State of the Art

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JEA: Optimized Water Management

The public utility that serves Jacksonville, Florida and its surrounding area has benefitted from a system that introduces intelligent, automated control to well pumping and water distribution. The solution has enabled JEA to meet growing demand with greater efficiency and savings.

Introduction

Water is an increasingly scarce commodity that requires careful management. For public utilities the task is made even more difficult by the rising costs entailed in pumping, treating and distributing water to their customers. Achieving the right balance that satisfies current consumption needs at a reasonable cost while ensuring water quality for the future requires that skilled operators be supported with the right tools.

1. The Need to Satisfy Growing Demand

JEA is the major public utility of Jacksonville, Florida providing drinking water, sewage disposal and electricity. The JEA electric system currently serves more than 360,000 customers in Jacksonville and parts of three adjacent counties. JEA's water system serves more than 240,000 water customers and 186,000 sewer customers, or more than 80 percent of all water and sewer utility customers in their service area. The water system comprises 150 artesian wells tapping the Floridian Aquifer, which is one of the world's most productive aquifers. Water is distributed through 44 water treatment plants and 3,480 miles of water lines. More than 2,500 miles of collection lines and six regional sewer treatment plants make up the JEA sewer system.

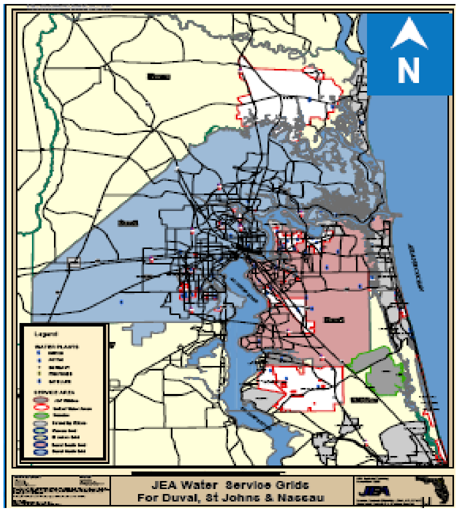

Figure 1: JEA supplies drinking water to more than 240,000 customers in the Jacksonville area.

2. Implementing a Solution

In the late 1990s JEA began to investigate alternatives for improving the efficiency of their water processing operations in order to respond to increasing demand. If they could operate more efficiently, they might reduce or delay the drilling of new wells, an expense surpassing $1 million for each well. Moreover, since JEA is both a producer and a consumer of electrical energy, they sought ways to more efficiently expend energy in pumping and circulating water in order to reduce their operating costs. JEA foresaw that improvements like these could have significant benefits but they would need to be achieved while maintaining, or even improving, water quality and service to their customers.

The system's planning capability is provided by Aleph5's Ernest optimizer. Ernest operates within the G2 object-oriented environment, making it possible for engineers design at a high level of abstraction in order to implement and monitor closed-loop control. JEA engineers defined inputs, such as sensors, and outputs, such as set points on equipment, as software objects. They represented the rule-based logic about how to apply the optimizer calculations in an intuitive natural language scripting that incorporates the concept of time. Typical optimization tasks, such as averaging the reading of a meter over time, checking a meter reading against mass balances, or checking the position of a pressure relief valve before changing a set point, were made parametrically without having to recode the algorithms.

The optimizer's target, expected water demand, is supplied by Gensym's neural network software trained on historical meteorological data and consumption patterns to provide hourly forecasts of consumption across a specified time period, typically 24 hours.

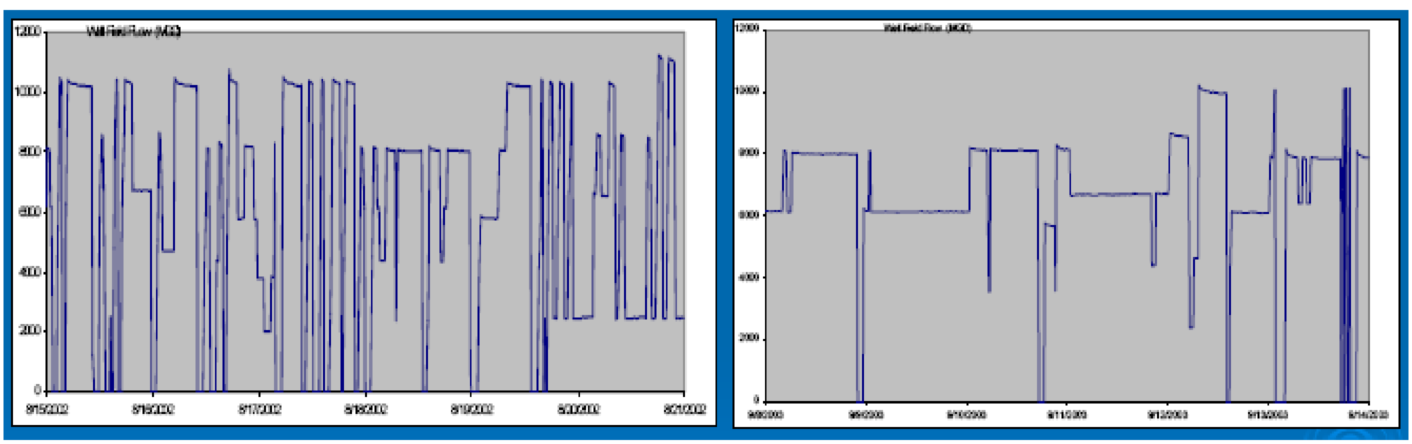

Figure 2: In the optimized system (on the right) pumps are used less often.

