Pilot of Cellular Data Acquisition and Alarming for City of Suffolk Wastewater Pump Stations

WaterJAM 2011

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With thanks to Suffolk staff: Craig Ziesemer, Becky Bolduc, and Bobby Gardner
The City of Suffolk has invested in a cellular data acquisition system in the collection system pump stations for consent order compliance. The same data acquisition system has been piloted to provide alarm functions for MOM compliance.

Can a cellular data acquisition system be used for alarm functions as well?
Background
The City of Suffolk has entered into a Special Order by Consent (SOBC) with the Virginia Department of Environmental Quality (DEQ), Hampton Roads Sanitation District (HRSD), and 13 area localities.

Primary objective of the SOBC is to reduce the occurrence of Sanitary Sewer Overflows (SSOs).

The SOBC focuses on Sewer System Evaluation Survey (SSES) and Management, Operations, and Maintenance (MOM) Programs to target system improvements.

- The SSES Program requires flow monitoring of the sewer collection system.
- The MOM Program requires long-term monitoring of the system.
Background: Special Order by Consent

City of Suffolk part of HRSD Regional Wastewater System
The City of Suffolk’s wastewater collection system includes:

- A service area of approximately 430 square miles and 30 miles long, north to south.
- All of the wastewater from the City’s collection system flows to HRSD treatment facilities via HRSD’s interceptor sewer system.
- 234 miles of gravity sewers.
- 59 miles of force mains.
- 140 pump stations.
Background: Overall Wastewater Collection System Features
Existing SCADA System
Existing SCADA System
General Description

- Central station computer with Human-Machine Interface (HMI) screen.
- Radio communications.
- Remote terminal units (RTUs) in pumping stations and other remote facilities.
  - Monitor:
    - Process conditions.
    - Equipment status.
    - Alarms.
  - Transmit data to the central station computer for display and data storage.
Existing SCADA System Ability to meet SSES/Flow Monitoring Requirements

- No flow monitoring equipment.
- Limited communication speeds (for real-time monitoring).
- Limited data storage capacity at remote sites.
- The HMI did not have the ability to trend flow data.
- SCADA hardware was outdated.

The System lacked the features and functions to meet the requirements of the SOBC
Existing SCADA System
Ability to meet MOM Requirements

- Limited communication speeds for real-time monitoring of the system flows, pressures, and other data and alarm functions.
- Limited data storage capacity at remote sites.
- The HMI did not have the ability to allow multiple users to access data.
- The System did not have the capability to automatically page Maintenance Staff.

The System lacked the features and functions to meet the requirements of the MOM
SCADA System Development
Overall Approach needed to:
- Address short-term SOBC requirements
- Provide a system that can be adapted/enhanced to meet long-term needs

A two-phased approach was developed:
- Short-Term SOBC Interim Flow/Pressure/Rainfall (F/P/R) Monitoring System
- Long-Term SCADA Expansion for MOM and Other Requirements
Short-Term Requirements:

- Rapid deployment.
- Able to handle all terminal 100 pump stations.
- Able to monitor flow, pressure, rainfall, pump ON/OFF, wet-well and groundwater levels.
- Accessible for data storage and manipulation.
Rapid installation of F/P/R monitoring equipment at 100 out of 140 pump stations.

Rapid installation of Telog data loggers.

Rapid data communication via cellular transmission.

Rapid deployment of data storage, processing and access through cloud-based enterprise file server.
SCADA System Development
Short-Term SOBC Interim F/P/R Monitoring System

- Rain Gauge
- Telog Data Acquisition Unit
- Wet Well Pressure Transducer
- Current Switch for Pump Status and Run Time
- Force Main Pressure Transducer
SCADA System Development
Short-Term SOBC Interim F/P/R Monitoring System

- Data Transfer – system can handle needed capacity
- System Scalability – can handle expansion
- Web Server Application – data is accessible to multiple users
MOM Plan was submitted in December 2008

Long-Term Requirements from the MOM:
  – Alarm functions
  – System status information
  – Readily maintainable

It would be advantageous if the Long-Term solution was based on what was implemented for the Short-Term.
Long-Term SCADA components:
- Permanent flow monitoring.
- Door entry monitoring
- Station alarm sensors
- Interface with Station equipment (motors, drives, emergency generator transfer switches, etc.)
SCADA System Development
Long-Term SCADA Expansion

Wireless communication
Pump station with Telog Data Logger

Internet

Enterprise File Server

Alarm notification through wireless communication

Database backup/archive

Web browser interface – PC and ToughBooks
Long-Term SCADA components:
- Upgraded data logger with:
  - More input channels.
  - Ability to handle discrete alarm inputs.
- Upgraded enterprise file server capable of sending discrete alarm notifications to multiple users
- Upgraded web interface that provides:
  - Alarm annunciation
  - Alarm acknowledgement
- Software/programming updates to provide alarming hierarchy and delivery via e-mail/text message to multiple parties
SCADA Demonstration and Evaluation
SCADA Demonstration and Evaluation
General Demonstration Description

- Thirteen pump stations piloted.
- Upgraded data logger with:
  - 8 analog inputs
  - 6 digital inputs
  - 16 alarm inputs
- Door entry/logging system
SCADA Demonstration and Evaluation
General Demonstration Description – Web Interface

- Force main pressure
- Wet well level
- Rain gauge
- Pump 1 run event
- Pump 2 run event
Alarm Hierarchy
- PS Mechanic
- Labor Supervisor
- Maintenance Manager
- Maintenance Supervisor
- Operations Manager

Normal Work Hours
- Two alarms sent, 10 minutes apart.
- If unacknowledged by return text message, alarm is elevated.

