MANSFIELD, OHIO — It sounds almost too simplistic to say that the City of Mansfield has saved money and improved operations by automating control of its water treatment and distribution facilities. After all, that’s what the Mansfield administration and city council intended to do by authorizing the addition of 10 programmable logic controllers (PLCs) and multiple remote telemetry units (RTUs) to provide operator monitoring and data acquisition capabilities at multiple well, reservoir, storage tank, pump station and treatment plant sites.

But it isn’t that simple a story, because the city did far more than just provide PLC control of equipment. Working with Toledo-based consulting engineering firm Finkbeiner, Pettis & Strout Limited (FPS), the City Engineering department, headed by James P. Lichtenwalter, and water plant personnel have implemented a sophisticated human-machine interface (HMI) for data acquisition and supervisory monitoring and control applications. Developed using the InTouch HMI application generation software from Wonderware Software Development Corporation, of Irvine, Calif., the system has optimized the use of departmental staff, achieved tremendous efficiencies in controlling production expenses and simplified data management.

And all of this replaces manual control with a system that makes it easy for plant operators to produce up to 25 million gallons of water a day for 53,000 residential, commercial and industrial customers in central Ohio.

Water Management Operations

The City of Mansfield has fared better than many eastern U.S. cities in handling the drought conditions of past years, thanks largely to its topography. Located in a valley, its 10 water wells are capable of producing up to 12 million gallons of ground water daily. The 1,000-acre Clear Fork Reservoir contains 4.5 billion gallons and the city can treat up to 24 million gallons of lake water daily. The water from all sources is treated at the main water treatment plant before being pumped uphill to the 12 million gallon Woodland Reservoir and the Shaker Heights elevated storage tank at night, for draw-down by customers during the day.

The city’s water treatment operations are similar to most other well-system based municipal water facilities. Groundwater comes into the plant from the wells and the
Clear Fork reservoir via a 30-inch main and is treated to remove impurities in several stages before being pumped out to the city's customers.

“Like most other cities, our biggest problem was managing the system so that we could meet water demand efficiently and cost-effectively,” said Angelo Klousiadis, plant manager. “All of our operations were handled manually by leaving the main filter building and walking down to a control panel located in one of the plant pump houses. If we needed to take action at a remote site, someone literally had to jump in a truck and go out to handle it. In addition, we had little more than circular chart recorders and operator note logs to track production data and prepare reports for various governmental regulatory agencies, including the EPA.”

Working with Finkbeiner, Pettis & Strout Limited, a system was developed that has centralized management of all facilities in the treatment plant and that provides far more data feedback on operations. Ten Allen-Bradley PLC-5/10s have been installed, seven at the treatment plant and three at major remote sites. In addition, Allen-Bradley RTU’s are located at other sites for remote data collection and alarm monitoring. All remote PLCs and RTUs are linked via ESTeem radio modems from Electronic System Technology.

“Our staff still manages all plant operations, but they no longer have to leave the filter plant control room to turn equipment on or off, or to monitor proper chemical processes,” Klousiadis explained. “We now have intuitive screen graphics that depict equipment status at all sites and provide real-time data in easily understood chart formats. Operators can point-and-click on the screen to turn equipment on or off and they get instant verification that the required action took place. We can even monitor site alarms centrally, so they know if there are break-ins. We also get alarms if there are equipment malfunctions; in the old system, we wouldn’t know if a pump malfunctioned until water didn’t show up somewhere. We also get enough data to do better planning to meet the daily water demands of business, residential and industrial customers.”

Easy System Implementation

The Mansfield control and HMI systems were developed in tandem and installed at the same time, under the direction of Finkbeiner, Pettis & Strout engineering staff, who wrote the PLC ladder logic as well as developed the InTouch screens. “FPS evaluated six HMI software packages and InTouch came out on top due to its software configuration efficiency, its ease of use, its user friendliness, exciting 3D features and, most important of all, its interfacing that other packages lacked,” explained Rohit Trivedi, FPS partner in charge of electrical services.

The HMI runs on a pair of IBM-compatible computers at plant headquarters, one for operator use and one for use by management. The management computer has a removable hard disk subsystem that is used for maintaining data logging. “This drive uses cartridges that can store up to six months’ worth of operating data, for trending and archival files as well as for environmental reporting,” Klousiadis said. “We’re now collecting data that we never even gathered before, simply because the capability is there. This includes all raw water in, all treated water out, and every chemical addition made in between. We’ve found that the new levels of data detail we’ve achieved give us the ability to really make our treatment systems efficient.”

