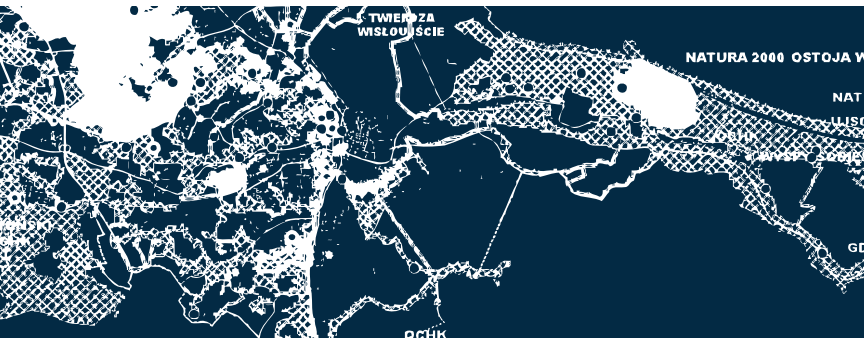
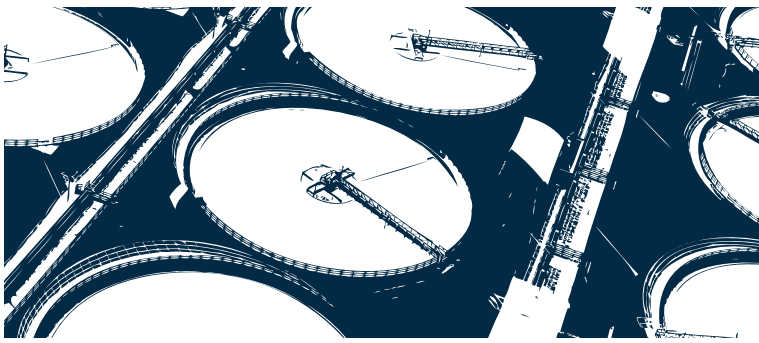
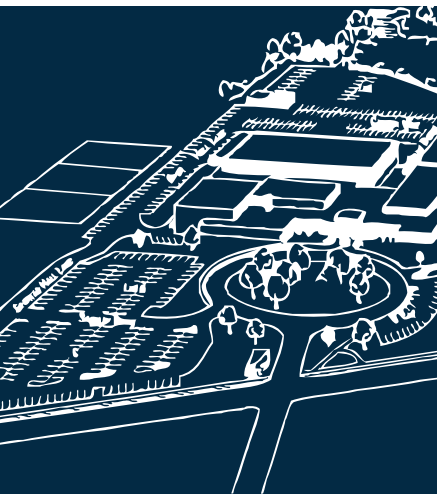
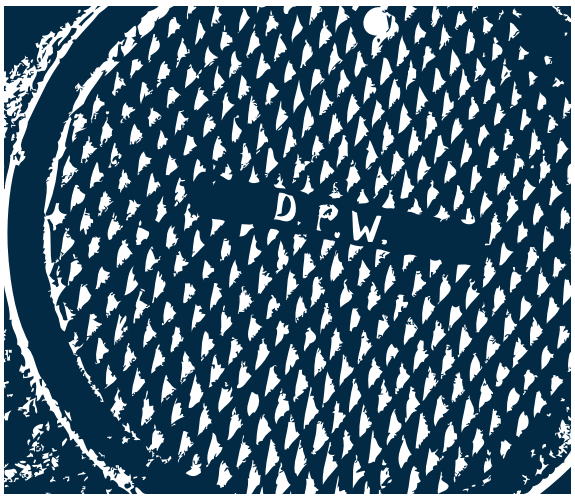
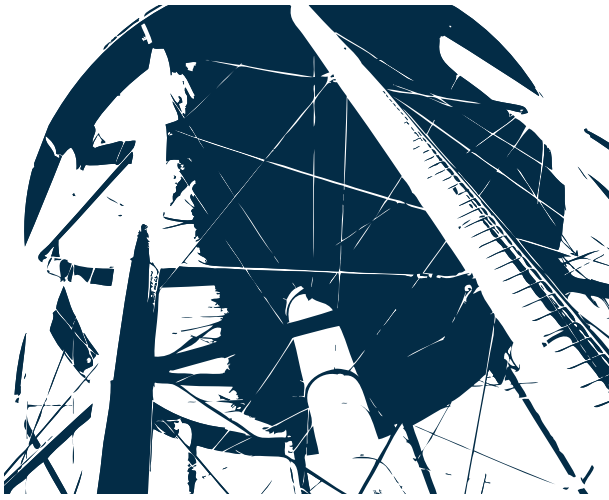
THE WATER
PROJECT SHOWCASE



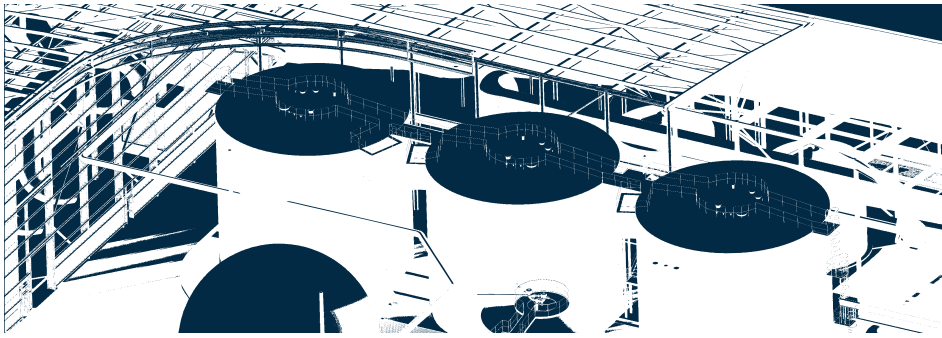








Extraordinary Infrastructure of the Be Inspired Awards



Bentley®
Sustaining Infrastructure

Bentley's mission is to provide innovative software and services that support the enterprises and professionals who design, build, and operate the world's infrastructure — sustaining the global economy and environment for improved quality of life.

The Water Project Showcase and *The Year in Infrastructure* series of publications are project yearbooks published by Bentley Systems, Incorporated that showcase the extraordinary work of Bentley users sustaining the world's infrastructure.

For information about how to enter your innovative project for consideration in the next Be Inspired Awards competition or for additional information about this program, visit **www.bentley.com/beinspired.**

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THE INFRASTRUCTURE BEHIND OUR MOST PRECIOUS RESOURCE

Water. It is humankind's most precious resource. Around the world, engineers, planners, and constructors are designing the infrastructure necessary to sustain our water resources. Their work delivers clean water to homes, treats and reclaims wastewater, manages stormwater, and provides the means to control floodwaters. The professionals who design, build, and operate water infrastructure strive to improve the quality of life for people around the world — and that goal is what drives the amazing projects presented in *The Water Project Showcase.*

Each of the projects presented here have been nominated for Bentley's *Be Inspired* Awards, an annual, global competition recognizing outstanding achievements in design and delivery of infrastructure. These projects also represent tremendous innovation in the use of Bentley's integrated water software to produce high-performance water infrastructure — performance that is measured in terms of operational efficiency, sustainability, and system reliability. Bentley's integrated water and wastewater solutions enhance mapping and data management, information sharing and collaboration, hydraulic simulation and analysis, design, construction documentation, field engineering, inspection, and operations and maintenance.

Bentley's solutions empower professionals to design and run their water models directly within the CAD or GIS platform of their choice (AutoCAD, MicroStation, PowerCivil, and ArcGIS) while giving them the ability to leverage virtually any external data in the process, improving the quality of collaboration and the performance of the design. The benefits are improved workflows and team productivity, leading to reduced project delivery time and costs.

These water projects — and the professionals who have made them possible — demonstrate our society's resilience in the face of tremendous challenges, both economic and environmental, and serve as a testament to the ability of engineers, architects, contractors, and owner/operators to ensure that water, our most precious resource, is a *sustainable* resource for generations to come.

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THE WATER **PROJECT SHOWCASE**

Innovation in Water, Wastewater, and Stormwater Networks
Innovation in Water and Wastewater Treatment Plants

Water projects in Asia include innovations from Manila Water Company, Zhengzhou Water Supply Corporation, Westernport Water, Veolia Water India, South Australia Water Corporation, Kuching Water Board, Maharastra Jeevan Pradhikaran, and many more.

Bentley®
Sustaining Infrastructure

Barwon Water

Barwon Water Improves Productivity, Asset Management, and Customer Service

Victoria, Australia

From Manual Identification to Simulation Analysis

Barwon Water, the largest regional urban water corporation in the state of Victoria, Australia, provides world-class water, sewerage, and recycled water services to more than 275,000 people across 8,100 square kilometers. Its AUD $1.138 billion asset base includes 5,781 kilometers of pipes, 10 major reservoirs, 10 water treatment plants, and nine water reclamation plants. The utility deployed WaterGEMS water distribution modeling software, integrated with its GIS, to simulate shutdowns and measure the impact on system performance.

A key performance indicator for customer service is the number of customers affected by planned and unplanned supply interruptions. WaterGEMS helped Barwon Water identify critical mains, defined as pipes that would interrupt service for a large number of customers should shutdowns occur. Prior to deploying WaterGEMS, identifying and quantifying every critical element in the utility's water distribution system would have been too manually intensive and required a great deal of analysis.

Hydraulic Modeling for Criticality

The use of hydraulic modeling capabilities has made it easier for the utility to "fail" a pipe and assess its impact on the system. The criticality analysis tool in WaterGEMS allows users to automatically simulate the shutdown of each individual segment of the system and determine the impact on performance.

How critical each pipe is to the system is automatically based on the number of customers that would be affected should the pipe fail. The criticality analysis results are then presented graphically in Barwon Water's GIS system. This helps operations and planning personnel to access the information and to more efficiently plan network improvements and optimize asset management decisions.

Barwon Water's system includes 30 network models. Pressure zones range from as few as 100 properties to more than 20,000. The report generated from WaterGEMS is based on the percentage of the zones' water demand that is not meeting defined minimum pressure levels. (The analysis is run with three defined minimum pressure scenarios.) In the Oracle database, the percentage of demand affected is linked to the number of lots affected. A scoring number is utilized based on the number of affected customers. A weighting factor is allocated on each defined minimum pressure. This score is then used to classify the level of criticality.

Improved Productivity

A critical pipe layer was created in Barwon Water's GIS Oracle Spatial database, which the utility had successfully integrated with WaterGEMS. The use of GIS data via a direct connection to the Oracle Spatial database has made the model building process more efficient. Because the criticality analysis results are visualized in the GIS system, the distribution of vital information to planning, operations, and management staff in Barwon Water has been accelerated.

"WaterGEMS helped Barwon Water identify critical mains, defined as pipes that would interrupt service for a large number of customers should shutdowns occur."

The efficient schematic process of critical mains identification has enabled Barwon Water to save an estimated two years of work, which corresponds to a cost saving of about AUD $200,000 while improving the accuracy of the results when compared to a manual, error-prone process.

Another of Barwon Water's objectives was to ensure that all water and sewerage systems and services are efficient and effective, and that they meet both legal and government requirements, as well as community expectations. This project enabled Barwon Water to optimize asset management decisions and more reliably meet customer service targets for planned/unplanned interruptions to supply, which will improve the overall quality of service to customers.

Brisbane Water

Maintaining Fire-Fighting Capacity While Managing Pressure To Reduce Leakage

Queensland, Australia

Resolving Requirements That Conflict

Brisbane Water is one of Australia's largest utilities, providing water and wastewater services to the city of Brisbane's 1 million residents and drinking water to an additional 1 million people in southeast Queensland. The utility was recently challenged by the need to accelerate two high-priority programs involving potentially conflicting drivers: a capacity improvement program to guarantee an acceptable level of fire-fighting capacity and a leakage management program that would help maintain reliable water supplies under the record drought affecting southern Australia. Utility engineers used WaterGEMS to deploy a rigorous hydraulic model to find operational scenarios that would satisfy the goals of both programs.

The Water Supply System Service Capacity Improvement (WSSSCI) program was conceived to improve the city's fire-fighting capacity to comply with Brisbane Water's performance targets. The work consists primarily of augmenting or replacing existing small-diameter (3-, 4-, and 6-inch) pipes, particularly in older areas that comprise dense developments of wooden structures from the early 1900s.

The Pressure and Leakage Management program is one response to the long-term drought that has caused a water crisis in southeast Queensland. The program aims to decrease water losses by reducing water pressure, thereby decreasing the leakage rate through small defects that occur in pressure pipe networks. The strategy involves breaking the network grid into discrete district metered areas (DMAs) of 500 to 3,000 properties each, helping city engineers to pinpoint leaks and prioritize and schedule repairs. It also supports separation of high-pressure from low-pressure areas, allowing for pressure modulation for certain pressure-sensitive areas.

However, because the formation of the DMAs requires numerous boundary valves to be closed, managing pressure and leakage could have a major impact on the WSSSCI program and Brisbane's ability to fight fires. As a result, the utility had to deploy a rigorous desktop fire flow modeling solution to perform the DMA design and verification to ensure fire-fighting performance was not compromised.

Lowering Overhead and Eliminating Delays

Faced with this challenge, Brisbane Water needed a software solution that would enable it to conduct numerous and frequent fire flow simulations without incurring large overheads and significant project delays. The utility tested several water distribution modeling packages and found WaterGEMS to be the best solution for its needs.

Ben Wilson, water and sewerage strategic planner at Brisbane Water, explained, "WaterGEMS was implemented in parallel with a program of system improvement, particularly in checking and correcting the underlying GIS data and process automation. As part of this effort, the Network Navigator connectivity-checking tools in WaterGEMS found and corrected the majority of these errors to which fire flow analysis models are extremely sensitive. The implementation of the software was an unqualified success."

With the help of WaterGEMS, Brisbane Water has in a short period of time been able to transition to a process of routine fire fighting analyses by all modelers across a wider range of applications, with answers often being available in minutes. Today, fire flow modeling in WaterGEMS is more efficient than ever. Wilson explained, "Traditionally, fire flow investigations are one of the most labor-intensive types of water modeling analysis. Previously, separate manual runs often took hours to set up, run, and save for each critical network location.

Practical and Interoperable Applications

The WaterGEMS Fire Flow Results Browser is a powerful new feature that significantly reduces these overheads. In a single fire flow simulation, our engineers immediately determined where and why the water network had failed to meet the desired standards of service." In addition, WaterGEMS model results can be read directly inside ESRI's ArcGIS, one of the four platforms (stand-alone, AutoCAD, and MicroStation) WaterGEMS supports out of the box. The ArcGIS integration allows a network model and its results to be overlaid on rich background maps and layouts, eliminating the need to import or export model results.

Fire-fighting analysis is now a necessary part of almost all studies, investigations, and designs that Brisbane Water carries out, including:

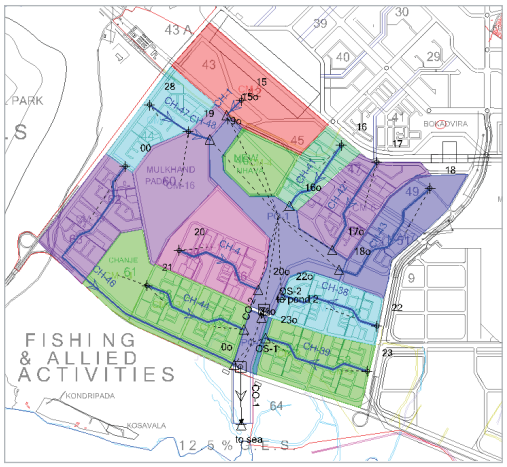
- Master planning and long-term infrastructure plans
  All new master plans now analyze fire-fighting capacity (not carried out previously due to modeling difficulties)
- Fire-fighting risk assessments and works prioritization
  Carried out under Brisbane's WSSSCI program
- Operational investigations
  A newly acquired ability to quickly gauge and report the impact on fire-fighting capacity from proposed re-zoning, valve openings or closings, or water main maintenance operations

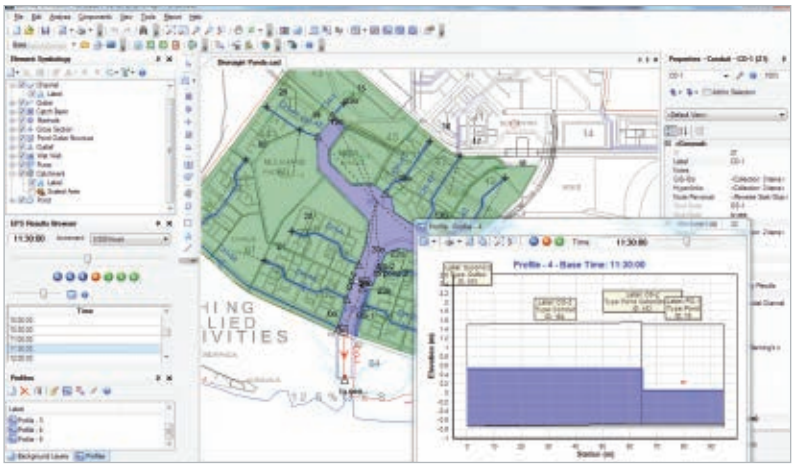
Wilson concluded, "Brisbane Water's implementation of WaterGEMS was an unqualified success. It met our aim of maintaining reliable water supplies under the ongoing drought while helping to ensure community fire safety. We estimate that we will save about half a million dollars in planning and design overheads in the long term. In optimized capital works, we expect to save tens of millions of dollars because we are able to run more analyses within the available time frame leading to optimized design."

CIDCO Ltd.

CIDCO Facilitates Design of New Stormwater Systems

Maharashtra, India





Topographic Challenges

City and Industrial Development Corporation (CIDCO) of Maharashtra, India, is a planning authority for the Navi Mumbai area. It is responsible for the Dronagiri project, one of 14 new nodal townships in the previously undeveloped Dronagiri archipelago. The region typically experiences heavy rainfall from August through November that floods the area completely.

To prevent this flooding from occurring once the area is fully developed, CIDCO deployed CivilStorm stormwater modeling and analysis software. CIDCO used CivilStorm to plan a drainage system of interconnected channels that would discharge the runoff from high-intensity storms into holding ponds. These ponds would be equipped with flap gates and outlet structures that would enable them to hold the runoff under the worst tidal conditions.

With CivilStorm, CIDCO was able to evaluate the Dronagiri archipelago for overland flows in different regions, examine the channels and holding ponds, simulate water levels in each holding pond under different storm and tidal conditions, and check the adequacy of outlet pipes from the holding ponds.

Dronagiri is located near Jawaharlal Nehru Port, one of India's largest and most modern seaports. It spans residential and industrial zones as well as a warehousing zone. The 2,700-hectare township borders the Arabian Sea on the north, the Dronagiri Hills on the west, and Karanja Creek on the south. Topographic data revealed that 99 percent of the area proposed for development was below RL 3.00 meters and the high tide level was 3.25 meters.

The ridge lines of Dronagiri Hills indicated that the catchment would drain storm runoff into planned residential areas and a market that would be below high tide. CIDCO adopted the Dutch Method of reclamation, which consists of holding ponds and retention ponds, to provide a stormwater disposal system and avoid flooding.

CIDCO authorities determined that the high tide in this region occurred at RL 3.25 meters and low tide at -0.75 meters. The water in the holding ponds would be discharged into the sea at low tide. But CIDCO needed a way to create the computations to predict the water levels in different holding ponds at different times ~~for~~ any given tide level as the rainfall progressed ~~for~~ each revision of the land use plan. In addition, the holding ponds had to allow water to accumulate during high tides and heavy precipitation, and to allow flow back into the sea at low tide.

Moreover, CIDCO had to consider road levels and surrounding terrain that were directly related to the holding ponds. Engineers also needed to know the land use development plans to determine how much runoff would enter the ponds and calculate their capacity (the runoff will vary depending on land use).

Approximations of water levels using manual calculations or Excel spreadsheets were required, but getting the results, which were often inaccurate, was time consuming. Using CivilStorm software for stormwater conveyance dynamic modeling, CIDCO's engineers were able to calculate thousands of iterations in a few seconds and build a stormwater network model of Dronagiri from the catchment to the tidal outfalls.

Because the modelers were able to test various scenarios for the modifications of the drainage systems to find out if they were adequate, the model simulated the effects of various changes in the planned drainage system. The software's dynamic calculations also served as an accurate support tool for crucial decisions regarding the road levels and land development in Dronagiri.

Environmental Impact

"The CivilStorm model helped a lot during the planning stage of the project to update the alignment and capacity of various channels and holding ponds according to the changes in land use development plans," said P.R. Natesh, executive engineer at CIDCO. "The same work would have consumed heavy manpower and time, and getting the results in the desired formats would have been hard to achieve."

The CivilStorm software helped CIDCO design and analyze the stormwater infrastructure to protect the Dronagiri archipelago during monsoon season once it is inhabited. Since the start of the project, CIDCO has developed basic infrastructure in the zone, and around 350 hectares (20 percent of the land) have been sold. In addition, around 90 hectares are currently being used for commercial purposes.

Natesh concluded, "Thanks to the efficient and timely use of CivilStorm, which ensured accurate dynamic calculations, CIDCO was able to handle complex hydraulic problems, ensuring Dronagiri would be flood free to the best of its capacity."

Maharashtra Jeevan Pradhikaran

WaterGEMS Powers Design of Breakthrough 24-by-7 Water System in India

Badlapur, India

Supplying Potable Water to Dense Populations

It is estimated that 1.6 million people die each year from diseases due to poor service provided by an intermittent water supply. During non-supply hours, pipes remain empty and dirty water enters the pipeline at vulnerable spots, causing contamination and associated health risks.

Therefore, transforming these supplies to 24-by-7 is a priority for developing economies. Badlapur, India, part of metropolitan Mumbai, is trying to supply its growing population with a 24-by-7 system – a first for the country. The population is expected to reach 300,000 by 2011. The transformation of the existing distribution system into a world-class water system required a new hydraulic model, according to Dr. Sanjay Dahasahasra, member secretary at Maharashtra Jeevan Pradhikaran (MJP).

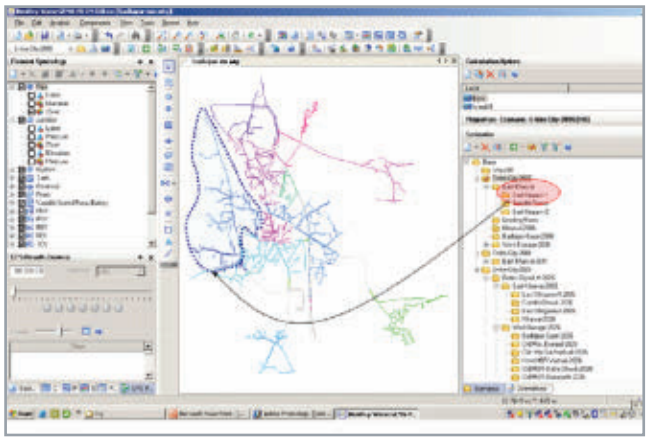
"Improving the water supply in Badlapur would not have been possible wuthout analyzing existing conditions using WaterGEMS."

The complex model encompassed the city's entire water distribution system and its operating pattern. It also required calibration of the network, analysis of the consumer withdrawal patterns during system modifications, and the creation of new zones and district metering areas to further improve service. Water loss and diversion caused by leaking underground storage tanks and oversized above-ground tanks also complicated the analysis.

The project team used WaterGEMS to design the existing and proposed pipelines in Badlapur. Features such as flow-control valves, reservoirs as source nodes, pipe junctions, pipe elements, and demand nodes helped to analyze and optimize the distribution network. The design team used the software to create a modeling process to analyze the data, describe the real-world network system, test maps, and synchronize with a GPS.

The project required management of a vast amount of data, comparison of permutations,and a combination of a large number of scenarios resulting from various alternative measures tocreate a comprehensive model. According to Dr. Dahasahasra, using WaterGEMS in this project resulted in reducing non-revenue water: 427 million liters water are additionally available annually, saving $70,000 per year. Over the 30-year lifecycle of the project, the savings will be substantial.

"Improving the water supply in Badlapur would not have been possible without analyzing existing conditions using WaterGEMS," said Dr. Dahasahasra. By the early part of this year, eight of the city's 34 wards had been converted to 24-by-7 systems by hydraulically isolating operational zones. Moreover, the duration of supply in two additional wards has been increased from three hours to 18 hours. This progress has greatly improved drinking water quality and reduced contamination levels.



Improved performance

Parameter	From	To
Revenue	91 %	96%
Losses	29 %	23 %
Staff/1000 connections	13.73	10
Complaints /1000 connections	55	5
Annual O&M expense/ 1000 connections	Rs. 34.55 Lakhs	Rs. 29 Lakhs
LPCD	171	135 (Only for areas where UG tanks are not leaking)

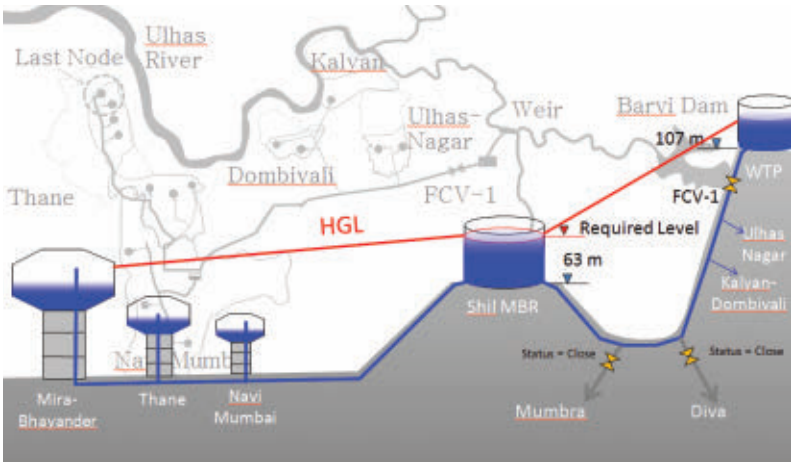
2008 WINNER

CASE STUDY

Government of Maharashtra, Water Supply and Sanitation Department

Crisis Management of Water Supply Systems

Maharashstra, India



Safeguarding Public Health of 17 Million People

Distributing safe, potable water within densely populated regions of a developing country like India is always difficult. But "difficult" became "daunting" in India's Mumbai Metropolitan Area (MMA) when the water supply for the 17 million people living there was suddenly and dramatically reduced. A 2009 India Supreme Court decision regarding the interstate sharing of water from the Krishna River (as defined by the Krishna Water Disputes Tribunal) cut the annual flow of water into the westward rivers of the state to 1,206 million cubic meters.

This led to a one-day-per-week interruption in MMA's water supply that, for some cities, turned into a 54-hour interruption. With the help of Bentley's information modeling software, this extended and potentially dangerous loss of water supply was remedied, millions of rupees that would have been spent each week to truck water into the area were saved, and the reliability of the water infrastructure in the region was enhanced.

As a result of the India Supreme Court ruling, every Friday at 6 a.m., the water for cities supplied by Barvi Dam is turned off. When the pumping is restarted at 6 a.m. on Saturday, every city in the region is supposed to receive water immediately. However, in many cities it was taking 30 hours after the pumps had been restarted for water to begin flowing.

Residents in the six municipal corporations and 13 municipalities impacted by these extended water service interruptions organized municipal meetings and demonstrations in protest, and civil disorder often broke out. To calm the outcry, the chief minister of the state-directed Maharashtra Jeevan Pradhikaran (MJP), the board responsible for managing the water supply, to take whatever measures were necessary to mitigate the crisis.

The solution was found with the help of Bentley Water, a desktop GIS for managing water utility assets, and WaterGEMS water distribution analysis and modeling software. Both were used to help MJP quickly prepare a hydraulic model that would give MJP the knowledge it needed to re-engineer the region's pipe network and solve the problem.

Analysis of the Problem and the Proposed Solution

MJP's study and analysis of the water system found that along pipe network remained empty after the region's pumps had been restarted, and it took 14 hours to refill it. Moreover, because the level of the terrain was uneven, communities in low-lying areas were drawing water easily while those at the tail end of the network were getting water as much as 30 hours after resumption of the water supply.

The first step in assessing the problem and developing a solution was to acquire satellite images with 0.6 meter resolution. Next, pipeline and features such as properties and roads were digitized using Bentley Map and Bentley Water. The data for various zones and sub-zones (called district metered areas or DMAs) was then stored in Bentley Water. An intelligent model of MMA's entire water pipe network was created in Bentley Water and exported directly to WaterGEMS without data loss. This allowed the critical hydraulic modeling work to begin.

"Using Bentley's technology on this project has not only saved money, but also enhanced the reliability of the water infrastructure in the region and helped safeguard the public health of 17 million people."

In WaterGEMS, engineers created three scenarios to simulate the crisis and identify probable strategies:

- The first scenario simulated normal water supply conditions, where water from the water treatment plant (at an elevation of 107 meters) upstream of Ulhas-Nagargravitates to a tank at Shil (at an elevation of 63 meters). From there, water is conveyed by gravity to tanks in all MMA cities.
- The second scenario added dynamic controls in the WaterGEMS model to simulate a problem with the opening and closing of the valve, which occurred after a one-day water interruption. The team ran the water model as an extended period simulation over 36 hours and compared the results with the real situation. The findings showed that the required water level in MBR at Shil was not attained because low-lying areas such as Mumbra and Diva were drawing too much water. Moreover, because there wasn't an adequate level of water at Shil, water did not flow at all to a number of cities, including Mira-Bhayander, Thane, and Navi Mumbai.
- The third scenario tried to resolve the problem. Based on findings in the second scenario, engineers analyzed different alternatives to control the flows by setting the valves at low-level areas to avoid excessive withdrawal.

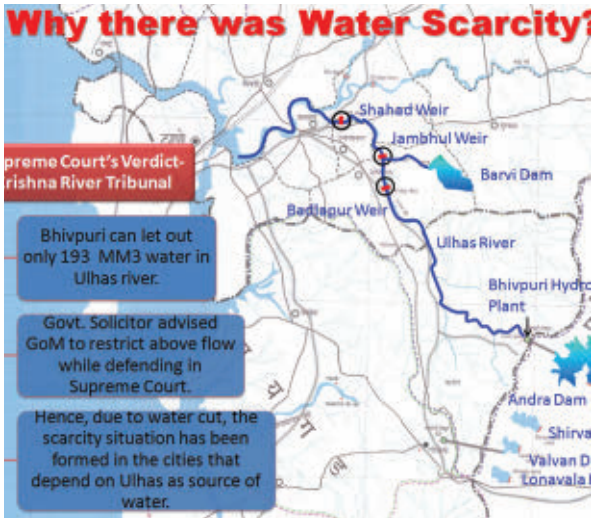
Consequently, the hydraulic grade line was elevated and the required level in MBR at Shil was attained. Using advanced programmable controls in WaterGEMS, the flow from valves at low-level areas was set to 10 million liters per day, which solved the entire problem without compromising the water needs of these areas. The analysis also showed that with this solution, water would start filling the network within an hour of the valve opening, which was also confirmed by field engineers.

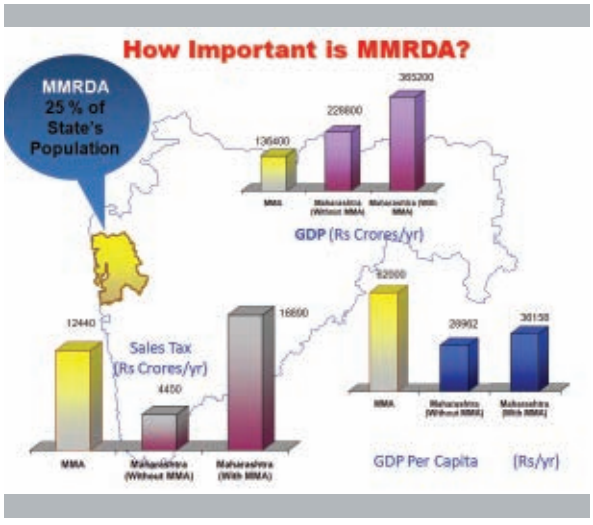
Project Benefits Based on Science

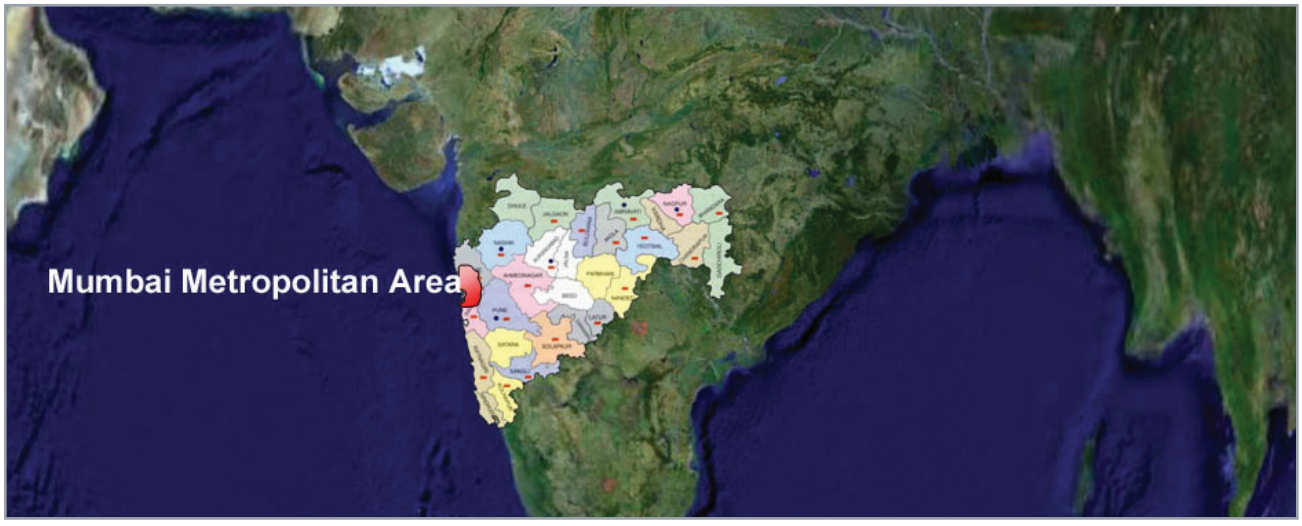
Clearly, had this same exercise been done in the field without a water model, scenarios would have been carried out randomly and alternatives would not have been tested to make sure they actually worked. This could have caused more problems than it solved. Once the modeled solution was implemented and the system re-engineered, 17 million people were able to get water in a reasonable amount of time after the planned interruption in service. This solved the law-and-order challenges that accompanied the civil protests and mitigated the disaster. These efforts were greatly appreciated by the local municipal bodies as well as the government of Maharashtra.

The proposed solution eliminated the need for the thousands of water tanker trucks that would have been required each week to deliver water to the affected cities in the absence of a functional pipe network. Since 20 liters of water are required for the daily sustenance of a single person and the volume of one tanker is 10,000 liters, servicing the water needs of the entire population affected by the extended service interruption would have required a weekly caravan of 26,000 tankers (assuming 25 percent of the population gets water from local sources). Hence, 182 million rupees would have been spent each week on these deliveries or 4.7 billion rupees over a six-month period.

Using Bentley's technology on this project has not only saved money, but also enhanced the reliability of the water infrastructure in the region. Moreover, it helped safeguard the public health of 17 million people. Lastly, this project also reduced the effects of human activity on the environment. Not having to transport water by tanker trucks through the MMA prevented the damaging effects of increased traffic congestion and air pollution.







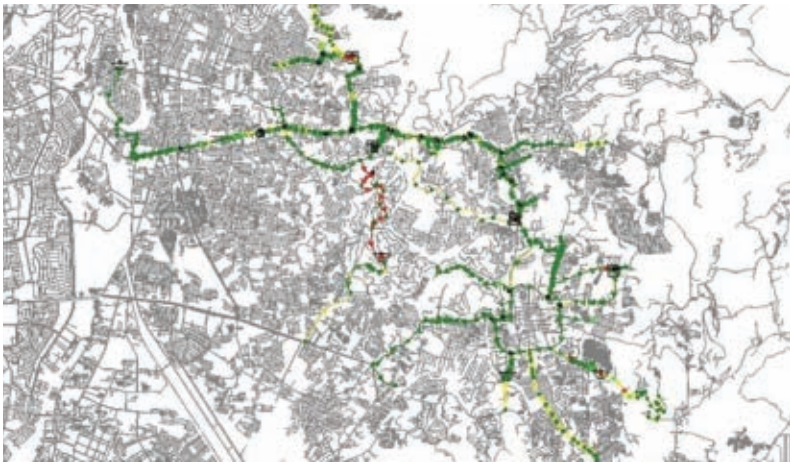
2009 WINNER

CASE STUDY

Manila Water Company

Manila Water Improves the Reliability and Efficiency of the Antipolo Water Supply System

Antipolo, Philippines



Optimizing the Water Supply System

Antipolo City is located in the northern half of Rizal Province, which is within the eastern boundary of metropolitan Manila. Antipolo City is the second largest in Rizal Province, with a total land area of 38,575 hectares. The topography of the service area is rugged, rising from the coastal plain at elevations of about six to 12 meters above sea level in the Mayamot area up to 300 meters on the eastern border of the service area.

The hilly terrain of the Antipolo area presented one of the major difficulties in designing the water distribution system for the area. Its topography has an extreme range of elevations with areas having elevations as high as 300 meters to a low point of around 20 meters above sea level. Efforts to overcome this challenge were previously made by maintaining high pressure heads at the pumping stations, but the extreme differences in elevation created intensively high pressure heads in the low-lying areas (areas near the source or downstream of Antipolo) and these high pressures resulted in pipe breakages.

In order to optimize the Antipolo Water Supply System, Manila Water set three goals:

- Plan for the anticipated rapid growth of the area from a current population of 656,000 people to 2.2 million by 2022
- Evaluate the steady state and transient hydraulics of the preferred pipeline, pump station, and reservoir combination
- Improve the reliability and efficiency of the Antipolo network system

This project was not going to be easy, since the Antipolo water supply system presented many challenges. The 1,200 millimeter suction line had limited capacity, serving as a constraint in maximizing the output of the first pumping station in Kingsville. Last but not least, communities living in the area for expansion consist mostly of low-income families who get their water supply from shallow wells, private deep wells, and water delivery trucks. This is not only too expensive but families have to tolerate low water quality, which may impose health risks.

To overcome these challenges, a hydraulic model of the Antipolo water system was created. Hydraulic and transient simulations were conducted to analyze network constraints and to identify possible solutions to improve the performance of the Antipolo network. Based on the simulations and intensive field investigation, network improvement projects were conceptualized, designed, and implemented.

Water Modeling Plan

First, the hydraulic network model was calibrated in WaterGEMS, based both on field data and the existing network database. Hydraulic and transient simulations using WaterGEMS and HAMMER helped to locate critical locations in the system. Strategies to control potential transients were also identified through appropriate flow control operations and the installation of surge protection devices. Pump operation schedules were also simulated using the model to come up with the most efficient scheme.

"With the network improvements in the Antipolo Water System, the people of Antipolo can now enjoy clean and potable water 24x7."

Manila Water has also successfully implemented a program to develop a water service connection scheme for low-income customers. This flagship project is called Tubig Para sa Barangay. Sixty-three millimeter HDPE pipes were laid on the narrow streets of the communities that will now receive the new potable water service. Service connections and water meters were installed in groups to save both space and cost. The type of service connection varies from individual, to shared (one meter serving four to five families), to bulk (community service with a mother meter).

WaterGEMS was used in creating and developing the water network model of Antipolo City. The GIS database (shapefiles) of the existing pipe network was automatically imported into the WaterGEMS model using WaterGEMS Model Builder to create the network model. Then the WaterGEMS TRex module was used to extract elevation data from the GIS database consisting of contour, topology, and GPS data.

Next, Excel files of the existing and projected demands (2007, 2008, and 2012) and demand profiles and other hydraulic patterns of the existing network were imported into the WaterGEMS model. Using the five-year demand projection, Manila Water's engineers also ran steady state and extended period simulations in WaterGEMS to design the network to supply the mountain communities and expansion areas of Antipolo.

The WaterGEMS model was then opened in HAMMER for transient analysis. Several scenarios were created using different pump operations and different times of power failure to identify critical areas affected by transients. Based on this, surge protection solutions were proposed, and appropriate flow control operations were identified.

