

# Water Distribution System SCADA Survey Report

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# WATER SUPPLY DISTRIBUTION SYSTEM SCADA SURVEY REPORT

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## **Acronyms**

American Water Works Association (AWWA)  
Bristol Standard Asynchronous Protocol (BSAP)  
Contaminant Warning Systems (CWS)  
Department of Health and Human Services (DHHS)  
Digital Prototype Systems (DPS)  
Environmental Protection Agency (EPA)  
General Electric (GE)  
Institute for Public Policy (IPP)  
National Institute of Hometown Security (NIHS)  
Nota Bene Technology (NBT)  
Short message service (SMS)  
Supervisory Control and Data Acquisition (SCADA)  
University of Missouri (MU)  
Vendor management system (VMS)

## **Abstract**

This survey was intended to develop an understanding of the status of Supervisory Control and Data Acquisition (SCADA) system usage in water supply utility distribution systems around the country. This information could be used to provide an understanding of impediments to full development of SCADA to support and verify hydraulic and water quality modeling, and to the implementation of contaminant warning systems (CWS) by water supplies.

With respect to information directly supporting this project, the intent was to learn:

- how data sets are being analyzed with respect to operations management, security management, and incident response management;
- how management is using their SCADA data;
- what are the interfaces with distribution system sensors and hydraulic modeling;
- do utilities identify benefits from using SCADA;
- how do utilities demonstrate economic benefits from using SCADA and distribution system models for management decision-making.

There were 26 responses to the survey. These were from four states. This number of respondents and states are not adequate to develop statistical analysis that would be relevant to national or regional trends in water supply SCADA use. So the results simply identify a snapshot of the respondents' use of this technology. Of this group of water distribution systems that responded to the survey, all have had SCADA systems a minimum of 5-10 years and majority of them over 20 year. SCADA data is used primarily for operational purposes and security monitoring, with limited management decision making application.

There were several major findings. Only one utility has developed a CWS. Slightly more than half use hydraulic modeling of their distribution system. An understanding of the management uses of SCADA data was developed.

### **Background**

SCADA systems have been used in water supply for several decades. Anecdotal information and experience of the authors of this document indicate that SCADA is used primarily for day-to-day operational decision making and short term planning. The more common applications of these monitoring systems include:

- security monitoring,
- water quality monitoring,
- equipment management,
- data management,
- process control,
- alarm condition identification.

The survey was organized using these generic applications.

Other and more advanced uses of SCADA data include verification of distribution system hydraulic and water quality monitoring, as a component of a CWS, optimization of energy efficiency, operational report generation, and operational cost control. The focus of this project was the first three of these advanced uses.

### **The Survey**

The intent of the survey was to determine the status of SCADA usage in water distribution systems, provide information so utility managers could compare their SCADA systems and usage of SCADA data to other utilities of similar size, and to provide data in support of this project. This would include how SCADA systems are being employed, including how management is using their SCADA data with respect to operational, security, incident response and data management, and a variety of related information about SCADA systems and usage.

In addition, the intent was to learn:

- how data sets are being analyzed with respect to operations management, security management, and incident response management;
- how management is using their SCADA data;
- what are the interfaces with distribution system sensors and hydraulic modeling;
- what do utilities identify as the benefits from using SCADA;
- do utilities identify economic benefits from using SCADA and distribution system models for management decision-making.

### Survey Design

The survey was developed based on the six more common applications of SCADA systems currently used in support of water distribution system operations identified previously. A series of questions associated with each application was prepared. There were numerous questions, so a decision tree display logic survey was developed. In this method, based on the response to a question, the software selects the next set of questions. If the answer to a question was positive, an additional list of questions on that subject are provided. If an answer is negative, a question on a different subject is provided. Further information on this approach is available at <http://www.qualtrics.com/university/researchsuite/basic-building/question-options/display-logic>).