3. Benefits of the Solution

Only a short period of time was required to develop and implement the expert system. Well-field optimization was placed into service less than eight weeks from project conception. The first sub-grid of the distribution system was ready for on-site testing and calibration six months after project conception. The results in this sub-grid demonstrate that optimization makes better use of reservoir capacity by drafting, or lowering, levels as needed to minimize cost and maximize well quality. Well-field conductivity has been substantially improved, providing an indication that salt intrusion has been reduced, which will significantly increase water quality. Some wells have even shown a downward trend in conductivity, indicating that the health of these wells is increasing. This application, when completed for JEA's network of over 39 facilities, will enhance the company's ability to service its growing customer base, reduce the need to invest in new wells and water mains, lower pumping energy costs, reduce equipment failures, and minimize maintenance.

While other utilities are investigating and experimenting with this type of automated supervisory control, the JEA system is believed to be the first to directly operate a production well field. The expert system and optimizer have already paid for themselves in a trial application in one well field where JEA has deferred $1.4 million in capital expenses. Larger savings of an estimated $170,000 per year in operating expenses, potential energy sale opportunities, and millions in capital expense deferrals are expected when the system is rolled out to one of the utility's two major grids.

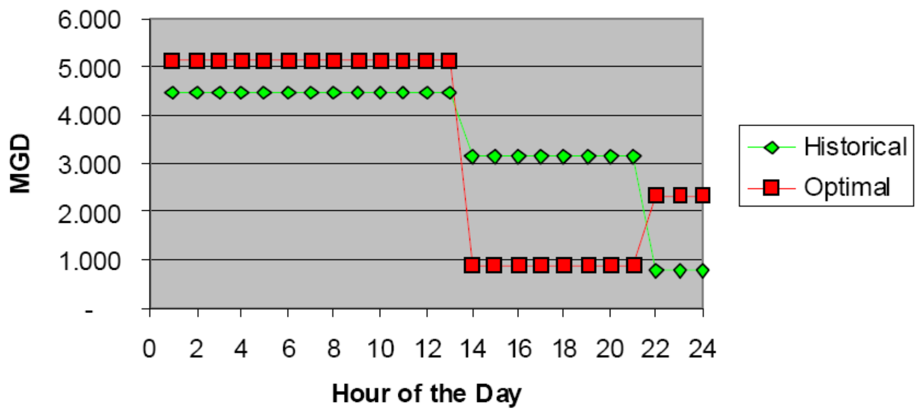

Figure 3: In the optimized system (in red) well production is minimized during on-peak hours in the afternoon and evening.

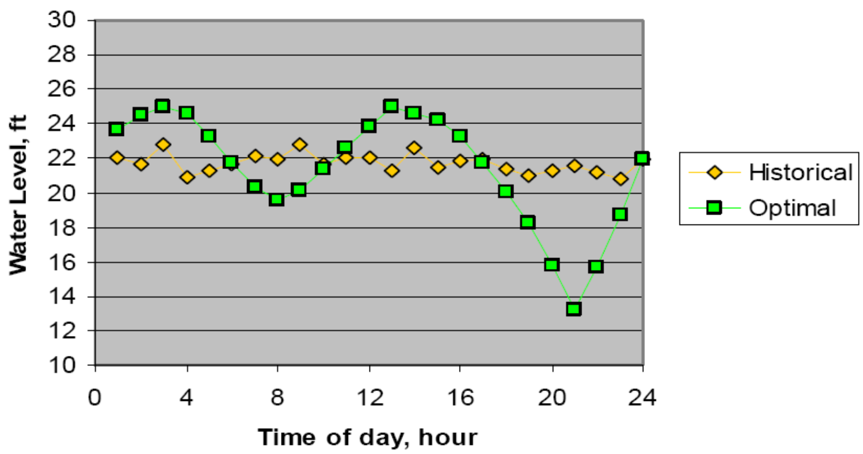

Figure 4: Reservoir water level is allowed to vary more in the optimized system as a consequence of less frequent pumping. Operators can be confident that the reserve will be sufficient to meet demand because the system accurately predicts future consumption and schedules accordingly.

Conclusion

Water is an increasingly scarce commodity and it requires careful management. For public utilities the task is made even more difficult by the rising costs entailed in pumping, treating and distributing water to their customers. Optimal management should ensure water quality and supply to meet current and future demand. Moreover, the utility needs to be diligent in minimizing costs – both long-term capital expenses as well as operating costs. As operating circumstances change day to day, achieving the optimal balance is beyond the ability of even the most skilled operators but it can be managed with the right tools in hand.

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