Christine Aubrey Nocum, network systems manager at Manila Water, explained, "With its impressive capability to integrate with our company's existing software applications, the use of WaterGEMS and HAMMER made it much easier for us to design and manage our water network as we continuously expand our services and improve the lives of our customers."

Cost and Health Improvements for Locals

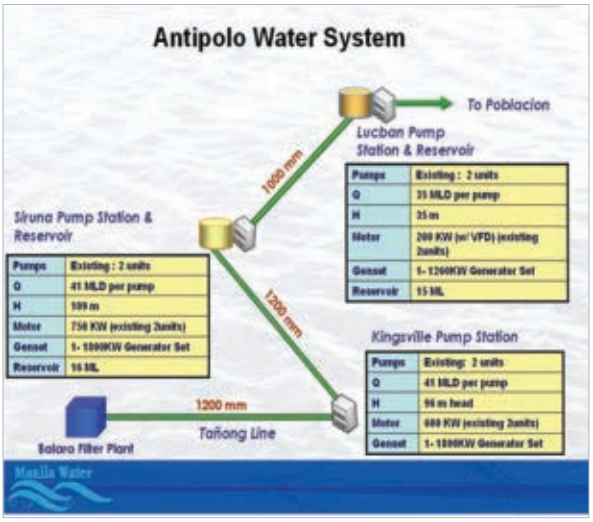
Nocum noted how this project affected the local population: "This project benefited a total population of more than 709,000 people, which equates to more than 140,000 households. And it will benefit 3,000 more households upon completion of the network's expansion. The completion of the network improvement project for the Antipolo Water System will not only improve the water supply and pressure in the area but more importantly, the quality of life of the people of Antipolo.

The Tubig Para sa Barangay project paved the way for low-income families of the mountain communities to have their own water service connections at a significantly lower cost. An ordinary water service connection costs at least PhP 7,511 (US $186) while the TPSB service connection costs only PhP 1,800 (US $44.57) and can be paid on installment basis. These families will also save on the cost of their water consumption. Getting water from delivery trucks costs them at least PhP 150/m3 (US $3.7/ m3) compared to an average of PhP 13/ m3 (US $0.32/ m3) with Manila Water. The project has also improved the health of the people in the Tubig Para sa Barangay communities since they no longer drink water from deep wells and water delivery trucks. Statistics show that diarrhea and cholera outbreaks in the communities have decreased significantly.

With the network improvements in the Antipolo Water System, the people of Antipolo can now enjoy clean and potable water 24x7. "The use of Bentley products has given our company savings in terms of both time and money. With WaterGEMS and HAMMER, the interface to GIS data is already built-in, unlike other brands in which you need to buy separate software for the GIS interface. The average time to create the model was two to three months using other software, compared to just two weeks to one month using WaterGEMS and HAMMER," concluded Nocum. "With the creation of the Antipolo Water System's network model using WaterGEMS and HAMMER, network improvements and the associated projects were identified and implemented, which resulted in savings on both capital and operational expenditures."

The installation of surge protection apparatus such as PRVs and SAVs at strategic locations identified from the network model decreased the incidents of water interruption due to pipe breakages from an average of six breakages per month to none to two breakages per month. This resulted in a decrease in leakages of 6.3 mld, or an equivalent amount of saving of almost US $75,000.

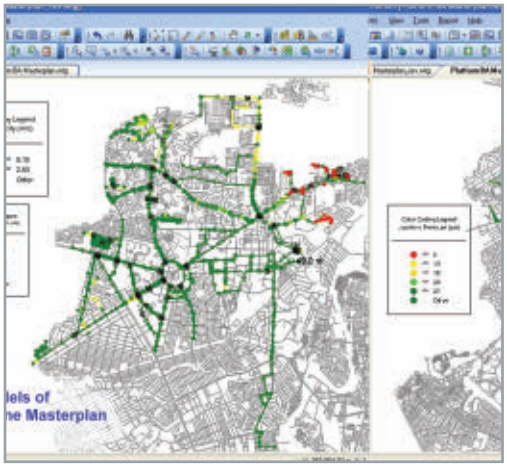
Furthermore, adjustments to the pump operation plan that were developed based on the hydraulic model and field studies, decreased the pump station operating expenditure or OPEX by almost $7,000 per month. Water availability was also improved from 18 hours per day to 24 hours per day.



Manila Water Company

WaterGEMS Plays Key Role in Reducing Non-Revenue Water for Metro Manila East Zone

Manila, Philippines



More Than 3 Million Households To Benefit

To ensure the reliability and sustainability of the water network and expand the supply of water to the Rizal provinces, Manila Water Company used Bentley's WaterGEMS to create a water network simulation model and reduce non-revenue water.

Manila Water's central distribution system is supplied by two primary network systems. In 2007, it was discovered that the east transmission line was already overloaded while the west transmission line was not fully utilized. Thus, one of the challenges facing Manila water was to solve the imbalance in the network system.

Although Manila Water had significantly reduced non-revenue water from 63 percent in 1997 to 24 percent in 2007, non-revenue water remained a primary challenge in ensuring the reliability of the water network. In fact, Manila Water still had to replace more than 1,000 kilometers of water mains. Some of the pipes being replaced were composed of asbestos cement and fiberglass reinforced polyester, which were still susceptible to breakages.

Thus, pipe bursts in major roadways still occurred, which disrupted water supplies and affected thousands of households in Metro Manila. In addition, water theft and illegal connections continued to be major causes of non-revenue water and water quality problems, especially in low-income communities. The challenge for Manila Water was not only to design network efficiency projects in these areas but also to gain the cooperation of the community to implement non-revenue water reduction and network improvement programs.

The 2007 master plan focused on these programs. It was designed by creating a hydraulic simulation model of the central distribution system using WaterGEMS. Through this model, network reliability projects were conceptualized on a per-business-area basis to ensure they were consistent with the development plans of the local governments. These projects included pipe replacements, DMZ/DMA formation, PRV installation, network reconfiguration, and Tubig Para sa Barangay or Water for the Villages.

Model Creation and Team Collaboration

Manila Water's concession area is subdivided into eight business areas based on political and hydraulic boundaries. To easily manage the creation and development of the hydraulic model, Manila Water's network planning team subdivided the model into eight submodels based on these business areas. Next, the network planning engineer assigned a design strategy for each business area, based on its specific development needs and plan. The models were then uploaded to the main server.

At the utility's main office, the network systems manager collated and checked the models to ensure that all of these submodels were aligned with the master plan for the whole concession area. The network systems manager also developed and updated the main hydraulic model of the whole master plan.

The data the network planning team needed to create the model, such as ground profiles and documentation of the existing water network, was provided by the GIS and GPS team, which gathered data from the field and uploaded it to the GIS database. Next, the network-planning team imported this data directly into WaterGEMS using the Model Builder and TRex tools within WaterGEMS. The project development group then developed the design of the projects based on the WaterGEMS model.

How the Population Benefits

The project has already benefited more than 3 million households, and that number is expected to increase upon completion of the project. Between 2007 and 2008, Manila Water has laid and replaced almost 800 kilometers of pipe, which has significantly reduced the number of pipe bursts and water supply interruptions. Ninety-nine percent of the central distribution system is now enjoying a 24x7 supply of potable water. Moreover, the average pressure was improved from 7 psi to 17 psi.

Aside from implementing technical solutions, Manila Water also built a strong relationship with local communities, especially in low-income areas. The goal was to develop a partnership with the local communities to stop illegal connections and water theft. Moreover, the Tubig Para sa Barangay scheme paved the way to authorize water service connections at an affordable cost.

As a consequence of these initiatives, the health of the people in the Tubig Para sa Barangay communities improved and water quality problems were reduced as illegal connections and water pilfering were eliminated. Statistics show that the improved water quality in the Tubig Para sa Barangay communities has significantly decreased the number of diarrhea and cholera outbreaks.

Using Bentley products has saved Manila Water both time and money. For example, using the WaterGEMS interface to integrate GIS-based data with the hydraulic model is built in, where other products require the purchase of a separate product to gain this functionality.

2009 FINALIST

Navi Mumbai Municipal Corporation

Navi Mumbai Deploys Bentley Software To Meet Demand for Public Services

Navi Mumbai, India

The Challenges of Growth

Developed in the 1970s with 20 self-contained nodes for 100,000 people in each township, Navi Mumbai was hailed as a model planned city. However, rapid migration and unsustainable population growth led to deteriorating public services and infrastructure in the 344-square-kilometer area. Among the challenges were an inadequate water supply, low pressures, sewer overflows, insufficient treatment and disposal, traffic jams, and frequent flooding. The Pollution Control Board had even started issuing warnings to the local bodies regarding violations of standards.

To alleviate the congestion in the city and solve these problems, Navi Mumbai Municipal Corporation (NMMC) deployed MicroStation and Bentley Geo Web Publisher to prepare a base map for city planning. The plan was to have an integrated and holistic approach for the improvement of the city infrastructure, with the objective to provide a sustainable environment.

"Bentley products offered a unique level of interoperability."

NMMC chose Tandon and Associates in Mumbai as project management consultants to develop a roadmap to achieve this goal. The roadmap included:

- Taking the city development and planning as a continuous process that requires periodic assessments of various alternatives and different scenarios
- Proposing a development plan with optimized lifecycle costs by establishing a link between asset creation and management to ensure sustainable service delivery

Preparing an integrated base map was challenging, as it had to allow interoperability from and to various applications, engineering software, and databases for city planning. MicroStation proved to be the perfect choice, and each asset location was registered in MicroStation using the MSLINK concept. This map remained the single data source used to share interdepartmental data and maps, and closely bound IT systems to track utility services and revenue transactions.

Holistic Approach to Sustainability

Various utilities were mapped along with detailed land-use patterns. Transportation, the water supply, sewerage, solid waste management, and stormwater systems were planned using WaterGEMS, Bentley Water, HAMMER, SewerCAD, STAAD.Pro, and PowerCivil. WaterGEMS, HAMMER, and SewerCAD were used for project designs and cost estimates, which helped prepare accurate city planning and capital investment plans.

The city development plan, sanitation plan, and mobility plan were executed using base maps. Service delivery and facilities centers use these base maps to undertake better service levels and efficient use of resources. MicroStation was not only a great visual tool for understanding the infrastructure needs of Navi Mumbai, but was also a powerful tool for communicating the city's vision to citizens and other stakeholders.

Vijay Nahata, municipal commissioner at NMMC, explained, "These Bentley products offered a unique level of interoperability—enabling us to analyze a water network of more than 600 kilometers in length and a sewer network of 240 kilometers. They also helped us to design an additional water network of 161 kilometers and a sewer network of 148 kilometers in length."

City mobility planning and an elevated transportation corridor of 11 kilometers were designed in just two months, which saved 10,000 man-hours. The timely implementation of public health saved 30 milliliters of water per day, which equals a savings 52 million rupees per year.

Redesigning the underground sewer system with SewerCAD also helped to remove two unnecessary pumping stations, saving 350 million rupees in operation and maintenance expenditures. The solid waste collection system was monitored through a vehicle tracking system with the help of the base map, saving a further 10 million rupees.

The mobility planning and transportation project saved the 1.5 billion commuters in Mumbai 10 minutes of travel time every day. This resulted in a productivity increase of 250,000 man-hours, which equals a savings of 5 billion rupees every year.

Overall, this integrated approach resulted in efficient planning and execution of the project, and the results were visible in increased tax revenue, reduction in operation and maintenance costs for the utilities, better transport planning, reduced non-revenue water, and improved citizen satisfaction.

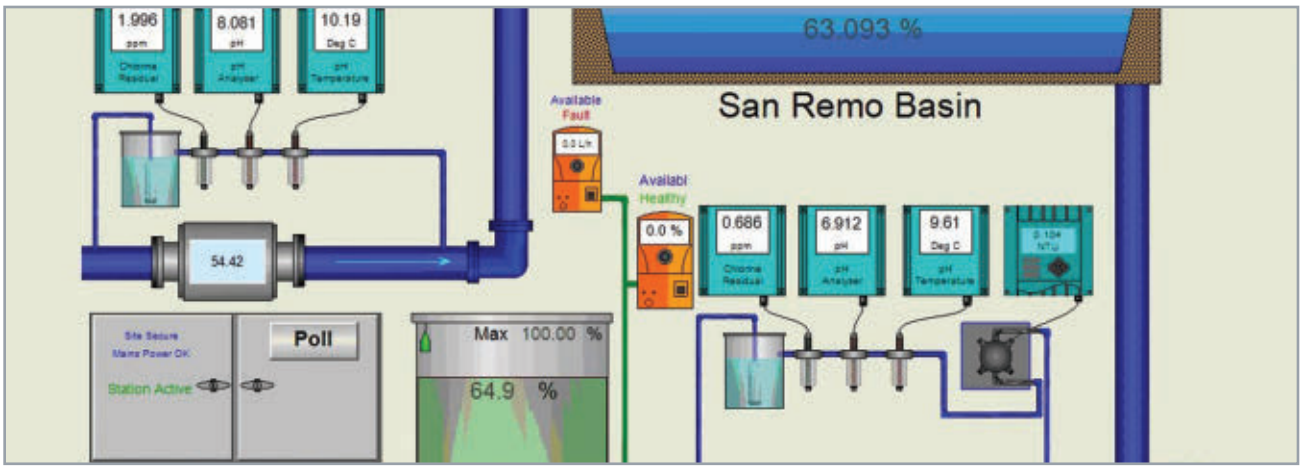
2010 WINNER

CASE STUDY

Westernport Water

Westernport Water Uses WaterGEMS To Achieve Automated Distribution System

Newhaven, Australia



Accurate Decision Tool Was Way To Go

Westernport Water provides water, wastewater, and recycled water services to nearly 16,000 properties on Phillip Island, in the state of Victoria, Australia, and an area of the mainland from the Gurdies to Archies Creek.

Using WaterGEMS water distribution modeling software integrated with a GIS and SCADA system (both introduced into the utility the past two years), Westernport Water's managers were able to achieve a high-performance, automated system. This targeted investment in new technologies is currently delivering substantial cost savings and contributes to the effective operation and management of more than $43 million in water assets.

The Open Spatial GIS, in conjunction with WaterGEMS, enables simple and easy updates of the system, including all new subdivisions. The Control Microsystems SCADA system allows field-measured data to be brought directly into WaterGEMS using the modeling software's SCADA Connect and Darwin Calibrator modules.

"The WaterGEMS water model will help deliver savings in leak detection by measuring and identifying non-revenue water."

Since SCADA Connect can use both historical and real-time data, the model is constantly up to date, but also has tables of previous values for trending and projections. This means that flow, pressure, and tank-level data for each demand zone can be fed on a real-time basis, enabling the system to model real-world conditions. Using the imported SCADA values, Darwin Calibrator, and the demand inversing tool in WaterGEMS, Westernport Water engineers can proportionally change the demand values assigned to those nodes within each demand zone.

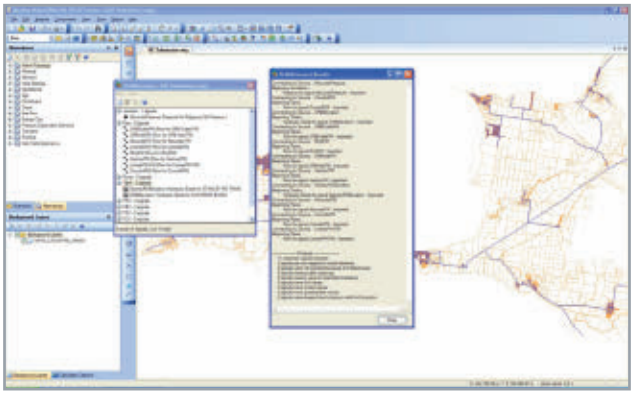
This innovative first for the water industry in Victoria allows the model to continually update demand groups. As a result, all calculated values in the water model are more accurate, since the exact flow from the SCADA system is used to calculate, for example, velocity, losses, and system curves. An up-to-date and accurate model gives engineering design and operational personnel the best possible platform for decision making.

Cost Benefits, Efficiency, and Environmental Improvements

Previously, Westernport Water engaged the services of external contractors to manually upgrade and calibrate its water model. The SCADA Connect technology with real-time updates will save Westernport Water the cost of these calibrations, which came to around $80,000.

Additionally, the WaterGEMS water model will help deliver savings in leak detection by measuring and identifying non-revenue water. Westernport Water is aiming to achieve a 25 percent reduction in water losses and recover up to $85,000 (retail value) of water. Reducing water losses also means that less water will need to be pumped to customers to achieve the same level of service so carbon emissions will be reduced as well.

Dean Jagoe, project engineer, systems, at Westernport Water, concluded, "Westernport Water's outlook on its ability to effectively develop and sustain our water distribution infrastructure has never been so positive. The integration of GIS, SCADA, and water modeling technologies will provide unprecedented scope for managers, engineers, operational, and maintenance personnel at Westernport Water to understand, on a real-time basis, how the water network is performing. The level of integration being achieved is expected to set benchmarks in informed decision making for our organization."



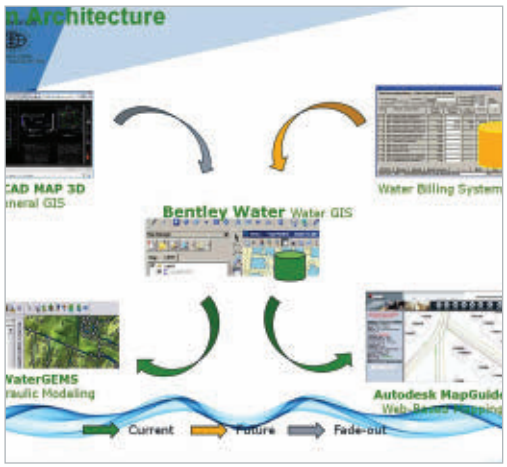
CASE STUDY

2010 WINNER

Cabanatuan City Water District
System Interoperability Using Bentley Water
Cabanatuan, Philippines

Cabanatuan City Water District serves approximately 30,600 connections through a 295-kilometer potable water network in Cabanatuan City in the Philippines. The commercial, industrial, and education hub of the province, Cabanatuan is experiencing increasing demand for domestic water service as the population grows.

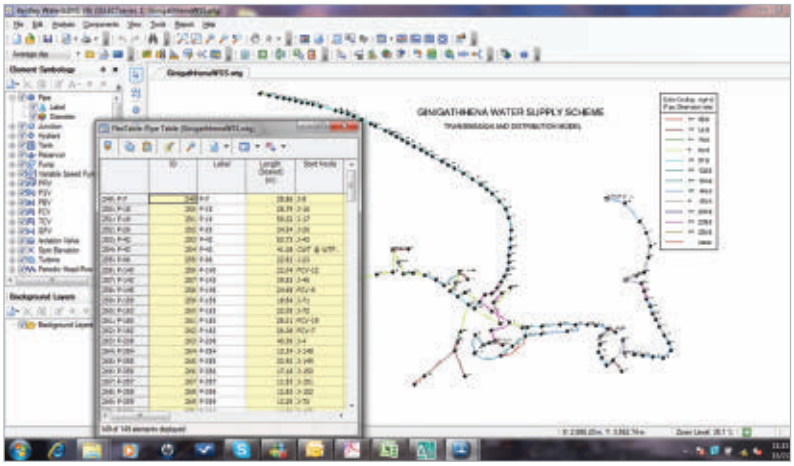
With a capital cost of $45,000, the city is combining features of MicroStation, Bentley Water, and WaterGEMS to modernize its system. This blend of Bentley technology will serve as the hub for system integration of geospatial data, network connectivity, and network modeling.

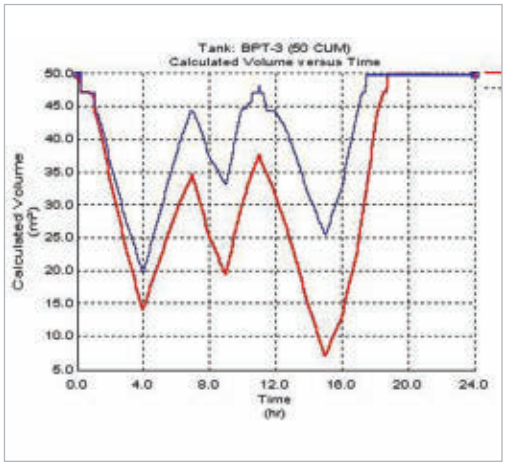


Ceywater Consultants (Pvt.) Ltd.
Ginigathhena Water Supply Project
Ginigathhena, Sri Lanka

This water supply project serves the town of Ginigathhena and its suburbs in Sri Lanka. The objective was to supply safe and reliable pipe-borne water from an intake at Lonarch stream, located about 984 meters above sea level. Raw water is conveyed under gravity about 2.35 kilometers to the treatment plant. The design flow of the transmission main is 3,000 cubic meters per day over 20 hours.

Because clusters of residents live in surrounding hills and valleys, elevation variations in the pipe network created high-pressure zones. WaterCAD was used to simulate the distribution network. Break pressure tanks and pressure-reducing valves were used in the model at locations with excessive pressures. HAMMER was used to check for excessive pressure build-ups or surges in the distribution network and transmission main.





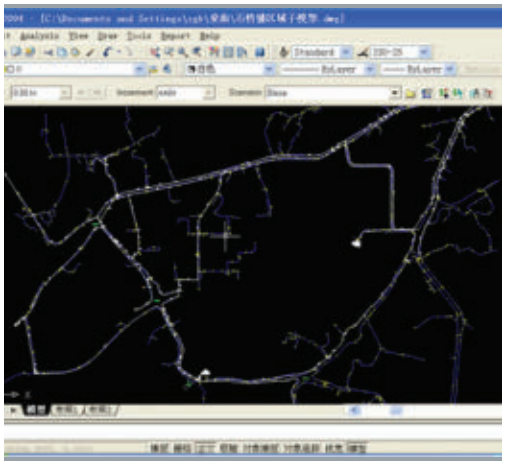
Chongqing Water Group

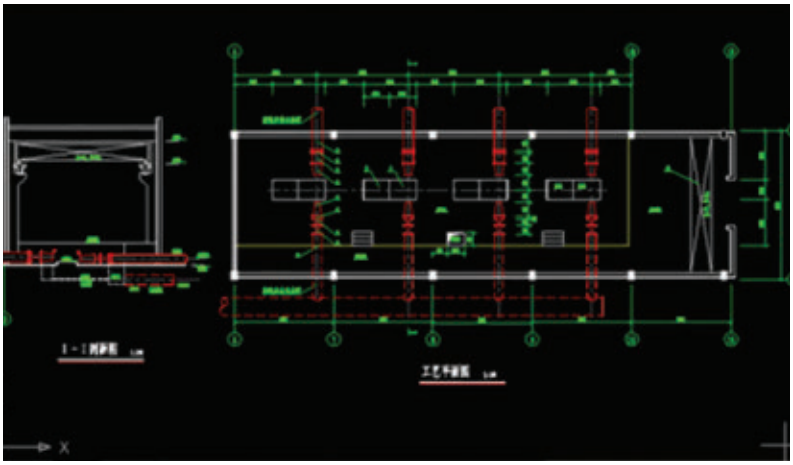
Network Design and Economic Operation of Water Supplies in Chongqing

Chongqing, China

The goals of this project in China were to optimize the design of the water distribution network in Chongqing, ensure the economic performance of the network, control network leakage, and improve management of the network's core assets.

The project involved creation of a hydraulic model to optimize the design of the replacement of the old pipe network, as well as creation of a hydraulic model that satisfied the expansion of the pipe network and integration with other regional networks. An optimal design developed with WaterCAD reduced design project costs by about $500,000 and yearly operation costs by the same amount.





CIDCO Ltd.

Design Optimization of Kharghar for 24 X 7 Water Supply

Maharashtra, India

CIDCO, a planning and development authority for Navi Mumbai in Maharashtra, India, is upgrading city services to bring water supply and sewerage to more residents on a 24x7 basis. Previously, water lines were laid for an intermittent supply of eight hours. As each network node is upgraded, the system will be optimized for current and future population demand scenarios.

The design team used WaterGEMS and WaterCAD to optimize the water supply for the Kharghar node based on existing and proposed scenarios. Challenges included dense urbanization and a rapidly growing population. The project will increase the reliability of water supply, ensure adequate pressure, reduce storage requirements in the node, improve operational efficiency, and reduce maintenance costs and downtime.

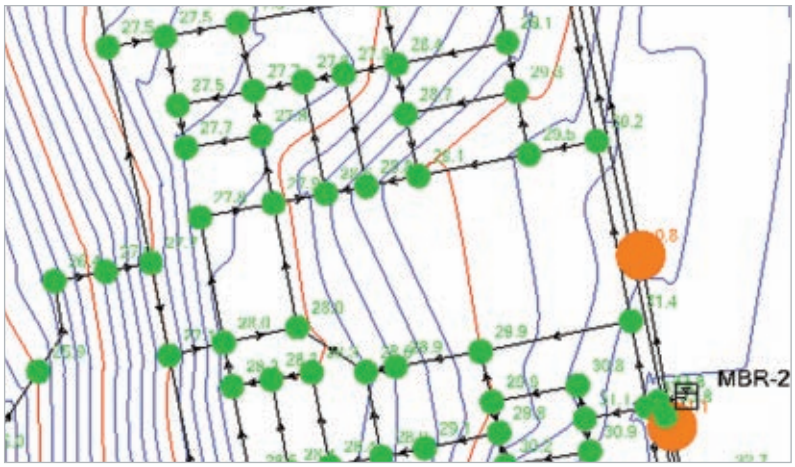
CIDCO Ltd.

Optimising Energy-Intensive Water Supply Network

Kharghar, India

CIDCO has undertaken a $4.18 million project to optimize energy use and improve the water supply for Kharghar, India. The goal is to examine the current adequacy of energy and water use for various future population-growth scenarios that will increase water demand and create challenges for providing adequate water quantity and pressure.

To optimize the use of the existing networks and upgrade to a 24x7 water supply system—as well as reduce or eliminate current storage tanks—CIDCO relied on WaterGEMS and HAMMER. The main benefits of this project are a reduction in power/energy bills and distribution costs, which will translate into lower water charges and consistent water service to consumers.



Coffs Harbour City Council

2030 Smartboards—Telemetry System

Coffs Harbour, Australia

The water department of Coffs Harbour, Australia, developed an innovative computerized control system that allows the water and wastewater system throughout the Coffs Harbour area to be controlled remotely and alerts staff immediately to possible pump or treatment plant failures. The $500,000 system uses SCADA telemetry monitoring technology.

MicroStation and promis•e are the software behind the innovation. These tools helped the water department generate electrical schematics, panel layouts, bills of material, wire lists, and terminal plans. The collaborative features supported multiple internal disciplines and third parties, such as the electrical subcontractor. Coffs Harbour now works with other cities to help them utilize this technology and learn from their experience.

Cradle Coast Water

Barrington Treatment Plant Backwash Process Upgrade

Barrington, Australia

The Barrington Treatment Plant is a dissolved air floatation and filtration configuration with a design capacity of 3.5 million liters per day. Filter run times were gradually reducing, leading to inadequate plant performance. Off-line, structural inadequacies mandated a full plant upgrade.

A model was created through WaterCAD using pipe lengths, inside diameters, and construction elevations. The model showed that a small variation in pipe diameter downstream of the bypass valve had a significant bearing on bypass flows. During commissioning of the valve control system, the valve position was found to be within 10 percent of calculated value.

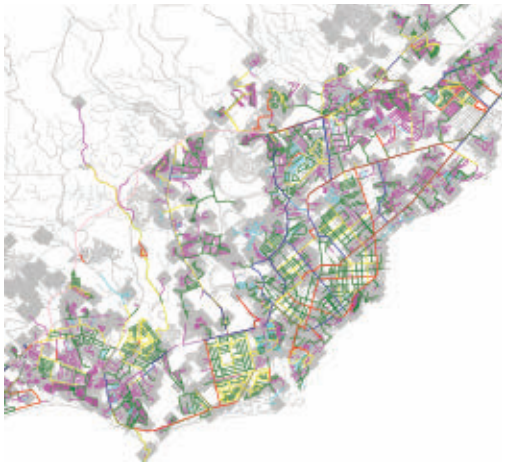
Davao City Water District

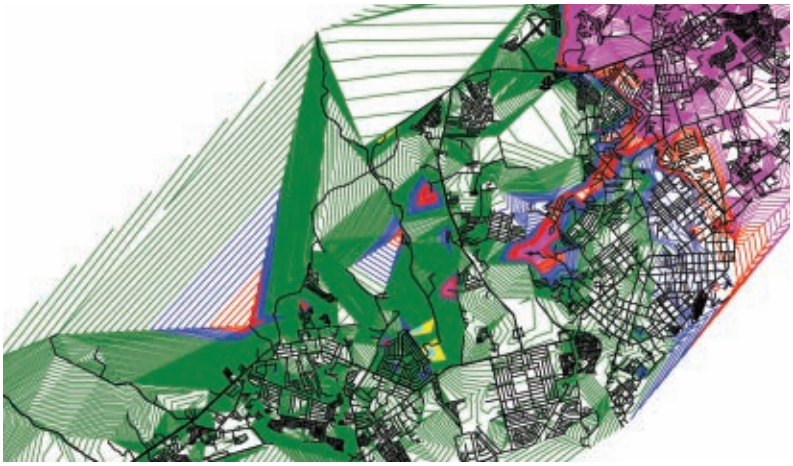
Installation of Pressure Enhancers at Different Strategic Locations

Davao City, Philippines

To sustain required residual water pressure during peak hours at remote service areas, the Davao City Water District installed an in-line booster station. The alternative of increasing the size or number of transmission pipelines would have required a huge investment and caused traffic congestion during construction along major thoroughfares.

WaterCAD and WaterGEMS were used for hydraulic modeling, analysis, and design, resulting in fast modeling of the water supply system's physical attributes and quick results of analysis and design works. Using MicroStation PowerDraft saved up to 70 percent of the time required for drafting work compared to conventional methods. The overall return on investment was 45 percent.





Delhi Jal Board

Master Plan for Improvement of Water Supply System

New Delhi, India

To meet demand for potable water in Delhi, India, where the population is projected to grow from 16 million to 25 million, Delhi Jal Board is reforming the water supply system with capital improvements, expansion into peripheral areas, reduction of water losses and non-revenue water, and eventual extension of service to 24x7.

A network model was created based on GIS data for the transmission and distribution system and hydraulic information from regional offices. Demands were calculated based on population projections and land use. WaterGEMS assigned water demands and identified bottlenecks, analysis that yielded proposals for laying pipeline, modifying pumping capacities and command zone boundaries, and other improvements.

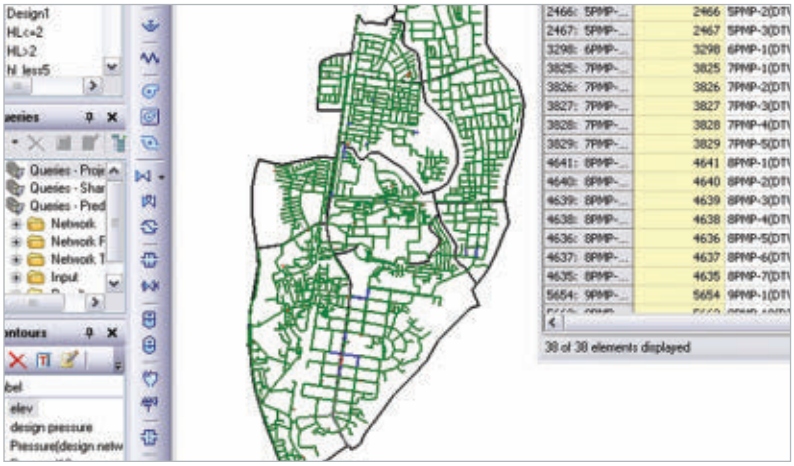
Design and Management Consultants Ltd of Dhaka Water Supply and Sewerage Authority

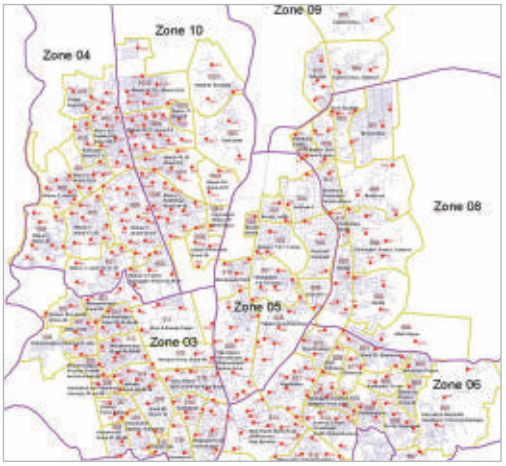
Water Supply Sector Development Project

Dhaka, Bangladesh

The $200 million Dhaka water supply project involves physical rehabilitation and strengthening of the water supply distribution network by introducing hydraulically self-contained district metering areas to minimize losses and enable 24-hour pressurized water supply. Using a GIS-based MIS system, a model was developed for the existing network.

The design for meeting demand covers three scenarios for sourcing water: only tube well, only surface water, and both tube well and surface water. Individual district metering area models were finalized and then combined in WaterGEMS to check the sustainability of the whole system as well as the water balance of zones.





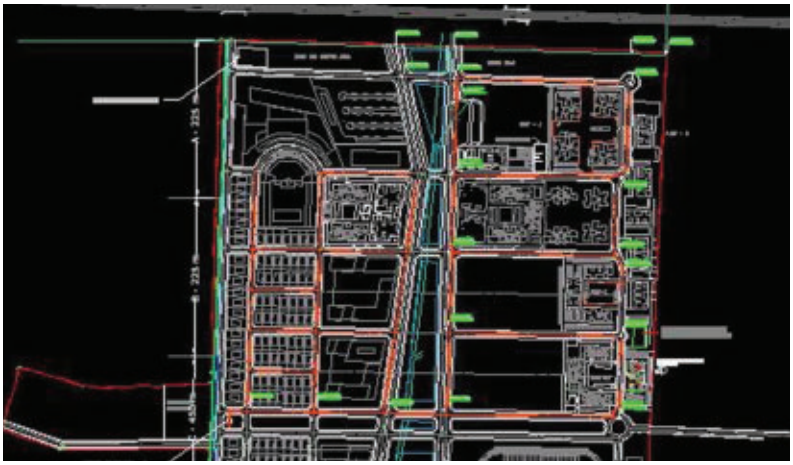
Development Consultants Pvt. Ltd.

Township Sewerage Model

Uttarpara, India

Development Consultant was awarded the infrastructure design and engineering contract for the $1 billion Hi-Tech City project in Uttarpara, India. Phase 1 involved the design and engineering of a sewer network system covering 350 acres, including interconnecting manholes, gravity flow, pressure flow, canal crossings, wet well storage, pumping, and a sewage treatment plant.

SewerCAD features such as sanitary sewer load estimation, hydrographs, patterned load, and flow monitoring helped save considerable time by enabling engineering decisions to be made more quickly and accurately. This greenfield project has been conceptualized without disturbing the environmental and community balance.



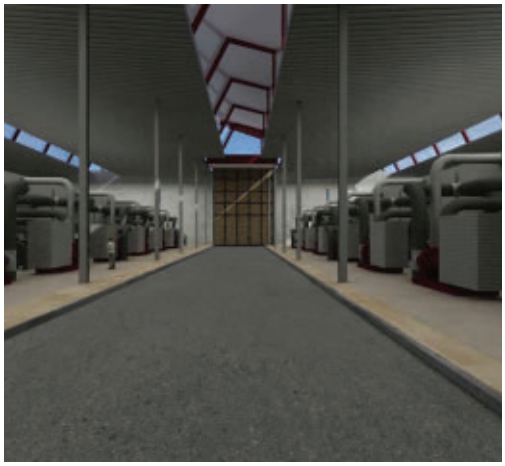
Hatch Associates Pty Ltd

Adelaide Desalination Project

Adelaide, Australia

South Australia Water commissioned a 100-gigaliter-capacity desalination plant to supplement the state capital's fresh water supply. The AUD $1.4 billion plant will take pressure off the existing fresh water catchment system, allow water levels to regenerate, and give Adelaide a reprieve from water restrictions. Hatch SMEC JV was established to support the Adelaide Aqua consortia in its bid to design, build, operate, and maintain the plant.

The team deployed front-end engineering and design applications from Bentley to deliver a design, technical, and commercial cost estimate in 12 weeks. Using PlantWise, the team modeled in excess of 300 pieces of equipment and 550 major piping process lines. The 3D model was also used to define the most efficient plant layout. The estimating process took 40 percent less time than anticipated.



2009 WINNER

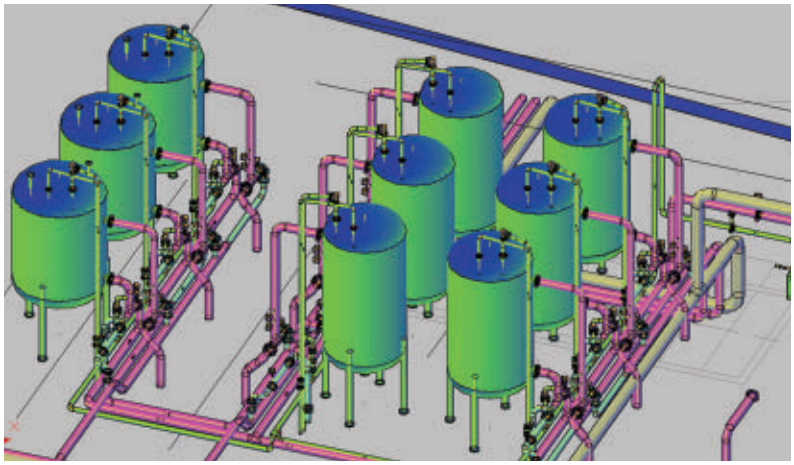
HDO Technologies Limited

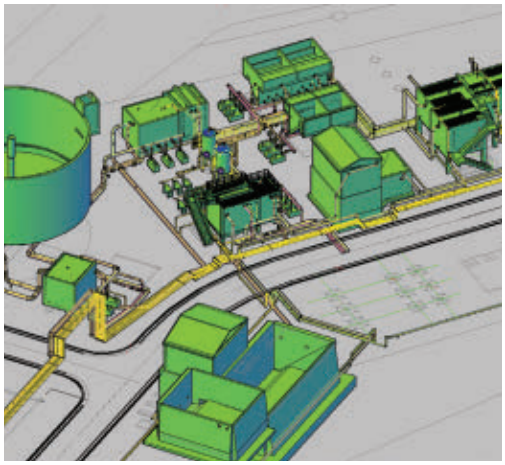
Effluent Treatment Plant CEMP Phase II

Kochi, India

Bharat Petroleum Corporation is expanding production capacity and modernizing facilities for producing auto fuels. HDO Technologies was awarded the engineering, procurement, and construction contract for an effluent treatment plant in Kochi, India. In addition to the design of the plant, several pieces of equipment were supplied by HDO.

Using AutoPLANT enabled concurrent modeling of equipment, piping, and structures. The software also aided HDO in clash detection, estimating material take-offs, and generating isometric and general arrangement drawings. This saved a considerable amount of time within a compressed schedule.





Kellogg Brown & Root Pty Ltd

Northern Network Pipeline Project

Chevallum, Australia

As a member of a broad alliance, Kellogg Brown & Root (KBR) undertook the planning, design, construction, and commissioning of about 48 kilometers of underground, reverse-flow pipeline in Queensland, Australia. In light of anticipated population growth, KBR's project goal was to help protect the region from drought by improving the current water supply infrastructure and its ability to sustainably service its users.

Bentley's promis•e was used to create all instrument control, electrical drawings, and documentation associated with the pipeline infrastructure rollout. KBR delivered its project services on schedule with standardization of design drawings. The company estimated that it saved about 7 percent in labor and time for the production of the instrumentation control and electrical drawings.

Kuching Water Board

Water GIS Implementation With Bentley Water

Kuching, Malaysia

Kuching Water Board manages the largest potable water network in Kuching, Malaysia, ensuring the quality and supply for a population of 736,000. The firm proactively seeks and adapts advanced infrastructure technology. In this instance, it used Bentley Water to create a single source of information concerning the water network assets.

In addition to using Bentley Water and WaterGEMS, Kuching Water Board enhanced its ability to leverage the software by providing several days of focused training. The software has enabled the company to work more collaboratively and with confidence that network assets provide reliable and prompt information for decision making.

