineers can use it to analyze gravity flow, overflows, flow splits/diversions, pump stations, and force mains with various dry-weather and wet-weather calculation methods. They can compare solutions with automated gravity system design and scenario management capabilities. OpenFlows Sewer also provides an easy-to-use environment for designing and analyzing stormwater systems, including inlet capture and bypass flows, gutters, detention facilities, open channels, and culverts.

Key benefits

Bentley's Sewer Network Engineering solution can help engineering teams:

Reduce design and operational costs

- Design optimized networks that can extract the maximum performance for the minimum cost.
- Simulate system performance to predict problems and act quickly to reduce operational costs.
- Design cost-effective system expansions and rehabilitation strategies.
- Predict and meet the demands of a growing population to deliver a resilient system that remains within budget.
- Plan and prepare your system for future growth or network changes (for example, water reuse).

Achieve better business outcomes and ROI

- Reduce design, operational, and maintenance costs.
- Identify accurate and cost-effective pipe size, diameters, and invert elevations while avoiding unnecessary pipe trench excavation.
- Improve decision-making and predict problems within the system before they happen.

Be compliant and mitigate risk

- Conduct easy model management and remediation analysis with unlimited scenarios.
- Handle a range of dry and wet weather conditions to predict different solutions, and how those solutions might perform under extreme conditions.
- Understand surface flooding depth and velocity, as well as flood hazards.
- Simulate and test alternative designs, such as WWTP capacity, and alternative routes to other WWTPs or retention tanks.
- Deliver the robust, high-performing and compliant sewer network local regulations demand.

Use Case

Modeling the Aburra Valley sewerage system to increase flood resilience and mitigate climate change

The objective

The rapid growth of Medellin's Aburra Valley in Columbia led to an increase of municipal run off into the Medellin River. A comprehensive evaluation of the sewerage system was required to help protect water sources, reduce environmental impact, and ensure optimal wastewater management for the community.

The challenge

To model 56 basins and nearly 3,000 kilometers of pipeline, and to understand the hydraulic performance of the network. Topological data—including spillways, discharges, and more—also needed to be incorporated.

The solution

Due to the complexity of the project, Columbia's multiutility public services company EPM concluded that only a digital platform could fully visualize the system and enable accurate decisions for future investments. EPM chose Bentley's OpenFlows Sewer to synchronize data obtained from the information system, captured in the field, and collected from meters, mobile sensors, and weather radar. With this data, they created the hydraulic model and simulated a range of dry and wet weather scenarios, for five-, 10-, and 25-year return periods, building in 10- and 30-year projected population growth. As result, EPM achieved their final sustainable strategy, and saved 17,640 work hours through digitization.

Storm networks

Managing stormwater is vital to prevent flooding and protect lives and property. Designing networks that can mitigate that risk—even under the most challenging conditions—is therefore a complex but critically important task.

Floods can wreak catastrophic damage to homes, communities, and businesses. Modern collection systems will have separate facilities to handle sewage and stormwater independently. But old networks in many cities will be combined, posing significant management and operational problems.

There is an increased risk that treatment plants can be overwhelmed, leading to the release of untreated sewage into the environment.

However, even the most capable, modern stormwater system is finding itself challenged by today's extreme weather. Heavy rain events that might have been predicted to materialize once every 100 or even 200 years are returning in five, 10, or 20. These return periods are putting pressure on cities and utilities to rethink stormwater management and system design. New approaches, such as "green-blue" initiatives and nature-based solutions, are gaining popularity, with more utilities working to divert and reuse stormwater. Factoring them into storm network designs is only going to become more important.

The answer to these challenges lies in the creation of an informed, resilient, well-planned, and cost-effective storm network. Bentley offers advanced hydraulic and hydrologic analysis software that can help storm network managers and designers address these challenges. It can simulate a network's performance under extreme conditions—and improve it—while also diminishing risk and reducing costs.

