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Flagstaff Intermunicipal Partnership Committee

Draft Report

Preliminary Design Report - Instrumentation and Hardware Upgrades for SCADA System

March 2012

1.0 Purpose

The purpose of this report is to present engineering investigations into development of a regional Supervisory Control and Data Acquisition (SCADA) system for Flagstaff Intermunicipal Partnership Committee (the 'FIP'). It is our intention to illustrate the information in detail, while maintaining objectivity of the report. The report discusses the existing as well as required instrumentation, data collection hardware and communication hardware at different remote sites. The report presents the requirements of SCADA system software and hardware at the central location and different remote sites.

For purposes of this report, remote sites are referred to as Water Treatment and Pumping facilities at Village of Heisler, Town of Killam, Village of Lougheed, Town of Sedgewick, Village of Strome, Village of Alliance, Town of Daysland, Town of Hardisty, Village of Galahad and Village of Forestburg. The office of 'Flagstaff County' is referred to as central location, in this report.

The information presented in the AECOM's Regional Water Operator's Consortium Study (the 'Study') was examined in detail. The Study analyzes two (2) models of SCADA systems, Stand-alone versus Master SCADA system and presents arguments in favour of Master SCADA system. In addition, the Study reviews two (2) options for data collection hardware i.e. Baseline Programmable Logic Controller (PLC) and Full Automation PLC. The FIP has already reviewed these options, and made a decision to proceed with Master SCADA system model along with Full Automation PLC. With this configuration, each remote site shall be equipped with higher-end PLC and the central location shall be equipped with SCADA hardware, such that all remote site PLC's communicate with central SCADA hardware over a public communication network.

2.0 Background

This project has been initiated in response to a need for sharing of certified operators among partnering municipalities of the FIP. A functional SCADA system with remote monitoring shall enable the sharing of certified operators, but limit the need to be physically present at the facility.

Alberta Environment has published (effective January 1, 2009) 'Minimum Certified Operator Attendance Guidelines for Waterworks Systems' for both WITH and WITHOUT remote monitoring and remote process control. Per Alberta Environment's Guidelines, to be considered a facility WITH remote monitoring or remote process control, the SCADA system must meet the following minimum requirements:

- Treated water must be continuously monitored to demonstrate a capability to comply with all registration requirements.
- Water production at the treatment facility must automatically shut-down if the treated water monitoring indicates treated water being produced does not meet registration requirements.
- Alarms must be set to alert the certified operator and any others as required.

We have discussed our understanding of the FIP's expectations from SCADA system, as below:

- Instrumentation and data collection system to accomplish remote process monitoring in order to meet Alberta Environment's Guidelines.
- Local controls to automatically shut-down the distribution pumps and disable / over-ride the control signal for starting raw-water pumps, if the effluent quality as measured by instruments is below the acceptable limits.

- Communications network to relay the local data collected from remote sites to central location.
- SCADA system at central location that include standardized graphic display for each remote site, a navigation menu to switch between various remote sites, site based alarm / fault display and site based communications status display.
- Alarm management system at central location that would report alarms to prioritized queue of operators over telephone network, and would provide attending operator with an ability to acknowledge alarms during phone call and thus prevent further dial-outs.
- In addition to the Water treatment facilities, the FIP wants to monitor Sanitary lift stations, for Pump Fault and Wet-well High Level alarm, within each community through SCADA system.

3.0 Instrumentation Requirements

The Study recommends provisions of following instruments at each remote site:

- Pressure Transmitter to measure distribution system discharge-header pressure and alarm in the event of continuous low pressure
- Level Transmitter to measure water-reservoir level and alarm in the event of critical low level
- Residual Chlorine Analyzer to measure effluent residual chlorine, for low chlorine alarm and to shut-down plant in the event of low chlorine
- Temperature Transmitter to measure effluent temperature
- pH Analyzer to measure effluent pH
- Flow-meter to measure distribution system discharge-flow

In addition, the Study recommends provisions of Turbidity Transmitter to measure effluent turbidity at Town of Sedgewick facility. Given the availability of funds, the Study recommends the provisions of additional ORP Analyzer down-stream of filters, at all remote sites, to aid in regular operations of facilities. However, these instruments are not included in the total project budget.

Although, the Study makes a note of existing instruments available at several remote sites, but fails to provide a detailed inventory of existing instruments. Also, the Study does not provide any guidance regarding the feasibility of re-use of existing instrumentation. During our site visits to remote sites, we were able to prepare an inventory of existing instrumentation that can be potentially re-used for this project. Based upon the age and operational status, we believe that the following Table presents a list of instrumentation that can potentially substitute the need for new instrumentation.