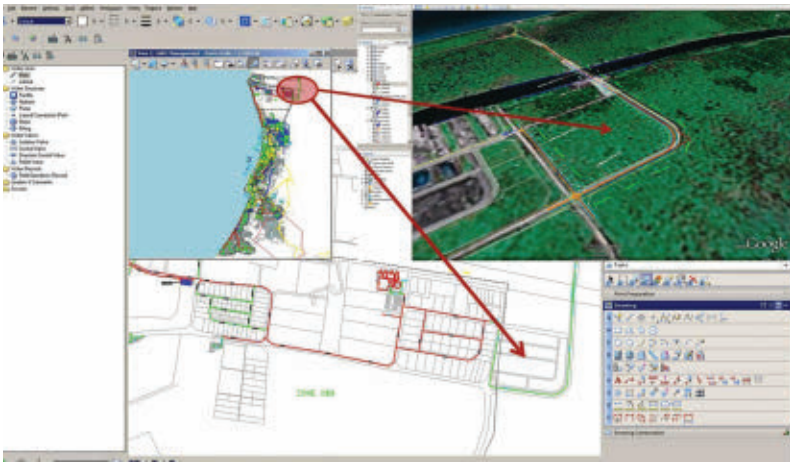
LAKU Management Sdn Bhd

GIS and Network Modeling Implementation

Miri, Bintulu, and Limbang, Malaysia

LAKU Management is studying the adequacy of its existing water distribution network to meet water demand in the three urban townships of Miri, Bintulu, and Limbang, Malaysia. The goal is to establish plans to upgrade existing systems for the control and management of water distribution in response to growing water demand. The $650,000 project is implementing integrated GIS and hydraulic modeling.

Using Bentley Water and WaterGEMS, this project will generate long-term benefits such as shortened time required to build or update network models for hydraulic analysis as well as better return on investment for the company. To ensure success, the company invested in training services for its Bentley Water and WaterGEMS users.



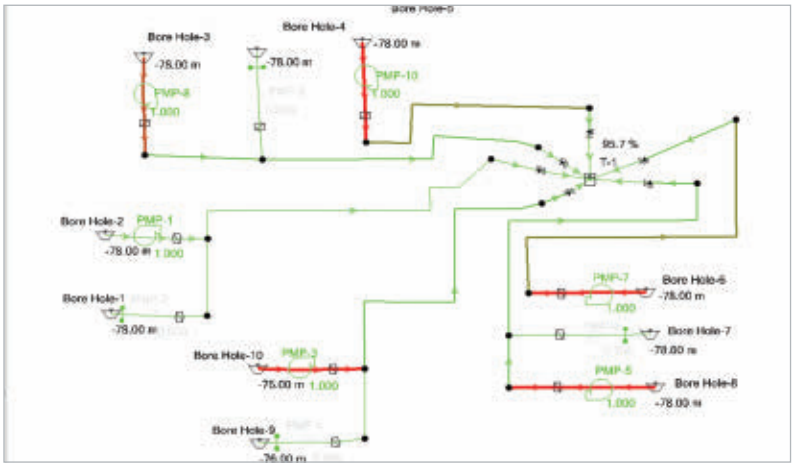
Larsen & Toubro Limited

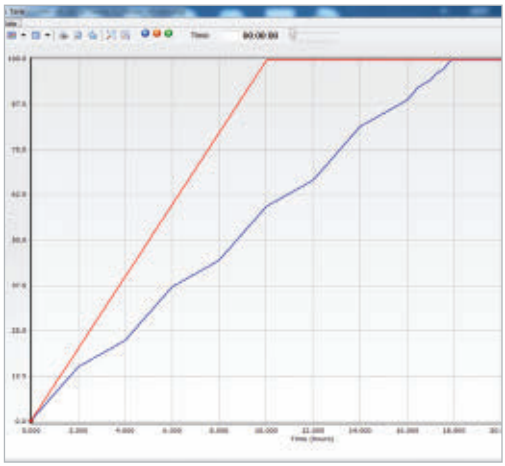
A Sustainable Approach in Water Transmission

Chennai, India

Larsen & Toubro's $120,000 sustainable water transmission project in Chennai, India, focused primarily on the need for energy conservation and savings. Based on a hydraulic model developed for this residential project, the team tried various approaches to filling up an underground water tank from multiple bore holes, then optimizing the hydraulic model for the various parameters.

Using WaterGEMS to create the basic hydraulic model for the analysis, the company conducted extended period simulations under various what-if conditions, including an energy cost analysis. Without modifying the basic optimized elements, the project team arrived at suitable operating conditions for the pump, resulting in about a 10 percent extension of pump life. Using WaterGEMS also achieved an estimated power savings of 9 percent.





Manila Water Company

Improvement of Wastewater System in Pamayanang Diego Silang

Taguig City, Philippines

The Pamayanang Diego Silang housing project in Taguig City, Philippines, is composed of 62 five-story buildings and two schools with approximately 15,000 residents. The aging wastewater system needed improved sewage flow and a simplified network to eliminate problems such as blocked sewer lines and overflowing sewer manholes. GPS technology was used in collaboration with SewerGEMS to determine where pipes and appurtenances were to be laid and installed.

Completed in December 2008, the $276,000 project optimized sewage treatment plant operations from 400 to 1,200 cubic meters daily and reduced monthly operating expenses by $1,700. The improved network efficiency eliminated daily maintenance activity, generating $6,122 in annual savings. The improvements also eliminated odor problems in the community and reduced carbon emissions from 792 to 0 kilograms per month.

ASIA

Manila Water Company

Providing Water Amid Climate Change

Binangonan, Philippines

Thirty kilometers southeast of Manila, Binangonan had provided 21 percent of its population with potable water, which was available for less than half the day. The network suffered up to 57 percent water loss, causing low pressure throughout the service area. Manila Water Company improved efficiency and reliability and extended service to the rest of the municipality.

The $3.96 million initiative involved developing a hydraulic model of the existing water system using WaterGEMS. Based on the simulations, three interconnected systems were built in phases. Reliability strategies developed using WaterGEMS minimized the effect of 2009's typhoon Ketsana so the 12,000 customers in the Phase 1 supply area had uninterrupted service. By 2012, 60,000 residents will have 24/7 water.

Metropolitan Cebu Water District

Metropolitan Cebu Water District GIS

Cebu, Philippines

The Metropolitan Cebu Water District developed a GIS to accommodate data and information concerning the water supply and distribution pipeline network, water production facilities, and major appurtenances. Developed by the GIS unit in collaboration with key departments, the $220,000 application is now updated by departmental users and source data owners. The objective is to maintain a common, accurate, and up-to-date GIS map for decision support.

Based on MicroStation GeoGraphics, the GIS application has a simple and user-friendly graphical user interface that was customized to help technicians update data more efficiently. The GIS was rapidly deployed to relevant site offices for data updating and maintenance work. The GIS map is now available through the LAN and WAN, making GIS data available online to satellite office terminals.

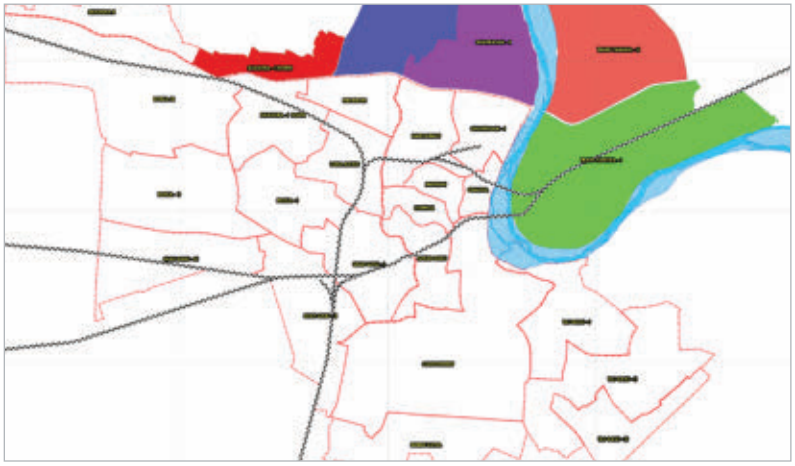
NJS Consultants Co. Ltd.

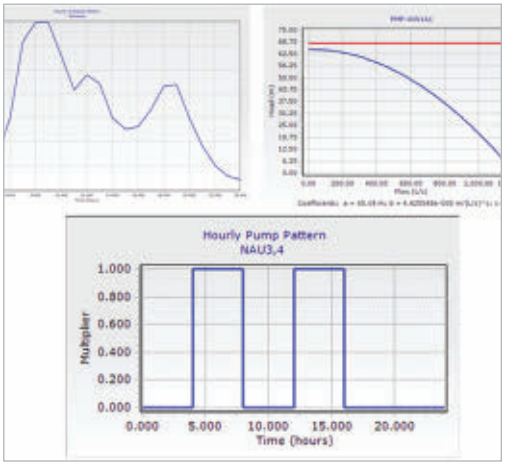
Agra Water Supply Project

Agra, India

The $267 million Agra Water Supply Project will augment the water supply for the citizens of Agra, India, and ensure the use of best practices in distribution system rehabilitation and operation management. The project involves development of GIS-based asset management and a hydraulic model for the city. Network modeling will result in water loss reduction and a distribution management program.

The GIS development and network modeling activities include GIS-based spatial database creation and design using ESRI and Autodesk solutions, water network modeling using WaterGEMS, GIS encoding and network programming using ArcSDE, and customized application development using web-based GIS technology.





SehNirman

Increasing Efficiency of Water Distribution System

Bhiwandi, India

In Bhiwandi Nizampur City, India, the ability to provide efficient water services is hindered by unplanned growth. Undocumented water connections and distribution pipelines have resulted in poor maintenance, mechanical damage, and a high percentage of unaccounted for water. The goal of this project was to carry out pipe-detection surveys, create a GIS of surveyed assets, and develop a hydraulic model of the water distribution network.

The simulation of the city of Bhiwandi encompassed 13 villages and an area of 26 square kilometers. Bentley Map, Bentley Water, WaterGEMS, and WaterCAD built a hydraulic model that was used to develop a leak management system and resolve the water loss problem. The project enabled remedial action as well as the laying of new water distribution pipelines.

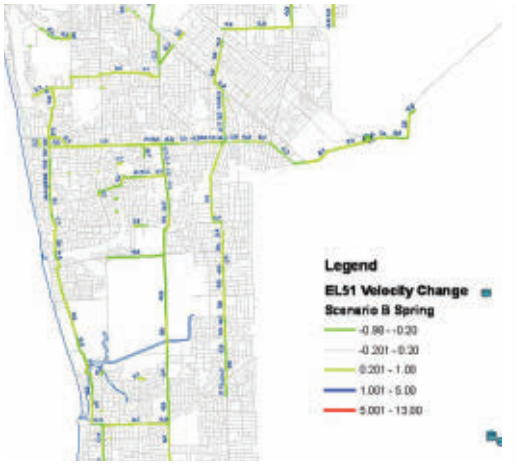
South Australia Water Corporation

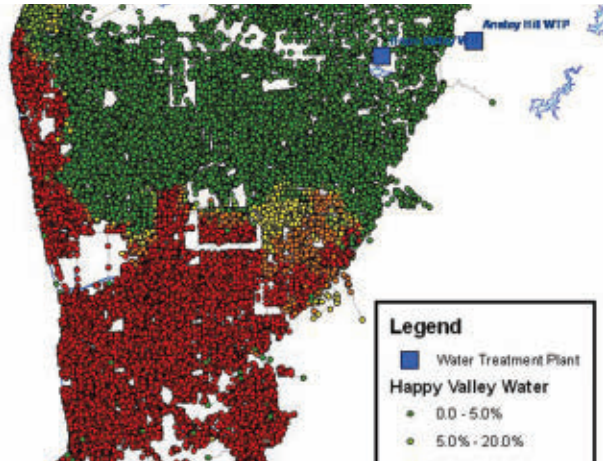
Integration of ADP and MAWSS

Adelaide, Australia

The Metropolitan Adelaide Water Supply System's goal for this $500 million project was to integrate two existing systems to better deliver water and wastewater services to 1.5 million people across South Australia. The plan involves extensive changes to existing supply configurations to increase water supply and security.

WaterGEMS and HAMMER were used to create detailed designs. The WaterGEMS model for the project, which includes six water treatment plants, 67,000 pipes, 96 storage tanks, 110 pump stations, and 240 control valves, has been extensively utilized through every phase of integration. WaterGEMS was also used to model changes in supply pressure, water age, chlorine residual, and water main velocity.





Veolia Water India Pvt-Ltd

Efficiency Improvement and Reducing Supply Discrepancies

Nagpur, India

The Nagpur Municipal Corporation is planning to outsource the city water distribution network on a public-private partnership basis to provide 24x7 water supply across the city of Nagpur, India. Veolia Water India is participating in a $6 million pilot project in the Dharampeth zone with a goal of improving system efficiency and service to customers.

Using WaterGEMS to prepare the existing distribution network model enabled the company to save about 360 man-hours by avoiding repetition of network drawing and data entry. With the use of WaterGEMS, Veolia applied a scientific methodology to convert from intermittent to continuous water supply, resulting in avoidance of waterborne diseases and establishing individual water connections with affordable tariffs.

VicRoads Design
Implementation of InRoads Storm & Sanitary
Victoria, Australia

VicRoads Design faced the challenge of delivering more projects in less time and a shrinking pool of experienced designers. The firm invested in an integrated drainage design tool that could automate repetitive manual calculations, integrate drainage design to facilitate plan production, remove errors through automation, develop and verify alternative drainage design scenarios quickly, and improve the drainage design knowledge in the road design group.

By implementing InRoads Storm & Sanitary, the firm now cannot only deliver designs quickly, but also develop much needed technical expertise in relation to drainage design while providing a fully integrated solution for road and drainage design projects. It has enabled experienced designers to focus on adding value during design and transferring knowledge rather than spending time on routine and repetitive tasks.

Wilbur Smith Associates Private Limited
Water Supply Scheme
Gangtok, India

Burtuk and Chandmari, two wards in Sikkim, India, had no public water supply, leaving the population dependent on unsafe, untreated spring water. The $4.45 million project to design and construct a water distribution system and service reservoirs included chlorinators at the reservoir locations and bulk flow meters on pumping and distribution mains.

The hilly terrain, high elevations, and fixed boundary conditions were major challenges to designing a system that achieves maximum residual pressure. Using WaterGEMS, Microsoft Excel, and AutoCAD reduced the time model builders needed for network drawings and helped them design a system with residual pressures within the boundary limits.

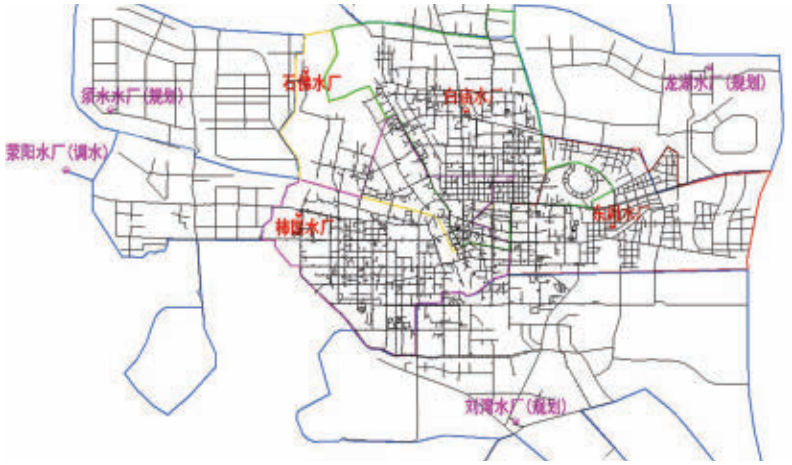
Zhengzhou Water Supply Corporation

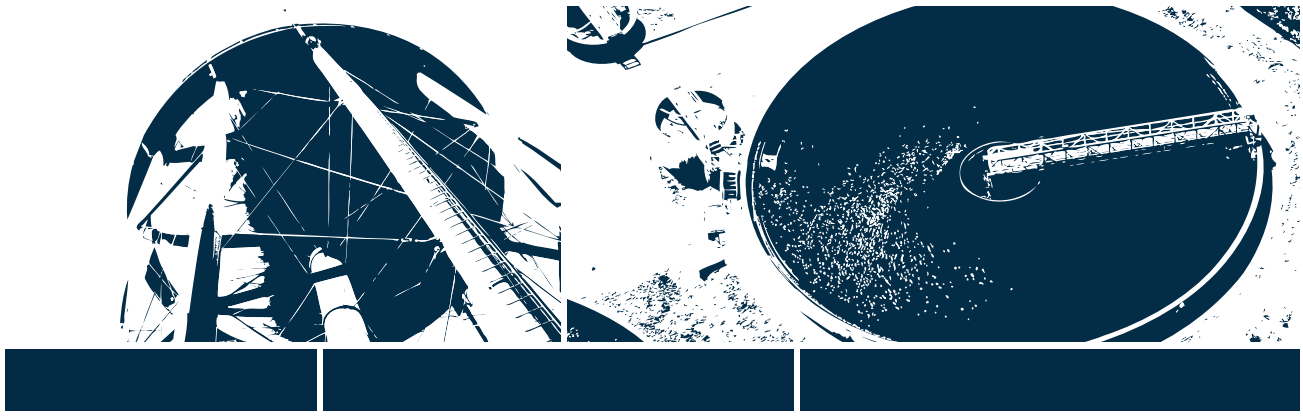
The Water Supply System Modeling of Zhengzhou

Zhengzhou, China

Serving a population of 3.4 million in northern China, Zhengzhou Water Supply Corporation decided to convert to digital management of the water supply network. Technicians built a hydraulic simulation model of the water supply network, which included the collection of basic data, import of GIS data, improvement of topological structures, and water allocations. Capital cost was $90,000.

WaterGEMS enabled the company to create a beneficial hydraulic simulation model. The model helps keep the error value within 1.6 meters between the model's simulated pressure outcome and measured value, and its flow error under 10 percent. The model and its application aid pipeline management and optimize dispatching crews for outages.





Share Your Inspiration With the World

The *Be Inspired* Awards competition showcases excellence and innovation in the design, construction, and operations of infrastructure projects around the world. The *Be Inspired* Awards program is unique—the only competition of its kind that is global in scope and comprehensive in categories covered, encompassing all types of infrastructure projects.

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Europe, Middle East, Africa & Russia

THE WATER **PROJECT SHOWCASE**

Innovation in Water, Wastewater, and Stormwater Networks
Innovation in Water and Wastewater Treatment Plants

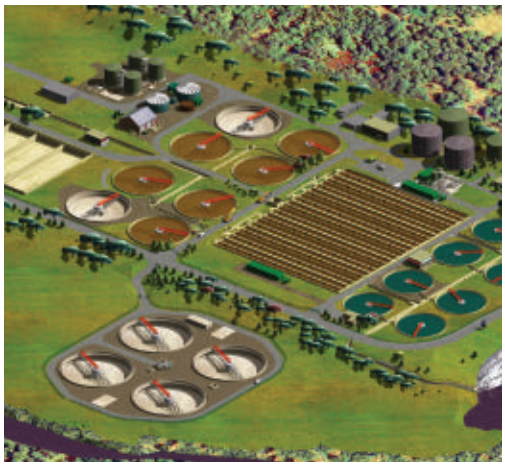
Water projects in Europe, Middle East, Africa & Russia include innovations from Sharjah Electricity & Water Authority, Atkins Water, URS/Scott Wilson, United Utilites Water, CH2M HILL, and many more.

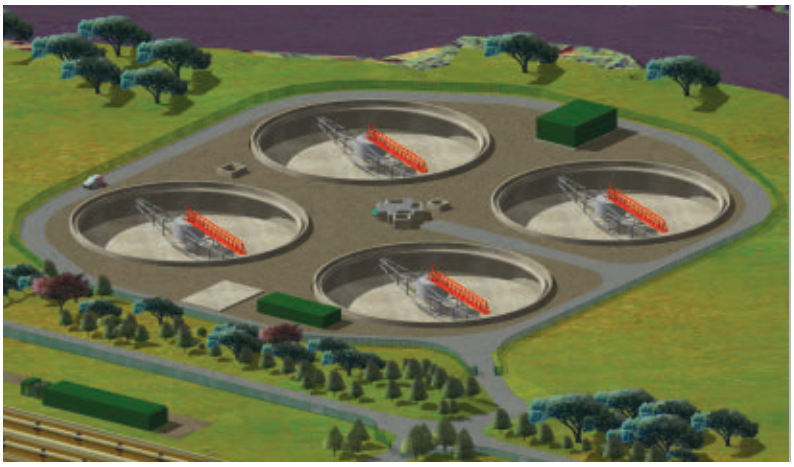
Bentley®
Sustaining Infrastructure

Atkins Water

Bolton Wastewater Treatment Makes the Grade

Bolton, United Kingdom





Single Largest Environmental Project Undertaken to Date

More than 15 years after the European Union passed a directive to protect the environment from the adverse effects of wastewater discharges, 20 percent of waterways in Manchester still rate an E or F in the U.K. Environment Agency's grading system with A being very good and F being bad. But the E-rated River Irwell may soon get an upgrade thanks to a £40 million environmental improvement program initiated by United Utilities, which operates the 50-year-old Bolton Wastewater Treatment Works on the river northwest of Manchester.

Regulated under the Urban Wastewater Treatment Directive of 1991 and the Freshwater Fisheries Directive of 1978, industrial plants and wastewater treatment works at Bolton, Rossendale, and Bury had been frequently cited for unsatisfactory intermittent discharges that contributed to the River Irwell's poor water quality. To prevent further deterioration of rivers and other aquatic ecosystems from these and other facilities, the European Union adopted the Water Framework Directive in 2000, which has a goal of restoring polluted waters to "good" status by 2015.

To achieve this, the Environment Agency has been working with United Utilities and other water industry stakeholders to determine what improvements should be made as part of their five-year investment cycles, known as Asset Management Plans (AMPs). The United Utilities' 2005-2010 cycle (AMP4) kicked off an aggressive £1 billion environmental improvement program to modernize wastewater treatment works throughout northwest England. Part of that plan, the Bolton Wastewater Treatment Works upgrade, is the single largest environmental project undertaken to date. It is being designed and built by the joint venture team of Galliford Try, Costain & Atkins (GCA), which was set up to manage assets for United Utilities in 2000 and was awarded the contract for AMP4 after successfully delivering a series of earlier projects.

The Bolton Wastewater Treatment Works serves 300,000 residential customers and an industrial equivalent of 140,000 customers, treating up to a maximum flow of 210 megaliters per day. The upgrade requires refurbishment of the existing plant, as well as major new construction, including two outlet culverts, two primary settlement tanks, a ferric dosing plant, a sludge treatment facility, and four secondary settlement tanks.

Atkins Water became involved when it began the six-month detail design phase in January 2007 to deliver 3D designs for visualization and simulation, in addition to traditional 2D plan and section drawings. One of the critical success factors for the project was to carry out all construction works and not impact the day-to-day operations of the existing facility.

"The GCA construction management team considers 3D visualizations to be a major tool in demonstrating construction sequencing to the client," explained Paul Heath, Atkins CAD manager. "Presentations containing images and time line video sequences produced from the 3D model of the proposed works are a major aid to the project because they demonstrate that the construction program is achievable."

As most of the construction is located on the current operating site, it was crucial to demonstrate early in the program the feasibility of upgrading the plant while maintaining full treatment operations. This would enable construction to commence in February 2007 and be completed by August 2009.

"Atkins used 3D images at public hearings to show the visual impact of locating the new tanks on the greenfield. The visuals helped gain buy-in from residents of the adjacent housing development who use the public footpath around the perimeter of the property."

The four secondary settlement tanks each 46 meters in diameter, the largest ever built for United Utilities, are on an adjacent greenfield. That siting required approval by the local planning authority, and in order to maintain the project's fast-track schedule, GCA had to secure approval on the first attempt.

Atkins used 3D images at public hearings to show the visual impact of locating the new tanks on the greenfield. The visuals helped gain buy-in from residents of the adjacent housing development who use the public footpath around the perimeter of the property. Not only was the proposed site development approved, but the project evoked so much enthusiasm that the local school used videos of the modeling as part of an educational project and scheduled site visits at various construction stages.

"This is an ongoing relationship that started with the early planning consultants and is one that both the team and the client are keen to continue going forward," Heath said. "The 3D visualization was without a doubt beneficial to the project in gaining stakeholder confidence in both the design and construction phases."

Optimizing Safety and Operations

Atkins' water and environment business operates within a distributed enterprise called the Integrated Alliance South (IAS), comprised of United Utilities, GCA, and Montgomery Watson Harza. Atkins designers used AutoPLANT to develop the 3D models, which enabled them to work seamlessly with the DWG format used by IAS partners as well as maintain interoperability with the DGN format. Direct plotting to a 3D PDF format allowed modelers to e-mail small files to key stakeholders, giving them easy access to the visuals.

The animated 3D models demonstrated how construction sequencing would ensure that the plant stayed fully operational. For example, the activated sludge plant consists of 12 biological treatment lanes covering 1.4 hectares about the same area as two football pitches. Operational constraints dictate that only one lane can be taken out of service at any time to enable the replacement of aerators and baffles. Simulating the procedure proved that it was possible.

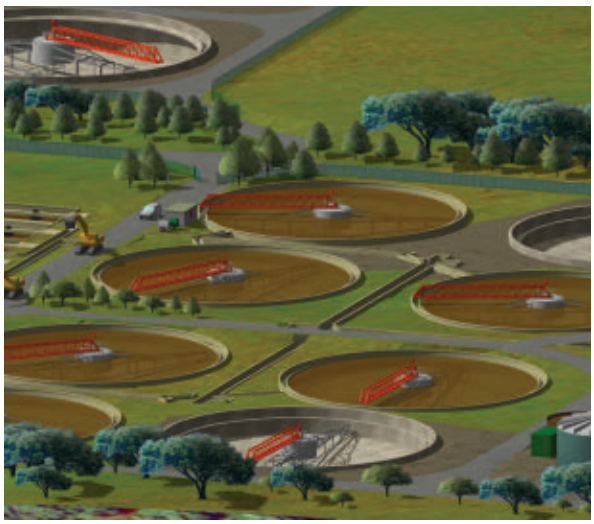
The models also enabled designers to optimize access stairways and platforms that operators use to get to the decant valves on sludge storage tanks. Each of the four 12-meter-tall tanks has up to 12 manually operated valves for drawing off sludge liquors. The models illustrated the valve locations and how they could be accessed, potentially eliminating unnecessary stairways. Considering the cost per stairway was £20,000, the savings could be significant.

"It was important to demonstrate that an optimum solution could be achieved by combining access platforms and optimizing the footprint of the plant, while maximizing construction efficiencies and, therefore, reducing costs," Heath said. "Access issues around the site during construction have been more easily resolved through clear understanding of work areas and service corridors."

Incorporating animation brought the visuals to life for plant operators, construction supervisors, and health and safety representatives. The models made it clear that cranes and other lifting techniques could be employed in areas restricted by existing operational structures. For plant operators, who in the past had to trawl through reams of 2D construction drawings, the 3D models provided an early virtual tour of the new facility, allowing them to spot and eliminate Hazards and Operability and Access Lifting and Maintenance issues from the design.

The visualizations became a core component of the interdisciplinary review process that promoted collaboration and communication among all stakeholders. Atkins estimates the cost benefits of the resulting improvements in safety and operations could be up to 0.75 percent of capital costs — a significant amount of money on a project of this magnitude.

United Utilities' investment in modernization will ensure that the Bolton Wastewater Treatment Works is able to meet the European Union directives for discharge consents by the year 2010. If, the River Irwell achieves the goal of a "good" water quality rating by year 2015, it will be the cleanest it has ever been since quality records began.



ASA Spa Livorno

Obtaining Time Savings With Integrated Water Solutions

Tuscany, Italy

Accessing the Same Data

In Italy, the management of water cycles is the responsibility of Ambiti Territoriali Ottimali (ATO). Since January 2002, the Azienda Servizi Ambientali (ASA), a utility company, has been responsible for operating and managing water, wastewater, and gas services of ATO 5, which covers the Tuscany territory. This zone includes 33 municipalities, three provinces of 2,444 square kilometers, and over 366,000 residents.

ASA has been a user of Haestad hydraulic analysis models for several years and is very satisfied with the software capabilities. It uses WaterGEMS for water distribution modeling, SewerGEMS for sewer systems modeling, CivilStorm for stormwater conveyance dynamic modeling, and HAMMER to efficiently identify, manage, and mitigate the risks associated with hydraulic transient, in particular from the submarine pipeline that serves the Elba Island.

"Using Bentley solutions, we were able to reduce the effort required to keep up-to-date data across departments, and we were able to implement a unique database accessible by several departments to eliminate data duplication."

However, ASA's challenge came from the fact that two different departments the Servizio Progettazione (modeling department) and Sistema Informativo Territoriale (GIS department) were using different data sources. Consequently, the modeling department had no access to the GIS data, and therefore was spending excessive time re-creating and re-entering network information. This workflow resulted in data duplication and difficulties identifying the correct data.

The GIS department was using an application developed by a third-party company for the capture of the network data in a customized environment with the data residing in an Oracle database. The modeling department was using Bentley's Haestad solutions for hydraulic modeling and required access to the system data residing in the Oracle repository. Bentley's challenge was to deliver a system and supported workflows that unified the Oracle data repository and the Haestad modeling applications.

Avoiding Redundancy

With such specific requirements, Bentley Professional Services proposed to ASA a solution based on MicroStation, MicroStation GeoGraphics, and Haestad applications. The modeling department, which already had shapefile data, chose a MicroStation-based environment. Bentley created a workflow for loading the data in shapefile format into the hydraulic models and customized tools in MicroStation for the topology cleanup of the hydraulic model. The same solution was implemented with the three Haestad applications: WaterGEMS, SewerGEMS, and CivilStorm.

In contrast to the previous workflow, the modeling department team members no longer need to manually enter the majority of WaterGEMS, SewerGEMS, or CivilStorm data. Instead, they can access the available data directly from Oracle using a Haestad tool called Model Builder, which automatically extracts the data from Oracle and builds a hydraulic model. Furthermore, MicroStation and the MicroStation GeoGraphics extension allow ASA to load cartographic layers and network models in the same integrated environment.

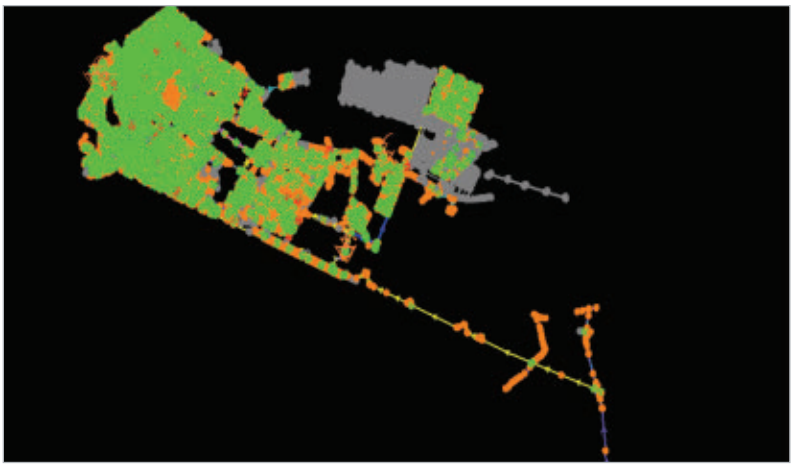
Carlo Calastri, resp. servizio progettazione e studi, explained, "Using Bentley solutions, we were able to reduce the effort required to keep up-to-date data across departments, and we were able to implement a unique database accessible by several departments, to eliminate data duplication. We estimate that we are saving around 200 euros per day by avoiding double work for data input and error-checking. "

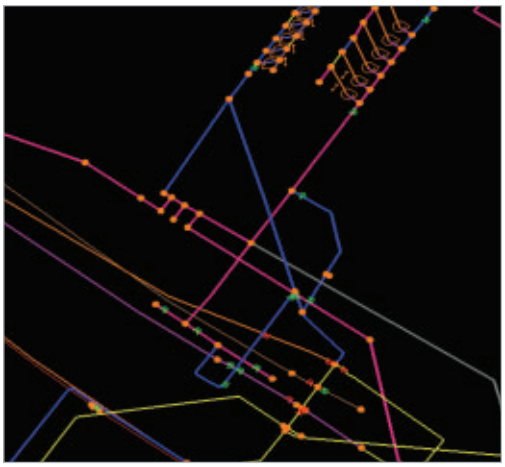
Calastri concluded, "If we consider three people working in the modeling department spending a third of their working time to enter data in the model, we can now recover that time for the analysis of existent networks and the design of new networks."

Sharjah Electricity & Water Authority

Sharjah Electricity & Water Delivers a Sustainable Water Supply

Sharjah, United Arab Emirates





Rapid Development Strains Water Resources

The Emirate of Sharjah in the United Arab Emirates continues to experience rapid development that's evidenced in its many new major industrial, commercial, construction, and agricultural projects. This growth has resulted in a huge demand for water in a region where surface water resources are nearly nonexistent. To help manage this demand, as well as model water supply patterns, plan maintenance projects, and reduce water leakage in its 2.800 kilometer water distribution network, the emirate needed efficient and integrated water network management software. Sharjah Electricity & Water Authority (SEWA) engineers chose WaterGEMS to address each of these challenges, and is currently using it to effectively manage its water network.

SEWA's geospatial and water professionals work with a variety of data, including data from a GIS, digital elevation models, parcel information, billing data for node demand calculation, and CAD data for infrastructure information. When SEWA's engineers receive GIS or CAD data from outside contractors, they can easily import it into their new WaterGEMS model using shapefile import or polyline-to-pipe conversion tools. These improved workflows enable other Sharjah government departments to easily access the same data, accelerating information sharing and communication across project teams.

WaterGEMS Analysis and Engineering

The following five land-use-designation zones had been identified: industrial areas, low-density residential areas, the old Sharjah City network, high-density residential areas, and the new Sharjah City network. WaterGEMS was used for criticality analysis in each of the zones to identify not only the impact of outages, but also critical segments and pressure zones. Next, the hydraulic properties of network elements were calculated and the results were visualized in longitudinal profiles for easier graphical visualization of calculated properties such as pressure or hydraulic grade line, and element characteristics such as elevations.

This enabled SEWA to create a network improvement and development program for its engineering teams. These engineering teams used it to help plan and execute projects ranging from the replacement of critical segments and valves to changes in the direction of flow to a reduction in pipes. The latter project enabled SEWA to redistribute water from areas of the city in which water flowed adequately to areas in which water flow was insufficient to meet demand.

Additionally, it enabled the engineering teams to address issues with a particularly troublesome segment of the network that's about 40 years old. In this segment, water loss from underground leakage was an ongoing concern, while high pressures in the system also caused occasional breaks in the transmission lines ~~pa~~rticularly in portions close to pumping stations where the pressure is necessarily high. Regular replacement programs as well as the criticality study done in WaterGEMS enabled SEWA to reduce water loss, ultimately conserving more of the potable water pumped into the network.

By deploying WaterGEMS for this network improvement and management program, SEWA was able to achieve continuous water supply without complaints from residents about water shortages, even with water production below the estimated demand of 105 million gallons per day.

Optimizing Natural Resources

Among the many benefits SEWA achieved through its use of WaterGEMS are:

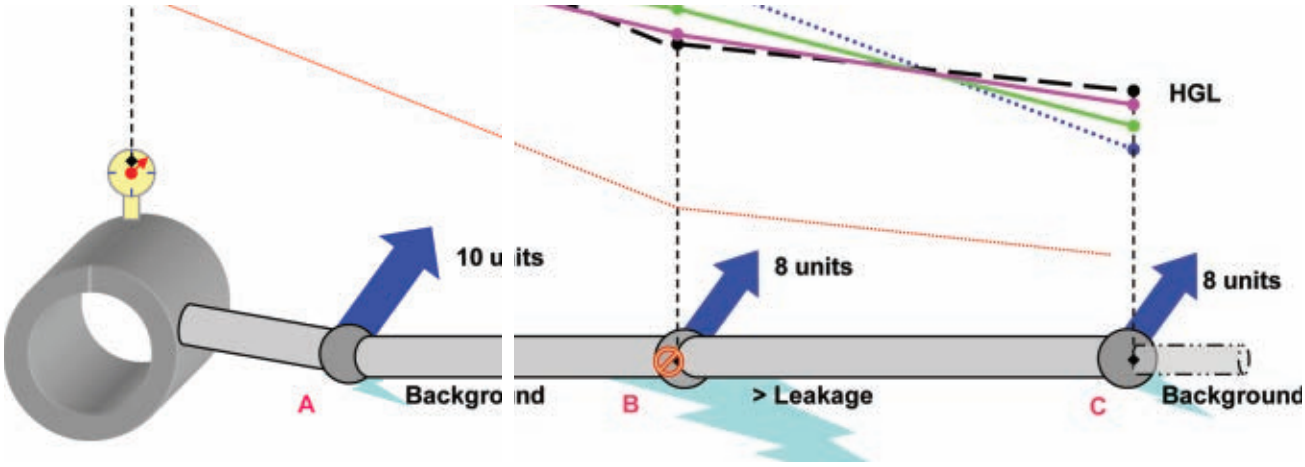
- A dramatic reduction in the number of complaints it receives from 343 in 2007 to just 13 in 2009, which translates to a 98 percent customer satisfaction rating
- The ability to supply water at 22 percent below the calculated water demand without customer complaints
- A steady reduction in water leakage ~~fr~~om 18.7percent to 11.6 percent to 8.9 percent of the supply
- Substantial savings in man-hours required for maintenance processes
- Improved engineering workflows empowered by the ability to locate the critical segments in the network, which facilitated rapid execution of projects by the engineering teams (for example, teams would know in advance what valves to close for each broken pipe)
- The ability to maintain stable pressure in the supply network for the five zones of Sharjah City

WaterGEMS helped Sharjah City engineers optimize the use of natural resources, supplying water in a safe and sustainable manner for future generations of the United Arab Emirates.

United Utilities Water

Establishing a New Method for Locating Hard-To-Find Water Leakage Sources

Warrington, United Kingdom



New Ways To Reduce Water Loss

The 2006 Water Management Report produced by the United Kingdom's House of Lords Science and Technology Committee estimated that about 15 percent of Britain's drinking water is lost to leakage, and other experts estimate the global figure is as high as 40 percent. In a world where water is increasingly scarce, loss of treated water is not just a revenue issue, it is very nearly a moral issue and water system managers everywhere are looking for new ways to reduce the amount of water lost to leakage.

United Utilities Water (UUW), the United Kingdom's largest operator of water and wastewater networks, has an added incentive. In the United Kingdom leakage is measured, targets are set, and failure to meet those targets results in severe financial penalties. To comply with these regulations, UUW teamed up with Bentley in an applied research project that investigated water system modeling in leak detection. The use of such models is routine for analysis of a system's hydraulic characteristics, but applying model-based methods to leak detection was new territory. The technology helped UUW locate hard-to-find leaks and determine the amount of water loss per hour in a given area, providing the water industry with an important new tool to help sustain world urban water infrastructure assets.

There are three main methods of leak detection traditionally used in the industry: sounding surveys conducted by field crews with audio sensors, step testing of subsystems, and permanently installed acoustic loggers. All three are effective, but, in addition to being expensive and slow, they tend to work best on larger "noisier" leaks. Since the hunt for leaks has been going on for several years, most of the low-hanging fruit has been found, and two other trends work against traditional methods. The replacement of ferrous pipes with high-density polyethylene (HDPE) reduces the acoustic signature of leaks, and increasingly sophisticated pressure management systems reduce both the acoustic signature and intensity of leaks. It is ironic that these two positive developments inhibit further leak detection.

Leakage can be modeled as a special instance of emitter flow, per the formula Qi = Ki * Pi , where Qi is the leakage aggregated at node i, Pi is the nodal pressure at node i, is the exponent (usually 0.5 for leaks as a default), and Ki is the emitter coefficient. If the emitter coefficient, Ki, can be optimized usefully, then, in theory, it can be a good way to detect leaks in a system. But leakage tends to concentrate in relatively few hotspots and, in practice, optimizing hundreds or thousands of nodal emitter coefficients in order to detect the handful of spots with significant leakage has proven to be a significant computational challenge.

UUW teamed up wth Bentley in an applied research project that investigated water system modeling in leak detection.

