High-Pressure Fresh-Water Booster Station Improves Water Reliability for Lincoln County, North Carolina Residents

Lincoln County's new high-pressure booster station, operating at 225 psi, maintains fresh-water pressure throughout an eight-mile pipeline while gaining to 220 feet of vertical elevation. The plug-and-play booster station, manufactured by Gorman-Rupp, not only provides reliable water service to the county's western Piedmont residents, it minimized installation time and costs by matching pumps, motors, controls, valves, pipes and accessories for maximum compatibility and performance.

Located in west-central North Carolina, Lincoln County has a total area of 307 square miles and is home to more than 86,000 residents. The City of Lincolnton, the county seat, situated in the center of the county, is approximately thirty-seven miles northwest of Charlotte in the Piedmont region of the state.

The county runs east to west in the shape of a long rectangle. On the eastern side of the county is Lake Norman, a nine square-mile man-made reservoir which supplies fresh water to county homes and businesses. The Lincoln County Department of Public Works treats up to 3.9 million gallons of fresh water per day and manages its distribution through 310 miles of water lines.

The City of Lincolnton draws its water from the South Fork of the Catawba River running just west of the city. It maintains a separate water treatment plant with a capacity of handling 12 million gallons per day, but with an average usage of 2.5 million gallons per day.

Water Distribution Problem in Western Lincoln County

The biggest technical hurdle for fresh-water distribution in Lincoln County is topographical. The county generally rises in elevation going from east to west, with the steepest elevation gains in the western part of the county.

"The county pumps water from its water treatment plant near Lake Norman through a series of three booster pump stations to supply its western county residents," said Adam M. Jolicoeur, WTP Superintendent, Department of Public Works with Lincoln County. "The last booster station on the line, just west of Lincolnton, had to pump to the highest point in the county,

Gorman-Rupp ReliaSource® pre-packaged booster stations include precisely matched pumps, motors, controls and accessories and arrive to the job site ready for immediate hook-up to piping and power.

an elevation gain of 220 vertical feet. This booster station has been adequate to keep water pressure at a reasonable range, but not without frequent line interruptions due to breaks in the underground PVC piping because of the need to maintain water pressure at 225 psi, triple the normal maximum."

Planning a Solution

"Instead of fixing a breaking pipeline, the focus was to create a secondary water source to service the western county residents," said Paul Smith P.E., Senior Project Manager at Woolpert, the engineering firm selected by the county to consult on this project. "The plan was to access additional water from the City of Lincolnton's water treatment system and put in an additional eight-mile 18" iron pipeline from their plant to the far western side of the county."

Lincolnton had excess water capacity, so the city agreed to sell the water to the county. But that was just the beginning.

"It was unique, and challenging because it is a blended system," said David Powell PhD, P.E., Senior Civil Engineer, formerly with Woolpert. "We were building a new interconnection from the city's water supply to the county's to supply redundancy. We proposed tapping into two 18-inch fresh-water discharge lines coming from city's water treatment plant and putting that water into the county's distribution system. There were a lot of regulations that had to be considered going into that decision."

The challenges of blending water from two water treatment systems, laying a new pipeline, and pumping uphill eight miles on a dead-end line, were all parts of this solution needing to be resolved. It was definitely an interrelated situation.

New Pipeline to the Western County

The pipeline was the longest construction component of the project. It was going from the point of lowest elevation at 1,010 feet directly across from the city's water treatment plant, running eight miles uphill to 1,230 feet into a water storage tank at the highest elevation in the western boundary of the county. Although the new and existing pipelines are on very different corridors, they are effectively running parallel.

"Contractors are used to normal pipeline water pressure of 40 to 80 psi, but this was a very high-pressure pipeline," added Powell. "The contractors had a much more stringent performance metric – stronger materials and bigger specifications. Cast iron 350 psi classification pipe material was specified."

Pre-Manufactured Pressure Booster Station

A key component of the project was the pressure booster station. Woolpert engineers grappled with how big it should be, where to put it, and how much flow was needed to overcome the challenge of the very high pressure.

"The county wanted a system that would require a faster start-up, minimal hands-on maintenance, and fit onto a very tight footprint," added Smith. "The county also required the appearance of the station to be unobtrusive. This led us to consider a pre-manufactured pressure booster station as a solution and what advantages it could have over a conventional booster station for this application."

Woolpert reached out to Tencarva Municipal, which provides pumps and associated liquid handling equipment for municipalities. The company has worked with Lincoln County on other water and wastewater projects in the past, and the county felt confident they could access local technicians and parts as needed.

"Effective pressure booster stations operate best with valves, controls, pipes and pumps that all work together to meet the required handling needs," said Guy Chapman, Sales Engineer at Tencarva Municipal. "If any one of these components fails, it can put the booster station's operation at risk.

There are a few companies that do pre-manufactured pressure booster stations," added Chapman. "One of these is Gorman-Rupp Pumps. We have had many successful municipal projects with Gorman-Rupp's ReliaSource® stations in the past, including their above-ground pressure booster stations."

"Their systems are custom-engineered, manufactured, assembled and tested at Gorman-Rupp's facilities," continued Chapman. "Pumps, motors, valves, pipes, NEMA-rated controls, enclosures and accessories are precision-matched and integrated for maximum compatibility and performance. The stations are ready for plug-and-play installation on location."

Based on Woolpert's specifications and Tencarva's recommendations, Gorman-Rupp custom-designed an above-ground pressure booster station as a complete system, ready for immediate installation and hookup to power and piping.