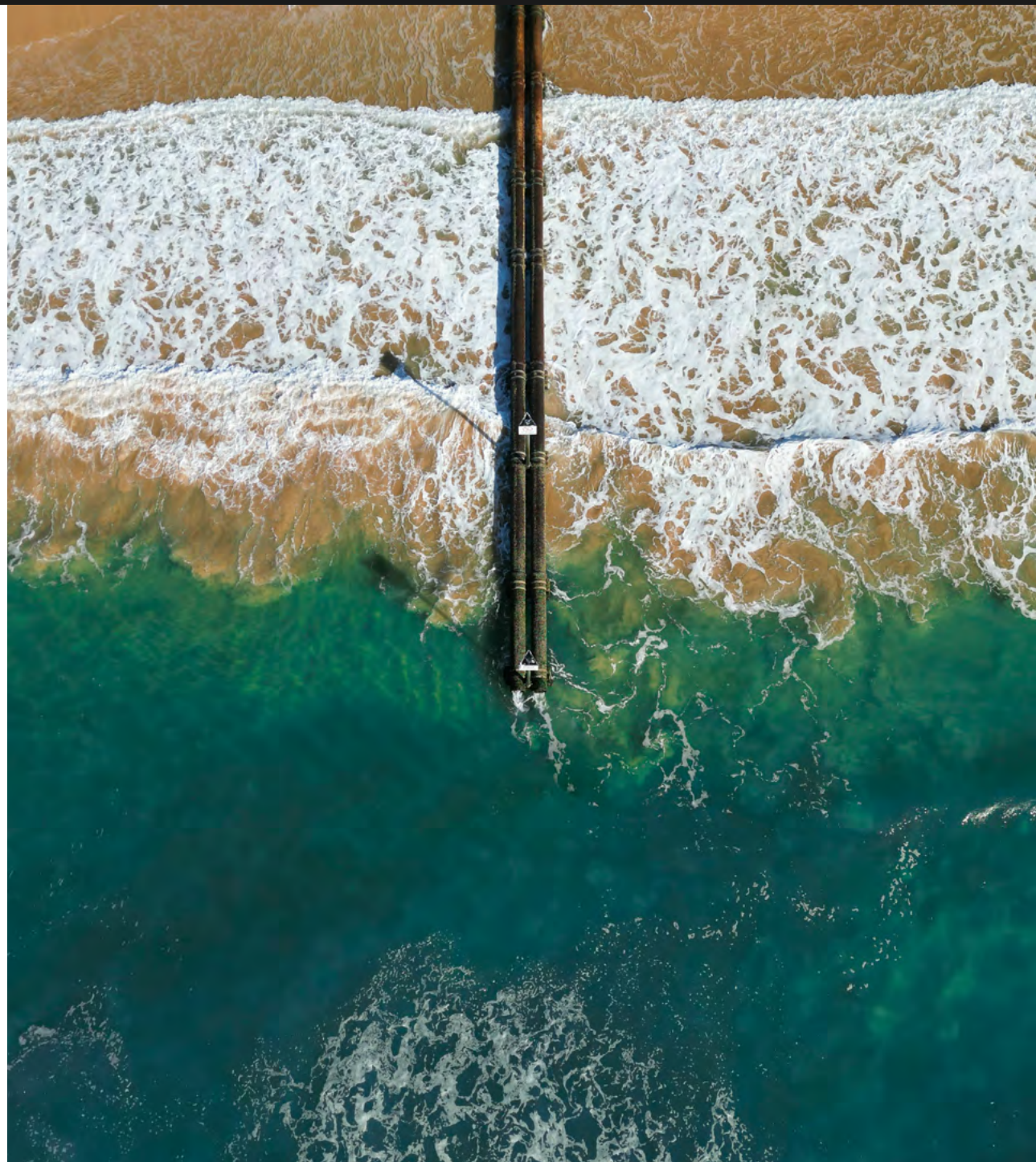
Five challenges storm networks face

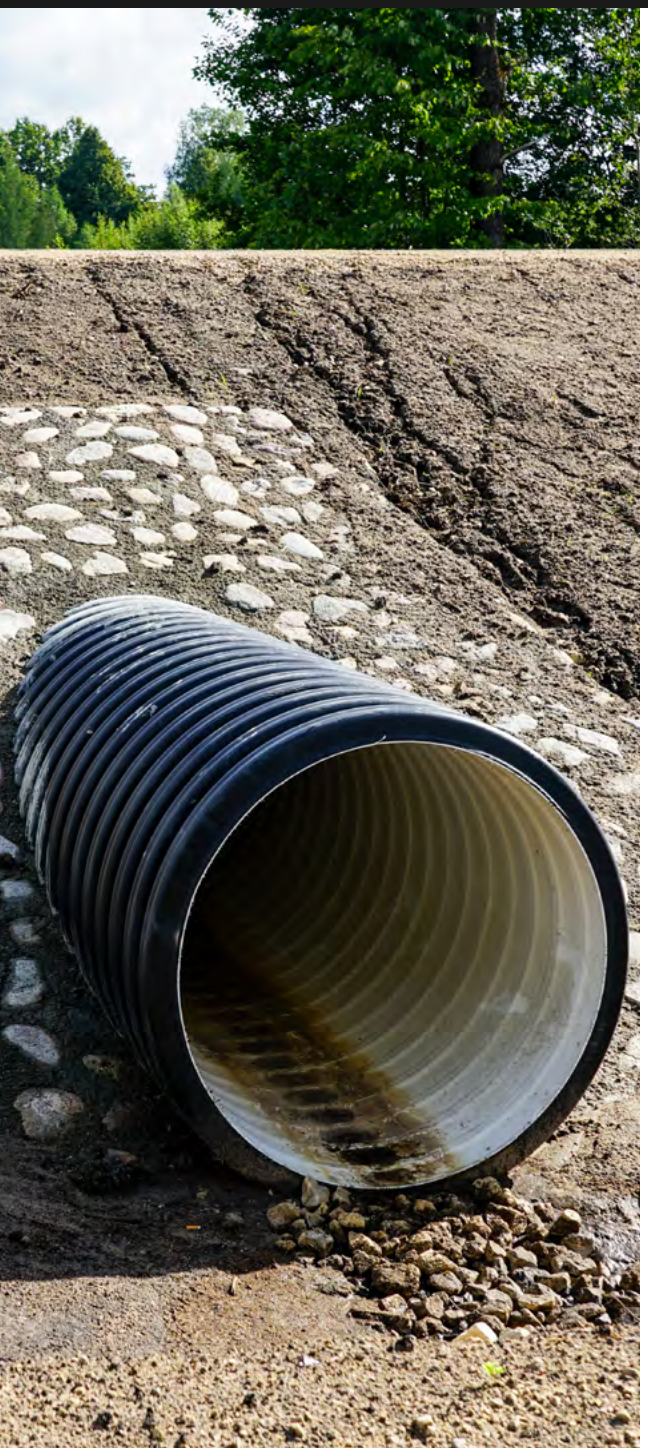
1. **Managing extreme rainfall events to minimize stormwater flooding.** Extreme rainfall events with a return period of 100 years or higher are occurring more frequently than networks are prepared for—often much more frequently.
2. **Implementing effective stormwater infrastructure control strategies.** New strategies are required to deal with this greater, climate-driven stormwater risk. Collection systems are expected to accommodate an ever wider set of rainfall scenarios. Analyzing performance and being confident systems can endure such stress—or adapting them so they can—is crucial.
3. **Ensuring regulatory compliance and meeting environmental goals.** Regulations around water quality and reuse are increasing. Meanwhile, tougher environmental goals are becoming a familiar part of a utility's business plan.
4. **Integrating green infrastructure.** New collection systems need to consider green infrastructure to manage extreme rainfall and mitigate flood impact.
5. **Minimizing capital investments.** Any new strategy for stormwater control must still sit within budget constraints. Smart, cost-effective design and construction are critical for minimizing capital spend.

How Bentley solutions can help

Bentley's multiplatform hydraulic and hydrologic modeling solution has been developed for the accurate analysis and design of any type of stormwater system. It is the leading software for such networks.