UUW and Bentley engineers got around this by matching simulated flows and pressures with field observed values and applying a genetic algorithm (GA) a search and optimization method based on the principles of natural evolution and genetic reproduction to the problem. Initial results were promising so Bentley engineers developed the algorithm into a user-friendly software tool and included it in WaterGEMS. They also arranged for a real-world benchmark test and evaluation of the new method to be conducted on UUW's system by a third partner, the United Kinggom's Atkins Water and Environmental Group.

Supported by Test Results

Atkins selected 13 district metered areas (DMAs) in UUW's systems for intensive leakage analysis by the new model-based method. An estimated total leakage of 10m3/hour was identified in 10 of the 13 DMAs, and this finding was confirmed by subsequent fieldwork. This translates to 15.4Ml/day, or about 3.4 percent of total leakage when applied across UUW's service region. Further trials, and refinement of the methodology, suggest that this figure can be improved to at least 5 percent of total leakage, which will save UUW about $10.6 million annually in terms of reduced non-revenue water.

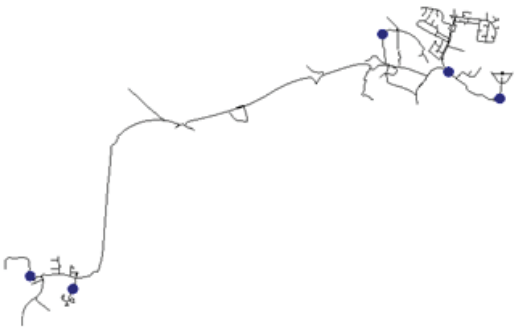
"The leakage detection optimization model developed in collaboration with Bentley," noted David Turtle, UUW's leakage and demand strategy manager, "is a valuable and important tool in helping to reduce leakage and to achieve annual targets agreed on with Ofwat, the U.K. water industry regulator."All parties in this collaboration are interested in spreading the news about a new, cost-effective way to locate leaks in mature systems. To that end, the complete model-based leakage hotspot detection method and practical applications have been submitted to the International Water Association (IWA) for peer review.

In addition, they have appeared in several publications. The potential population affected is most of the developed and developing world, and the project has made significant contributions:

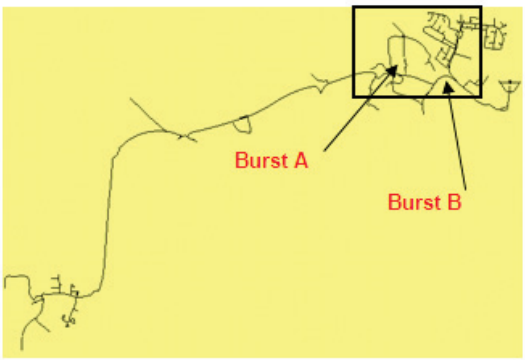
- It solves a long-standing problem for the water industry, and enables utilities to focus their maintenance and repair efforts on the areas of their systems most likely to contain leaks.
- It has already been developed into existing system modeling packages with familiar, user-friendly interfaces.
- It has resulted in important practical and theoretical knowledge being shared with the international engineering community.
- It provides a means of better sustaining world urban water infrastructure assets by detecting leaks that were previously unidentifiable.

The method and tool were presented at the Water Loss 2008 conference organized by Bentley, which was attended by 65 water system professionals from more than 20 countries.

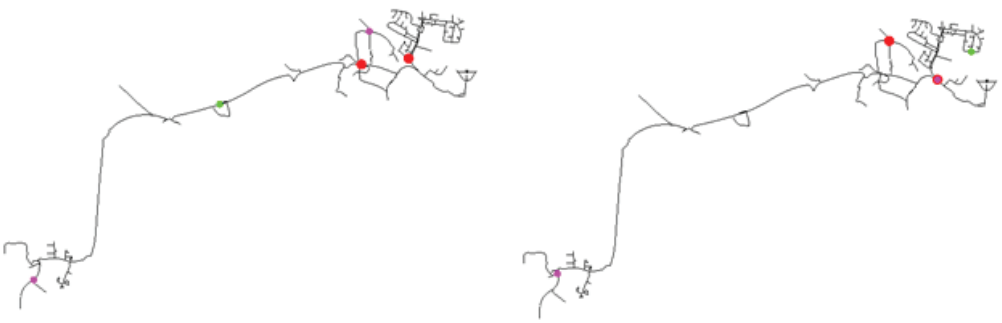
The new methodology developed by UUW and Bentley researchers fills an important need by helping managers in mature systems to further reduce water leakage after other methods have been exhausted. It also enables managers in any system to identify the water loss hotspots so that leak reduction programs can be effectively prioritized. By publicizing this new method and making it available for use worldwide, these organizations are having a significant positive effect on the world's water infrastructure.



District meter area for leakage detection study with locations of pressure loggers



DMA with field identified leakage hotspots



Two typical predicted leakage detection solutions identified with three snapshots of field data at 2:00AM, 2:30 AM and 3:00AM

2008 FINALIST

CASE STUDY

URS/Scott Wilson

Bahrain's Water Garden City To Provide Sustainable Services

Manama, Bahrain

Development Maximizes Value of Key Asset

Bahrain is a group of 40 islands in the Arabian Gulf midway between the Qatar peninsula and Saudi Arabia. On the north shore of the kingdom's capital city, Manama, a new mixed-use urban development aims to maximize the value of its key asset: water. Water Garden City incorporates luxurious marinas and beaches to create a premier seaside community in the heart of the Gulf's fast-growing financial district. Developer Albilad Real Estate is building the city on a 400-hectare site that has been reclaimed from the sea. Accommodating a potential population of 30,000 on land and another 10,000 afloat, the designers are challenged to provide ecologically sustainable infrastructure, including a gravity sewerage network. The design was cost-effectively achieved with the help of Bentley software.

URS/Scott Wilson, a global integrated design and engineering consultancy and lead consultant for the project, worked with subconsultants to develop the master plan for Water Garden City. The plan incorporates road corridors, building massing, and land-side marina facilities, as well as a large-scale marina sculpture called the Pearl, symbolic of Bahrain's heritage. Part of the land was previously reclaimed from the sea; for the remainder, URS/Scott Wilson prepared specifications, carried out the tender evaluation, and supervised reclamation. That work is now complete. URS/Scott Wilson's engineers are currently progressing the preliminary infrastructure designs, including potable water, sewerage, storm water drainage, irrigation, district cooling, power, solid waste management, and telecommunications services.

URS/Scott Wilson's engineers used SewerGEMS Sanitary, included in the SewerGEMS application for urban sanitary and combined sewer analysis and modeling, to design the sewerage network for this major residential commercial project. The network design was submitted to the Ministry of Works, Sanitary Engineering Planning and Projects Directorate, and subsequently approved.

The gravity sewer network proposed for the project included three intermediate sewage lifting stations. Minimum depth of manholes was assumed to be 1 meter, with the maximum depth of manhole limited to 5.5 meters to avoid dewatering problems during the installation of the sewer network and potential inflow of saline water during operation. Permissible velocities derived from the network modeling ranged from 0.6 meters per second (m/s) to 3 m/s.

"By using SewerGEMS, we achieved a savings of approximately 30 percent to 40 percent of the network design time compared to the previous design process using Excel spreadsheets," said URS/Scott Wilson infrastructure design engineer Prasada Rao B.V.R.K. "Considerable time was also saved in developing the profiles of the sewer network. Thanks to the ability of SewerGEMS to run directly within AutoCAD and MicroStation, we could generally achieve a 25 percent savings in time spent in drawing production."

"By using SewerGEMS, we achieved a savings of approximately 30 to 40 percent of the network design time compared to the previous design process."

The project team found the "what-if" scenario manager to be extremely useful, because it provided a way to manage and compare different design options, such as designs for both average and peak flow situations. "Because the design process was well structured, time was saved in reviewing and checking designs," he said.

Prior to commencement of works, a thorough Environmental Impact Assessment was carried out to identify, assess, and address any environmental impacts resulting during the design, construction, and life of the project. Potential impacts considered included hydrodynamic, marine ecology, and seawater quality. In general, the development was found to have no significant residual impacts. Precautions included design provisions such as oil-interceptors on surface water drains and an irrigation system designed to re-use treated sewage effluent.

Water Garden City will provide a convenient location for people to live and work. A wide range of facilities will be incorporated into the project, including residential accommodations and retail and commercial space, together with hotels and civic developments, and a marina — all of which will provide excellent opportunities for both the people of Bahrain and visitors to work, live, and enjoy their leisure time.

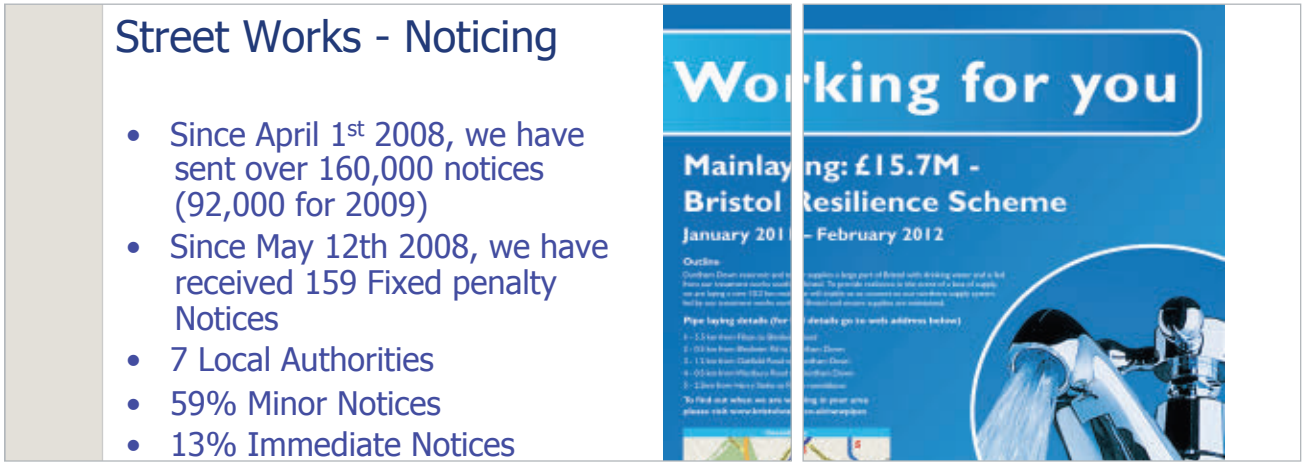
Bristol Water plc/Daniel Contractors Limited

Street Works Reporting Tool

Bristol, United Kingdom

Collection of street works information on behalf of Bristol Water was labor intensive and incomplete. The company was determined to reduce disruption and improve communications with the traveling public so it employed a consultancy to upgrade its Bentley Exor information modeling software.

To provide real-time reporting, a custom application was developed in collaboration with Exor. Bristol Water is now able to meet its reporting needs and provide greater accuracy in information management. With street works performance reflected in future efficiency assessments and regulated charges on water companies, Exor tools significantly reduce the risk of fines.



CH2M HILL

New Cairo Water Supply Hydraulic Modeling Analysis

Cairo, Egypt

The population of New Cairo, Egypt, is expected to grow from about 350,000 people to 5 million by 2020. With a budget of $3 million, the Egyptian government is using public-private partnerships to improve and expand water service to New Cairo. To this end, CH2M HILL was contracted to evaluate the hydraulics of the New Cairo Raw Water System.

CH2M HILL built a hydraulic model of the system. WaterGEMS performed extended-period modeling simulations for pump cycling evaluation, and HAMMER performed hydraulic transient (surge) analyses to size surge tanks for the system. Information from the analyses will allow appropriate modifications to the surge protection system and operating procedures, and ensure a sustainable water system.

Faber Maunsell

Lee Tunnel – Planning and Reference Design

London, United Kingdom

Due to shifting weather patterns and greater population, London's excess sewage frequently overflows into the River Thames, which decreases oxygen in the water and causes overall health risks. The Lee Tunnel is part of a new 40-kilometer storage-and-transfer network of tunnels below London that will halve the volume of untreated discharges into the river.

The Lee Tunnel project comprises 7 kilometers of 7.2-meter internal diameter tunnel and runs from Abbey Mills Pumping Station in West Ham to Beckton Sewage Treatment Works. Faber Maunsell created a model of the pumping station, tunnels, and adjoining shaft that was used as the basis for creating visualization. ProjectWise controlled the flow of data across the project team and enabled potential reuse of the data for lifecycle management of the project.

2008 FINALIST

HCWW

Master Plan for Water and Sewage Sectors

Cairo, Egypt

This project, which involves creation of a strategic master plan for potable water and sewage networks for all of Egypt, includes collecting data about the existing potable water networks, creating a unified GIS model for these networks by local consultants and contractors, and sharing calculations and data between many disparate offices. The massive project, currently involving more than 1,200 people, is expected to be completed in 2037.

WaterCAD, WaterGEMS, SewerCAD, and SewerGEMS are contributing to the creation of the master plan. By using Haestad software, HCWW will be able to manage, operate, and maintain all water and sewage company activities in 16 cities. Information and reports can be shared easily among all cities in Egypt and aid in HCWW's decision making.

ISKI Genel Mudurlugu

Infrastructure Integration of Mega City

Istanbul, Turkey

The goal was to provide an effective means for users to access, display, and print the engineering and managerial data generated by the Istanbul Water and Sewerage Authority. By applying a file-server approach and using a CAD application with a VBA application to manage the files inside the CAD environment, users now have access to, and can easily share among departments, as-builts, city infrastructure maps, and other related engineering data sets.

The new system was developed using MicroStation, MicroStation GeoGraphics, MicroStation PowerDraft, Bentley Water, Bentley Wastewater, Descartes, and InRoads. Using the ISKABIS system, the Istanbul Water and Sewerage Authority recorded reductions of 40 to 90 percent in spending on blueprints, photocopies, and couriers. The time to retrieve information about pipe and valve locations dropped from eight hours per document to 30 minutes per document.

2007 WINNER

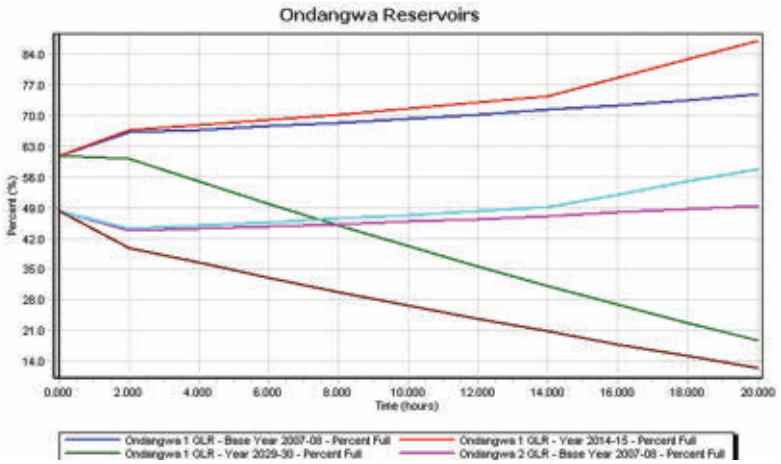
Lund Consulting Engineers CC

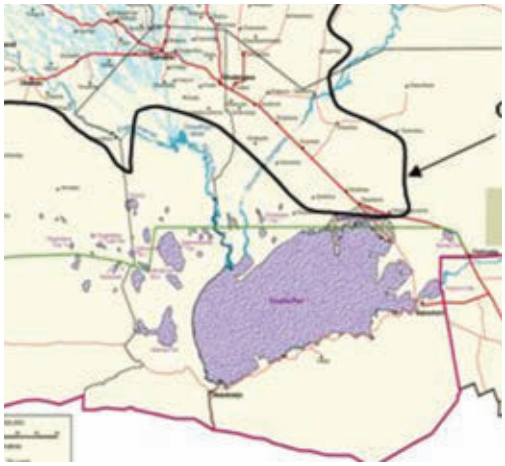
Master Plan for the Center North Water Supply Area

Windhoek, Namibia

To determine future capital development and capital management expenditure requirements, NamWater compiled an infrastructure master plan for the central north water supply area in Windhoek, Namibia. The 2.6-million-hectare project area has a population of 742,500 people. A team of multidisciplinary consultants overcame challenges associated with covering such a large investigation area when accurate data was not always available.

The project team compiled a network model using WaterCAD, which saved time in analyzing current and future capabilities of various sections and zones to satisfy the water supply currently, short-term through 2014-2015, and long-term through 2029-2030. The software contributed to the success achieved in projecting network upgrade and extension possibilities for the future.





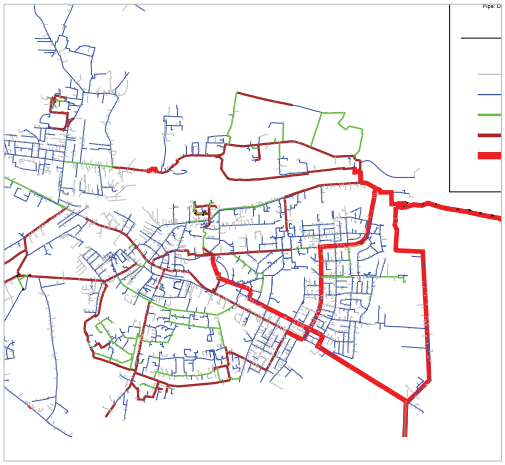
MPGK Chełm

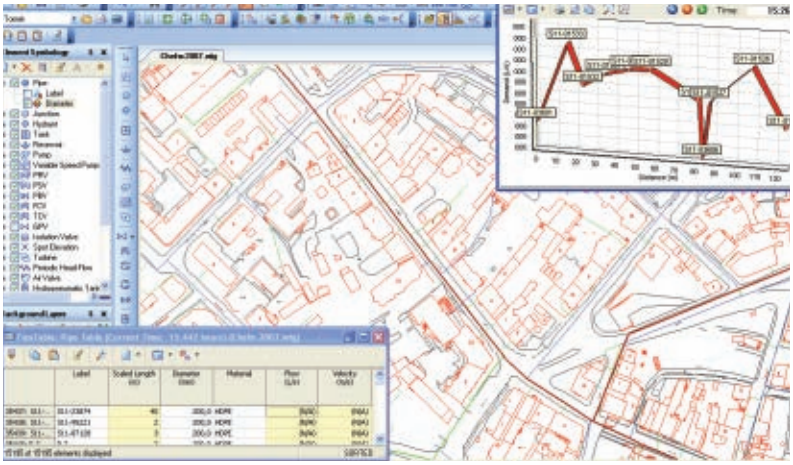
Hydraulic Model of Water Network

Chełm City, Poland

The goal of this project was a full diagnostic of the water network system, analysis of water demand for Chełm City in Poland, optimization of water networks, and connection to a SCADA system. The challenge was the scale of the project, short time for implementation, lack of data, and mixed formats due to data acquisition from many sources.

The project involved 300 kilometers of water systems and 15,000 pipes. With WaterCAD, MPGK built one of the first complete hydraulic models of the water network in Poland. WaterCAD helped MPGK save money, analyze the demand for water, save water, and preserve the environment, helping to sustain society as a whole.





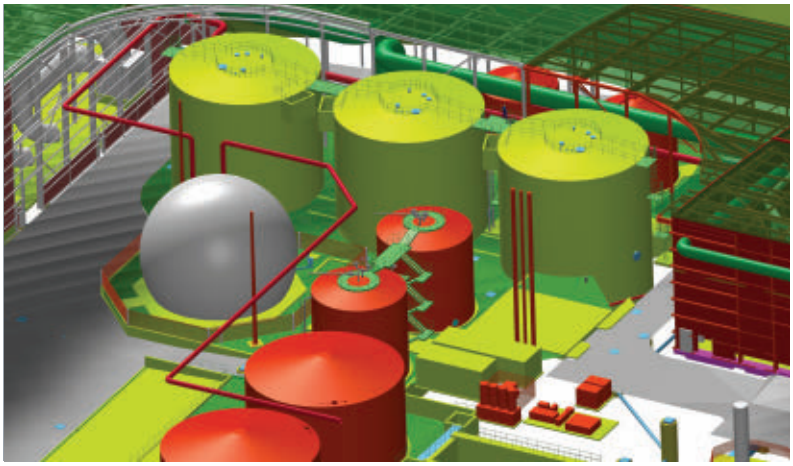
MWH Global, Inc.

Brighton and Hove WWTP

Brighton, United Kingdom

This $300 million project provided interceptor sewers and three lift-pumping stations in Brighton, United Kingdom. MWH had overall conceptual responsibility for the treatment works, pumping stations, and marine outfall. MWH provided overall design coordination as well as detailed design of the civil, architectural, and reinforced concrete at the treatment works and the pumping sewerage systems' station superstructures.

MWH relied on MicroStation, TriForma, PlantSpace, Bentley Architecture, Bentley Structural, and Bentley Navigator to design systems serving a population equivalent of 300,000. MWH also used ProjectWise to collate, store, and version control all of the CAD design files and drawings for this project and to launch design models by a design team spread across multiple locations. The ability to store files in one central, universally accessible data store proved invaluable.



2010 FINALIST

National Water and Sewerage Corporation

Gulu Intervention Program

Gulu, Uganda

The goal of this project was to improve the water supply and sewerage services in the Gulu municipality of Africa. Challenges included security issues, lack of data, limited funds, lack of experience, few references, procurement and financial regulations, and Uganda Electricity Board regulations.

Using WaterCAD, the National Water and Sewerage Corporation was able to complete its project, providing a reliable water supply, improved sanitation, increased service coverage and sales, and reduced non-revenue water loss. It expects a full return on investment within three years. Already, WaterCAD has saved the corporation a year's time and $50,000.

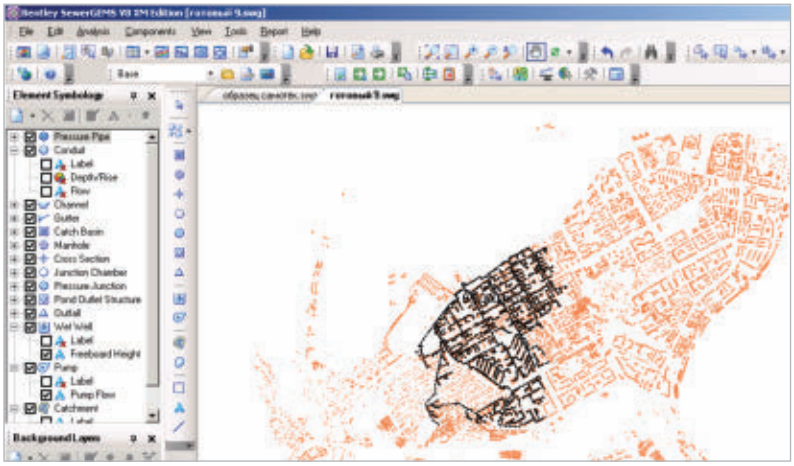
Novogor Prikamie

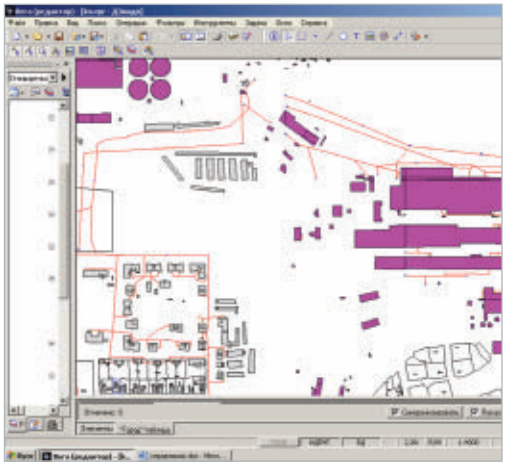
Global Model of Sewer System

Perm, Russia

Novogor Prikamie operates the municipal water and wastewater system in Perm, Russia, which boasts a population of 1 million people. The city discharges about 100,000 cubic meters of untreated effluent a day into the Kama River due to the lack of capacity of the main sewerage collectors and treatment facilities. This project created a scalable hydraulic model to identify solutions for rehabilitation and construction as well as to prioritize routine work orders.

The project team used SewerGEMS to import data from other systems and develop the model. Despite being new to the English-language software, team members completed the project within four months with no outside contractors at considerable savings to the company. A new main unloading manifold is now being designed to increase network throughput and prevent stormwater from flushing into the river.





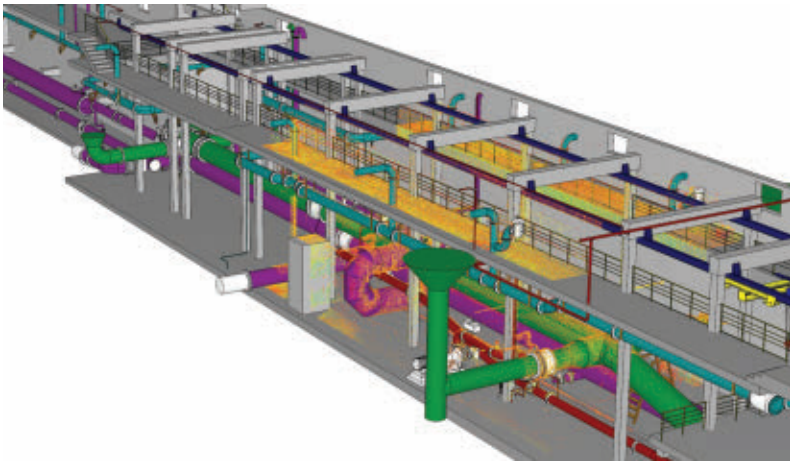
SEBES

Collaboration in Drinking Water Distribution

Esch-sur-Sûre, Luxembourg

As the main drinking water producer in Luxembourg, SEBES collects, stores, controls, and distributes water to major clients and subdistributors. The company undertook a global integration, communications, and traceability project to respond to concerns about archiving, retrieving, accessing, and sharing data. Capital costs were $70,000.

A ProjectWise installation implemented the functionality required to fulfill the specifications set up by the dedicated team. ProjectWise Integration Server provided scalable, standards-based data warehouse functionality. Teams of supervising staff, technical development, maintenance, chemical laboratory, and land surveying now collaborate through one central server installation.



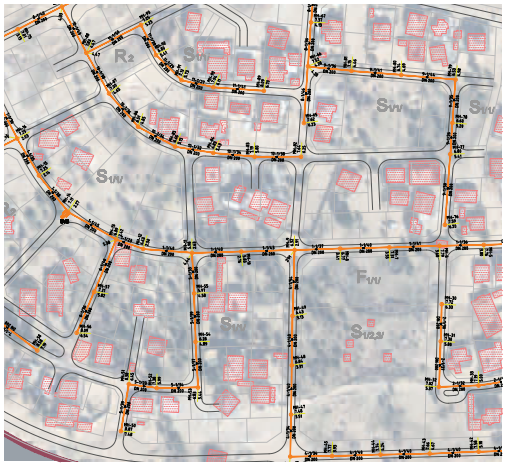
Secon Private Limited

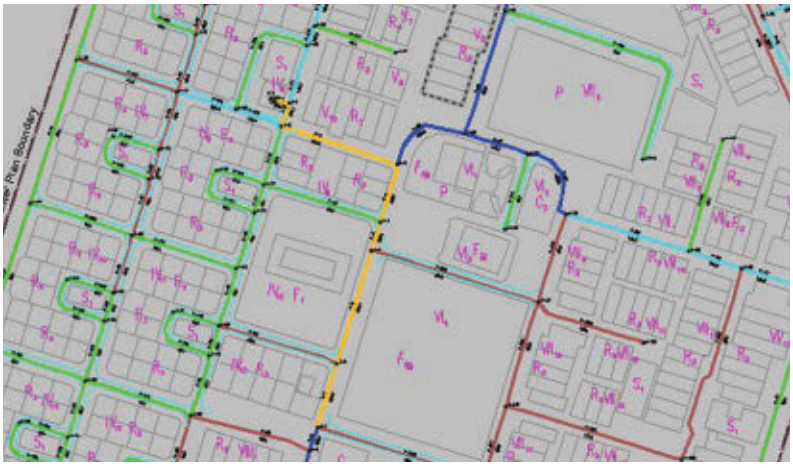
Project for Design of Water Supply, Sewerage, and Stormwater

Tripoli, Libya

The goal of this project was to provide the inhabitants of 13 municipalities around Tripoli, Libya, with potable water, sewerage collection, and stormwater management. Secon was contracted to conduct survey investigations and prepare detailed project reports for 100 master plans covering the region—all within 18 months.

Analysis of the drinking water distribution system, sewerage collection system, and stormwater collection system involved testing various design parameters and modeling various scenarios. The project team used WaterGEMS, SewerCAD, and StormCAD to analyze scenarios for each master plan, which covered topography varying from sea level to hilly terrain.





Latin America

THE WATER **PROJECT SHOWCASE**

Innovation in Water, Wastewater, and Stormwater Networks
Innovation in Water and Wastewater Treatment Plants

Water projects in Latin America include innovations from Agua y Alcantarillado Bogota, Sabesp, Aquadatos SA, GMI SA Ingenieros Consultores, and many more.

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Sustaining Infrastructure

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Firm Saves $50,000 in Water System Design Costs, Enhances Efficiency of Workflows

Arequipa, Peru

More Freshwater Needed for New Concentrator

Peru's Cerro Verde mine, located 20 kilometers south of Arequipa, is a rich source of copper and molybdenum. Its principal owner-operator, Sociedad Minera Cerro Verde, replaced the mine's ore processing system with a concentrator that will triple copper production, significantly increase molybdenum production, and extend the useful life of the mine by 19 years. However, the new concentrator uses the primary sulfide method and separates copper and molybdenum concentrates by differential flotation. As a result, it required more freshwater than the site's existing water system could provide.

GMI SA Ingenieros Consultores won the contract to develop the basic and detailed engineering for a permanent freshwater supply for the new concentrator process. As part of the bidding process, GMI had to prove it could decrease the number of man-hours usually budgeted to create drawings, calculations, and other documents for this kind of project. To ensure its efficiency, GMI turned to new technologies, primarily HAMMER and AutoPIPE.

A key project goal was to establish an efficient water supply system for the new primary sulfide plant while maintaining the water supply to the old plant facilities, limiting the impact to the mining operation. A second project goal was to prevent water hammer (fluctuations caused by a sudden increase or decrease in flow velocity) in the pipelines.

The mine's previous water supply system ran from an intake pumping station on the Rio Chili, about 10 kilometers from the Cerro Verde mine. That system pumped river water to two settling tanks to remove solids. The water then passed through two other pumping stations before it reached the mine. The new freshwater system comprises an enhanced Rio Chili intake structure, three new pumping stations to supplement or supplant three existing stations, a sludge treatment plant, a water treatment system, and overland pipelines to the freshwater storage tank inside the concentrator facility.

GMI expanded the old system by adding a new collection pump station (PS1A) that conveys freshwater to the water treatment plant. The plant's three parallel pumps take the water to a second new pump station (PS2A) where its discharge joins the discharge of the old pump station (PS2). The water is then carried through a pipeline composed of two parallel lines (12-inch and 24-inch, respectively). GMI designed across connection to join the two lines, creating a 30-inch pipeline toward the third new station (PS3A).The water will then be discharged to a storage tank located at the concentrator plant.

A team of 25 engineers performed the engineering for the Rio Chili pumping and pipeline system expansion. The services that GMI provided included architectural, geotechnical, civil, structural, mechanical, piping, and electrical engineering, and instrumentation design. It performed hydraulic calculations and transient analysis for all pump stations, reviewed the pipe sizing of overland pipelines, and supplied all documentation, which included drawings, calculations, installation specifications, and tender documents to obtain construction bids.

To prevent water hammer, GMI used HAMMER to perform highly accurate transient analysis. On past projects, GMI typically used spreadsheets to perform basic calculations, but the calculations provided only maximum values for pressure and water forces and often led to an overestimation in the design requirements. Lacking software to calculate transient pressures and forces, GMI could easily end up developing designs that were too conservative and, therefore, unnecessarily expensive.

Automated Calculations Equal Greater Efficiency

Armed with the data provided by transient analysis, GMI was able to recommend specific devices to protect against transient events and assure normal operation of the pumping facilities. Moreover, these recommendations included only what was necessary to avoid any risk of damage to the system.

Similarly, GMI had previously relied on spreadsheets to calculate pipe stresses. Using AutoPIPE software on this project, GMI performed piping stress analysis and determined pipe sizing and the supports and anchors that were required. The software displayed the expected forces and reactions, and enabled the engineers to export those values for structural calculations.

The AutoPIPE model provided GMI with the support arrangement for the entire pipeline and could easily be exported to AutoCAD. In AutoCAD, GMI checked deviations and updated the drawings. Using AutoPIPE, GMI determined the necessary support and anchor arrangement, minimizing volumes of concrete and the number of supports. By minimizing forces related to anchors, supports, and equipment, GMI achieved an economical installation and assured proper operation of the equipment.

Again using AutoPIPE, GMI was able to introduce more realistic (that is, not absolutely rigid) frame supports. The supports' modeled behavior when subject to displacements, forces, and reactions was more realistic using AutoPIPE. Clearly, this data saved GMI many reworks, since the induced displacement of supports is considered in the AutoPIPE model. Without this option, GMI would have had to input the support reaction forces to other software, potentially designing overly expensive supports.

By using stress analysis software with the AutoPIPE model, GMI accounted for dynamic effects such as wind or seismic movement, taking into account the relevant code requirements. AutoPIPE also gave GMI the ability to consider the effect of soil covering the pipeline. Given some basic soil properties, the software determines its effect on the pipe. This allows GMI to obtain valuable information by inputting soil properties into the model. In addition, GMI used modal analysis, another AutoPIPE feature, to assure a natural resonance frequency of the system that was different from the pump motor frequency. This is another benefit of AutoPIPE's inclusion of the support system as well as the pipes in its model.

"Bentley technology enabled us to easily perform all the special calculations required for the project, where on previous projects we had to contract with external consultants in order to deliver these engineeringservices," said Esteban Rios Pita, mechanical engineer at GMI, in charge of the engineering portion of the project. "In addition, Bentley software allowed us to check design results more directly."

"Bentley technology enabled us to easily perform all the special calculations required for the project."

Rios Pita continued, "Moreover, the stress analysis workflow became more efficient, and we shaved man-hours off design and reworks, with the time budgeted for the work being more than adequate. In fact, we tried several piping arrangement scenarios and chose the most efficient one in terms of feasibility, cost, and constructability. We also tried designs incorporating different material specifications to determine the proper pipe thickness."

Anchor block calculations were executed by the civil engineers, and the reaction forces and moments were determined by piping-stress engineers. GMI took the information from AutoPIPE and exported it to an Access file, including all workable combinations according to the scenario under analysis. It was then able to customize reports and filter the main alternatives according to the applicable code.

Next, GMI delivered the Access file to the civil engineers, who used the values to design anchor blocks, while considering sustained and occasional loads. This increased efficiency, since it was easier for civil engineers to detect applicable loads and identify the anchor position inside the pipe model. The same procedure was used for support calculations. The type of support used was identified in the exported AutoCAD file, and the forces were taken from the Access database. These values were used to design steel and concrete infrastructure.

By adopting the new technologies in HAMMER and AutoPIPE, GMI produced engineering drawings faster than otherwise possible. And because GMI created a tabulated database for reactions, moments and forces, it was able to perform anchor and support calculations in less time. Ultimately GMI saved approximately $50,000 on the project and was assured it could meet the engineering project's deadline.

CASE STUDY

2007 FINALIST

LATIN AMERICA

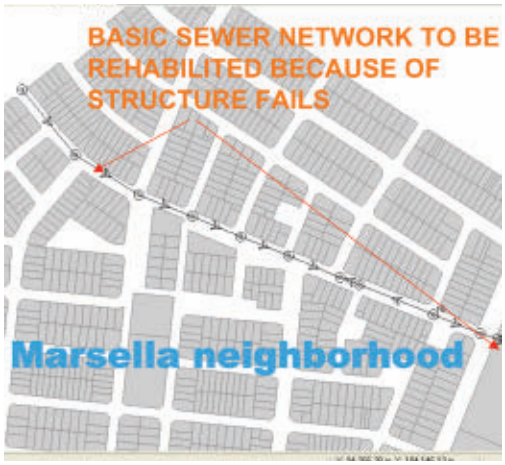
Acueducto: Agua y Alcantarillado Bogotá

Acueducto de Bogotá Infrastructure Management System

Bogotá, Colombia

In the design phase of Bogotá's water, wastewater, and storm drainage networks, input of geospatial data was time-consuming and error-prone, making the design process inefficient. It took two days to process one design project. By establishing connectivity between the geospatial information and design software using Haestad's integrated solutions – WaterGEMS, SewerGEMS, SewerCAD, and StormCAD – two projects can now be processed in one day.

The efficient importing of geospatial information into the Bentley solutions allowed the designers to spend more time exploring alternative designs for the networks. It also created a monetary savings of 75 percent and provides reliable engineering support for calculating the budget for the municipality.



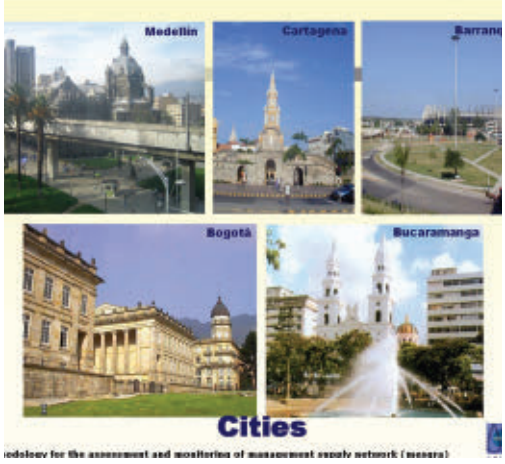
Aquadatos SA

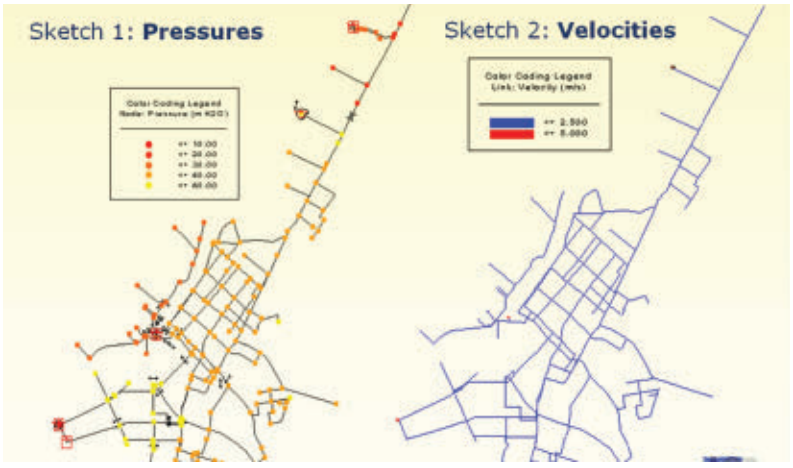
Methodology for the Assessment and Monitoring of Management Supply Network

Bogotá, Colombia

The Colombian Water Supplies Regulator needed a standard by which to evaluate the technical, operational, and financial performance of water distribution systems in the country. Aquadatos helped establish a standardized process to evaluate water projects. The goal of the project was to provide easy-to-use analysis procedures that could easily be adopted by Colombian towns to facilitate the monitoring and control tasks of the regulator.

Using WaterCAD, Aquadatos developed the Methodology for the Assessment and Monitoring of Management Supply Networks (MESGRA), which consists of four fundamental analysis aspects: hydraulic network capacity, network physical status, operation and maintenance efficacy, and performance indicators of the system. Twenty Colombian cities were evaluated by the application of the developed methodology to prove its efficacy.





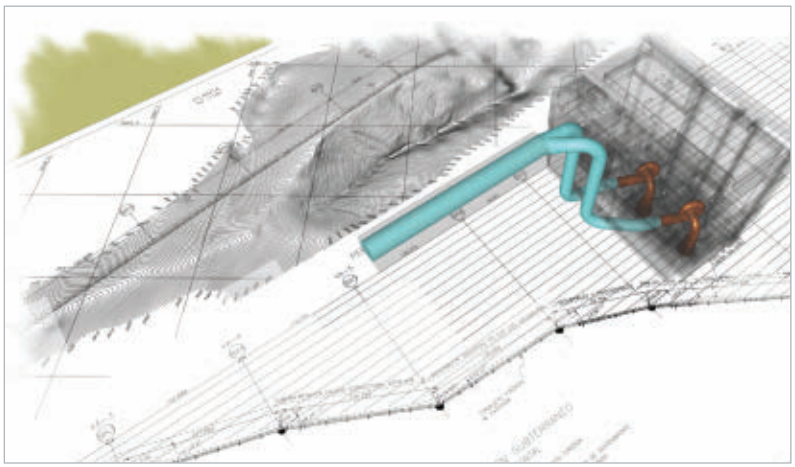
Engevix Engenharia S.A.