"The pump booster station was specified for 675 GPM and 323 feet of total dynamic head," explained Powell. "The traditional class of cast iron that is used in most booster pump stations was not going to be appropriate because it would not be able to hold the pressure. We needed the high pressure because of the distance the water was traveling and the elevation gain."

Consequently, we specified two variable-frequency drive pumps," added Powell. "One of the unusual

Each pressure booster station is pre-tested before it leaves the Gorman-Rupp facility to ensure it will perform to design conditions when it is delivered.

aspects of the pump station is that the pumps are fairly small, but the motors are twice the size of the pumps to accommodate the head they are pushing against."

The double-suction pumps are designed for a wide range of municipal conditions. They are ideal when pumps must periodically operate at capacities above or below design capacity or during intermittent high head conditions. Their dual-volute casing design equalizes radial forces and lessens radial reaction of shaft and bearings, assuring smooth, vibration-free performance.

"These VFD pumps slowly step up, ideally designed that way because they are pushing uphill," explained Jolicoeur. "The pumps gradually increase because they are pumping up exceeding 200 psi."

"The entire pump station shipped to the job site completely assembled and tested from the factory and was up and fully functional within three weeks from delivery on the site," continued Chapman. "This minimized the installation effort by the contractor and made for a smoother and faster installation which was completed in October 2022."

A variety of modular enclosure options are available that allow stations to blend into the surrounding environment. Their overall size and roll-up access doors provide easy access to station components for routine operator maintenance.

"Having a single-source contact for the entire functionality of the pump station is extremely important," explained Chapman. "It provides single-source system responsibility. If there's an issue, Gorman-Rupp engineers fully understand the integration of the pumps and controls."

Surrounding the pump booster station is its 11' x 24' faux brick facade enclosure designed to attractively blend in with the surrounding landscaping. The enclosure resists corrosion, mildew, fungus and mold. Two-way sliding cover panels provide easy access to all equipment for maintenance or service. Vandal-resistant door hardware and padlock-able sliding covers provide added security.

"As far as booster stations go, this is one of the most interesting I've ever seen," added Jolicoeur.

Surge Mitigation

One of the factors to be considered on the high-pressure pump station was eliminating pressure surge in the pipeline.

"Because of the high pressure, we needed to put a surge tank on both the influent side of the pump station and on the effluent side of the pump station," said Smith. "Placing a surge tank on one side of a booster station is common, but on both the influent and effluent sides is unusual. The influent side of the pump station is coming from the city – we couldn't risk any surge going back into the city's system because it was not rated for high-pressure – so we had to have a surge tank on the influent side. We definitely had to have a surge tank on the effluent side because of the elevation we were pushing against."

The two 2,500-gallon surge tanks are located underground and are separate from the pressure booster station. In the event that the pumps kick out, the surge tanks ensure the water pressure is maintained throughout the pipeline, despite the uphill flow of water.

System Controls

"Our key reason for specifying a pre-manufactured station was so we could get it fully tested at the factory and make sure all the controls were operating properly," added Powell. "It still needs field testing when it's on the site, but it was very beneficial to run it through all the paces before it shipped."

The booster station is quite far from the county's water treatment plant, so it needed to be standalone, reliable, and capable of making decisions based on remote inputs.

The control system has some very unique features built into it. Operationally, the pumps are managed using SCADA. Both the city of Lincolnton and Lincoln County have separate monitoring control telemetry installed. The operator enables it and then the VFD takes over and does its preprogrammed system start up until the pumps get to their operational level.

The booster station controls also had to monitor the water level. A typical booster pump station operates on pressure, where the pressure sensor turns on when the pressure is low, or off when the pressure is high. With this station the water pressure had to be pulled from SCADA, using both the City of Lincolnton's system and the county's system.

GORMAN-RUPP PUMPS

From left to right: Jonathan Drazenovich, P.E., County Engineer – Lincoln County Public Utilities, Guy Chapman, Sales Engineer – Tencarva Municipal, Adam Jolicoeur, WTP Superintendent – Department of Public Works with Lincoln County, Paul Smith, P.E., Senior Project Manager – Woolpert & Eric Knudsen, Northeast District Manager – Gorman-Rupp Pumps Engineered Systems.

Because readings of water levels were based on the SCADA system information, not based on local information, a failsafe timeout mode was necessary if the system lost power or lost communication. So, if cell service went down the station would not continue pumping out thousands of gallons of water based on the last known prior communication.

The various SCADAs, VFD inputs, and water indications were critical factors in designing the station's control system. Ensuring that the station could operate effectively both with and without this information was of utmost importance. The actual programming of the control system was done by Gorman-Rupp under the guidance of Woolpert.

Project Success

"We have had multiple events in the years prior with loss of water pressure to our customers in the west county area," said Jolicoeur. "Water was shut off to homes, schools, and businesses. The fire department had to put out notices – it was quite disruptive. This project has eliminated that problem completely."

About Gorman-Rupp Pumps

For more than ninety years Gorman-Rupp Pumps USA has manufactured pumps for municipal, sewage, industrial, mining, construction, petroleum, OEM, government, agriculture and fire markets.

The company's extensive line of pump products includes self-priming centrifugal pumps, standard centrifugal pumps, submersible pumps, rotary gear pumps, diaphragm pumps, engine-driven pumps, and priming assist pumps. In addition, Gorman-Rupp manufactures a complete line of state-of-the-art packaged lift stations and booster stations that include pumps, motors, controls, piping, accessories and enclosures.

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