After Hours
- After Hours phone is first number notified
- If unacknowledged by return text message, alarm is elevated to hierarchy.
SCADA Demonstration and Evaluation Findings and Recommendations

- Interface with existing equipment
  - Panels can have old components that are not reliable.
  - Pump controls often were in need of replacement.
  - Old bubblers replaced with transducers.
  - Generator transfer switch wiring was not consistent.
  - UPS needed for level components.
  - Reduced functionality sometimes has to be accepted if equipment upgrade cannot be afforded.
Alarm Interface Issues:
- Difficult to select a single station to view its alarm condition quickly.
- Volume of text alarms can overwhelm a busy mechanic.

Alarm Interface Solutions:
- Remove status conditions from alarm notification (e.g., generator RUN)
- Separate priority from non-critical alarms; combine non-critical alarms into common PUMP STATION IN ALARM text message

Cellular Reliability
- If cellular service is lost, alarms are not transmitted rapidly, but all data is saved.
- Tornados in 2008 and Hurricane Irene in 2011 did not significantly disrupt cellular service.
Program Implementation Recommendation System Components
Program Implementation Recommendation System Components

- Data logger
- Cellular modem for data and alarm transmission
- Pump controls
  - New panel in accordance with Public Facilities Manual (PFM), if possible
  - New pump control unit – only if existing controller must be replaced and new panel is not possible
- Wet well transducer and alarm floats in accordance with the PFM
- Pull status input from existing equipment
- Door entry management system
- UPS power for data logger, modem, and instrumentation
Program Implementation Recommendation System Components

Telog Web-based Pump Station Status Map
## Program Implementation Recommendation

### Construction Cost Estimate

<table>
<thead>
<tr>
<th>Pump Station Configuration</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosed Wet Well / Dry Well Pump Stations (60)*</td>
<td>$6,000</td>
<td>$360,000</td>
</tr>
<tr>
<td>Enclosed Submersible Pump Stations (42)*</td>
<td>$5,600</td>
<td>$235,200</td>
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<tr>
<td>Outside Submersible Pump Stations (22)*</td>
<td>$8,000</td>
<td>$176,000</td>
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<tr>
<td>Telog Hardware (124)</td>
<td>$5,600</td>
<td>$694,400</td>
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<tr>
<td><strong>Project Total Construction Cost</strong></td>
<td><strong>$1,465,600</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Work above includes the following items:
  - Field elements and modifications to existing pump station equipment provided in the Pilot Study
  - Panels and enclosures for all hardware
  - Conduit, wiring, and required electrical work
## Program Implementation Recommendation

### Annual Cost Estimate

<table>
<thead>
<tr>
<th>Annual Costs</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>Cellular service (140 stations)</td>
<td>$35.24/ station/month</td>
<td>$59,000</td>
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<tr>
<td>Telog service fees for enterprise file server operation</td>
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<td>$28,000</td>
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<tr>
<td>Enterprise file server maintenance/rental/etc.</td>
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<td>$75,000</td>
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<tr>
<td>Operation and Maintenance Labor</td>
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<td>$119,000</td>
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<tr>
<td>Project Total Annual Cost</td>
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<td>$222,000</td>
</tr>
</tbody>
</table>
Program Implementation Recommendation
Implementation Approach

● Delivery Approach
  – Design/Bid/Build
    • Preparation of biddable plans and specifications is costly
    • Not as flexible to deal with changing conditions in the field
  – Find and Fix
    • Use PFM specifications and details were applicable, and develop standard details for specifics related to SCADA implementation as needed.
    • Require unit prices for specific equipment and components; labor/service categories; and common variables.
    • Allows for assessment of each station’s unique needs and development of work orders to fit.
    • Allows for prioritization and program adjustment during the entire implementation phase
Can a cellular data acquisition system be used for alarm functions as well? Yes, with the following advantages:

- Data and alarms reside on a common database
- Single field unit (data logger) provides both data acquisition and alarm functions
- Alarm notification available by text message, e-mail, and web-based annunciation
- Automatic networked communication system – no need for repeater stations, etc.
- High data transfer capacity
- System scalability – easily expanded when needed
- Web server application – data and alarms are easily accessed with common Internet browser software
Questions?