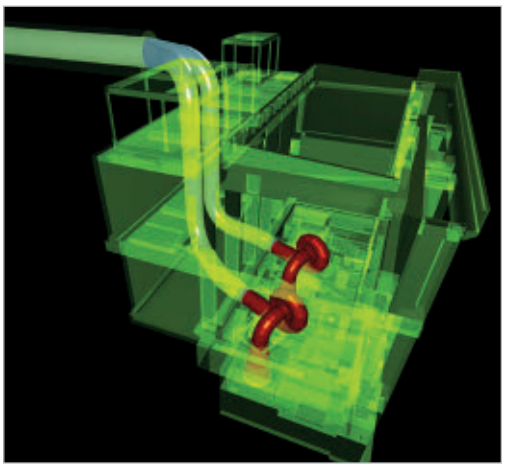
Tarucani Hydroelectric Power Plant

Huasamayo, Peru

The Tarucani Hydroelectric power plant in Peru has been designed to make use of the resources currently derived from the high basin of the Colca River, using a 342-meterhead from the terminal tunnel inlet. In constructing hydroelectric power stations, designers need to be able to foresee hydraulic transients created by closings and openings of hydraulic control equipment such as valves and gates.

The use of HAMMER to calculate hydraulic transients at the Tarucani plant's penstock allowed visualization of the pressure in each point of the duct for conditions of closing. For instance, the formation of an air pocket caused by negative pressures could be visualized to reveal an interruption that could create very high overpressures. This information was inaccessible prior to using HAMMER.





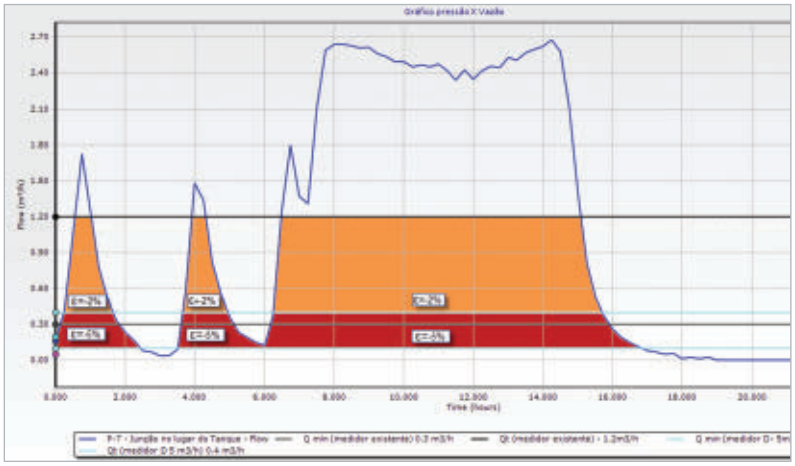
Sabesp

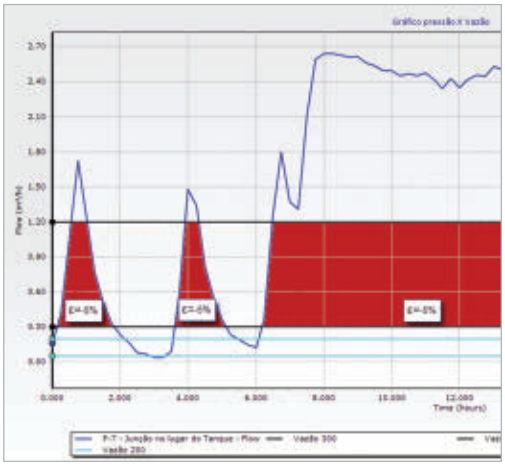
Hydrometers Readjustment—PAHI Project

São Paulo, Brazil

The Santos business unit of Sabesp undertook a $1.6 million project to analyze water demand and readjust metering in São Paulo, Brazil. The project focused on connections with issues related to fraud, on-site auditing, debts settlement, and practices related to non-revenue water. Hydraulic network modeling was applied to reduce water losses and unbilled water.

WaterGEMS was used to analyze consumer demand, water connections, and hydraulic variables that affect water metrology, such as pressure, flow, and use of water pumps. As part of the readjustment, consumer demand profiles were raised, resulting in an average increase of 210 percent in water volume billed. The water loss rate in the global distribution network decreased from 500 to 400 liters per connection per day.





Sabesp

Sector Casa Verde Water Network Infrastructure Renewal

São Paulo, Brazil

With 85 percent of the water distribution network over 40 years old, the Casa Verde sector in São Paulo, Brazil, was experiencing high rates of water loss at 700 liters per connection per day. The objective of this $4.9 million project was to optimize the system and reduce water loss. The infrastructure renewal program also improved performance to meet demand through 2020.

Sabesp performed hydraulic simulations using WaterGEMS to compare performance results and obtain cost/benefit analyses for proposed interventions. One scenario evaluated the replacement of the old network using high-density polyethylene materials. This approach proved to meet the program goals for present and future performance, eliminating the need to replace the water network infrastructure in 2020.

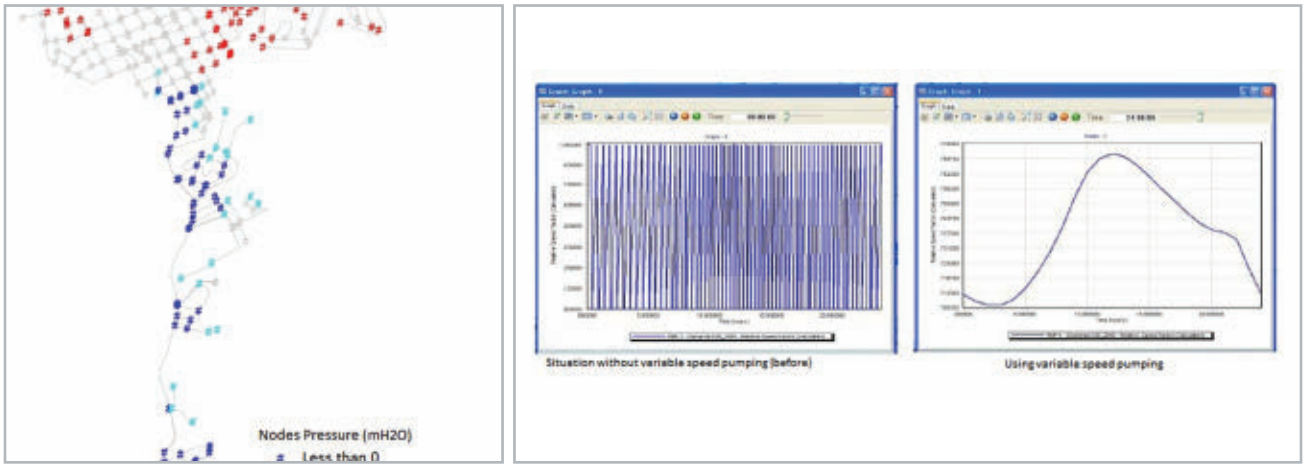
Sabesp

Sector Sacoma Water Network Optimization

São Paulo, Brazil

Hydraulic simulations were created to represent the characteristics of one of the main water supply sectors in the metropolitan region of São Paulo, Brazil. The model is being used to diagnose problems and then evaluate proposals for optimizing a new sector configuration.

Sabesp used WaterGEMS to create the simulations of the Sacoma sector and evaluate system improvements, such as decreasing water loss in the smaller diameter distribution networks and improving the electro-mechanical performance by using speed pump variations.



Sabesp

Improving Operation Performance of the Water Mains System at São Paulo

São Paulo, Brazil

Sabesp's water main system is composed of eight treatment stations and 137 regional tanks serving São Paulo's metropolitan region. This project was the development of a decision-support system to simulate and analyze the best operational rules for operating the calibrated networks. With integration between WaterCAD and the GIS, Sabesp reduced network model creation time by 70 percent. Reducing the changes in valves and pumps prolongs equipment life.

A significant reduction in electricity cost is also possible by reducing the use of pumps in peak electricity cost periods. In addition to full tracking of operations, integration with legacy systems, improved management of operation stoppages and maintenance events, the firm expects a 20 percent reduction in energy cost from operational expenses.

Sabesp

Use of Hydraulic Model for the Optimization and Losses Reduction Planning – The Passagem Funda Water

São Paulo, Brazil

The Passagem Funda Water System is located in Brazil, where it uses 274 kilometers of pipe to serve 240,000 inhabitants. It suffered from topographic differences of up to 100 meters and a total loss of about 880 liters per service connection daily. Hydraulic simulation by the team of engineers of Sabesp was important both for diagnosing and redesigning the system.

WaterCAD enabled Sabesp to diagnose the system of distributing water and helped to determine actions to reduce losses of water in areas that had the greatest indicators. From the model, it was possible to identify the critical areas of water losses and propose solutions to eliminate leakage. The project succeeded in reducing water loss by 57 percent, saving $170,000 per month to produce potable water.

Sabesp

Water Loss Reduction Using Hydraulics Simulations

São Paulo, Brazil

Located in São Paulo, Brazil, the Sabesp ML business unit of the state-owned utility operates a 242-kilometer water distribution network serving 240 million inhabitants in Cidade Tiradentes and Santa Etelvina. Water losses of 880 liters per connection per day represented a loss of 52 percent of all treated water in these sectors.

A loss-reduction initiative used WaterCAD-generated hydraulic simulations to define operational parameters, change pressure levels to improve system efficiency, and define priority maintenance actions to reduce losses. Sabesp reduced water loss to 36.7 percent. The initiative also saved electric energy totaling 8,000 kilowatt hours per month.

About Be Inspired

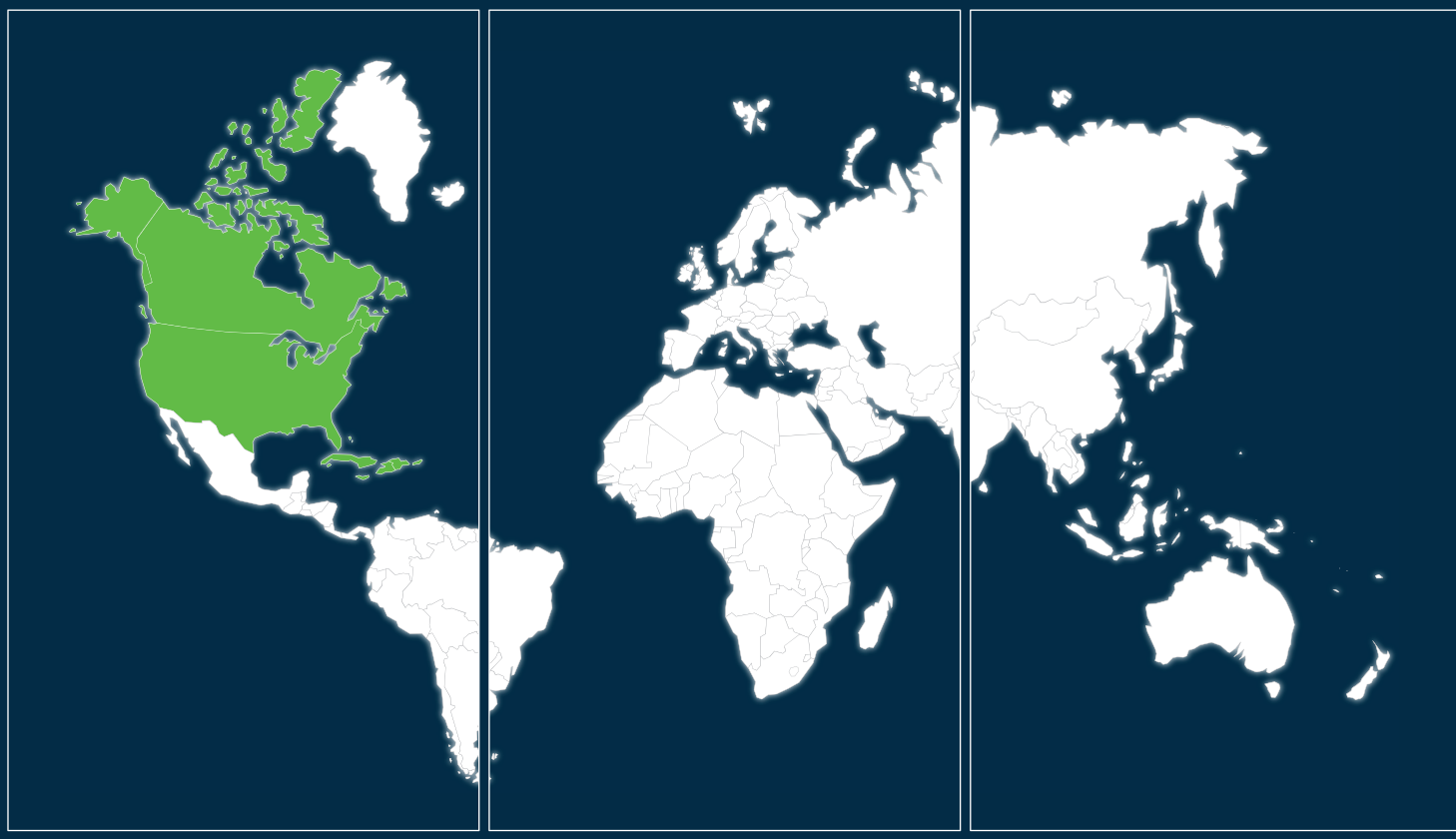
Since 2004, the *Be Inspired* Awards competition has showcased excellence and innovation in the design, construction, and operations of infrastructure projects around the world. The *Be Inspired* Awards program is unique—the only competition of its kind that is global in scope and comprehensive in categories covered, encompassing all types of infrastructure projects.

For more information on how to enter your project in the next *Be Inspired* Award competition, go to www.bentley.com/beinspired.

North America

THE WATER **PROJECT SHOWCASE**

Innovation in Water, Wastewater, and Stormwater Networks
Innovation in Water and Wastewater Treatment Plants



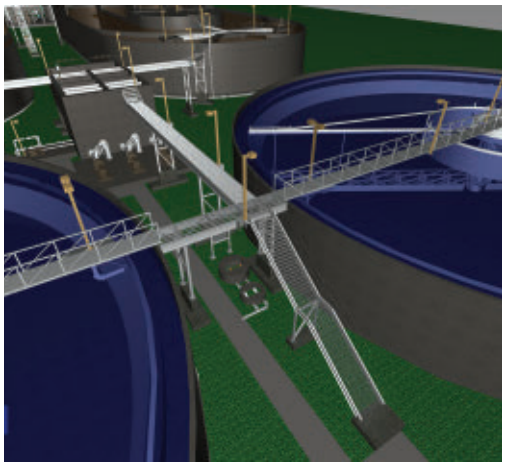
Water projects in North America include innovations from Salt Lake City Department of Public Utilities, Hatch, Mott MacDonald, Gwinett County Department of Water Resources, CH2M HILL, Arizona American Water Company, City of Phoenix, Freese and Nichols, and many more.

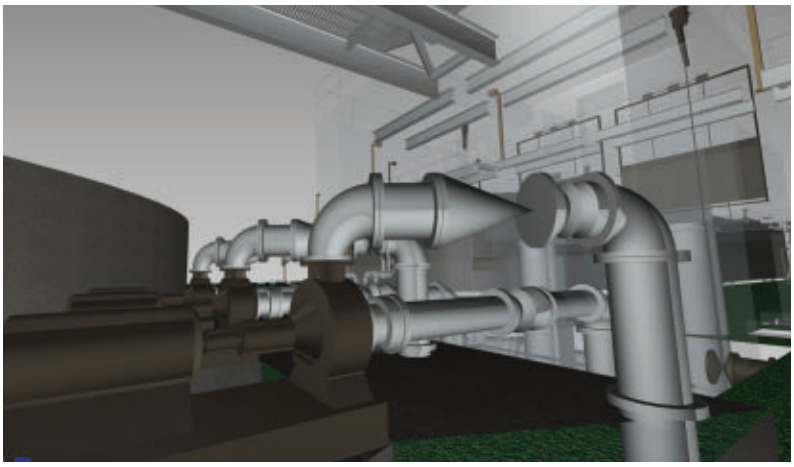
Bentley®
Sustaining Infrastructure

CDM

High-Capacity Wastewater Treatment Facility Reclaims Water Resources

Fort Walton Beach, Florida, USA





Integrating a Living Database Into 3D Models

The growing area of Okaloosa County was in critical need for increased wastewater treatment capacity. The county's Garniers treatment plant was more than 30 years old, treated only 6.5 million gallons of water per day, and was close to a school and residential area. Okaloosa County teamed with CDM to design and build a new, state-of-the-art wastewater treatment facility.

The Arbennie Pritchett water reclamation facility will serve a population of 181,000 in the Florida panhandle, treating 10 million gallons of wastewater per day to stringent Florida Department of Environmental Protection standards. The $49.3 million facility will support resource conservation and economic development in this vibrant coastal community, including the military and civilian personnel at the Eglin Air Force Base. Using an innovative approach of leveraging downstream data for operations, it will feature biological nutrient removal and ultraviolet disinfection that will discharge effluent to rapid infiltration basins, allowing this valuable water resource to be reused via groundwater recharge.

The facility was designed using intelligent 3D across all disciplines architectural, civil, electrical, HVAC, instrumentation, plumbing, process, and structural for more than 20 buildings and structures. The program called for alternative, design-build delivery to meet an aggressive schedule. Final design had to be completed within 5.5 months of notice to proceed. To meet this short time frame, the team needed to be able to quickly visualize the facility to agree on the form and function of the elements early in the design process.

Enabling Proactive Design

A suite of Bentley software including AutoPLANT and STAAD.Pro enabled CDM to maximize staff skill sets and interact in a collaborative design environment to build the virtual facility. The project incorporated intelligent 4D design by integrating a living database into the 3D facility models, providing a lasting platform for efficient operations and maintenance. The 3D/4D approach allowed for the 3D models and intelligent data to continue through the full lifecycle of the facility. ProjectWise helped CDM manage more than 5,000 documents and provide the latest information to team members.

Deliverables from 3D/4D design approach met the expectations of both the project team and the client. "We knew going with a design-build approach would streamline the process. However, the 3D and4D elements that CDM brought to the project have really taken the process to a new level. With each conversation or decision, we can see our new facility in real time," said Jeff Littrell, director of Okaloosa County Water & Sewer System.

Maximizing Talent in Virtual Environment

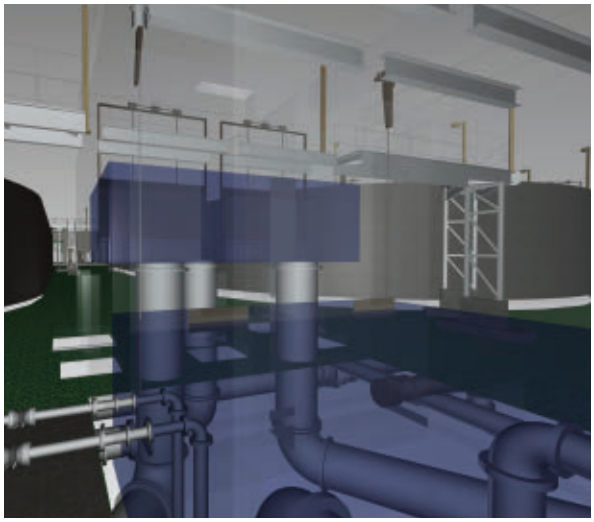
The CDM project design team consisted of a core group of 42 designers, engineers, and support staff with contributions from more than 100 CDM staff overall located in more than 18 offices. The firm met the aggressive design schedule, allowing construction to proceed on time by expediting the staff learning curve, providing superior design content, and achieving a collaborative environment with up-to-date, accurate, and real-time visual content throughout the design process. CDM's innovative design also enhanced sustainability by reducing power usage and operational costs through the improved treatment process.

"The integrated 4D model, O&M manuals, computerized maintenance management system, process monitoring and control software provided seamless complete facility integration."

CDM was able to maximize staff skill sets and interact in a collaborative design environment to build a virtual facility. Client meetings were much more productive, focusing on reviewing 3D models in lieu of 2D drawings. By commenting directly on the 3D models in real time, the owner provided valuable input, ensuring that expectations as well as the project schedule and budget were met. The client could quickly visualize the facility and agree on the form and function of the elements early in the design process.

Typically, this type of collaboration would take weeks, if not months, due to delays in communication, iterative processes, and conflicting priorities. The virtual approach saved significant time and resources. In addition, having all parties involved eliminated any faulty assumptions, since recaps of all decisions were restated for agreement. Process and instrumentation engineers collaborated on single-source intelligent P&IDs, leveraging data downstream in the detail design model.

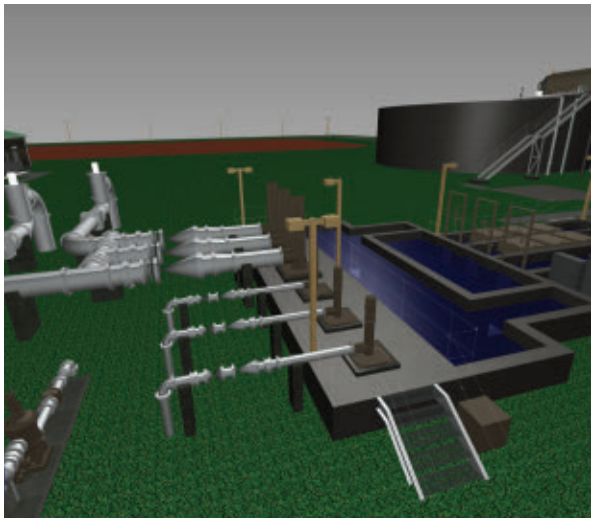
"Bentley's products and services are built on providing 3D design and the associated 4D in a managed environment, which allowed us to deliver on the simple principle of providing our clients with a superior and more cost-effective project solution by utilizing state-of-the-art technology in intelligent plant design," explained William Nelson, vice president of project technology development at CDM.



The software leveraged all intelligent component data within the central project database, such as on-demand custom valve schedules, instrumentation, equipment reports, and datasheets. Datasheets were easily populated from internal sources and vendors and then synchronized to the central database to repopulate AutoPLANT P&ID, maintaining consistent and current drawings and information. Custom datasheets, exploiting extended data capabilities in AutoPLANT, supported efficient procurement.

Custom templates and data tokens allowed extended data on all instrument and equipment datasheets. This extended attribute database – with individual datasheets to break equipment into basic components – allowed data export to the owner's computerized maintenance management system. Using a data-centric model connected to an enterprise-level electronic document management system, CDM thus provided a fourth dimension to the living facility model.

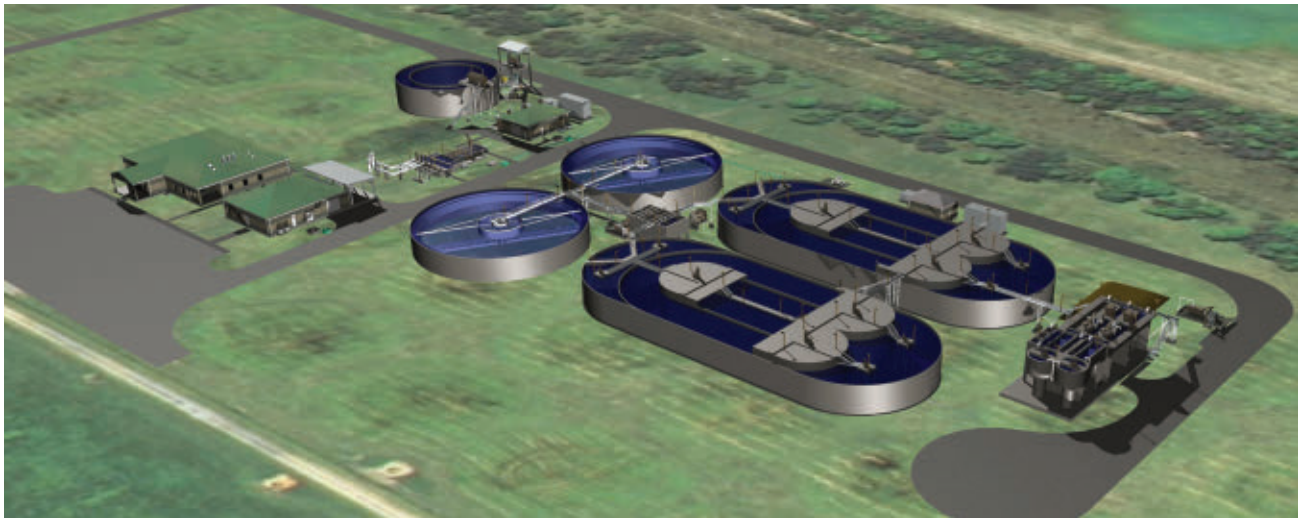
Collaboration Pays Dividends



The integrated 4D model, O&M manuals, computerized maintenance management system, and process monitoring and control software provided seamless, complete facility integration. Equipment information and maintenance procedures can be updated in all databases, providing a real-time, sustainable tool supporting ongoing knowledge management and transfer, preserving continuity through any staff changes.

Avoiding data re-entry reduced errors, saving time and money. Also, by adding enhanced extended data from the design process, involving operations staff in all stages of the project, and avoiding redesign made it easy to add asset management in the future. Best of all,the facility's 4D model will support efficient operations and knowledge transfer for generations to come.

Beginning at the conceptual stage, the integrated 3D model and collaborative environment paid dividends. Among them were a 17 percent reduction in man-hours for about 300 design drawings; a 30 percent compression in the design schedule by using a collaborative rather than an iterative approach; minimized construction conflicts with quality deliverables; reduced re-engineering and redesign; and more effective team and client reviews.



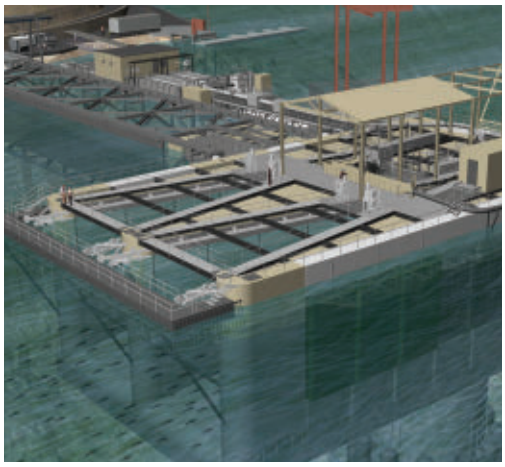
2008 WINNER

CASE STUDY

CH2M HILL

Re-Engineered Water Intakes at Round Butte Dam Protect Native Fish

Madras, Oregon, USA



Designing a Unique Selective Water Withdrawal System

Because Chinook salmon, steelhead trout, redside trout, and bull trout are among the fish species the Federal Wild and Scenic Rivers Act protects, keeping them out of water intakes at major hydroelectric dams is critical. Simple modifications, such as installing baffles and gates, are sometimes all that is needed to keep fish from the intakes. But there are also strict water-quality regulations established by the Federal Energy Regulatory Commission (FERC) and the Clean Water Act (CWA). To comply with FERC and CWA requirements, selective water withdrawal at Round Butte Dam in Oregon required a far more complicated and innovative design.

When Portland General Electric Company (PGE)constructed Round Butte Dam in the 1960s, one of three dams that comprise the Pelton Round Butte hydroelectric project, it also constructed an upstream and downstream migration system to maintain anadromous fish runs. However, the downstream system was deemed ineffective due to migration problems in Lake Billy Chinook, the reservoir behind the dam, negatively impacting the fish population.PGE abandoned the system in favor of a steelhead trout and Chinook salmon hatchery program.

Now, as part of a 50-year FERC license period, PGE and the Confederated Tribes of the Warm Springs Reservation, which co-owns the dam, have committed to re-establishing the fish runs while meeting CWA water requirements. To accomplish the objective, CH2M HILL designed a one-of-a-kind selective water withdrawal system that modifies the direction of the surface current. The system better guides the migrating fish into a fish-handling area, provides a fish-collection system, and ensures that the water released complies with state and tribal water-quality standards.

The system consists of a selective water withdrawal top structure and a selective water withdrawal bottom connected by a 40-foot-diameter vertical flow conduit. The intakes dewater through two conventional V-screens supported by an elaborate steel framing with a unique geometry used to support the screens and fish facility. The selective water withdrawal bottom is anchored to the bedrock and placed in front of the existing intake structure, which contains bottom exclusion plates that prevent fish from entering the powerhouse flow. The goal was to have the system operating by the 2009 migrating season.

Other challenges included designing and construcing a steel-and-concrete platform in the middle of the lake that would selectively divert water from specific lake depths as well as divert migrating fish from the turbine intake. Using traditional 2D CAD file methods would have been complex and time consuming, and developing the engineering data and material quantities would have taken more effort.

Advantages of Using 3D Models

To maintain the tight schedule, the contractor and steel fabricator came onboard at the start of the final design, which would not have been possible without using the 3D models and data generated for material lists. The decision to develop 3D models of the structure in place of 2D CAD files was made early in order to visualize the project and share it with the design team and fabricators.

The project team used TriForma to track materials and quantities, and fabricators used the program to collect data and materials to construct specific components. The software also helped track the weight of the project to maintain a design based on weight and determine the center of gravity for each structural component, important when designing floating structures. Because TriForma automatically generated the data in the database, extensive engineering calculations were eliminated.

The 3D model became the sole source of design information that tied all of the aspects of the project together, from seeing the design take shape and driving the engineering data to maintaining the design and unifying the project team. Whenever a component change was required, the model was revised and the data extracted for quantities and materials. The components developed and extracted from the 3D model files drove the design cycle all the way to the construction process.

Visualization for Stakeholder Buy-in

"The first thing CH2M HILL did on this project was help the client understand and communicate the various options being considered through 3Drenderings via MicroStation models," said Wally Bennett, CH2M HILL project manager for the Round Butte Selective Water Withdrawal project."We took advantage of 3D tools because of the very complex geometry and the need to visualize these structures. We would not have been able to implement such a geometrically complex solution without state-of-the-art 3D tools."

These tools helped the designers and consultants understand the issues, resolve conflicts, and design solutions while saving thousands of man-hours in the process. The software helped design, fabricate, and construct a structure that encourages fish populations to thrive, guaranteeing that fish species will flourish for generations to come resulting in a truly sustainable environment.

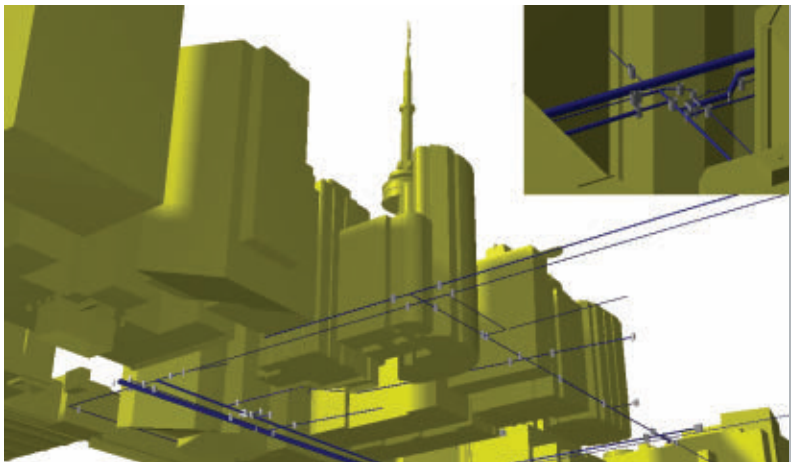
CASE STUDY

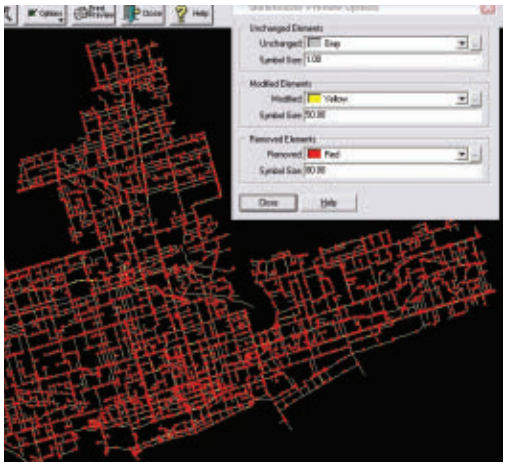
2008 WINNER

City of Toronto

Skeletonization of Water Distribution Model Allows Toronto To Save More Than $1 Million

Toronto, Ontario, Canada





The Goal: Automated, Repeatable, and Sustainable

The City of Toronto operates and maintains an extensive water network that includes more than 3,500 miles of water mains, over 65,000 water valves, almost 42,000 hydrants, and 450,000 service connections. The water network, however, is up to 150 years old in some areas, and the Canadian climate increases the occurrences of water main breaks and potential service disruption. For these reasons, information about the water facilities is essential to the operation and maintenance of a system of this size, age, and complexity.

The Survey & Mapping Unit of the Technical Services Division of the City of Toronto maintains an as-built mapping environment that emulates the real world network with 307,956 pipes/segments. The system architecture includes MicroStation, MicroStation GeoGraphics, Bentley Water, and Oracle. The Bentley Water data model has been extended to include facility attributes to populate the City's data warehouse and work order management system.

"By enabling us to automatically skeletonize our complex water network from a high level of detail to less granular detail, WaterGEMS allowed us to bridge the data needs of two different user groups."

The City's asset management group is a key user of data as they must model the water network and manage the Capital Work Plan. However, the increased number of graphic elements and associated database records required to maintain the level of detail of the Physical Water Network presented a risk to the efforts of the asset management group. There were concerns that increased level of detail would increase the complexity of the work without adding value to the modeling activities. City staff debated at length on the water network standard. Fortunately, the need to mitigate this risk coincided with the Bentley acquisition of Haestad Methods and the City's exposure to the capabilities of WaterGEMS.

Skeletonization consists of selecting for inclusion in a water distribution model only the parts of the hydraulic network that have a significant impact on the behavior of the system. WaterGEMS enabled the auto-skeletonization of the Physical Water Network to create a twin network, appropriate for the different business requirements. From a financial point of view, the savings from implementation of a simplified twin network across the entire city (conversion from the Physical Water Network level of detail) was estimated to be $ 600,000 (Canadian) with additional downstream maintenance costs of $500,000 (Canadian) over the next 10 years. Alternatively, the cost of not creating a twin presented a risk that the Physical Water Network with its increased level of detail would disable the asset management and capital planning activities.

The Skelebrator module of the newly acquired WaterGEMS offered a unique integration opportunity to provide a twin skeletonized network to the asset management group and eliminate any associated risk to the modeling activities. As Bentley SELECT subscribers, the City of Toronto was able to obtain the Skelebrator module for a very low cost; a nominal fee compared to the estimated costs to create and maintain a skeletonized network over the next 10 years.

"By enabling us to automatically skeletonize our complex water network from a high level of detail to less granular detail, WaterGEMS allowed us to bridge the data needs of two different user groups while saving the City over 1 million Canadian dollars," explained Bob Gaspirc, manager of mapping services, City of Toronto.

While the physical network contains 307,956 pipes, the twin network only contains 76,989 pipes, one fourth the complexity. The portions of the Physical Water Network that are not modeled are not ignored. Rather, the effects that these features contribute to the system are accounted for within the parts of the Physical Water Network that are included in the twin network. Bentley technology provided a bridge not only between two different user groups but also between two different data models and two different businesses. The process is automated, repeatable, and sustainable. The solution is scalable and flexible, allowing for skeletonization of additional users with different needs and associated LOD.

With the acquisition of WaterGEMS, the City began to generate the twin water network. The project was launched in December 2004. Approximately five days of staff time was required to develop the conversion rules and the pilot conversion was confirmed in January 2005. The existing network was completed shortly after to coincide with the start of Capital Works Planning.

2005 WINNER

CASE STUDY

Freese and Nichols, Inc.

Airport Plans a Reduction in Energy Usage of 1.6m Kilowatt Hours

Dallas-Fort Worth, Texas, USA

Model Development and Conversion

When the Dallas/Fort Worth International Airport (DFW) engineering staff explored opportunities for cost savings in DFW's water system, it retained Freese and Nichols to update the airport's water and wastewater models and analyze its capital improvement plan. Freese and Nichols first converted, developed, and calibrated the existing water and wastewater system models. It successfully accomplished this using the GIS-ID (to maintain associations between records in the source file and elements in the model) and the modeling building tools in WaterGEMS and SewerGEMS software. The model development and conversion tools enabled engineers to update and maintain the model as the system grew, providing a cost-effective method for switching software packages. And, as an added benefit, WaterGEMS and SewerGEMS integrated easily with the Bentley products already in use at DFW.

The airport's water system functions as a closed system in which pressure is controlled by transferring water between the two pump stations, recycling it into ground storage tanks. The unique valve and system pressure monitoring techniques available in WaterGEMS helped reduce the amount of time previously required by calibration efforts, further increasing the value of converting the water model to WaterGEMS.

Freese and Nichols engineers determined that adding an elevated storage tank in the airport's 2009 Water Capital Improvement Plan would improve energy efficiency. They then used the energy cost analysis tools in WaterGEMS to calculate the amount of electricity the tank would save DFW airport. They compared the operation of the system with and without an elevated storage tank under maximum-day and average-day operating scenarios.

During maximum daily demand frequent pumping is still required, as illustrated in Figure 1. The graph does not show a significant divergence until approximately 10 p.m., when water demand decreases and the elevated storage tank allows for reduced pumping. The engineers found that over a 48-hour period the elevated storage tank reduces energy consumption by approximately 35 percent.

Figure 2 illustrates the cost savings during average-daily demand provided by the elevated storage tank and the energy savings calculated in WaterGEMS. The tank completely eliminates the need for pumping during low demand periods. Without the elevated storage tank, the pumps would still be required to operate during off-peak hours to maintain system pressure. The estimated reduction in energy consumption is approximately 51percent, which would save about$117,000 in energy costs per year at current water usage rates.

The energy cost analysis provided by WaterGEMS is evidence of a positive cost-to-benefit ratio in energy savings over the life of the elevated tank. It is estimated that the elevated tank would reduce the number of kilowatt hours by 1.6 million. It would also have the net effect of reducing the carbon footprint of the DFW airport by 2,030 tons of CO2 per year, which is equivalent to removing the carbon emissions of more than 2,000 cars for an entire year.

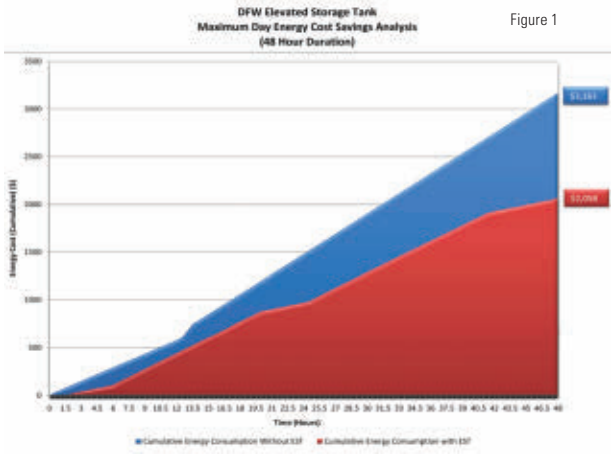


Figure 1

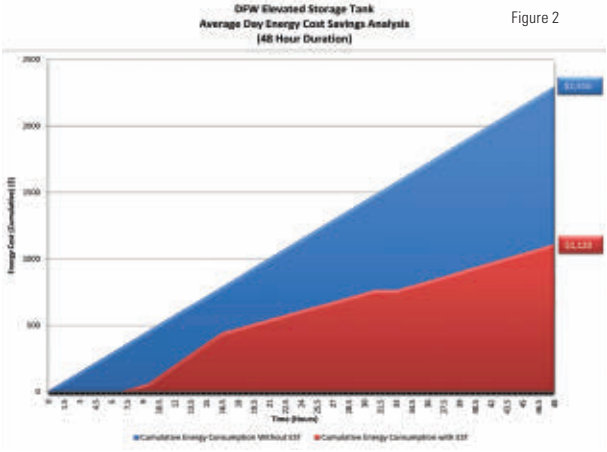


Figure 2

Hatch Mott MacDonald

Hatch Mott MacDonald Improves Water Flow for City of Newark

Newark, New Jersey, USA

Model-Enabled Water Flow Using Gravity

The goal of this project was to determine if the relocation of a supply source had the potential to reduce the City of Newark, New Jersey's, annual cost of $750,000 to pump 20 million gallons per day of water.