### Survey tool

The survey questionnaire used was reviewed by an expert in the University of Missouri (MU) Institute for Public Policy (IPP). The survey was developed using Survey software Qualtrics. It was an online survey hosted on the website:

<http://gutenson.dev.expert.watersonline.org/surveys/wds>

### Implementation

To develop the survey, a web search of SCADA manufacturers and technologies was conducted. SCADA Survey content was drafted, and the survey content was entered on software package Qualtrics. The draft survey was posted online, and comments were requested from individuals associated with water supply SCADA use. Comments on the draft survey were processed and appropriate modifications were made to the questions. Upon final approval, the survey was advertised to the water supply utility sector and the survey was launched.

There were 26 responses to the survey. These came from four states. This number of responses and states are not adequate to develop statistical analysis of the data that would have any relevance to national or regional trends in water supply SCADA use. The reviewing statistician identified that a sample of 30 is needed to begin to have a representative sample. Smaller samples have an increasing chance of being skewed by outliers in the data. In other words, a sample of less than 30 simply does not produce enough statistical power for there to be confidence in the results of the survey (MU IPP, 2013).

### Data Analysis

Statistical analysis was done on the data collected from 26 respondents. Percentages of respondents and summaries of responses were developed.

The respondents of the survey were categorized based on their size as small (<10000 customers), medium (10000> and <100000 customers) and large (>100000 customers) utilities. Respondents

were also categorized based on source waters: ground water system, surface water system, or combination of both.

## **Results**

A table of the survey questions is located in **Appendix A**. A table of the response statistics is located in **Appendix B**. Of the respondents to this survey, fifteen were small systems, eight medium and three large.

### **A. Results for the Most Common Uses of SCADA.**

The survey responses that follow are divided into the SCADA use categories used to design the survey.

#### **General Information**

Regardless of size all the participating utilities have been using SCADA to monitor or control their distribution system for a minimum of 5-10 years and majority of them over 20 years. A majority of them received an upgrade in last 2 to 3 years. 46 % of them received an upgrade within the last year. The majority of the respondents use only one SCADA system; six of them have more than one SCADA system to support their operations.

#### **Security Monitoring**

Fourteen of the twenty six respondents have security monitoring capabilities for their distribution systems. All of these utilities use that capability. Only one utility has developed a CWS, which is alternatively termed an event detection system.

#### **Water Quality Monitoring**

The responding utilities have hydraulic sensors including flow, pressure and depth, and water quality sensors including but not limited to pH, chlorine and turbidity placed at different locations in their distribution systems. The locations include pumping stations, water storage towers and storage reservoirs.

Fourteen of the twenty six respondents have the majority (50-100%) of the hydraulic measurements performed by their SCADA systems; this includes the large respondents. 50% of the respondents have very few (0-25%) water quality measurements performed by SCADA. The respondents that don't have any water quality measurements performed by SCADA are small scale utilities. These results may indicate that the number of security and hydraulic and water quality measurement sensors placed in these distribution systems by utilities, and the percentage of measurements performed by SCADA are dependent on the size of utility.

Only one responding water utility has a CWS. Sensor placement optimization software was used to locate water quality sensors in that system.

### Equipment Maintenance

Responses from our survey were almost evenly divided with respect to equipment maintenance and SCADA. 53 percent have SCADA provide them with equipment status monitoring including run-time, oil pressure and temperature and use this data for maintenance prediction or repair and replacement forecasting. 53 percent (8 of 15) of small scale respondents have SCADA provide them with equipment maintenance data; one of large scale respondents uses this capability.

### Data Management

Twenty of twenty six respondents use Windows as the operating system platform to run their SCADA while the rest use MacIntosh, open-vendor management system (VMS) or In-touch Window ware. This decision has been mainly based on the preference of the SCADA technician and treatment plant managers.

The results of the survey show that there are several SCADA software packages that utilities are using. The software employed by this group of utilities is a combination of multiple manufacturers, with General Electric (GE), Siemens, Invensys and Rockwell Automation being the manufactures used by these respondents.

