CHAPTER 10

INSTRUMENTATION AND CONTROL EVALUATION

Chapter Outline

10.1 INTRODUCTION

Daily, and sometimes hourly, observations of system operating parameters is required to ensure that the water system is performing within regulatory standards and meeting operational goals. Immediate notification of critical alarm conditions is paramount to ensuring a continuous supply of water to the public and is often necessary to protect the City's infrastructure.

Instruments installed throughout the existing water system currently measure a number of variables including reservoir levels, well pumping rates, chlorine residuals, and equipment operating modes. In many cases, the information they produce is recorded locally at a given facility and operators must be physically present to observe the collected data.

This plan proposes a water system instrumentation and control system comprised of programmable logic controllers (PLCs) located at each water system facility; water treatment plant, wells, finished water pump stations and storage reservoirs. These localized PLCs will collect and transmit data generated by instruments at each facility to a central PLC located at the water treatment plant. The central PLC will be programmed to automatically operate the water system. Operators will be able to make operational changes and control specific field devices from the central PLC.

A supervisory control and data acquisition (SCADA) system will interface with the PLC and provide the operators with another access point to the control system. The system will allow operators to measure and log system parameters such as flow, pressure, temperature, run status, and will collect information from the central PLC and format the data into a user interface that will be displayed on the monitor of a desktop computer. Operators can start and stop equipment, open or close valves and make other process and equipment adjustments from this computer interface.

Data transmitted through a PLC system is available immediately and thus more useful than data that is stored at a remote pumping station or reservoir facility. Telemetered alarms provide immediate warning of malfunctions and low water levels, reducing the response time for emergency situations. The electronic collection of operational data in a centralized location improves operator efficiency and the reliability of collected data. Additionally, the data collected by the PLC system can be easily formatted and stored by the SCADA system and utilized for regulatory reporting requirements and future reference.

The installation of a PLC and SCADA system will promote a more efficient operation of the water system by providing the City with information on, and control of, its system using fewer staff resources.

10.2 EVALUATION CRITERIA

The primary purpose of a PLC based control system is to provide the water system operators with a reliable and efficient means of monitoring and controlling daily operations. The following qualities are required of the new control system.

Expandability

It is anticipated that the installation of the control system will begin early in the overall water system improvement program. The system should be designed to handle current operational needs and provide broad expandability to permit the integration of new water system facilities as they are designed and constructed.

Reliability

The control system must be stable, and capable of providing uninterrupted control of the water system.

Accessible

The control and SCADA systems should provide the operators straightforward access to operational parameters of the various process components and be configured to allow remote access from an off-site computer to monitor plant performance, make adjustments, and respond to alarm conditions.

Secure

The security of the control system and in particular the SCADA system is important because a compromise or destruction of this system could have a wide impact on multiple areas of the water system and the general public.

10.3 Existing Instrumentation and Control System

The existing well control system was constructed in 1962 and consisted of a cam and lever control assembly that was driven by a pressure transducer installed at the existing elevated reservoir. Changes in water levels were transmitted to the cam system which rotated and triggered a series of relays. The activated relays generated a DC signal that was transmitted across a telephone line to a corresponding relay at each of the well facilities, which in turn activated the required number of well pumps.

This was an aging system and required frequent maintenance and repair. In December of 2008 the system failed. The cam and lever system and the pressure transducer were removed and replaced with an interim system consisting of a new pressure transducer and a PLC located in the same control building at the site of the existing elevated tank. The new PLC still relies on the existing relay system and phone lines to transfer the start/stop signals to the individual wells. Well sequencing is controlled by the use of a jumper patch panel between the PLC and the relays. System operators can modify the well activation sequence by switching the cables on the patch panel.

The new components of this system will be relocated and integrated into the proposed control system once the new elevated tank is operational and the existing tank is decommissioned.

10.4 Proposed Instrumentation and Control System

Local PLCs installed at the various water system facilities will transmit collected data to the central PLC at the water treatment plant and will in turn be utilized to disseminate command information from the central PLC to the process equipment and devices as directed.

The proposed communication system will utilize an Ethernet radio system with unlicensed radios operating on a spread spectrum frequency. This system will allow the City to operate their

system independent of a third party communication system. The relatively short communication distances and flat topography will require modest antenna structures throughout the system.