Using WaterGEMS, Hatch Mott MacDonald engineers determined that the water could be supplied at a location where the flow could be achieved through gravity during a portion of the year, and where the total dynamic head (TDH) of a pump required to meet demand during summer would be substantially less than the current pumping arrangement, saving hundreds of thousands of dollars annually.

Currently, pumping is done at a remote site outside of Newark. Water is then brought into the city and delivered to the 260-A zone through the use of PRVs. It was determined that a supply line in closer proximity to the 260-A zone would allow for gravity flow or low head pumping directly to the zone at less TDH. However, engineers needed to use a hydraulic model to ensure that adequate flow and pressure could be delivered through the transmission network from a new supply location.

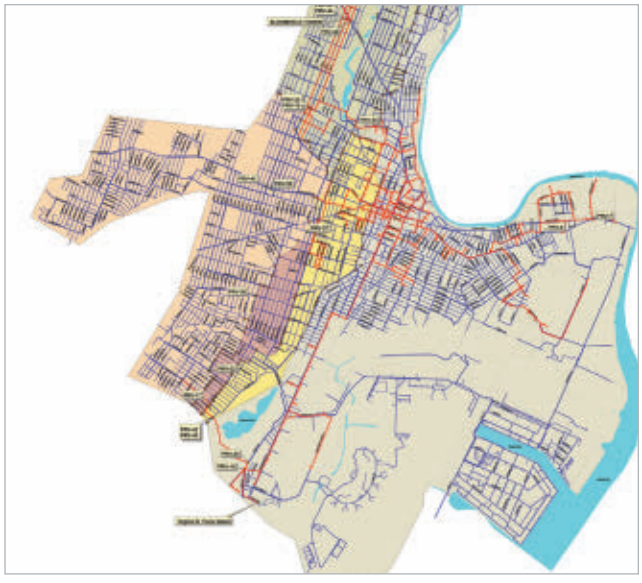
The analysis of the city's water network using WaterGEMS identified that an existing 36-inch diameter transmission main could be transferred from the 360 zone to the 260-A zone, and would provide adequate flow and pressure for domestic and fire protection purposes. Based upon this analysis, it was determined that 10 million gallons per day could be supplied at this new location at an annual cost of approximately 80 percent less than the current cost to pump water. It was further determined that based upon the proximity of an existing PRV, which transfers 25 million gallons per day and currently burns 100 feet of head, a small hydro-turbine could be used to power the proposed pump station, thereby eliminating all purchased power costs, with the added potential to sell excess electricity to the utility.

Immediate Return on Software Investment

Further analysis performed using WaterGEMS directly within ArcGIS to geo-code customer billing information identified significant leakage between the higher and lower pressure zones of the city's water system. A field investigation to review the location and open/closed status of zone "division" valves resulted in adjustments that would reduce pumping requirements at the existing booster station by an additional 5 million gallons per day. It would also take advantage of the ability to supply additional water via gravity to the lower elevation zones.

This would result in reducing overall pumping at this station from 20 million gallons per day to 5 million gallons per day of water on an annual basis, greatly reducing annual pumping costs from approximately $750,000 to $187,500. Based upon the costs to secure low-interest financing for the construction of a new booster pump and hydro-turbine facility, and to make minor piping infrastructure improvements, the electrical savings would exceed the debt servicing costs, and the ROI would be immediate.

Using WaterGEMS, the concept was quickly validated, and based upon the anticipated ROI, the software paid for itself in one analysis. From an environmental perspective, developing the hydropower generation potential at an existing PRV location will provide a renewable source to generate electricity, reducing the city's energy costs and overall carbon footprint.



Gwinnett County Department of Water Resources

Gwinnett County Saves $45,000+ in Force Main Repairs

Duluth, Georgia, USA

Resolving Unsolved Pipe Break Issues

Located approximately 30 miles northeast of Atlanta, Gwinnett County, Georgia, is home to more than 800,000 people in a 437-square-mile area. The Gwinnett County Department of Water Resources provides water, wastewater, and stormwater services at the best possible value to customers. When the department couldn't find the cause of a recurring force main leak in a small subdivision, it applied Bentley's HAMMER for transient analysis and modeling and ultimately found a cost-effective solution to the problem that saved the county more than $45,000.

Randy Rosbury, planning manager at Gwinnett County Department of Water Resources, said: "Hydraulic analyses and field investigations revealed that the force main was not installed as designed, resulting in high surge pressures. Based on modeling what-if scenarios, the county's engineers proposed the addition of two air relief valves (ARVs) at a total cost of $14,800, 75 percent less than the previously suggested low-cost solution. This new option provided a viable alternative that was within the county's budget."

The county water department owns and maintains more than 230 sewage pumping stations with firm capacities ranging in size from 115,200 gallons per day to 30 million gallons per day. The staff has been performing sewer and water modeling for at least five years. However, it has only been within the past year that the department invested in transient analysis software with the purchase of HAMMER.

One of the first projects examined with HAMMER was the Cascade Falls subdivision sewage pumping station, which had been upgraded in 2007. The 2,168 feet of PVC force main had been lengthened by adding an additional 1,589 feet of ductile iron pipes (DIP), and the pumps were increased in size from a firm capacity of 446,400 gallons per day to 996,200 gallons per day. However, the pumping station had experienced multiple breaks in the PVC section of the force main for no apparent reason. The water department initially considered three solutions. These ranged in cost from about $60,000 to nearly $500,000, none of which were viable for a variety of reasons.

Solution 1: Partial Replacement

The first solution recommended replacing a 1,100-foot segment of the PVC pipe with high-density polyethylene to strengthen the weaker section of the force main. The cost of this solution was approximately $60,000. However, given the current alignment and high pressure surges, partial replacement would only relocate the weakest section. Replacing the entire PVC section with DIP would enable the force main to withstand high transient and pressures.

Solution 2: Full Replacement

Replacement of all of the PVC with DIP would make the force main less susceptible to failure during transients. However, if the force main were replaced, air relief valve installations would be required to minimize the transients. The department estimated that this approach would cost about $265,000, plus design work. This amount of money, not currently in the capital improvements program budget, would have taken months to appropriate and would have delayed the project. In the meantime, the subdivision would have experienced further breaks, repairs, and possible sewer spills.

Solution 3: Relocation and Replacement

The most expensive option, relocation and replacement of the entire force main, was the last solution considered due to the estimated $495,500 cost and the time delay associated with easement acquisition and funding appropriation. Moreover, rerouting would not reduce transient pressures in the system. Because there were inherent problems with each solution, the county needed a fourth solution that would not only reduce transient pressure but also be financially feasible.

Field Investigation and Analysis

Using HAMMER, the water department performed a hydraulic analysis of the force main to determine the primary cause of the main failures, evaluate the proposed remedial repairs, and determine the effects a new alignment would have on the station and the force main.

A careful review of the force main profile indicated three areas that were deeper than standard, presumably to lower high points and negate the need for ARVs. Interviews with field operations staff revealed an ongoing hammer problem that could be felt while standing on top of the force main. Since startup of the new pumps, the station had only pumped 88 percent of the original design, indicating more total dynamic head than anticipated. Interviews also revealed that the force main was installed on rock, confirming the theory that high spots were probably much higher than the as-builts reflected.

Drawdown test results and field observations indicated that the force main may not have been installed as designed. It is important to note that depth-to-rock is variable in Gwinnett County, and the contracting firm may not have excavated to the design depth as a result of its encountering rock. These assumptions would be impossible to confirm without digging up the force main. Since the majority of the pipe is located under the centerline of the street, this would have been costly and disruptive. Therefore, a different field investigation was needed.

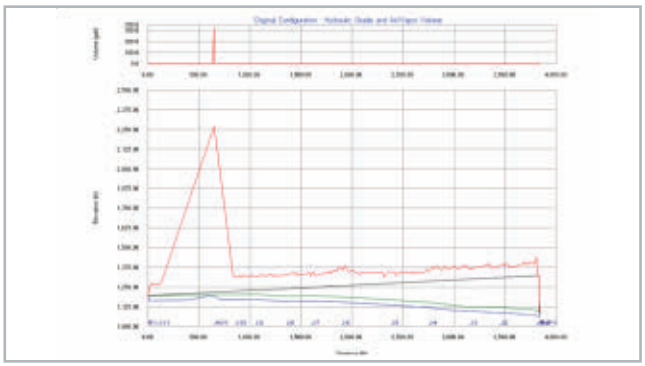
A "pot hole" dug at one high spot would confirm the actual installed force main depth, which could be used in the hydraulic analysis. The force main high point requested for pot holing was reported at a depth of 38 inches, confirming that the force main was not installed to the required design depth of 10 feet.

After creating a simple model in HAMMER, the department ran transient analyses on a small simple force main using HAMMER's scenario management tool to perform "what-if" scenarios. Actual force main alignment was copied for interpretation by people unfamiliar with hydraulic modeling. However, elevations were altered to match the hypothesis that the three high spots were not excavated to the proper depths.

Four "what-if" scenarios simulated possible configurations for the force main:

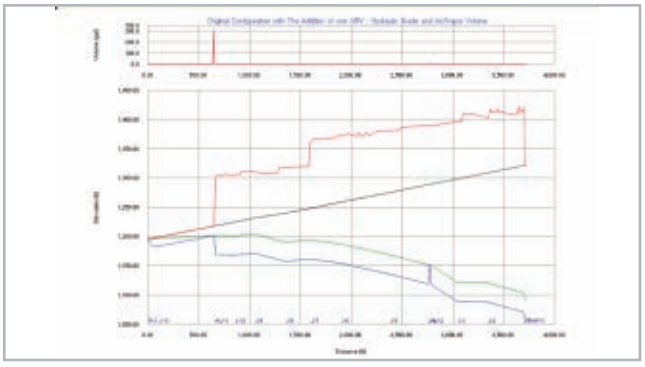
Scenario 1: Original Configuration

With the model programmed to duplicate the hypothesized installed conditions, the transient analysis indicated a 503.99 psi spike in pressure at the original ARV location, resulting in a maximum hydraulic grade line (HGL) of approximately 2,255 feet. During the140-second analysis, this pressure spike fluctuates and travels the entire length of the force main several times.



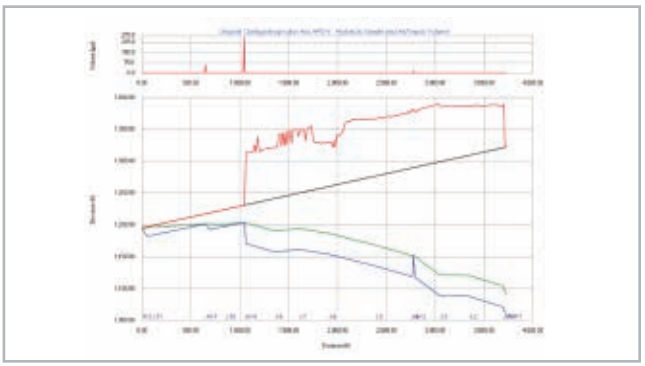
Scenario 2: One Additional ARV

A second scenario was run with an additional ARV installed at the first intermediate high point. Elevations were assumed at a standard depth of five feet, indicating that the force main bed was not excavated beyond the rock. If the elevation assumptions were correct, the installation of the second ARV would lower the maximum HGL to approximately 1,415 feet, which translates to a pressure spike of 140.36 psi.



Scenario 3: Two Additional ARVs

The same assumptions were made regarding the installation of the pipe. With two additional ARVs installed on suspected highpoints, the maximum HGL was reduced to 1,338.9 feet, translating to a pressure transient of 107.42 psi.



Scenario 4: Three Additional ARVs

The last scenario determined that the addition of yet another ARV was unnecessary because it did not produce any substantial improvement in the system. Without the analysis in HAMMER, the third ARV would have been installed.

Cost-Effective Solution Selected

The field investigation and analysis revealed that the force main was not installed as designed due to underlying rock, resulting in high surge pressures. More specifically, the following assumptions were confirmed:

- The design force main profile indicated that high points were lowered to eliminate the need for ARVs. Field measurements of the actual depth indicated the force main at the high points were not installed as designed, thus creating unforeseen high points without the benefit of ARVs. The hydraulic model confirmed these findings and the resulting transient pressures.
- Statements from the Collection's staff regarding "feeling it under the sidewalk" indicated that a hammer condition was present. The hydraulic model confirmed this finding.
- The addition of two ARVs at the intermediate high points greatly reduced the transient pressure experienced to an acceptable level within the hydraulic model. These could be installed by in-house staff at a cost of less than $5,000 per ARV. This also removed the need to relocate the force main or reinstall a new force main in its current location causing a major inconvenience to residents as well as a major expense to the county, which would include repaving of the entire road.

Since none of the proposed alternatives was a viable solution, the county's engineers proposed a fourth solution identified by conducting the transient analysis project using HAMMER. This solution consisted of adding two ARVs in the water system at a cost of $14,800 to implement materials cost at $10,000, six in-house personnel at $50 per man-hour, and two eight-hour days for a total of 96 man-hours, which means a total installation cost of $4,800.

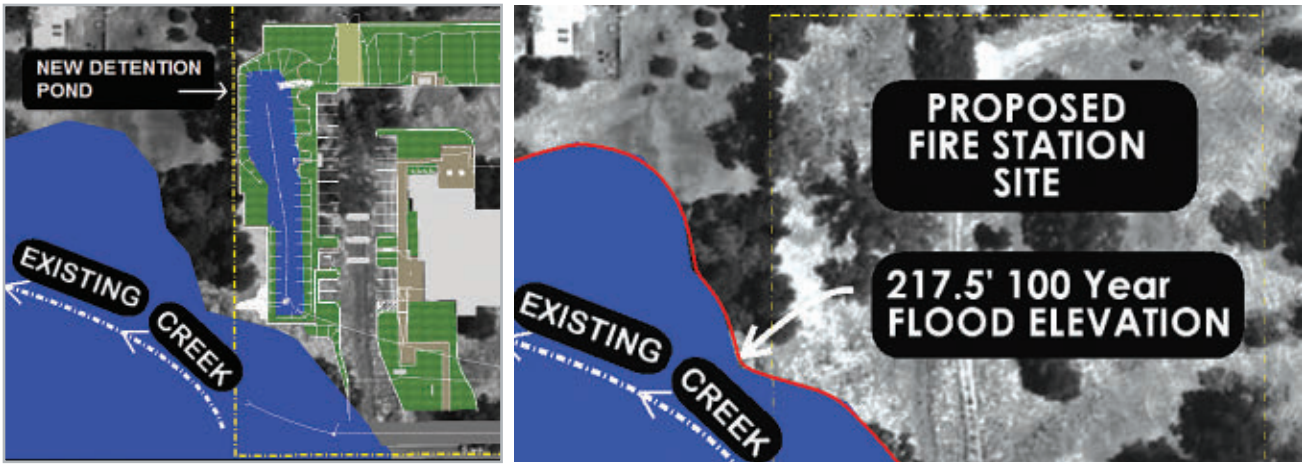
The hydraulic model confirmed that the addition of two ARVs at intermediate high points would reduce the transient pressure to an acceptable level. These could be installed by in-house staff at a cost of less than $15,000. This also eliminated the need to replace all or part of the PVC pipe, or relocate the force main.

Rosbury concluded, "Using HAMMER, the county's engineers proposed a viable solution that would reduce the transients to an acceptable level, mitigate force main failures, stop residents from feeling the hammer effect, and cause no damage to the road or sidewalks. The expected results were realized, and residents and county personnel were completely satisfied with the results. The county saved between $45,200 (when compared to Solution 1) and $485,758 (when compared to Solution 3)."

KASL Consulting Engineers

KASL Quickly Delivers Site Plans To Create Civil Information Models

Orangevale, California, USA



Dynamic Design Produces Sophisticated Structures

Orangevale is a small but densely populated, unincorporated community in Sacramento County, Calif. The Sacramento Metropolitan Fire district retained KASL Consulting Engineers of Citrus Heights, Calif., to design a new fire station that would serve this growing urban area in a sustainable way. KASL utilized Bentley's computer modeling technology to prepare, analyze, visualize, and rapidly revise the site/civil design.

Completed in early 2009 at a capital cost of $4.5 million, Metro Fire Station No. 29 is a 12,800-square-foot, single-story fire station with enough paved area for three drive-through bays and a back-in bay for the battalion chief. The facility also features a standby generator, truck wash building, and plenty of paved parking.

The project's most significant design challenge was the requirement to limit stormwater runoff from the site to pre-development levels. The rapid shedding of stormwater by new impermeable areas is a factor common to all urban development projects. But at this site, the community required sustainable stormwater control and low-impact development methods to be used. No heavy metals, oils, or other contaminants could be allowed to enter the stormwater drainage system. In addition, the stormwater management structures had to be aesthetically pleasing and fit into the landscaping plans.

KASL knew that sophisticated tools and techniques were needed to balance these many requirements. The firm decided to deploy civil information modeling (CIM) software from Bentley to efficiently create and change the site designs. "This was a pilot project for us. We have been producing digital terrain models and 3D surface models for a while, of course. But this time, we started to utilize civil information models to hydraulically design and produce our 2D plan and profiles for the site's underground utilities," explained KASL Principal Derek Rayner, P.E. "This worked very well, even though many of our partners on this project were a little behind the curve on the use of 3D models."

Rayner found that using the CIM models to drive design and plan production resulted in substantial cost savings for the client, mainly in reduced design fees. "One major benefit is when changes are required, the tools allow for a quick remedy without undue additional cost," he said. "Modeling also provides the client with a better picture of the finished product prior to its being built."

KASL used CivilStorm to dynamically design and analyze all stormwater structures, including a detention pond, outlet, and other utilities. Accurately modeling every aspect of the stormwater system, CivilStorm performed a full range of analysis necessary for verifying hydraulic capacity and demonstrating stormwater compliance.

CivilStorm was used in conjunction with InRoads to develop landscape contours, determine earthwork quantities, produce the design, and model the underground utilities in 3D. The resulting stormwater design was sophisticated and sustainable, including grassy swales used as bio-filters, mechanical filters for stormwater runoff from pavement, and an on-site detention pond to reduce peak flows.

Regression Analysis Resolves Complex Design Geometry

The powerful regression analysis features in InRoads, combined with its unique element design capability, enable users to resolve complex design geometry efficiently and accurately in accordance with unique engineering design criteria. These played an important role in this project due to its various design challenges.

For example, the truck wash building presented some unique problems. Since by design the runoff water from the trucks was likely to be especially high in contaminants, the water needed to be routed directly to the sanitary sewer system to collect and treat for toxins before water ended up in the Sacramento River. On the other hand, designers did not want to overburden the sanitary sewer system with relatively clean rainwater. So drains in the truck wash building lead to the sanitary sewer system, and an all-weather cover built tall enough to accommodate ladder trucks routes rainfall to the stormwater system.

Site aesthetics posed another challenge to designers. Though just a single-story building, the fire station is nearly 30 feet high. Nearby residents wanted the visual impact of the station reduced. Also, KASL worked under a mandate to retain as many native oak trees as possible. Since existing above and below ground utilities passing through the site needed to be rerouted and a new 12-inch water main for Orangevale Water Company had to be brought in, designers needed to find ways to move a lot of earth without destroying trees or making the fire station too prominent.

"There was a residential subdivision behind the new fire station site," Rayner explained. "The design team had to consider the view from that area. We were able to use the digital terrain model and a SketchUp model from the architect to visualize the roofline appearance, and ended up going with a design that lowered the finished floor elevation considerably. Unfortunately, this meant that we ended up exporting quite a bit of soil, which we're usually able to avoid when balancing the earthwork on our projects' sites by comparing pre- and post-developed surface models (digital terrain models). But it was the right solution for this project."

The KASL team developed the digital terrain model in InRoads and automatically generated design profiles with the utilities database. Utility interferences were detected and resolved with automatic tools from InRoads Storm & Sanitary tools. Since the software enabled rapid changes and revisions, the team was able to compare and contrast numerous different utility designs and site geometries. To

minimize tree loss — about half of the lot's trees were ultimately preserved — and viewscape impact, KASL reconfigured historic drainage patterns, used cut slopes and retaining walls to lower the building pad, and excavated significant amounts of soil. Stormwater structures were also designed and placed with an eye to managing appearances.

Visualization Communicates Design Aesthetics

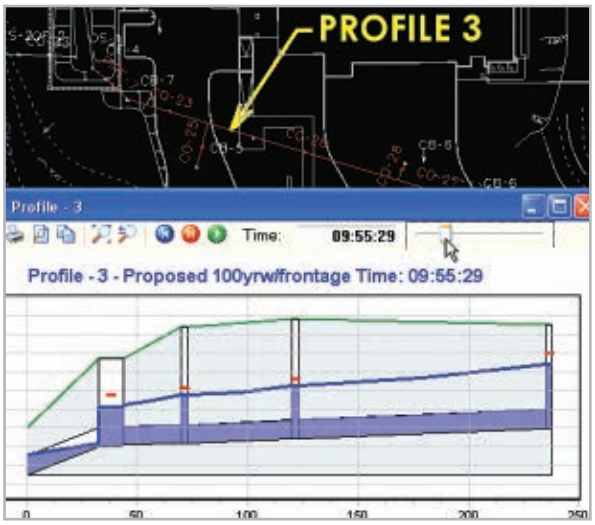
To verify conclusions and communicate with the public, KASL imported its digital terrain model (surface models) into Google Earth and referenced in a 3D SketchUp model of the building provided by the architect. This combined site work, surrounding real-world information, and the proposed building into one visualization.

Together with ProjectWise and 3D PDF files, visualization proved to be an effective way to communicate rapidly developing information with all stakeholders. ProjectWise gives InRoads users the security to store, distribute, track, and manage InRoads data and models across unlimited users, offices, project team members, and locations. Rayner said that one enormous benefit of a model-based design approach is the assurance it gives designers.

"The tools give design engineers greater confidence. We know that changes are being captured in the model database and will automatically be reflected in all the plans." Rayner added that another major source of savings resulting from the use of the model was reduced change orders during construction. "Because people are looking at a model when giving approvals, and because the plans are always up to date, there are far fewer surprises once site work begins."

Once this relatively small project was completed, Rayner noted that KASL began to use model-based design routinely. "This project convinced us that this is the way to go. It saves errors and omissions, it automates and speeds up plan production, and now that we're applying it on bigger jobs, we're seeing far fewer design errors and more production out of our design staff."

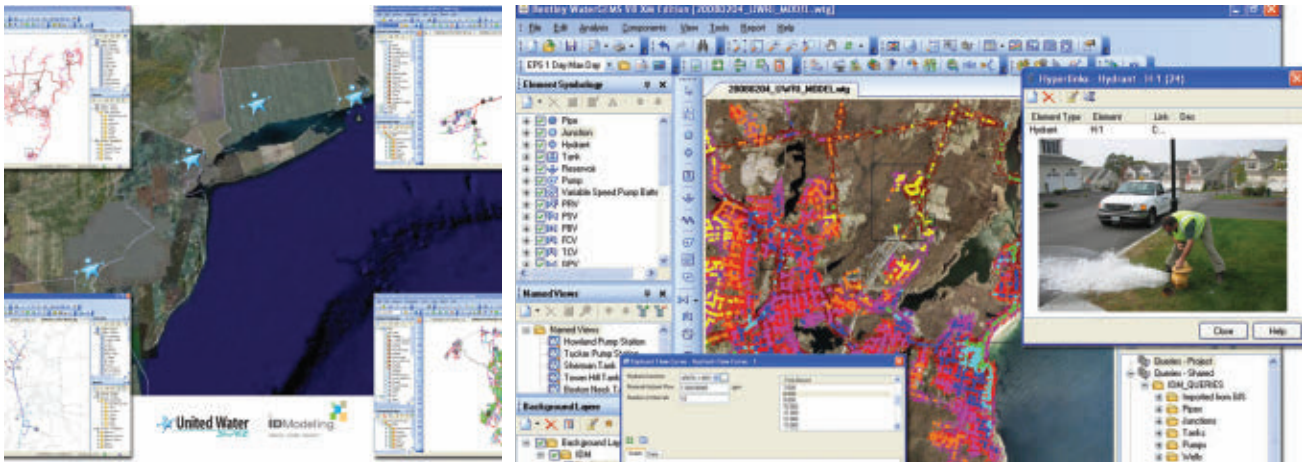
In fact, the only challenge that KASL is facing with 3D modeling is that customers are still relatively unfamiliar with it. "It's fascinating where the technology is going. But not all of our clients and consultants appreciate it, and consequently it's not a typical request on all our projects. We have to do some evangelizing," concluded Rayner. "But it's happening—more people are working with building information modeling, and as owners start to see the advantages of having CIM (site) models included with their BIM models for operating their facilities, they'll start to demand it."



IDModeling/United Water

United Water Adopts Innovative Moeling Processes To Improve Water System Management

New England Region, USA



Achieving Business Goals by Maximizing Efficiencies

The mission of United Water, which provides water and wastewater services to 7 million people throughout the United States, is to establish itself as the premier water-services company in North America. In so doing, United Water realizes that hydraulic models are mission-critical tools, and instrumental in achieving business goals and maximizing efficiencies for its customers. These tools help evaluate designs, aid in master planning and water quality studies, and facilitate energy management, operation scenarios, and capital improvement plans to name a few.

To focus on improving efficiency in its water networks, United Water worked with IDModeling, a company that delivers hydraulic modeling solutions for growing and maintaining rapidly aging and increasingly stressed water and wastewater infrastructure, to develop four models representing four separate water systems in the states of Connecticut, Delaware, New Jersey, and Rhode Island. IDModeling worked under the leadership of Buck, Seifert, and Jost, water and wastewater engineering specialists, for the United Water New Jersey model.

The two companies set out to standardize and streamline how these four models, and any future models, are built, developed, calibrated, documented, and updated using Bentley software. United Water combined its forward thinking with IDModeling's workflows, templates, and techniques, and WaterGEMS and SewerGEMS technology to improve the quality of its hydraulic models.

The company first determined that it spent a disproportionate amount of time repeating model construction tasks necessary for all hydraulic models. Similar challenges that faced each model included:

- Disparate data sources
- Multiple people working on the model simultaneously
- Managing updates from CAD/GIS
- Standardizing symbology for each project
- Documenting projects
- Starting from scratch for each new model
- Varying data confidence
- Learning curve for new modelers
- Model sustainability

The teams came to a general consensus that if they could reduce the time it took to build, develop, and calibrate models, they could more appropriately allocate their budget dollars toward learning the water system and establishing proactive scenarios within the model for improved planning and operational strategies. Ultimately, the resulting benefit would be improved project selection, enhanced customer service, and significant capital-operational cost savings.

IDModeling leveraged the extensibility and flexibility of WaterGEMS platforms to create modeling templates that provide customized components. This greatly enhanced the model creation, quality assurance-quality control, calibration, and analysis process. WaterGEMS uses ODBC and XML to allow for scalable, sharable, and customizable model templates/ standards that work for any model. The WaterGEMS templates help streamline the learning curve and reduce errors commonly associated with data entry.

Best-Practice Standards-Based System

IDModeling also developed standardized ranking matrices that are deployed on every modeling project and linked to WaterGEMSFlexTables. These matrices help the modeling project team track the quality of each piece of data included in the model. Each matrix adds tremendous value to the project, as low data scores can point the model calibrator toward those data that might be candidates for further research and improvement.

Other innovations implemented using Bentley's technology include calibration routines, which are currently under development, using Bentley's WaterObjects.NET. These tools give the user much greater flexibility to explore "what-if" scenarios to pursue optimal system calibration and greatly reduce model calibration time.

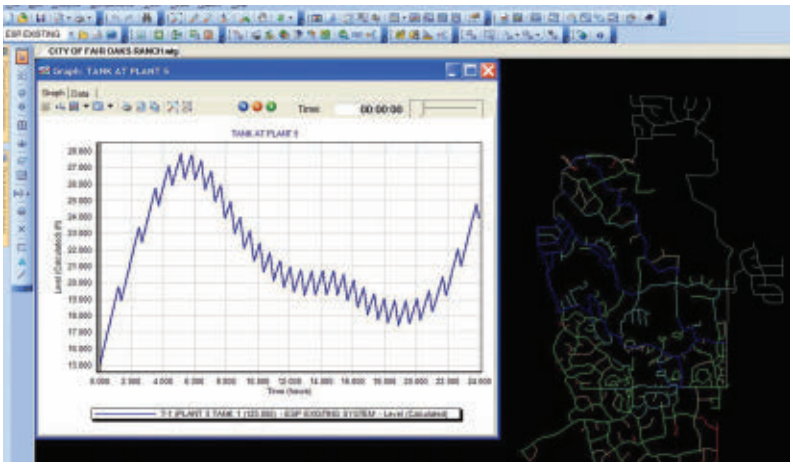
Commenting on the project, Nick Curcio, hydraulic model specialist at United Water, said, "The user-friendliness and interoperability of WaterGEMS and SewerGEMS, enhanced by IDModeling's modeling templates, serve to improve the quality of United Water's hydraulic models. This technology moves the models into a central role to manage and maintain information that improves the stewardship of United Water's critical infrastructure assets."

This project significantly contributes to United Water's quality assurance programs by providing the data integrity and reliability of a standards system for United Water's models. "Our team has defined standards and hard-coded expectations for these critical tools, which is unique in our industry," said Curcio. "The next step is to realize our ROI expectations and apply the ergonomics of our model toward better operations and planning."

M&S Engineering Ltd.

City Expands Water Supply Without Deploying Additional Water System Management

Fair Oaks Ranch, Texas, USA



When the Time Frame Is Minimal and Scope Is Broad

Fair Oaks Ranch is a city in south central Texas, just north of San Antonio. Like most Texan cities, water is always a concern. So in late 2007 when negotiations with the region's only available water supplier broke down, Fair Oaks Ranch was in a real bind. The city had not only been negotiating for enough additional water to fulfill commitments to two major subdivisions, it had also been in discussions for the maintenance of current water rates for its existing 8,500 customers.

With additional water from the only source now out of the question, Fair Oaks Ranch had to find away to keep both pledges and do it fast the city's promised delivery date was just six months away. Fair Oaks Ranch approached M&S Engineering to analyze the situation and provide a solution.

The time frame was minimal and the scope was broad. M&S Engineering first determined the three major objectives:

- Analyze existing infrastructure and water sources to see if the proposed subdivisions could be supplied without an adverse effect on current city residents
- Based on this analysis, generate a list of options for consideration
- Evaluate combinations of the options, taking into account factors like cost, feasibility, constructability, and time to complete

Each objective faced additional complicating factors. To analyze the existing infrastructure, for example, meant that M&S Engineering would need a schematic of the entire water system, which did not exist. The system had been built piecemeal over a 30-year period by various developers and no single plan or comprehensive CAD drawing had ever been completed. The city did have a SCADA in place, but it was of no use for calibrating a model. In fact, as in many smaller water agencies, most of the relevant system knowledge resided between the ears of expert operators, and that knowledge had to be captured.

Generating options was also complex. In addition to expected difficulties, the larger of the two proposed developments is 50 feet higher than the greatest hydraulic grade in the city so the list of options had to contend with the possible need for additional wells and/or an elevated water tank. The alignments of any new transmission lines would have to be considered, and the city would have to make an intelligent and economically sound choice between hydropneumatic tanks — which come with additional energy and maintenance costs — or large static tanks.

And last but not least, M&S Engineering would have to attach costs and benefits to each option and come up with a phased capital improvement plan that met immediate needs and prepared the city for future development. "There were a myriad of major challenges, and the aggressive time frame forced us to rely heavily on automation and time-saving capabilities," explained M&S Engineering Project Manager Daniel Konstanski. "M&S Engineering was able to meet what appeared to be an unmanageable project schedule almost exclusively due to WaterCAD."

Time-Saving Ability of WaterCAD

Because there were no existing electronic drawings, M&S Engineering engineers built a system schematic from scratch working from multiple sets of developer drawings assembled over 30 years. "This presented a major problem. We would have to draw everything by hand and then draw it by hand again to enter it into the modeling software," continued Konstanski. "Fortunately, Bentley support staff and instructors guided us on how to use the extracting capabilities of WaterCAD to take the drawings we made and create a working water model automatically. This saved us hours of repeat work."

But the model needed substantial refinement and calibration based on actual operations data, and this data did not exist in digital form — M&S Engineering would have to figure out how to extract it from Fair Oak Ranch's expert personnel. This was done by physically sitting down M&S Engineering experts and city operators at computers running the model. Small changes were made to the model and then analyzed, and by doing this repeatedly, accurate solutions were arrived at iteratively.

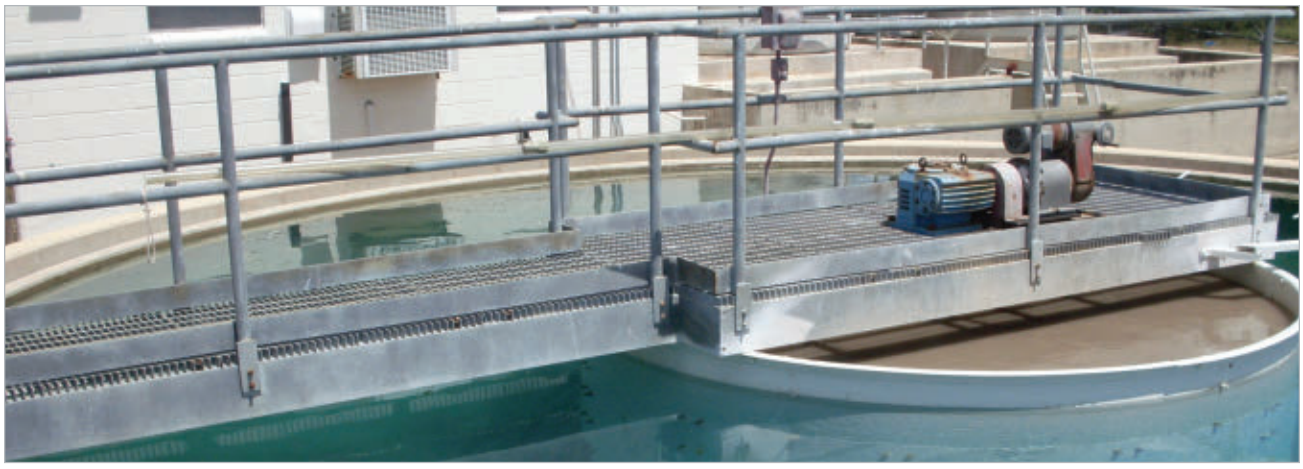
"WaterCAD was an invaluable tool for facilitating coordination through its simple yet detailed outputs and multiple visualization options," said Konstanski, "Graphic displays, tables, and graphs were essential in facilitating communication between the different parties and allowing them to cooperatively achieve an outstanding result. "With an accurate model in place, M&S Engineering could turn its attention to evaluation of different options. Konstanski added, "We were able to quickly but thoroughly evaluate a large number of options and then compare the different results through output and report functions. Through the use of linked scenarios, each with different small changes, we were able to quickly progress through the options without having to create different water models for each potential solution."

As a result, M&S Engineering was able to provide the city with a cost-effective solution and was also able to sketch out a four-phase capital improvement program that will not only create a fully interconnected and much more efficient water system, but position Fair Oaks Ranch as a more pervasive water provider to the region.

M&S Engineering Ltd.

M&S Engineering Saves Design Time on Water Treatment Plant Expansion

Seguin, Texas, USA



Setting a Standard for Green Stewardship

The management of Springs Hill Water Supply Corporation has implemented a set of in-house policies to increase the efficiency and cost effectiveness of its water distribution system. The policies include green infrastructure improvements that set the standard for environmental stewardship for the benefit of its constituents. Equally important, they set an example for neighboring utilities to follow.

To meet Springs Hill's goals, M&S Engineering deployed WaterCAD for water distribution system analysis and design and MicroStation for infrastructure design. The software helped the engineering team develop a sustainable solution for doubling the capacity by expanding an existing surface water treatment plant, as part of an effort to decrease the burden on the region's fragile groundwater resources. The realized time savings using Bentley software directly contributed to substantial cost savings.

Factors that contributed to project success included state-of-the-art technology; coordination across multiple project teams, operational personnel, and stakeholders; use of green technology; and the development of a solution that combined the best of what had performed well for the plant operators over the past two decades with new and more efficient technology.

Among the obstacles M&S Engineering had to overcome were:

- Limited regional precedence for the incorporation of green infrastructure into a water utility
- A very tight time frame for design, permitting, bidding, and construction
- The need to incorporate 40-year-old infrastructure

By leveraging experienced personnel and robust software, M&S Engineering was able to efficiently deliver the project ahead of an almost impossibly tight schedule. The addition will work seamlessly with the existing infrastructure currently operated by Springs Hill with little additional operator training.

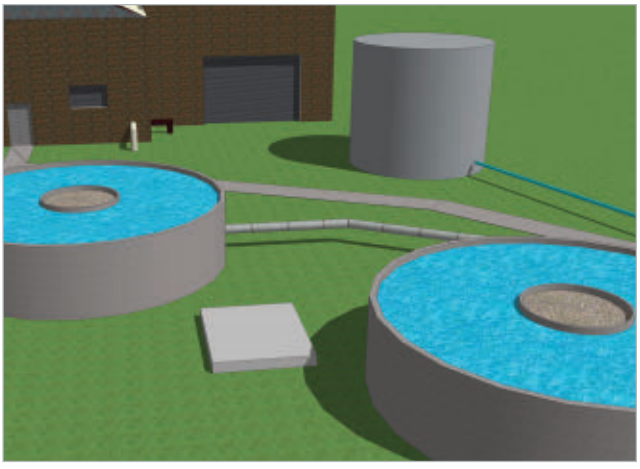
WaterCAD and MicroStation were key to this project being completed successfully and on time. M&S Engineering had used WaterCAD to complete a system-wide calibrated water model of the Springs Hill system. The model was used to evaluate the impact of the different options for increasing the water treatment plant's production, allowing the project team to evaluate a variety of potential solutions quickly and efficiently.

Decreased Reliance on Groundwater

Daniel Konstanski, project manager at M&S Engineering, noted, "The software's interface and capabilities saved us countless hours. The number of small time increments saved through the efficient use of the user-friendly software added up to a substantial savings in both time and money."

The expansion of the water treatment plant was one facet of a system-wide plan to decrease reliance on fragile groundwater sources in the area. Overuse of water in several regional aquifers became a major environmental and economic concern in the Southwest, and the area around Springs Hill Water Supply Corporation was no exception.

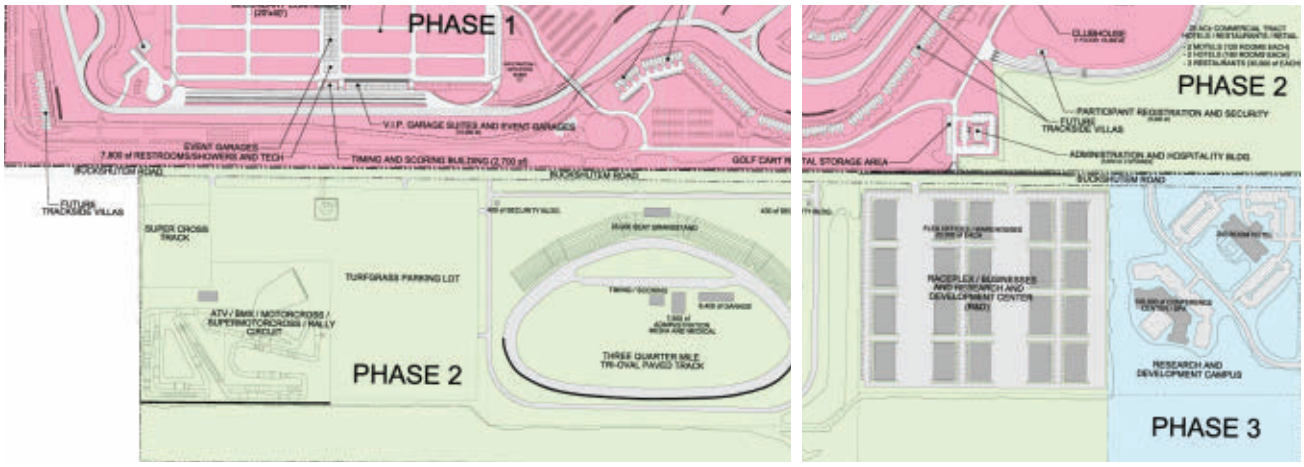
Konstanski explained: "Through the use of WaterCAD, it was possible to evaluate the impact of the planned expansion as well as of several other related projects to determine which would yield the greatest benefit to the area's natural resources. This provided a return on investment in hours saved evaluating different options as well as an environmental return."



