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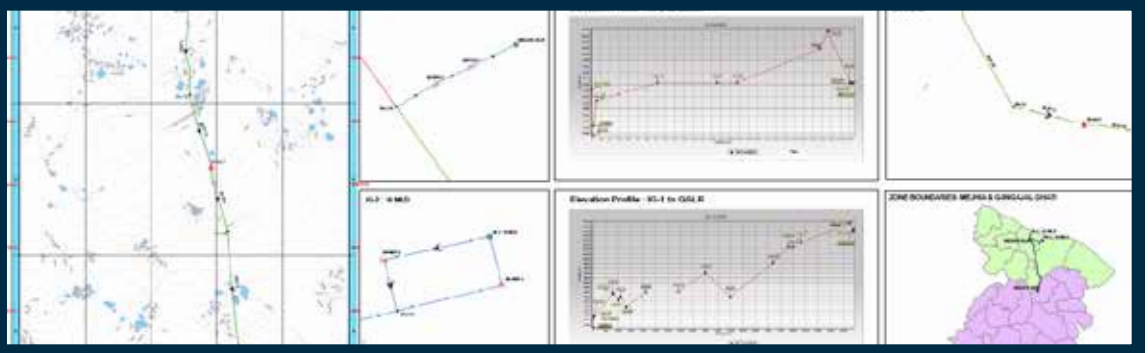
Advancing Infrastructure



Project Summary

Organization:
DTK Hydronet Solutions

Solution:
Water, Wastewater and Stormwater Networks

Location:
Bankura, West Bengal, India

Project Objectives:

- To provide a consistent, equitable water supply to 600 habitations in the rural villages of Bankura that is safe to drink.
- To increase water supply coverage in the region from 0.027 percent to 100 percent.

Products Used:
WaterGEMS®, HAMMER®

Fast Facts

- Out of 122 nations in the world, India is listed as 120th in poor water quality, equating to 1 million people per year being affected by water-borne illnesses.
- The Public Health and Environmental Engineering Department (PHED) of West Bengal and the Asian Development Bank jointly funded this utility project.
- The existing water network comprised concrete asbestos pipes and was completely discarded.

ROI

- Using Bentley software cut total project costs by 16 percent, saving INR 2 billion.
- Creating a hydraulic model with WaterGEMS and reviewing innumerable scenarios saved 40 percent in design costs and 80 percent in design time.

Rural Villages in Bankura to Receive 100% Water Supply with New Bulk Water Supply Scheme

Bentley Software Optimizes Design of Water Distribution Network

Improving Water Conditions in Rural Bankura

The economy of India is the sixth largest and fastest growing in the world. While urban India is undergoing consistent development, rural India continues to face immense infrastructure challenges. Sixty-five percent of Indians reside in villages, and 80 percent of these villagers solely rely on groundwater for drinking and sanitation. Out of 122 nations in the world, India is listed as 120th in poor water quality, equating to 1 million people per year being affected by water-borne illnesses. As a result, rural Indians walk 8 kilometers each day on average to fetch clean water.

DTK Hydronet Solutions, an advanced water distribution and storm and sewer network modeling company, was retained by the Public Health and Environmental Engineering Department (PHED) of West Bengal and the Asian Development Bank to provide water distribution services to Bankura. Bankura is an administrative unit within the state of West Bengal, and it is inhabited by many indigenous tribal communities. Currently, these tribes are facing acute drought challenges. Surface water sources are almost dry, and the groundwater is severely contaminated with arsenic and fluoride, making it non-potable.

This project covered four blocks of Bankura out of 24, spanning 600 villages and almost 1 million villagers. Water availability in this region is currently 20 liters per capita per day, and it is supplied through an existing 100-kilometer pipeline network that only supplies water for less than 45 minutes per day. Due to these constraints, approximately 90 people die annually due to water-borne diseases in Bankura.

"In order to improve all these conditions, a system had to be designed that will make conjunctive use of ground and surface water, which would at least provide 70 liters per capita per day of water," said Devashri Karve, water engineering consultant at DTK Hydronet Solutions. "It should be 24/7, continuous, equitable, and sustainable, with a minimum residual height of 12 meters, dynamic pressure management system, and, most importantly, doorstep delivery of water to all the households of Bankura."

Analyzing Present Conditions and Determining the Optimal Route

Bankura's existing water network consisted of asbestos cement pipes that had a long history of leaks and repairs. Therefore, DTK Hydronet created a separate hydraulic model to analyze the behavior of the existing network, and the organization determined that the network is antiquated and incapable of catering to present and future water demands. Subsequently, they decided to discard the existing system in its entirety and design a new water distribution network.

DTK Hydronet needed to identify the most efficient routing option that would carry the water to the four designated blocks in Bankura. The water sources identified for this project were infiltration galleries in Damodar River and Mukutmanipur Dam. DTK Hydronet chose to use two-stage pumping via a booster station to transport the water from these two sources to the four blocks.

In the first stage of pumping, water is pumped from the source to ground-level reservoirs in every block. In the second stage of pumping, water will be pumped from these ground level reservoirs to their respective tanks in those blocks. While this option was not the most inexpensive, DTK Hydronet selected this solution because it was the most reliable given the large expanse of the project and area's rolling terrain.