Bentley's Storm Network Engineering solution helps engineers improve workflow efficiency and optimize system design, so reducing stormwater flooding risk while minimizing the capital investment required. It also enables them to design faster and more efficiently, reduce errors, and save time and costs.





Bentley's Storm Network Engineering solution

By predicting emergency scenarios and simulating them during the modeling phase, OpenFlows Storm, part of Bentley's Storm Network Engineering solution, can help your network be better prepared for extreme events, increasing its resilience and long-term durability. Its easy integration with OpenRoads™ Designer allows transportation professionals to consider storm runoff in critical infrastructure, such as roads and bridges.

Stormwater engineers can use Bentley's software to model rainfall and runoff for urban catchments, inlet capture and bypass flows, gravity storm sewers, pressure piping, 2D surface flows, ponds, outlet structures, open channels, and culverts.

- Detect system bottlenecks and improve capacity
- Determine the best option for sewer overflow controls to reduce floods and construction and operational costs
- Easily manage models with scenario management and 1D solver options
- Easily integrate data across multiple platforms
- Model complex pond outlets for a variety of tailwater conditions

Key benefits

Bentley's Storm Network Engineering solution can help engineering teams:

Reduce design costs

- Design high-quality stormwater systems with minimal capital investments.
- Design cost-effective pipe sizes and invert elevations.
- Optimize the design, size and location of sewers, channels, ponds and more, ensuring low-impact development.
- Determine project quantities for construction budgeting and better project management.

Achieve better business outcomes and ROI

- Reduce floods and mitigate flood impact.
- Improve emergency response times.
- Deliver better network resilience with more predictive maintenance.
- Decrease WWTP overflows and storm gate openings, with a resulting reduction of environmental impact.

Be compliant and mitigate risk

- Limit stormwater flooding and comply with regulations.
- Perform remediation analysis for a variety of system conditions.
- Perform critical storm analysis.
- Simulate green infrastructure to reduce floods and environmental impacts, supporting the overall resilience of the city infrastructure.

Use Case

Developing a cost-efficient stormwater network solution for a new housing complex in Florida

The objective

Partway through the construction of the Mallory Apartments housing complex in Florida, developers hit a problem with the originally designed stormwater structure. The city of Fort Meyers proposed a solution, but it would have delayed construction and—with the extra expense of a scuba team—have been cost prohibitive.

The challenge

As this was midway through construction, money had already been spent on elements of the originally proposed stormwater solution, so there was a keen need to both reuse it—especially the existing reinforced concrete pipe (RCP)—and find an answer that was more cost-effective than Fort Meyers'.

The solution

Using OpenFlows Storm, the project's civil engineers found they could quickly input the current stormwater scenario and modify the design to reroute the network. They could also choose and identify the size and lengths of RCP to match those of the already purchased material. These capabilities enabled them to keep construction on track and deliver a solution that satisfied stakeholders, while keeping costs down. As a result, the engineering team was able to save USD 10,000 in project costs, while avoiding a six-month delay.

Strong, resilient water infrastructure, ready for the future

To work in the water resources sector today is to work in an industry witnessing unprecedented changes and challenges.

The coming together of increasing demand, tighter regulations, aging infrastructure, and ever-harsher climate events is creating what could be—perhaps literally—a perfect storm of issues to overcome.

However, it is also true to say there has never been a more capable engineering software solutions available to water professional with which to address these problems.

Bentley's mission is to empower organizations and their teams to design, build, and operate better and more resilient infrastructure. Through the adoption of our intelligent digital twins, and the mature and intuitive analysis software around them, water professionals can find answers to all these challenges. They can understand more, react faster, make decisions with confidence, and plan for the future more effectively.

Efficient, reliable, adaptable infrastructure is essential for our changing world. We are proud to provide advanced engineering software solutions that help make it possible.

Questions?

If you would like to discover more about Bentley's engineering solutions for water, sewer and storm networks, visit www.bentley.com/software/hydraulics-and-hydrology/.