Paulus, Sokolowski & Sartor, LLC

PS&S Designs Thunderbolt Raceway Motorsports Park's Stormwater Systems

Millville, New Jersey, USA



Creation of a Motorsport Resort

The New Jersey Motorsports Park will be a three-phase, multifaceted complex with a 4.01-mile raceway as its focal point. Phase I, which is essentially about creating a motorsports resort, will have design features and characteristics similar to those of the legendary Virginia International Raceway that opened in southern Virginia in 1957.

Engineering of Phase I of the project is complete. Phase I encompasses 507 acres, and will require the movement of approximately 400,000 cubic yards of material as part of the creation of six infiltration basins. Stormwater management facilities have been designed and approved by NJDEP in accordance with the Stormwater Management Rule (N.J.A.C. 7:8), following guidelines outlined in the New Jersey Stormwater Best Management Practices (BMP) manual. In addition to the basins, the project employs the use of nonstructural stormwater management measures, also known as Low Impact Development (LID) techniques for pre-treatment of stormwater runoff prior to it reaching the basins. Since there is no curbing proposed for the project, impervious areas are disconnected from storm sewers, allowing filtration and removal of pollutants by surface vegetation. Dedicated/deed restricted filter strips of vegetation along the proposed track ensure that these areas will remain as vegetated areas.

The project has received all municipal, county, and state approvals. A portion of the property is presently owned by the Delaware River and Bay Authority (DRBA) as part of Millville Airport (also known as America's First Defense Airport). Sale of this property to New Jersey Motorsports Park requires Federal Aviation Administration (FAA) approval in the form of a Land Release.

FAA regulations require that all stormwater management basins be designed so as not to attract waterfowl and to drain completely within 48 hours. The biggest challenge was the proper sizing of the six infiltration basins without impacting the race track. In addition, in order to be able to construct what will be one of the longest road courses in the United States, it will be necessary to pipe a large drainage ditch that traverses nearly the entire width of property. The drainage ditch conveys 108 acres of runoff from the airport and necessitated 1,760 linear feet of 84" culvert.

Calculation of Conflicting Requirements

Bentley products were chosen for the design of this project because of the products' ability to perform iterations of a multitude of calculations with greater ease and speed than competitors' software:

- StormCAD was utilized to size approximately16,000 linear feet of storm pipe
- The design of six infiltration basins was performed using PondPack
- HEC-RAS and FlowMaster were utilized to design an 84" culvert to pipe an existing drainage ditch

The most significant impact came from the use of PondPack. The physical challenges of the site were complicated by the need to satisfy a myriad of sometimes conflicting requirements. The project's stormwater design needed to satisfy the stringent stormwater regulations set by the New Jersey Department of Environmental Protection (NJDEP).

Due to the close proximity to the Millville Airport, the project also needed to meet the requirements of the FAA. The NJDEP and FAA requirements presented an interesting challenge. To meet the groundwater recharge requirement of NJDEP, stormwater needs to remain on site and slowly percolate into the ground. On the contrary, the FAA's requirement for stormwater basins is that they must completely drain within 48 hours to deter water fowl from congregating. Detailed infiltration calculations were required for the project to demonstrate that the requirements of both regulatory agencies were met. PondPack enabled these calculations to be performed with ease and efficiency.

Rebecca L. Koze, project engineer at Paulus, Sokolowski & Sartor, explained: "Throughout the design process I found the Bentley software to be an enormous asset. In particular the ease with which PondPack enabled the infiltration calculations of the six stormwater basins to be preformed is far superior to all the other programs I have used. StormCAD was utilized in the design of approximately 16,000 linear feet of storm pipe.

The biggest benefit of using StormCAD for storm pipe calculations is the ease with which revisions can be made. Throughout the design process, revisions to the overall project layout were made. By performing the required storm pipe design revisions in StormCAD, a significant amount of time was saved. The program enables the tracking and updating of design information. The coordination between calculation, plan view drawings and profiles is unmatched."

A major aspect of the project design consisted of the piping of an existing drainage ditch; 1,760 linear feet of 84" culvert pipe was designed to accommodate the runoff from approximately 195 acres. PondPack was again utilized to calculate the runoff volume to the ditch. FlowMaster was then utilized to calculate the culvert size required prior to modeling the ditch in its existing and proposed conditions in HEC-RAS.

It is estimated that project costs for Phase I will be $40 million and at completion of Phase III will exceed $100 million. At its completion, the New Jersey Motorsports Park will be a powerful magnet and catalyst for smart growth throughout the Millville and Cumberland County region.

Paulus, Sokolowski & Sartor, LLC

PS&S Designs BMW's U.S. Headquarters Expansion

Woodcliff Lake, New Jersey, USA

Modeling Complex New Infrastructure

To win the design contract for BMW's North American Headquarters' South Campus Expansion project in Woodcliff Lake, N.J., Paulus Sokolowski & Sartor (PS&S) needed to address the project's tight schedule. To significantly reduce design time, PS&S deployed Bentley's WaterCAD and StormCAD software products for water distribution and storm sewers modeling rather than inefficient and labor-intensive hand calculations. The campus expansion design incorporated two existing office buildings, an existing maintenance building, and an apple orchard.

PS&S provided comprehensive civil and site services for the project, including integrated site analysis and design, master planning, and construction-phase services for the entire 80-acre site. It also provided surveying services including preparing boundary and topographic surveys as well as subdivision plans and documents. PS&S worked together with the borough and its professionals to rezone the project site prior to initiating the design. New construction elements included two three-story buildings, surface parking, and infrastructure.

The site design incorporated a total vertical drop of more than 100 feet, creating a challenging site to develop within the parameters of the new zoning ordinance. Numerous retaining walls were required to minimize site disturbance and address infrastructure requirements. Additionally, freshwater wetlands and rock outcrops located throughout the site impacted the overall layout. This required multiple grading iterations to meet strict municipal zoning and address site constraints. Lastly, potable and fire water system analyses were required by the local water purveyor.

The project design included a very extensive and innovative stormwater management plan to meet the New Jersey Department of Environmental Protection's (NJDEP) Stormwater II regulations. The plan incorporated a nearly two-acre wet pond, a 1.8 million gallon subsurface detention tank, a surface retention basin, and groundwater recharge and water quality measures. A reduction in stormwater runoff at the site positively impacted the adjacent properties. Moreover, properly sized storm sewer systems convey the on-site impoundments where the run-off is detained prior to release off site.

PS&S prepared multiple stormwater studies to select the most efficient and cost-effective stormwater solution for the project. Options for the southeastern watershed area included underground detention comprised of a series of large diameter, high-density polyethylene pipes and manifolds, concrete box culverts in series, a large detention tank, and an above-ground retention pond at the base of the slope.

While more costly, the project team selected a 120-foot diameter, 22-foot deep Natgun pre-stressed wire-wound concrete water tank to address peak flow attenuation for this area because of site constraints and local zoning criteria. Design of the subsurface detention tank included incorporating the outlet control components into the tank, HS-20 loading for future traffic loads on the tank, and five 18-inch vertical air transfer vents with a modern, stylish appearance.

By using WaterCAD and StormCAD, the project team reduced substantially the time it took to perform storm and water design analysis. Indeed, the flexible and user-friendly software eliminated the hours of training typically necessary to use such tools for project design and development. The flexibility of the programs allowed for multiple iterations of the models to determine the most efficient system design. This enabled the project team to meet its stringent deadlines and successfully transform a challenging site into a Class A development. Implementing an underground detention tank beneath a parking area preserved the environmentally sensitive apple orchard, steep slopes, tree buffers, and freshwater wetlands.

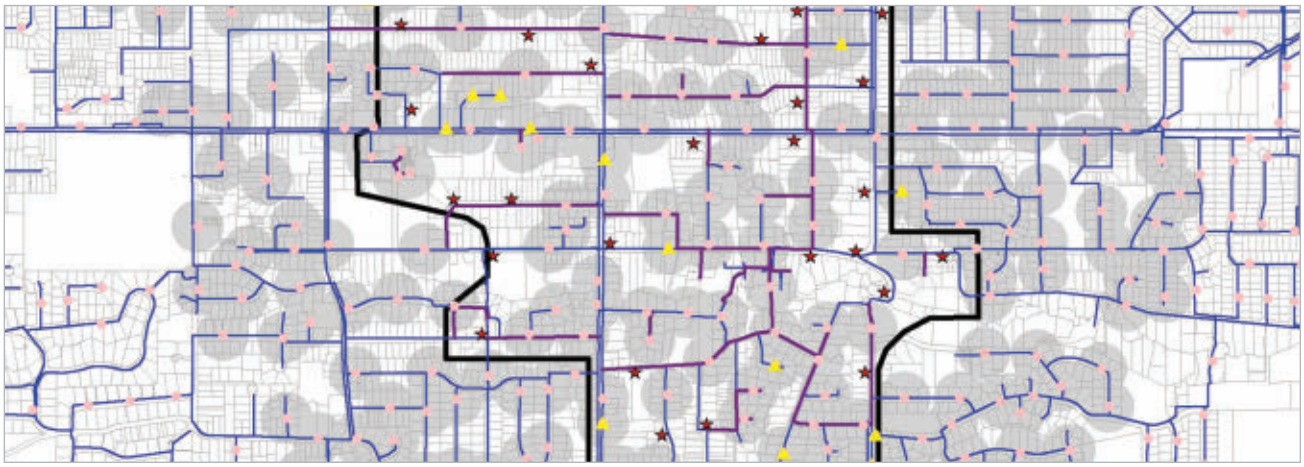
The massive detention tank was hidden underground in an area already assigned to be disturbed, thereby reducing the overall site disturbance for the entire project. Keeping the apple orchard retained the beauty of the complex, while tree buffers along the property boundaries screened the development from the adjacent properties and traffic.

CASE STUDY

Salt Lake City Department of Public Utilities

WaterGEMS Provides Salt Lake City With Improved Fire Flow Planning

Salt Lake City, Utah, USA



The Challenge of Low Pressure During Peak Demand

The past several years, pipelines in areas of Salt Lake City, Utah, have fallen behind current fire flow service requirements, and customers regularly complained of low pressures during peak demands. This was caused by a combination of problems, including small pipe diameters (4 inches and smaller), dead-end pipelines, and pressure zone boundary issues.

To resolve them, the Salt Lake City Department of Public Utilities used WaterGEMS to evaluate required distribution system improvements to meet pressure, fire flow, and fire hydrant coverage requirements in the area serviced by Green Ditch and Big Cottonwood Tanner Irrigation Companies. The software also helped the department develop a prioritized plan for the completion of these improvements.

WaterGEMS, which can run within ArcGIS, MicroStation, AutoCAD, or as a stand-alone application, was used to complete all modeling tasks. The water model was built as a complete representation of the city's distribution system and included all of the pipelines, pump stations, tanks, and control valves in the current system.

WaterGEMS was also used to determine which pipes were the best candidates for replacement in order to meet current fire flow requirements. In addition, the utility used the model to determine the best placement for control valves (and their settings), along with the boundaries for the new pressure zones. Pressure and flow patterns were consistent with field observations and fire flow tests that the city's engineers used for calibration of pipe roughness coefficients. The performance of the distribution system was evaluated against four criteria:

- System delivery pressure: pressure should not drop below 60 psi during peak demand conditions
- Fire flow capacity – 1500 gpm or 3000 gpm at 20 psi, depending on the area
- Fire hydrant size – replace all 4-inch pipe diameter hydrants
- Fire hydrant coverage – hydrants should be located no more than 500 feet apart

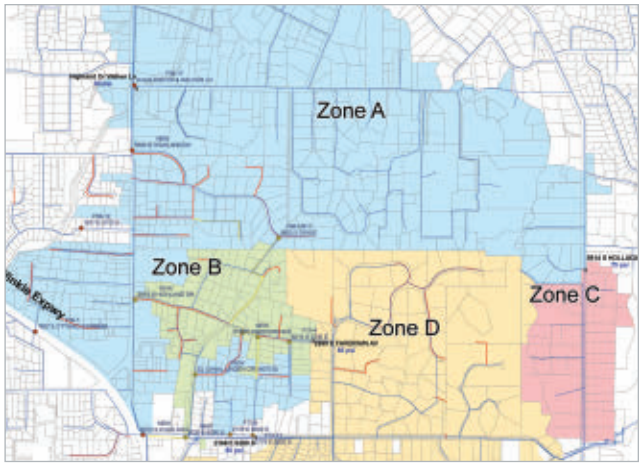
No constraints were placed directly on flow velocity in the system; however, pipe velocity was used to identify possible restrictions in the system. During the fire flow evaluation, it was determined that existing pressure zone boundaries in the area would need to be modified, as they created less than ideal pressure ranges throughout the zones. In addition to the boundary adjustments, two new zones would also be created.

Testing Design Alternatives

Brandon Arnold, GIS specialist at the Salt Lake City Department of Public Utilities, said: "By combining the high-powered modeling capabilities of WaterGEMS with Esri's ArcGIS, Salt Lake City was able to develop a plan of action that improves the city's infrastructure and provides a great benefit to our customers. The water model has also been critical in determining new pressure reducing valve settings and provided a very easy way of doing 'what-if' scenarios to test different design alternatives."

The first phase of this project, including the creation of two new pressure zones, was completed in late 2009. This was the largest phase and included numerous pipe replacements, as well as the zone boundary changes. As a result, all new hydrants now meet the 1500 gpm flow requirement. Some areas are even able to meet the 3000 gpm required by the presence of larger homes.

Arnold concluded, "This project enabled the city to boost the available fire flow to the area and provide a higher pressure for many customers, increasing customer satisfaction."



Stearns & Wheler GHD

Stearns & Wheler Deploys SewerGEMS

Allegany County, Maryland, USA

Curtailing Sanitary Sewer Overflows

When Allegany County, Md., signed a consent order agreement with the Maryland Department of the Environment to curtail sanitary sewer overflows in the Jennings Run-Wills Creek and Bedford Road Sanitary Districts, it had two goals: minimize environmental impact and improve the entire sewer system to ensure its long-term reliability. The sanitary sewer overflows were caused by excessive rainfall derived inflow and infiltration (RDII) in the sanitary collection system. Reducing them would lead to water quality improvements in local waterways, enabling residents to use these areas for recreation, and promote a more sustainable future by providing superior environmental quality for people, animals, and plants.

The county selected environmental engineers Stearns & Wheler to implement key requirements of the consent order agreement. The tasks to be completed included performing an infiltration and inflow analysis, implementing a sewer system evaluation study (SSES), and developing a rehabilitation action plan.

Among the challenges associated with this project were existing Allegany County agreements with other municipalities that limit its sewer flow discharges into their sewer systems. The county determined that without substantial improvements to its own sewer system, the peak flow rates from a design storm would significantly exceed the agreed-upon discharge limits.

It further found that reducing the flow rate caused by RDII to a level that met downstream limitations would be difficult and costly. However, the alternative installing very large pipes to temporarily store the peak RDII would be also be costly and pose great challenges. To achieve the agreed-upon flow-rate limits and manage capital cost, the project team used a combination approach that included reducing the excess flow in the system by rehabilitating and replacing old piping, and incorporating a storage area to temporarily reduce peak flow rates during periods of heavy rainfall.

In completing its SSES, Stearns & Wheler used SewerGEMS to develop a dynamic hydrologic and hydraulic model for each of the district's collection system. The model was integrated into a system-wide approach that included gathering extensive field data to address the collection systems' failings. The modeling results were first used to project flow rates and volumes for a selected design storm. Next, the results allowed the team to perform a detailed alternative evaluation that provided it with options to remove the constructed overflows in the future.

Laura Siemers, an engineer at Stearns & Wheler, said, "Using SewerGEMS allowed the project team to evaluate several options to determine the best solution for addressing the problems within the sewer systems. SewerGEMS' graph capabilities enabled our engineers to easily compare the model results and observe data on the same graph. It also saved time by reducing the importing and exporting of data.

> *"Using SewerGEMS allowed the project team to evaluate several options to determine the best solution for addressing the problems within the sewer systems."*

Siemers added, "The capability to have many sets of R, T, K values facilitated many different options for evaluating possible solutions. The management of the R, T, K sets for the catchment allowed values to be adjusted quickly to save time during the calibration process."

SewerGEMS was also used to manage the capital cost of recommended improvements by monitoring the hydraulic grade rather than the pipe capacity. In some cases, designers were able to keep pipe sizes to a minimum by allowing some level of surcharging within the manholes while maintaining a buffer to prevent overflows.

Stearns & Wheler started the project in late 2006 and submitted the SSES report to the MDE for review in November 2008. The county has since implemented the study's recommendations and will soon begin the design phase.

The model was used to develop an implementation plan for improvements to the two sanitary sewer districts. These will enhance customer service and reduce basement backups and sanitary sewer overflows. Fewer overflows will reduce the negative environmental impact on local waterways and potentially lead to there being used for recreational purposes by residents of the county. Moreover, the construction and repair work recommended by the study will have the added benefit of creating jobs in this community where many residents fall below the median state household income level.

The Walsh Group

Water Treatment Plant Expansion Eases Pressure on Water Supply

Scottsdale, Arizona, USA

Establishing a BIM-Oriented Mindset

With its sunny southwest climate and an abundance of golf courses, Scottsdale, Ariz., is one of the nation's fastest growing cities. In fact, the population has grown by more than 35 percent in the past 10 years. This rapid growth, however, has put pressure on Scottsdale's water supply, which is a precious and vital resource in the arid region.

In response, the city called for a plan to ensure the long-term availability of safe and abundant drinking water. Part of that plan is to expand the Scottsdale Central Arizona Project (CAP) water treatment plant, which already supplies 48 percent of the city's drinking water. By increasing capacity from 50 to 80 million gallons per day, the plant will be able to process additional surface runoff, thus supplementing the drinking water supply when other sources are stressed.

Adding capacity at an existing, highly complex facility is always challenging. In this case, CAP consisted of 15 structures interconnected by a spaghetti-like mesh of poorly documented piping, utilities, and other underground structures. The schedule, phasing, and logistics of design and construction were also demanding.

The difficult task fell to the southwest regional office of The Walsh Group. From the beginning, Virtual Construction Manager Dan Klancnik realized that implementing building information modeling (BIM) would be strategic to project success. "With traditional 2D plans, coordination and planning without schedule-jeopardizing errors would have been nearly impossible," he said. "Our team set out to not just implement BIM and virtual construction as an addendum or afterthought to the project processes, but rather to incorporate BIM seamlessly into our workflow. Because of this, fostering a culture of BIM buy-in was paramount."

The Walsh Group began by organizing meetings with the Bentley BIM project coaching team and project stakeholders, including employees of The Walsh Group's construction division, Archer Western Contractors, as well as the client, designers, and key subcontractors. These were the planning and education sessions, which were an important early factor in establishing a BIM-oriented mindset.

Klancnik had ambitious goals for using BIM on the expansion project. The 3D model would be the central repository of information for the design team; facilitate communication among team members and stakeholders; provide visuals for communications with the city and community; generate work plans for field crews; produce materials lists and quantities; facilitate safety planning; enable interference management and design coordination; establish project phases and construction sequences; and facilitate site logistic planning.

"The universal language for effective communication among all parties throughout the design and construction phases was BIM," Klancnik explained. "The goal was to integrate BIM seamlessly into our processes at every level from the field crews to the project executive to reduce workflow redundancies and aid effective communication. After project completion, the BIM would be handed over to the client to aid in management of the new facility."

With strategic use of existing plans and new as-built surveying, an accurate model of the existing facility was created and superimposed on proposed architectural and structural designs. From that point forward, BIM served as the project's central database. The Walsh Group and Archer Western Contractors held weekly, model-based coordination and collaboration meetings with engineers and subcontractors. At weekly client meetings, model-based visuals proved to be an instantly accessible way to communicate design updates and building processes. When construction commenced, model-based scope-of-work meetings were held daily with field crews.

BIM Provides ROI and Shortened Schedule

The Walsh Group made a substantial investment in new software, tools, and training in order to use BIM as the organizing principle for this major infrastructure project. Even so, the firm not only quickly recovered its investment but also achieved a substantial payback. "Our best estimate is that the project team spent an additional $45,000 on model-based processes," Klancnik calculated. "So far, the project has saved over $149,000 in potential conflicts and reduced the 28-month construction schedule by five weeks."

Bentley's BIM tools also helped the project team identify and resolve potential safety issues that might otherwise have gone unnoticed. "Overall, the team achieved success by communicating and freely exchanging model content on every level of the project," he said. "A key benefit of the model-based process is the way it made technical information accessible to key project participants, who were able to contribute usefully even when they had no expertise in reading technical drawings. The 3D visualizations produced by designers were instantly comprehensible to everyone gathered at weekly meetings."

The model also revealed new information to those who had been analyzing technical drawings for years. "In one instance with the composite model, we were able to identify a truss designed with a six-inch overlap into a steel beam," Klancnik recalled. "If we had approved the incorrect design for fabrication, it would have cost $40,000 and a four-week delay." Similarly, a conflict between a carbon steel pipe and a support beam was detected in time to save the project nearly $50,000 and another four-week delay. In all, about 20 major conflicts and countless minor conflicts were revealed by model-based analysis, greatly reducing project costs, delays, and on-site confusion.

Swinerton Management & Consulting

$800,000+ Saved on Sanitary Sewer Upgrade Project

San Francisco, California, USA

Sewer Overflows and Other Challenges

Richmond is part of the San Francisco Bay Area in Northern California. Elevations range from sea level to 1,500 feet (0 to 457.2 m) and the annual temperature is 50° to 70°F (10° to 21°C).

The typical annual rainfall in Richmond is 20 to 25 inches (50.8 to 63.5 cm) which falls primarily from November through April. However the 2005/2006 winter season was particularly wet with three months accounting for 26.86 inches (68.22 cm) of rain alone. Excessive precipitation caused sanitary sewer overflows (SSOs) in the Richmond sewer system as well as problems at the wastewater treatment plant.

The vast majority of the sanitary sewer system more specifically consists of vitrified clay pipe that in many cases has been in the ground for more than 100 years. As one can imagine in an aging sewer system, it suffered from a large infiltration and inflow (I&I) problem, the extent ofwhich is described below.

Wastewater treatment is provided by an activated sludge facility with a design flow rating of 16 mgd (60,567 m3/d). The average daily dry weather flow to the Richmond wastewater plant is 7.25 mgd (27,444 m3/d). During a rain event he flow can quickly increase to the maximum influent pump capacity of 39.2 mgd (148,388m3/d). Once the maximum influent pump capacity has been reached, the sanitary sewer system begins to surcharge and SSOs result in various locations throughout the system. During the winter of 2005/2006 one particular area of trouble proved to be MacDonald Avenue and the need to increase sewer capacity along this road became a priority.

As a result of the SSOs that occurred in that period, it was determined that hydraulic modeling of the sewer system was required. Several software programs were evaluated by Swinerton, including MWHSoft's InfoSewer, Pizer's HYDRA, Boss International's StormNET, and both Bentley's SewerCAD and SewerGEMS. After much evaluation, the decision was made to purchase the Bentley products.

An extensive hydraulic model for MacDonald Avenue was developed using SewerCAD during March 2006. The final model consisted of 204 pipe segments, 196 manholes, eight junction chambers, and one outlet, representing 59,538 feet (18,147 meters) of sanitary sewer pipeline ranging in size from 6 inches (15.24 cm) to 18 inches (45.72 cm). The model was evaluated by analyzing five distinct flow conditions:

- Existing system – no I&I
- Per capita sanitary at 100 gpd
- Per capita sanitary at 100 gpd plus standard I&I flow
- Per capita sanitary at 100 gpd plus standard I&I flow plus peaking factor
- Per capita sanitary at 100 gpd plus high I&I contribution plus peaking factor

"After carefully evaluating a number of hydraulic modeling software, I determined that Bentley had the best tools for doing this work."

Rick Fuller, senior project manager at Swinerton explained: "When the model was presented to the Richmond City Engineer, and as the impact of I&I and increasing flows to the sanitary line became revealed using the thematic mapping functionalities of SewerCAD, the under-capacity of this line became immediately evident. That presentation required less than 10 minutes for the City Engineer to agree this capital improvement project was needed. At that point I was directed to seek bids and develop a cost for the project."

Fuller continued: "But in the meantime, Richmond's Redevelopment Authority (RRA) discovered that a significant portion of MacDonald Avenue was going to be dug up, a portion that in fact was already scheduled to be modernized with new paving, medians, sidewalks, landscaping, and lighting and it was going to start immediately. So, the initial reaction of the RRA was to say 'No, you cannot do this work.' "

RRA had already awarded contracts and our work would result in significant costs due to delays. I gave another presentation using the SewerCAD hydraulic model. Again, it took less than 10 minutes for the RRA to realize the sanitary sewer line had to be replaced; if not right now, then very soon. So an agreement was reached between the City Engineer's office and the RRA."

A Two-Phase Approach

The agreement called for splitting the MacDonald Avenue project into two phases. The first phase was completed by the general contractor already awarded the redevelopment work on what came to be known as "Upper" MacDonald. Since the general contractor's scope was being increased, even

though the original work was going to be delayed, there were no complaints. For the Phase One work, the City allocated $1,494,525 and the general contractor completed the work on time (May – July 2006) and under-budget finishing the job at a total cost $951,050 for savings to the City of $543,475.

A second contractor was hired to perform the Phase Two work. The City allocated $2,812,527 for this portion of the work. Phase Two was completed on time (June – August 2006) and under-budget with a total cost of $2,537,884 for a savings of $274,643. In summarizing the costs, the MacDonald Avenue projected was estimated to cost $4,307,052. The project actually cost $3,488,934.The total savings were $818,118. Fuller explained: "Both contractors were very experienced in doing pipeline replacement work."

And both contractors knew this work was just the beginning of a lot of work that needed to be done on the Richmond sanitary sewer system. As a result of there being no change orders, no extra, unplanned work, both contractors have done a great job of putting themselves at the top of the list for future work.

The most significant impact on cost control/savings had to do with the details provided by the hydraulic modeling. The contractors knew everything they needed to about what was in the ground and what was going to replace it. The model provided each contractor with pipe length and diameter. The pipe material for the project had been specified as being SDR 26 sewer pipe and availability was never a problem.

Fuller concluded: "In December 2006, the City of Richmond settled a lawsuit with an environmental group called Baykeepers. As part of the settlement, Richmond agreed to spend $20 million over the next five years upgrading its sanitary sewer system. And Richmond has bond money in place allocated just for this purpose. The most important tool for both the City of Richmond, and for Swinerton Management & Consulting, who will manage the bond money for Richmond, is the ability to perform detailed hydraulic modeling on the sanitary and storm sewer systems."

"Using SewerGEMS, we can utilize the City's well-developed GIS data to identify problem areas in the system. With SewerCAD, detailed design data can be provided to the consulting engineer so that bid specifications can be generated for the work to be done.So everyone will get the documentation they need with the hydraulic model including the City, its consultants, it bond agent, and the environmentalists who are paying close attention to work being done in Richmond."

2007 FINALIST

NORTH AMERICA

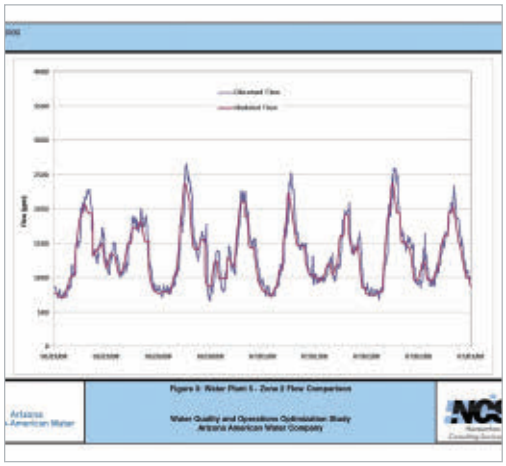
Arizona American Water and Narasimhan Consulting Services, Inc

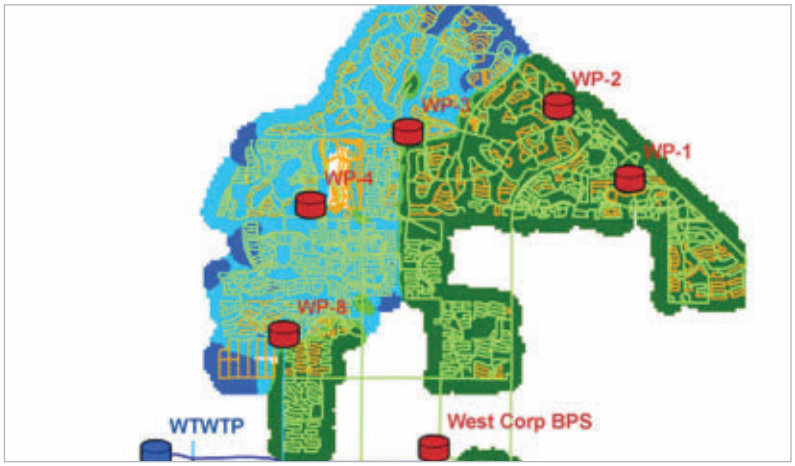
AguaFria Water Distribution System Optimization

Phoenix, Arizona, USA

Arizona American Water Company provides water and wastewater services to approximately 350,000 people in Arizona. To ensure a sustainable water supply for its customers, the company built a new 20-million-gallon-per-day surface water treatment plant, with possible future expansion to 80 million gallons per day. The cost of the current phase of the treatment plant is approximately $64 million.

Arizona American Water Company initiated a study to maximize the use of renewable resources, meet operational constraints, comply with applicable water-quality regulations, identify potential transients, and optimize operational costs. WaterCAD, WaterObjects, and HAMMER created an integrated water model representing the entire system, which resulted in a new treatment plant that went into production at optimal efficiency.





2010 FINALIST

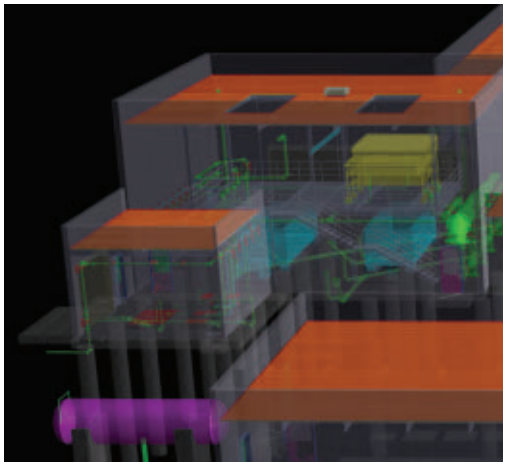
Carollo Engineers

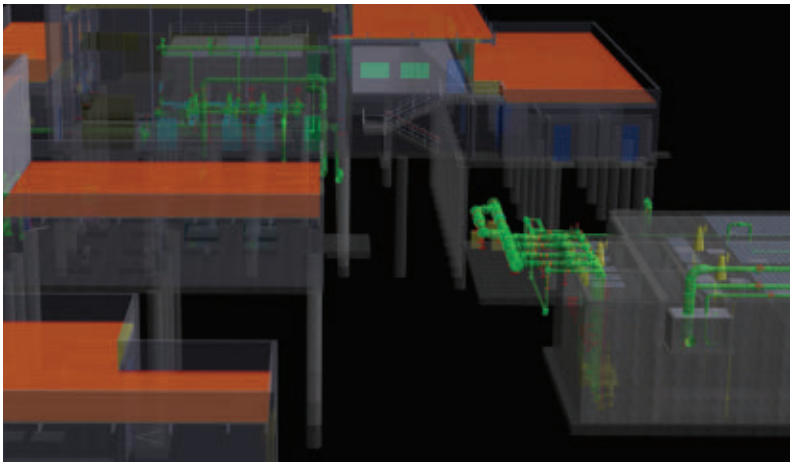
Ak-Chin Indian Community Water Reclamation Facility

Maricopa, Arizona, USA

The Ak-Chin Indian Community located near Maricopa, Ariz., initiated this $31 million capital improvements project to provide advanced water and wastewater system capacity for future development in the community, including a planned commercial center. The project consists of a new water reclamation facility that includes a membrane bioreactor and UV disinfection process, a new drinking water treatment facility, and miles of water, wastewater, and reclaimed water pipelines.

Carollo Engineers used MicroStation, ProjectWise, STAAD.Pro, Bentley Structural, Bentley Architecture, PlantSpace, TriForma, and InRoads to accelerate both the design schedule and the necessary time for community design reviews. MicroStation's 3D design helped the design team identify potential conflicts between different design disciplines, minimizing potentially costly changes during construction. ProjectWise enabled the team to share information and collaborate on design documents from multiple offices across the country.





2010 WINNER

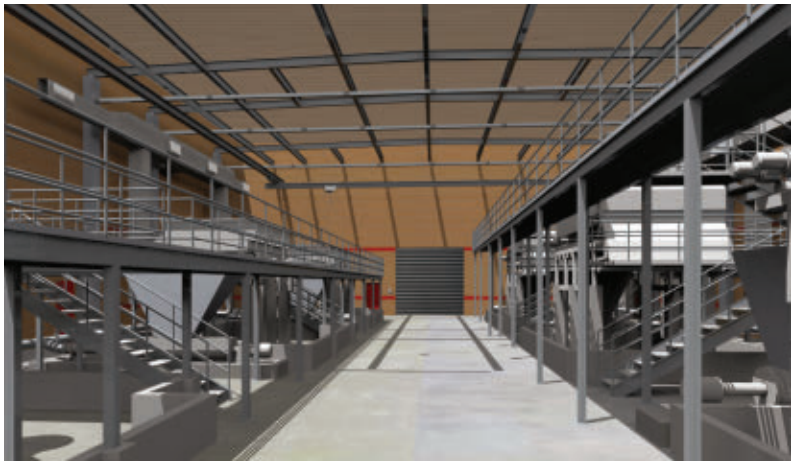
Carollo Engineers

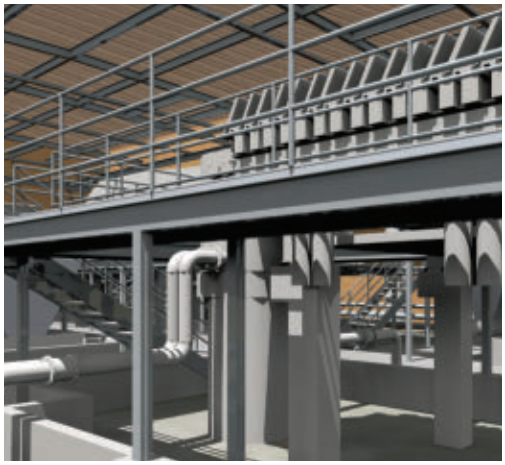
Casa Grande Water Reclamation Facility Phase 3 Expansion

Casa Grande, Arizona, USA

Located in one of the fastest-growing counties in the United States, this water reclamation facility in a community of 40,000 people in Pinal County, Ariz., is nearing its current capacity. The goal of this project is to expand the facility from a rated capacity of 6 million gallons per day to 12 million gallons per day, along with the addition of a new solids-handling building to provide thickening and dewatering capabilities.

The solids-handling building, including the structural, mechanical, plumbing, air supply, and odor control systems, was designed in PlantSpace. The interaction of the structural, mechanical, and HVAC systems could be visualized by the project team and utility conflicts and equipment access could be reviewed before design completion.





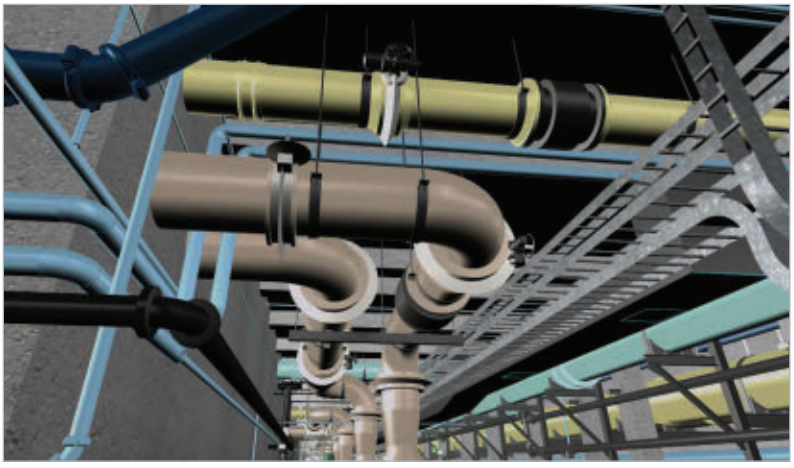
Carollo Engineers

Denver Metro Wastewater Reclamation District

Denver, Colorado, USA

The Metro Wastewater Reclamation District in Denver, Colo., serves approximately 1.5 million people and operates the Robert W. Hite Treatment Facility, which includes two complexes for sludge removal. Metro selected Carollo Engineers to provide $17 million of design services for expansion of its South Secondary Improvements Project. The goal was to create capacity to handle flows of over 200 million gallons of wastewater per day and meet more stringent future discharge criteria.

Carollo used MicroStation, Bentley Structural, Bentley Architectural, PlantSpace, InRoads, ProjectWise, Bentley Navigator, STAAD.Pro, and RAM for Structural Analysis to develop a design incorporating many novel engineering features as well as communicate the project vision and layouts to all stakeholders. Design engineers had real-time access through Bentley Navigator to evaluate potential layouts, coordinate with other disciplines, minimize conflicts, and maintain efficiency.



2010 FINALIST

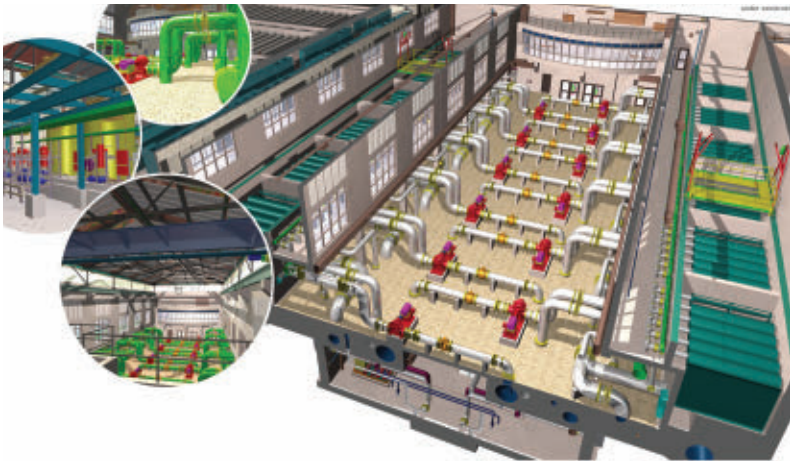
CH2M HILL

Lakeview Capacity Expansion Membrane Filtration Plant

Mississauga, Ontario, Canada

Designed by CH2M HILL, the Lakeview Capacity Expansion Membrane Filtration water treatment plant in Mississauga, Ontario, serves as a showpiece for this type of facility. Utilizing state-of-the-art filtration technologies, this is the largest membrane filtration plant in North America. Additional design considerations included the architectural appeal for public tours to showcase the unique site.

The project was designed simultaneously in two North American offices and involved almost 50 team members. Using Bentley Architecture, Bentley Structural, and Bentley Building Mechanical, building information modeling (BIM) was used to complete this complex facility in a short time frame. BIM allowed quick extraction of 2D contract documents from the model, early visualization of the design, and a central source of data for estimators, designers, and contractors.