Uneven Landscape and Dispersed Homes Pose Challenges

The length of the pumping main network is around 400 kilometers. Due to Bankura's undulating landscape, this network is highly prone to transient pressures. The hilly terrain ranges from 16 meters in height to 150 meters in height within a short distance. Therefore, it was a challenge to manage all pressures in the system.

The mountainous topography also caused the distribution model to be susceptible to high pressures. As a result, DTK Hydronet used pressure reducing valves (PRVs) to dynamically manage these pressures.

"Bentley WaterGEMS enabled 'conceptioneering' in this 4,000-kilometers-long Multi-Village Rural Water Supply's Single Hydraulic Model to benefit about 1 million villagers in India. Design evaluation and analysis was efficiently done in a pareto-optimal timeframe of 25 resource days, making the project one of its kind!"

– Devashri Karve, Water Engineering Consultant, DTK Hydronet Solutions

"By using this, the system would manage pressures during low demand hours and, during high demand hours, it would maintain adequate pressures," Karve said.

Also, due to limited land availability, the utility had already fixed some locations for overhead tanks, so it was a challenge to identify effective operational zones for every location. The population density of Bankura is very low, and the small groups of habitations are scattered across the area. Consequently, district metered area (DMA) demarcation for this project was different than conventional urban DMA demarcations. Separate feeders were provided to all the DMAs, certifying an equitable supply of water to all locations, no matter how far away from the tank location.

WaterGEMS Develops Optimal Hydraulic Model

DTK Hydronet used Model Builder, TRex, and LoadBuilder, which are modules that are incorporated within WaterGEMS, to initially develop the hydraulic model. Using these three capabilities within WaterGEMS saved 80 percent on design time, allowing one person to complete the tasks of five people. As a result, the first model was created in only five days. Additionally, CONNECT Advisor inside WaterGEMS allowed for swift access to all the technical resources, and the Network Navigator feature helped to develop an error-free model.

The project team then divided the hydraulic model in multiple scenarios in WaterGEMS, including transmission main and distribution scenarios. Previously, the data had to be manually entered, but with the Scenarios feature in WaterGEMS, DTK could generate an innumerable number of water supply schemes. The project team created more than 30 scenarios for transmission mains pumping schedules and costs, as well as more than 90 scenarios for distribution. The utility had initially set the pumping hours to be 22 hours per day, but DTK Hydronet determined that they could curtail two hours of pumping after implementing the Scenario Energy Cost capability in WaterGEMS. As a result, four hours are now for maintenance purposes and 20 hours are dedicated to pumping.

Using the Software to Analyze Network Options

DTK Hydronet conducted mass balancing of all 78 tanks to check overflow and emptying conditions at any time of the day, which saved water and tank construction costs. Next, the organization used the Darwin Designer capability within WaterGEMS for the preliminary designs of the 78 zones. Darwin Designer was used to obtain multiple optimum-cost-design solutions.

The organization came up with a new methodology for using Darwin Designer. They first set the diameters to 100-milimeters and then computed. Post-computing, DTK created queries based on velocity ranges, giving the team a tentative, telescopic hydraulic model of distribution networks. These networks were then further fine-tuned and optimized. DTK Hydronet conducted a criticality analysis with WaterGEMS to generate reports for operators of isolation step tests and DMA operations. They optimized the number of isolation valves using criticality analysis, and then used PRVs to dynamically manage the pressures. "With the optimal number of isolation valves, we aim to restrict the nonrevenue water to 15 percent," Karve explained.

The rising main was then analyzed for different operational alternatives, and the project team exported the rising main model to HAMMER to check and analyze for transience and pipeline failures. Then, DTK used this GIS-integrated model to generate the bill of materials, bill of quantities, and multiple maps. Lastly, the team exported the hydraulic model and submodel as iModels to facilitate an easy construction process. Previously, DTK created maps and construction drawings based on data from an Excel spreadsheet. Now, since WaterGEMS is GIS-integrated, DTK created Python scripts to create 350 maps in four days.

Bentley Software Advances Design and Saves Costs

This project achieved all design, engineering, operations, and environmental objectives. The design and engineering impact included: a single GIS-integrated hydraulic model; adherence to engineering standards for better safety; detailed analysis of every possible alternative; and savings of 40 percent in design costs and 80 percent in design time. In addition, cost-effective operations and future provisions for SCADA connectivity were additional benefits of the project.

The entire distribution network was designed for minimum cost and maximum pressure benefits. The transmission main was analyzed for safety, and the pumps were designed to operate optimally and profitably. Using Bentley technology saved nine months in design time as the design was completed in one resource month. DTK had estimated that this project would initially cost INR 12 billion, but with cost optimization of pipe diameters, materials, and pumping machineries, they reduced the cost by almost 16 percent. Five percent of capital was saved on pumping machinery and 11 percent in capital was saved on pipes.

New Water Supply System to Upgrade Quality of Life

This project provides a continuous, 24/7 water supply to every resident of the designated four blocks within Bankura, improving the standard of living and quality of life for 1 million villagers in rural India. "Infrastructure is an interface between nature and its people, and such an inspired project will definitely have an impact on the lives of thousands," Karve said. "With a present coverage of only 0.027 percent, this project will increase the water supply coverage to 100 percent by the year 2021. Additionally, the water will be 100 percent arsenic and fluoride free."

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