Structured Levels of Data Detail

The Mansfield screen graphics were designed to be intuitive yet easy to use. All screens were set up in a “tree” fashion so that it would take no more than two clicks of a mouse to get anywhere in the system. The overview screen is a map of the Mansfield region,
showing the location of each water facility. Each site on the map is a “hot” button and clicking on it zooms in for a closer look and more detail.

The water treatment plant map shows all elements of the facility, and clicking on any of the four buttons for major chemical additives (coagulant, carbon, caustic or chlorine) brings up a detailed screen of each of those processes. These include windows showing automatic feed rates and flow pacing ratios, where appropriate, as well as available supplies of chemicals (such as coagulant, chlorine or carbon). They show current data as well as a graph of the previous 24 hours.

Graphics screens of outlying facilities, such as wells and pumps, reservoirs and elevated tank storage, show equipment as well as security system status. “We didn’t have physical plant alarming in most remote sites in the past so there was no way to report an intrusion,” Klousiadis said. “With this new system, we’ll get a horn alarm within the treatment plant if an unauthorized entry is made and the door on the screen replica of the site will open and will begin flashing red to indicate the alarm. We can then investigate and make an appropriate response. We also have alarm help screens that assist operators in understanding the alarm event logging system so that all activities are consistent in nature.”

The site screens are quite realistic. They not only include windows with current and historical level data — for anywhere from 24 hours to four days — but they include very detailed views of the facilities. In addition, a new power monitoring screen helps plant management control the use of electrical power, so that operations run smoothly yet costs are kept in control. The power company rate structure for Mansfield provides a tremendous price break for consuming less power during the day than at night. If daytime usage is maintained at one-fourth or less of the total nighttime consumption, then the power costs one-fourth the normal day rate. “For this reason, we’ve always turned our big pumps on only at night to pump water up from the plant to the Woodland Reservoir, then gravity-feed the water to customers throughout the city during the daytime,” Klousiadis explained. “Using the big pumps only at night means we get the best rate — but we have to manage our daytime usage so it doesn’t exceed one-fourth of the nighttime usage. This has meant a savings of about $20,000 a month. The problem is that we haven’t had the fine detail needed to guarantee proper daytime usage.

“With the power monitoring screens FPS built into InTouch, we can spot trends as they occur and make sure we don’t surpass that limit — and by doing this we may be able to save another 10% a month on our electrical bills, or as much as $2-3,000 a month,” he added. “The bonus is that anytime we do have an extraordinary event that puts us over the day’s limit, we now have the logged data we need to track down the cause and correct it so it doesn’t happen again.”

A new data tracking chart is the equipment run-time screen, which tracks the elapsed hours of run-time, the projected maintenance interval and elapsed percentage of operating time for all major water system components. This includes high and low service pumps, flocculators, well pumps, and filters. “In the past, we’d set things up to run a certain number of hours before maintenance but all too often readings wouldn’t be taken in time and maintenance would wind up overdue,” Klousiadis said. “This meant we either had equipment failures or the service job was bigger than it should have been. Now we have alarms that pop up automatically when routine maintenance schedules are reached. This same screen can also help us monitor performance and we can see if there’s any degradation as a piece of equipment approaches the end of a PM period.”

One of the most important screens created for the new system is the Process Control Measurements screen, which provides real-time charts showing actual data trends and averages for all primary water treatment activities:

- Treated water turbidity
- Treated water Cl₂ residual
- Treated water pH
- Raw water turbidity
- Raw water KMnO₄ residual.

“This one screen now allows our operators to more tightly monitor and control the chemical feeders and movement of treated water on a continuous basis,” Klousiadis said. “In the past, pH, turbidity and chlorine residuals were tested once every two hours. The plant’s operation is now more streamlined.”
“All operators know exactly what has been added and when, so that we have far better control over our output and feeds are more precise now,” he continued. “We simply didn’t have any real system monitoring before, plus increasing or decreasing chemicals could only be done on an hourly basis — the operators could only make their rounds so often. Adjustments are now being made as needed, based on laboratory testing and computer screen readings. We also have better recordkeeping for providing monthly reports to the EPA on all flows, chemical feeds and residuals.”

**Labor Efficiency**

The City of Mansfield has not made any reductions in staff or redeployments because of the new system. “People are still doing their same jobs but they are doing them better and easier now,” Klousiadis said. “Everybody was concerned about staff reductions when we first talked about computerization, but they’ve learned that it’s really making their lives easier and the city has gained better control for production of potable water.”

In fact, to simplify training and make staff more comfortable with using the computer, mouse and Windows programs, FPS had the primary PC installed first and loaded it with simulated programs. This helped familiarize the staff with using the computer so that when the time came to begin monitoring the plant and remote facilities they were no longer threatened by the situation.