A graphic based SCADA system will be installed to allow system operators to access the PLC system through a desktop computer. Measured variables can be viewed, trended and saved on the computer. The computer-based interface will also provide centralized alarm management with stored alarm logs. The SCADA system will operate independently of the PLC system. This allows the SCADA computer to be removed or shut down without impediment to daily automated operations. The SCADA system will be accessible from off-site locations with the use of a computer and an Internet connection.

The SCADA system will also serve as a mechanism to collect and manage operational data. This information can generally be placed into one or more of the following categories:

- Operational and treatment process data, used to maintain the wells, treatment plant and storage facilities within established parameters and notify operators of out-of-limit conditions.
- Technical information used to provide operating cost and efficiency information.
- Historical data, used to identify long-term trends in water quality and plant performance. This information that can be used for evaluating and optimizing system facilities.

The following sections discuss the proposed instrumentation and control systems specific to the various facilities within the overall water system.

10.4.1 Water Treatment Plant

The water treatment plant will be the most complex of all the facilities in the water system. The following is a summary of anticipated instrumentation and control elements.

- Operational control of each process unit in the plant
- Monitoring of the treatment process (to confirm regulatory compliance)
- Master flow meter (instantaneous flow, daily totalized, and trending)
- Unauthorized entrance or intrusion
- Monitoring of utility power quality
- Automatic transfer switch status and alarms
- Generator status and alarms

10.4.2 Well Facilities

Under the proposed treatment regime, each well will deliver flow to the water treatment plant with the exception of the 5th & Maple and 3rd & Cedar wells which will continue to deliver directly into the distribution grid. The following I&C functions are anticipated at each well facility.

- Operational control of the pump
- Monitored operating status of the pump
- Master flow meter (instantaneous flow, daily totalized, and trending)
- Automated discharge valve control
- Automated pump to waste valve control
- Totalized flow to waste
- Static and drawdown levels in the well

- Chemical feed pump performance (5th & Maple and 3rd & Cedar only)
- Monitoring for chlorine residual and pH (5th & Maple and 3rd & Cedar only)
- Unauthorized entrance or intrusion
- Automatic transfer switch status and alarms
- Generator status and alarms

10.4.3 Finished Water Booster Pump Station

The finished water booster station will transfer treated water from the ground storage facilities into the elevated storage tank near the water treatment plant. I&C functions for this facility are:

- Operational control of the pumps
- Monitored operating status of the pumps
- Pump speed
- Suction and discharge pressure
- Master flow meter (instantaneous flow, daily totalized, and trending)
- Unauthorized entrance or intrusion
- Automatic transfer switch status and alarms
- Generator status and alarms

10.4.4 Storage Facilities

It is recommended that storage facilities will be equipped with the following I&C functions:

- Liquid level (instantaneous and trended)
- Automated inlet/outlet valves
- Unauthorized entrance or intrusion (for elevated storage only)

10.5 Proposed System Operational Modes

A call for water sequence will most often originate at the elevated reservoir near the water treatment plant. As the liquid level in the tank drops, it will signal the finished water pump station to transfer water from the ground storage tanks and replenish the consumed volume. The ground storage reservoirs will in turn activate the treatment plant to ensure these tanks remain relatively full. Finally, the plant will activate an individual well, or series of wells, to produce water and replenish the ground storage tanks as needed.

Liquid level trending from the elevated tank at the WTP may be utilized to develop a pumping sequence and operational mode for the finished water pump station that anticipates demand and economizes pump performance.

10.6 Recommended Improvements

The recent failure of the City's old telemetry unit provides the opportunity to construct a modern PLC based control system from the ground up. It is recommended that the City begin an in-depth evaluation of the specific instrumentation and control needs for the facilities proposed in this plan and to develop a system that incorporates the recommendations of this chapter as well as other operational needs. The development of an improvement project to provide comprehensive water system control is viewed as critically important to the continued operation of the existing water system. This project should include the design, specification, procurement, installation and

testing of an integrated alarm and process monitoring and display system, and should include the training of staff operators in its operation. The system should be designed to handle existing system operational needs and provide broad expandability in order to allow the integration of new water system facilities as they are designed and constructed.