In addition to an existing SCADA system, only one of the respondents applies water quality modeling software for demand forecasting; that system includes InfoWater with a computer algorithm. Fifty three percent use hydraulic modeling software like KyPipe, EPANet, SynerGEE water and InfoWater.

Nineteen, or 73 percent of the respondents use wireless radio as their mode of SCADA telemetry, eleven have fiber optic, and four use leased line as their mode. The protocols that are being used for communications within the SCADA systems are Modbus, Ethernet, Genius Global, and Bristol Standard Asynchronous Protocol (BSAP).

The data collected through the use of SCADA sensors in the distribution systems can be used for a variety of managerial purposes including historical trending of water quality, water usage and bill generation, regulatory reporting etc. Survey responses indicate that utilities are using the data from SCADA sensors mainly for security, equipment status monitoring, historical trending of water quality/usage, maintenance prediction, and plant process control. Most monitoring of regulatory compliance is done using manually collected data or a combination of manual measurements and SCADA data.

Fifty percent of respondents have a storage and analysis system for data collected by SCADA systems and eleven of them store the data indefinitely. Seventy six percent have remote access to this data.

### Process Control

Nineteen of responding utilities including all the large scale respondents are using their SCADA system to remotely control processes including pumping system operations, chemical addition and water storage leveling. Seventy six percent of them have the capability for these features of their SCADA systems to be accessed from locations other than the primary SCADA control interface. Several can also access the systems using the internet.

### Alarm Handling

Utilities who responded to the survey have numerous alarm notification capabilities within their SCADA systems, mainly for change in hydraulic characteristics, security, equipment, and water quality. Notification is usually by pop-up (17 of 26) on screen, phone (13 of 26) or short message service (SMS) (5 of 26) text messaging. Note that a number of the utilities use multiple methods of alarm notification. The majority of the operators at these utilities consider about 10% of the alarms generated are nuisance. Alarm notifications are grouped into categories based on priority by 13 respondents. Operators consider water quality change as the first priority. In most cases once the alarm is triggered the SCADA system does not have the capability to notify the emergency services like fire or police.

### Cost

Eleven respondents estimated the replacement value of their entire SCADA system to be in the area of \$100,000. Twelve of them estimated the annual upkeep expenditure to be lower than \$5000. Ninety six percent of them estimated their SCADA system downtime to be lower than 10%. 18 of them believe to that they have seen noticeable cost savings by usage of SCADA system.

The respondents identified a number of areas of cost savings, including remote control of distribution system processes with control from more than just one central location, which reduces manpower and travel costs going to the individual sites in the distribution system to exercise equipment control. Another obvious cost savings results from using SCADA data to generate monthly user bills, which reduces the time and travel for water meter reading. These are obvious financial savings, although the respondents could not quantify them.

### B. Operational Uses and Benefits of SCADA

Operational uses and benefits identified by operators and managers are of potential interest to SCADA users, water distribution system managers, SCADA designers and SCADA trainers.



Data sets are being applied for management of a number of operational activities and management uses. Respondents use the systems and data as follows:

• Security	53 percent
• Equipment status monitoring (run-time, oil pressure, etc.)	53 percent
• Historical trend analysis	50 percent
• Monitor water usage	46 percent
• Maintenance prediction or repair/replacement forecasting	42 percent
• Control plant processes	30 percent
• Optimizing alarm handling and response	30 percent
• Historical trending of water quality	26 percent
• Monitor materials consumption	23 percent
• Equipment calibration	19 percent
• Monitor system performance	15 percent
• Event prediction	15 percent
• Equipment maintenance scheduling and performance analysis	11 percent
• Monitor regulatory compliance	7 percent
• Manage incident response	7 percent

Respondents were asked to rank the importance of listed SCADA functions. A number of utilities consider more than one as top priority. Following are the percentages each was ranked as top priority:

• Alarm condition notification	50 percent
• Process control	38 percent
• Water/air quality monitoring	30 percent
• Data management	11 percent
• Security	11 percent
• Equipment monitoring	7 percent
• Energy management	7 percent

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