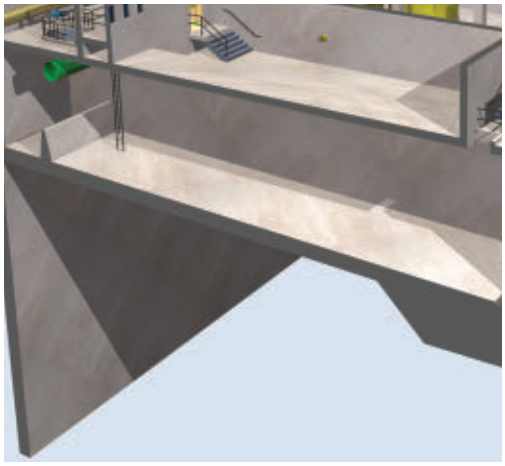
CH2M HILL

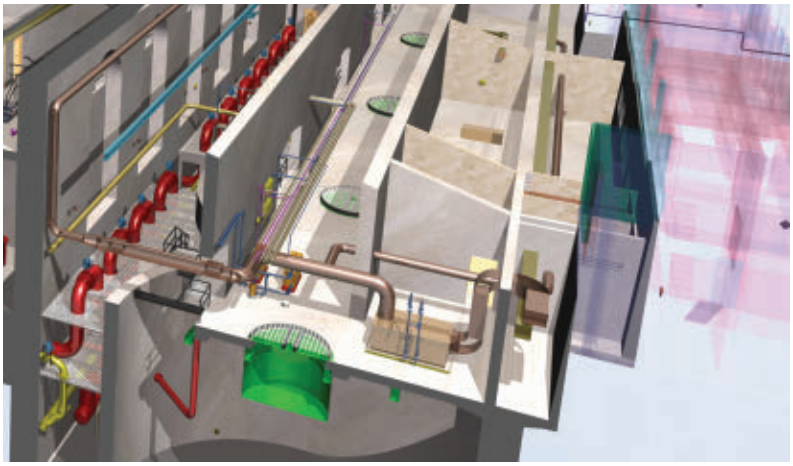
R.C. Harris Residue Management Facility

Toronto, Ontario, Canada

This plant provides approximately 40 percent of the city of Toronto and southern York region's water supply. As a publicly accessed lakefront site with expansive views to Lake Ontario, it is also a popular leisure park to the residential neighborhood and surrounding region. The design of the facility not only had to satisfy functional and operational requirements, but also had to fit within the confines of this inhabited and historically designated site.

The solution was to place the facility entirely underground. Given the complexities of the site, traditional 2D design and production would have lead to costly guesswork. Using MicroStation, TriForma, and GEOPAK, the team used visualization methods to clarify construction issues, allowing more time to be allocated to problem-solving and feedback.





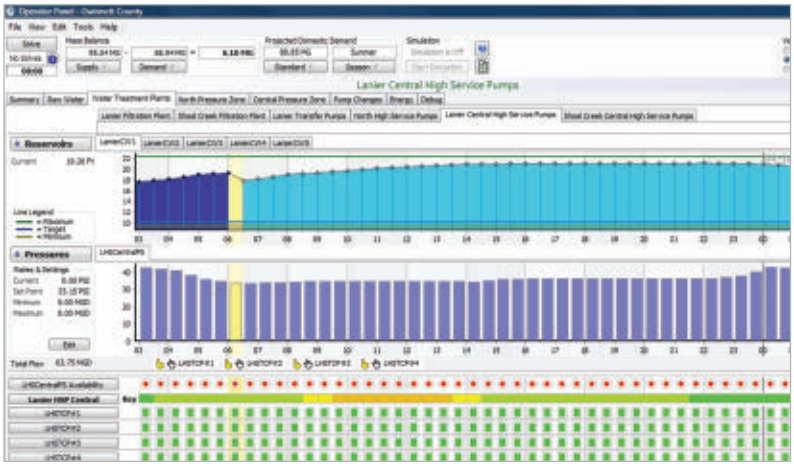
CH2M HILL

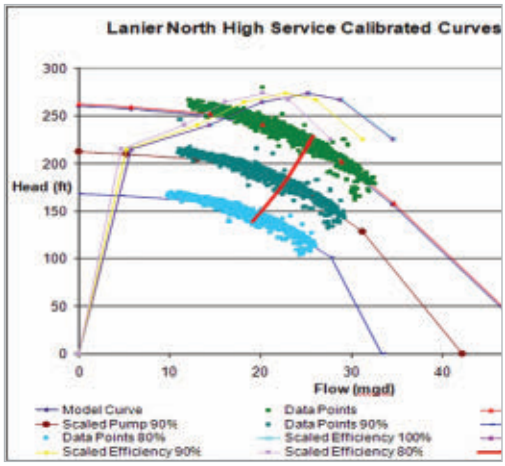
Real-Time Energy Optimization Implementation

Buford, Georgia, USA

Gwinnett County Department of Water Resources produces drinking water for 750,000 residents in a growing county 30 miles northeast of Atlanta, Ga. CH2M HILL and Derceto provided a detailed design and completed installation of the Derceto Aquadapt energy management and operations optimization system for the drinking water production plants and ancillary distribution system. The capital cost was $900,000.

CH2M HILL performed significant hydraulic modeling using WaterGEMS. The new highly accurate system controls pumps, tanks, treatment plants, and flow control valves to optimize management of energy usage and distribution constraints such as flows, pressures, level, and water quality. The system went live in December 2009 and is expected to reduce energy costs by about $460,000 annually, paying for itself in just over two years.





2010 FINALIST

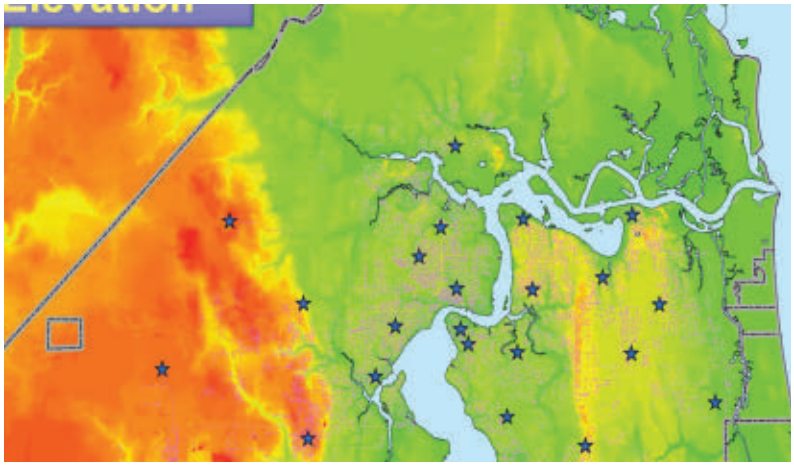
CDM

JEA Water Distribution System Model Calibration

Jacksonville, Florida, USA

As the water, sewer, and electric utility provider in Jacksonville, Fla., JEA retained CDM to develop a calibrated and accurate model of its water distribution system. CDM first updated JEA's existing WaterGEMS model with piping, customer demand data, and accurate elevation data. Calibration was achieved by conducting hydrant flow tests throughout the distribution system as well as utilizing SCADA to compare model results to system data.

The calibration was complicated by the absence of elevated storage, few pumps operating on variable frequency drives, and about 28 water treatment plants contributing flow into two large pressure zones, making the system susceptible to demand fluctuations. WaterGEMS adjusted nodal demands and pipe characteristics in specific areas, and JEA will use the calibrated model to optimize system operations.



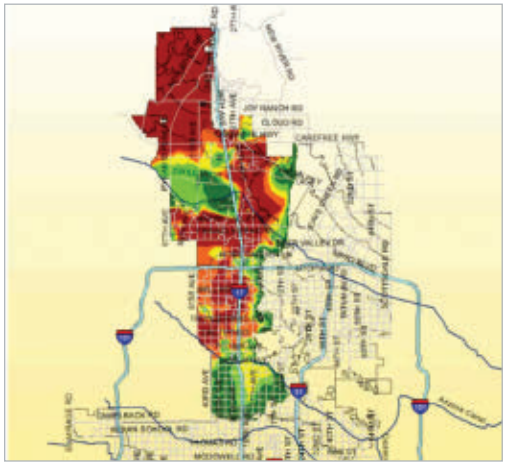
City of Phoenix

North East Area Delivery Optimization

Phoenix, Arizona, USA

Phoenix, Ariz., has long been recognized as an environmental leader. Its sustainability motto "Living Like It Matters!" was put into action when its Water Services Department undertook a $90,000 project to optimize the cost of operations while producing the same level of water quality at two plants serving a 140-square mile service area in northern Phoenix.

WaterGEMS was used to model and identify operational strategies and hydraulic conditions as well as calculate energy costs. WaterGEMS' WaterObjects extended software capabilities calculated operational costs and optimized against the water-quality model for trihalomethane formation. This unique approach, which adjusts for both trihalomethane formation and energy management, has saved the utility about $2.6 million annually.



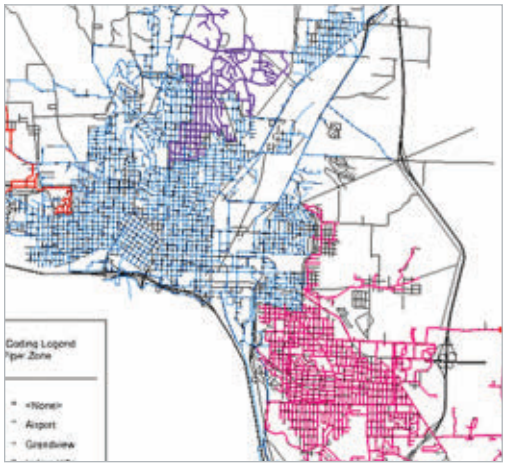
City of Sioux City

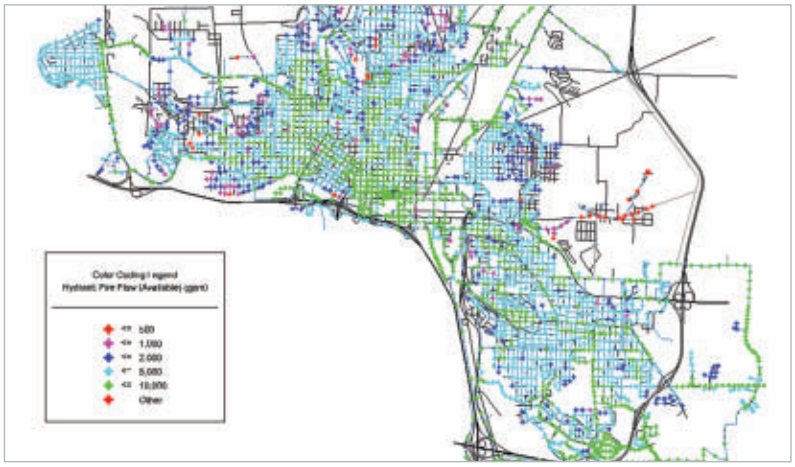
Sioux City Water System

Sioux City, Iowa

Sioux City, Iowa, developed a GIS of its water, sanitary, and storm sewer systems, and creation of a water model was the next logical step. Consultants had previously developed localized models for site-specific projects. However, a system-wide model had not been created for the metropolitan area.

The city developed the hydraulic model in-house using WaterGEMS. The GIS was quickly converted into a working model, the customer service database was incorporated to develop demand distribution, and GIS contours were included to assign elevation to nodes. The model has been used to solve problems with water pressure and fire flow availability as well as to assess options for removal or rehabilitation.





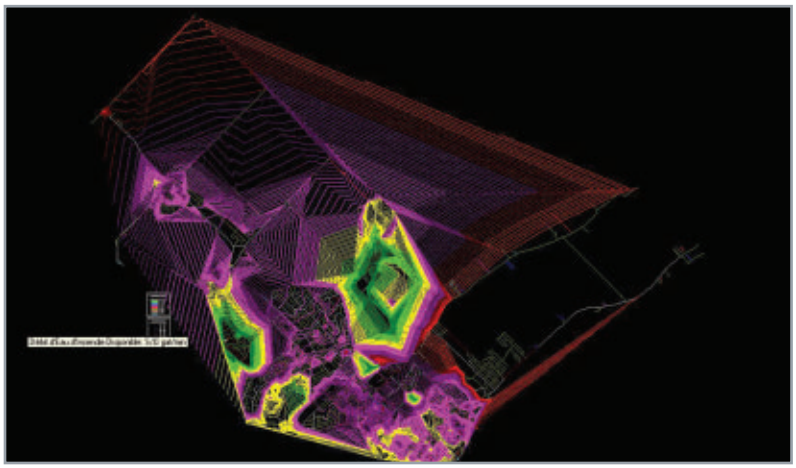
City of Trois-Rivieres

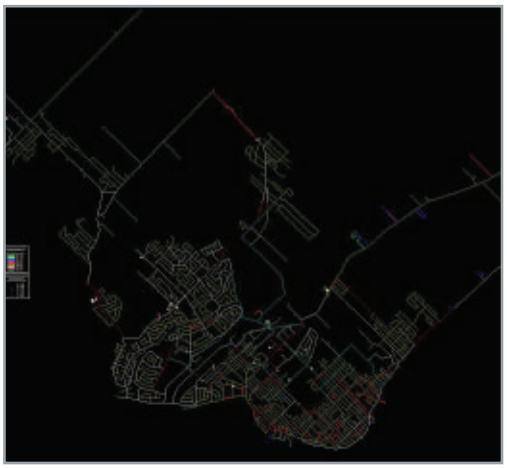
Water Model of City

Trois-Rivieres, Quebec, Canada

Quebec recently merged five small municipalities with the City of Trois-Rivieres to form a city with a population of 125,000. The project involved modeling the expanded city's water network. The biggest challenge was to retrieve all information regarding the water systems. One-third of the population receives water from 20 different wells and these wells are not interconnected.

Through collaboration with Groupe BPR and Bentley, the city created a model that gives dynamic calculations that are close to actual. The city now has a better understanding of flows, demands, and system pressures in the system. It can schedule its work in areas where it is most needed and make 10-year budget forecasts.





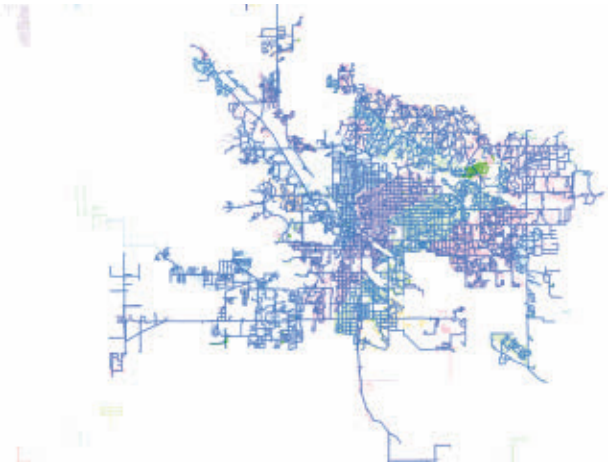
City of Tuscon

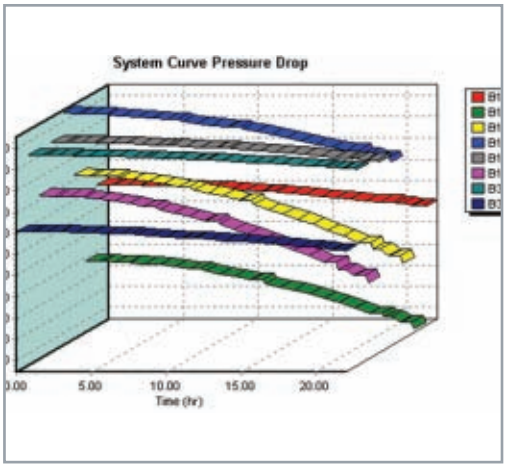
Hydraulic Modeling and GIS Applications at Tucson Water Department

Tuscon, Arizona, USA

The water department of Tucson, Ariz, converted its paper water-system maps to an ArcSDE geodatabase integrated with operation and maintenance and an asset management system. The planning and engineering division created dynamic EPS hydraulic models of its systems using data contained within the geodatabase, SCADA data, billing information, and other data sources.

These models are used for CIP planning, master plan approval, fire flow analysis, system investigations, water quality analysis, and vulnerability/threat assessment. Created using WaterCAD and WaterGEMS, the models have saved time in routine tasks, annual analysis, and long-term planning efforts, and have provided the project teams with a better understanding of the strengths and weaknesses of the city's water system.





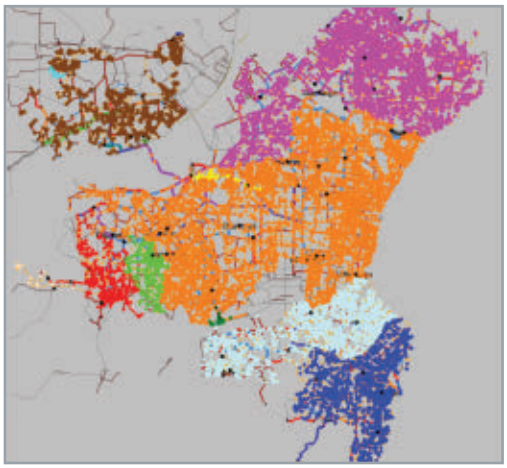
Farnsworth Group, Inc.

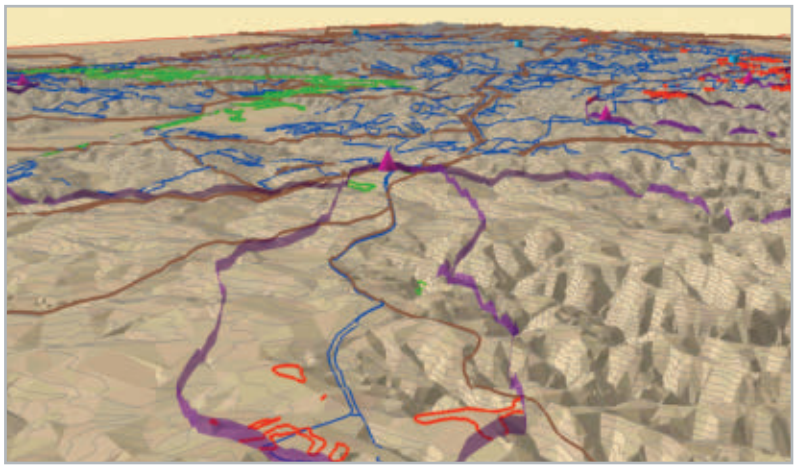
St. Louis and St. Charles EPS Calibration

St. Louis and St. Charles, Missouri, USA

Located at the confluence of the Mississippi and Missouri rivers, St. Louis and St. Charles counties experience daily water demands of up to 390 million gallons per day. As part of a CPS study to identify capital improvement projects for the next 20 years, Farnsworth Group built a hydraulic model using WaterGEMS. The EPS model provided geographic spatial-demand allocation based on more than 360,000 real-time billing accounts as well as SCADA extraction and verification of field operations data.

Three criteria guided EPS calibration for four current-demand scenarios: flow and pressure at four water treatment plants, tank-level trending at 32 storage tanks, and pressure trending at more than 50 pressure transmitters. The advanced features of WaterGEMS in conjunction with in-house tools saved an estimated 50 percent in labor hours to construct the model, having created the demand alternatives in fewer than 20 hours per alternative.





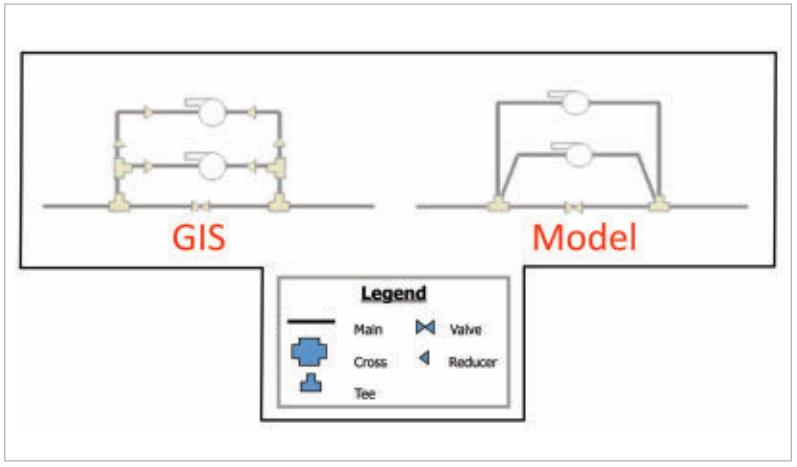
GeoAdvice Engineering Inc.

Hydraulic and Criticality Conditions–City of Saskatoon

Saskatoon, Saskatchewan, Canada

As a contractor for the city of Saskatoon in Saskatchewan, Canada, GeoAdvice Engineering used a water distribution system model built in WaterCAD to classify water mains based on their hydraulic and vulnerability performances. Running hydraulic simulations determined the condition of each of more than 30,000 pipes in the water supply and distribution system.

A criticality analysis was then performed through an automated simulation process, in which each segment of the network was taken out of service. Factors such as system demand deficit caused by each outage determined the criticality of that segment. This project allows the city to make decisions about which pipes are to be replaced to maximize the lifetime of each pipe.



IDModeling, Inc.

Sustainable GIS-Integrated Hydraulic Modeling

Voorhees, New Jersey, USA

American Water undertook this GIS-hydraulic model integration project to facilitate long-term hydraulic model maintenance by establishing procedures for creating a 1:1 relationship between the hydraulic model and GIS. The goal was to reduce the time and effort spent updating the hydraulic model from the continuously changing GIS so that up-to-date models can be used for planning, design, analysis, and operational studies.

ID Modeling worked with ArcGIS and WaterGEMS to streamline American Water's model development workflow, improve GIS/data management and mapping, standardize the GIS data model, develop specific topologic rules, create an hydraulic model template, and develop a first GIS-integrated hydraulic model. Once everything was configured, the actual procedure to update the model from the GIS took 10 to 15 minutes.

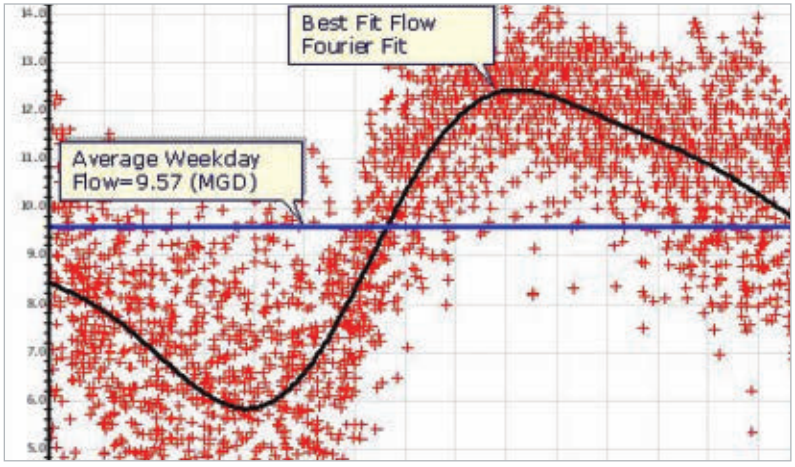
Jacobs Carter Burgess

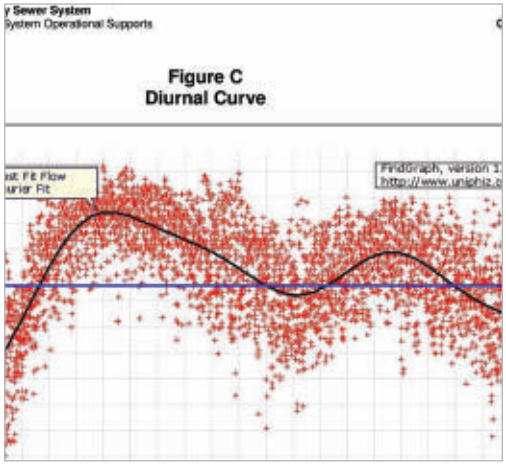
WaterGEMS Modeling for Sewer System Operational Supports

Collier County, Florida, USA

Collier County's current wastewater collection system was analyzed, designed, and constructed using modeling software using a GIS system interface with AutoCAD. Since then, Collier has invested significant resources in GIS, with special emphasis on its utility infrastructure system, and wanted to incorporate computer modeling software capable of interfacing with the Florida County's GIS.

The team expanded the WaterGEMS model in phases by adding all pump stations (county-owned and private) and pressure and gravity mains into WaterGEMS and recalibrating it using updated flows. In the modeling enhancement and calibration process runs, 697 pump stations were modeled. The WaterGEMS model was successfully enhanced so it can interface with the county's GIS.





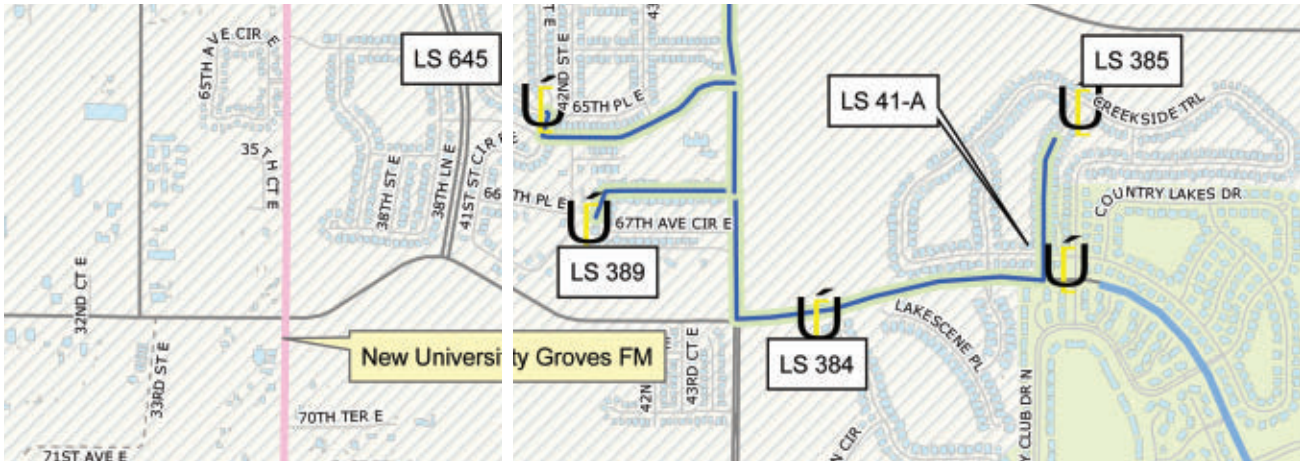
Manatee County Government

Lift Station 41A Disconnect

Bradenton, Florida, USA

The primary goal of this project was to address reduced flows in an existing force main as a result of diverting flow elsewhere as part of a much larger project to divert flows away from an overloaded master lift station. Lifecycle analysis of several alternatives using SewerCAD led to using the existing force main as the host pipe for a smaller-diameter carrier pipe.

Although this project involved only a small number of pipes, there are more than 1,000 pipes and 40 lift stations involved either directly or indirectly. SewerCAD was chosen for its ability to handle a system of this size. The ability to immediately model in variations without having to either fragment or skeletonize the system was a huge time savings.



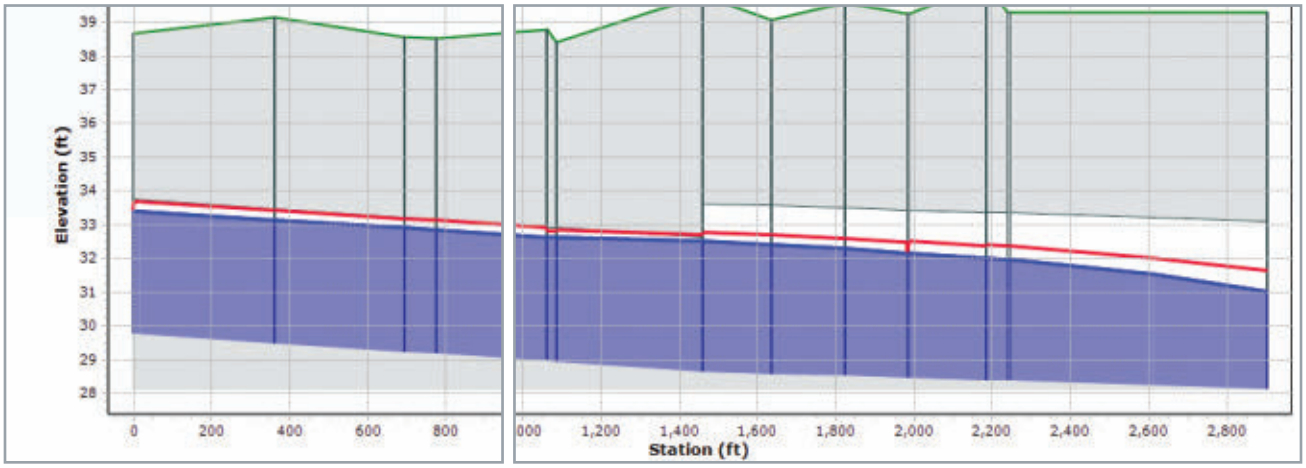
Maverick Engineering, Inc.

Harlingen Downtown Drainage

Harlingen, Texas, USA

The $2.5 million downtown drainage project is located in the downtown area of Harlingen, Texas. The purpose of this project was to redirect storm drainage to the outfall east of Business 77 to prevent flooding south of the downtown area. The major challenges of this project included working around existing utilities and having enough ground cover for the boxes while keeping the slope required for drainage.

StormCAD made it easy to make changes and determine if different designs would get the results required. The reports created by StormCAD, along with the profiles, helped Maverick Engineering see where it needed to make changes and/or had a problem (for example, ground cover, inverted or no slope, or flooding). StormCAD also integrated with AutoCAD easily so that the firm could use street details that had been drawn in AutoCAD.



Morrison Hershfield Limited

East Rocky View Regional Wastewater System

East Rocky, Alberta, Canada

This project provided a centralized wastewater collection and treatment system for the hamlets and towns in the east side of East Rocky, Canada, affecting about 90,000 inhabitants. A challenge was to model 18 lateral lift stations tying into a regional force main. Using WaterCAD, every tie point of the lift station was assigned a node and the nodes were isolated from the regional force main with residual pressure at the tie point.

Once the horsepower of the pumps and the size of the lateral force main for every lateral lift station were determined, the disconnected nodes at the tie points were connected to the force main to confirm whether the residual pressure at the nodes before connecting is similar to the residual pressure after connecting the nodes.

National Water Commission

May Pen Water Supply Project

Kingston, Jamaica

The May Pen Water Supply System in Kingston, Jamaica, is supplied by nine wells with an estimated total flow of more than 9 million gallons per day, but the 106,500 people in the project area use an average of nearly 7.5 million gallons per day. To identify where the unaccounted-for water is going, the National Water Commission conducted hydraulic simulations of the supply system.

Based on simulations conducted with WaterCAD, several problem areas were identified and recommendations were made to improve the performance of the water supply system. If all the recommended improvements are implemented, an estimated net increase of J$44,119,438 in annual revenue is possible. These improvements will enable the May Pen Water Supply system to meet the development demands within the area.

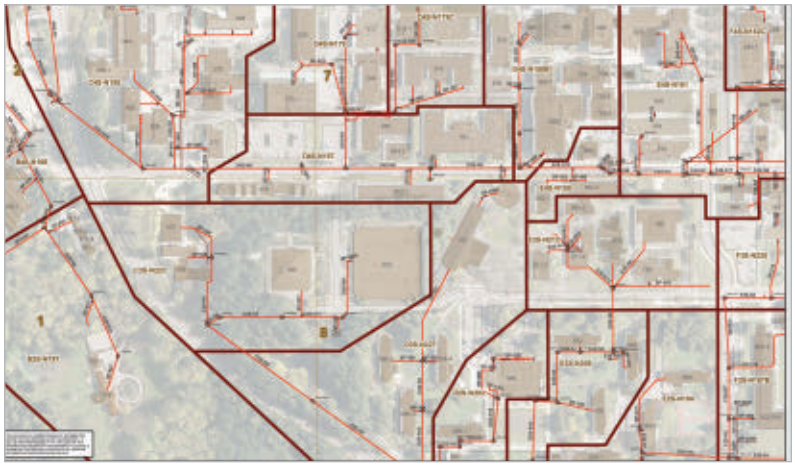
Urban Systems Ltd.

UBC Integrated Water Management Plan

Vancouver, British Columbia, Canada

Established in 1908, the University of British Columbia educates a student population of 50,000. The university's principal campus in Vancouver is 1,000 acres and has an award-winning model for environmental sustainability. Recently, the university selected Urban Systems to create an integrated water master plan that complements the university's commitment to sustainable growth.

WaterGEMS, SewerGEMS, and GIS recordkeeping enabled the creation of an adaptive framework for scenario-based decision making that ensures a water infrastructure that is neither over- nor under-sized. Peak demands have been significantly reduced, and accurate modeling indicated that only marginal upgrades are required to accommodate 25 years of growth. An estimated $6.5 million will be saved on avoidable future capital upgrades.



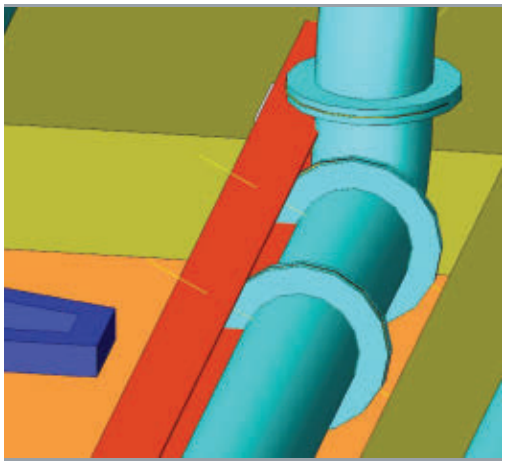
The Walsh Group

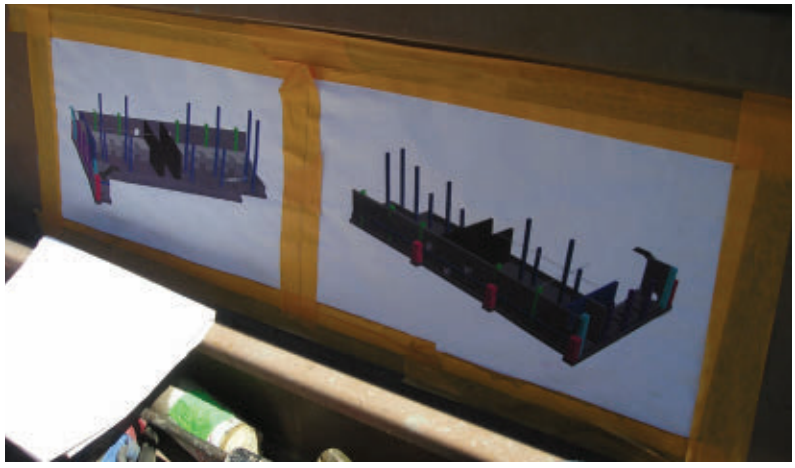
Arizona CAP Water Treatment Plant Expansion

Scottsdale, Arizona, USA

This project involved the expansion of the Scottsdale Central Arizona Project water treatment plant for additional reutilization of surface runoff to supplement the supply of drinkable water when other sources are unavailable. Using Bentley's building information modeling (BIM) software, the firm strategically surveyed and modeled the existing conditions into a 3D geometrically accurate model.

The Walsh Group superimposed Bentley's BIM models of the proposed designs for architecture, structural, and major MEPs with the existing conditions model to create the composite model. From project start to the eventual handover to the client, the regularly updated composite model was the central information database, saving more than $149,000 in avoided conflicts and reducing the 28-month construction schedule by five weeks.





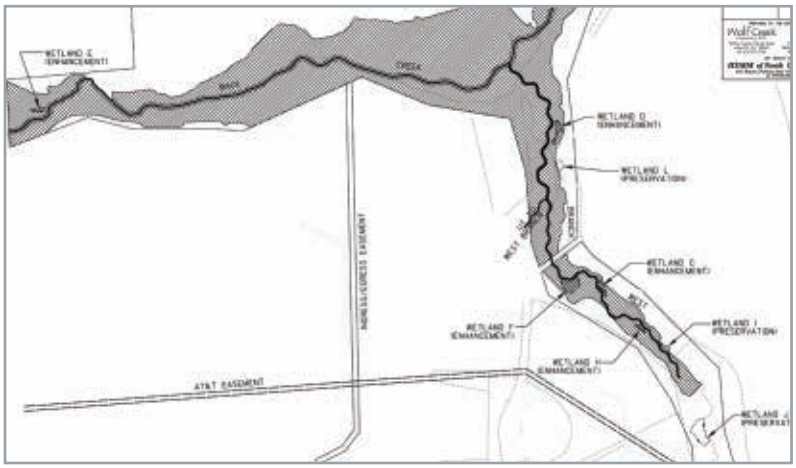
WAZ Engineering

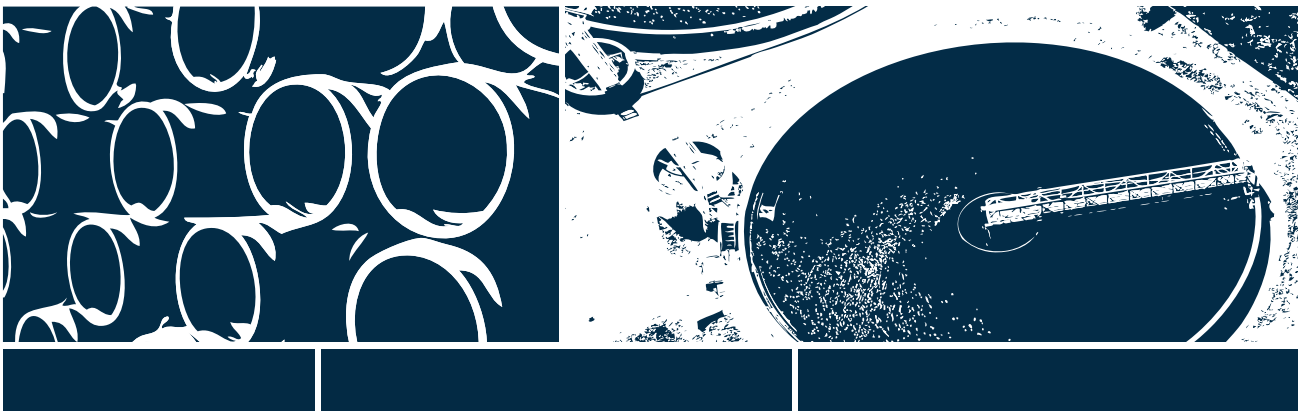
Heath Dairy Stream Restoration

Randleman, North Carolina, USA

As a source of pollution in the watershed that supplies water to the city of Asheboro, N.C., the Heath Dairy Farm Stream in Randleman, N.C., is part of a restoration project to mitigate the impact of development on the watershed. The $1.2 million project will restore 8,850 feet of Back Creek and associated tributaries, reforest 52 acres of riparian buffer corridor and upland areas, and reduce nonpoint source sedimentation and nutrient input to the Back Creek watershed.

WAZ Engineering used MicroStation and GEOPAK to design the stream restoration and relocation. The solution to controlling costs was to minimize earthworks, produce clear plans and specifications, and limit the number of change orders during construction. Detailed plans based on an accurate digital terrain model and illustrative cross sections accomplished this goal.





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PRODUCT LEGEND

Water Distribution
WaterCAD, WaterGEMS

Wastewater
SewerCAD, SewerGEMS

Transient Analysis
HAMMER

Stormwater
StormCAD, CivilStorm, PondPack, InRoads Storm & Sanitary

Civil Design
InRoads, GEOPAK Civil Engineering Suite, PowerCivil, MXROAD

Plant Design
AutoPLANT, AutoPIPE, PlantSpace, promis•e, PlantWise

Structural Analysis
RAM Structural System, STAAD.Pro, Structural Modeler, Bentley Architecture

Platform Products (Across Industry)
MicroStation, ProjectWise, CloudWorx, Bentley Navigator

Software Customization
WaterObjects.NET

GIS/Asset Management/ Web Publishing
Bentley Water, Bentley Wastewater, Bentley Geo Web Publisher, Bentley Map, Descartes

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PRODUCT LEGEND

Water Distribution
WaterCAD, WaterGEMS

Wastewater
SewerCAD, SewerGEMS

Transient Analysis
HAMMER

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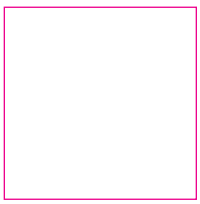

Recognizing the critical importance of being a good corporate citizen, Bentley is uncompromisingly committed to supporting ecological sustainability. This support goes beyond the stewardship of environmental resources to include investment in strategic educational and training initiatives that foster a workforce of skilled infrastructure professionals capable of meeting the world's growing sustainability challenges.

The Water Project Showcase is one small example of Bentley's commitment to promoting sustainable development through its business practices. As part of this effort, this publication has been printed on Forest Stewardship Council (FSC) certified paper, which identifies products that contain wood fiber from well-managed forests.

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