Table 1: List of Existing Instrumentation in Potentially Re-usable Condition

Location	Pressure Transmitter	Level Transmitter	Residual Chlorine Analyzer	Temperature Transmitter	pH Analyzer	Flow-meter
Town of Killam	Yes (E & H)	Yes (E & H)	Yes (HACH CL17)	-	-	-
Village of Heisler	-	-	-	-	-	-
Village of Lougheed	-	-	-	-	-	-
Town of Sedgewick	-	-	Yes (Blue I Technologies)	-	-	-
Village of Strome	Yes (E & H)	Yes (E & H)	-	-	-	-
Village of Alliance	-	-	Yes (W & T)	-	-	Yes (ABB)
Town of Daysland (to be installed)	-	-	Yes (Swan Analytics)	-	Yes (Swan Analytics)	-
Village of Forestburg	-	-	-	-	-	-
Village of Galahad	-	-	Yes (W & T)	-	-	Yes (ABB)
Town of Hardisty	-	-	Yes (Prominent Dulcometer)	-	-	Yes (Controlotron)

In addition, Town of Sedgewick has an existing Turbidity Transmitter (Thermo Scientific's Aqua-Clear) that can be re-used for this project.

We do recommend that all re-used instrument be re-calibrated by a qualified vendor to ensure accuracy of data.

4.0 Process Monitoring / Control Hardware Requirements

The recommendations made by the Study, in favour of full automation PLC have been accepted by the FIP. In addition, the Study has presented a very strong case in favour of Allen-Bradley PLC Hardware, given its existing presence at three (3) remote sites and ongoing installation at two (2) more sites. Although, the Study has implied the potential for using existing PLC hardware at three (3) locations to implement SCADA system, it lacks the details of existing controllers and availability of spare Inputs / Outputs (I/O).

For implementation of SCADA, each PLC would require a minimum of six (6) Analog Inputs for analog instrumentation. Each PLC would require a minimum of one (1) discrete output to shut-down the plant (raw water pumps / distribution pumps), in the event of effluent quality dropping below acceptable limits. Also, each PLC would require a minimum of three (3) Discrete Inputs per Sanitary Lift Station (to capture Pump 1 / 2 Fault and High Level Alarm).

Based on our site visits and ongoing upgrades documentation review, the following Table shows the list of existing Process Monitoring / Control Hardware that can be re-programmed to implement SCADA system.

Table 2: List of Existing PLC Hardware

Location	Installation Year	PLC CPU	Spare Analog Inputs (6)	Spare Discrete Output (1)	Spare Discrete Inputs (As Noted)
Town of Killam	2008	Allen-Bradley CompactLogix L32E Series	No	Yes	Yes (6)
Town of Sedgewick	To be installed	Allen-Bradley SLC 5/05 Series	No	Yes	No (3)
Village of Strome	2009	Allen-Bradley CompactLogix L32E Series	No	Yes	No (3)
Town of Daysland	To be installed	Allen-Bradley CompactLogix L32E Series	Yes	Yes	Yes (3)
Town of Hardisty	2004	Allen-Bradley SLC 5/03 Series	Yes	Yes	No (9)

5.0 Communication Network Options

The Study recommends the use of cellular broad-band network for communication of data between remote sites and central location. However, given the FIP's less than optimum experiences and expressed concerns regarding the penetration of Cellular network within some communities, we recommend that wired public broad-band network should be utilized, if available within the area. We had submitted an enquiry to two main wired internet service providers within Alberta communities (Telus and EastLink) regarding feasibility of obtaining 'Unmanaged ADSL Broad-band Data' connection at remote sites. The results are listed in Table below:

Table 3: Results of Unmanaged ADSL Broad-band Connection Enquiry

Location	Telus / EastLink Response
Town of Killam	Available from Telus
Village of Heisler	Not available
Village of Lougheed	Available from Telus
Town of Sedgewick	Available from EastLink
Village of Strome	Not available
Village of Alliance	Not available
Town of Daysland	Available from EastLink
Village of Forestburg	Available from EastLink
Village of Galahad	Not Available
Town of Hardisty	Not Available

Telus has claimed that with its recent upgrades, it had improved the Cellular Network penetration within the communities, which do not currently have access to its wired data connection services. Due to lack of wired data connection option, we recommend the use of Telus Cellular Network for Village of Heisler, Village of Strome, Village of Alliance, Village of Galahad and Town of Hardisty.

There are alternate high-speed wireless internet providers, such as Syban, Tera-byte etc… available within some communities. Although these service providers claim to have

more reliable service compared to cellular networks, we believe that cellular networks have higher potential of continuous upgrades in future, providing benefits to its subscribers. Most private high-speed wireless internet service providers are slow to keep up with the technology and upgrade the hardware. Also, the service charges tend to be higher compared to cellular network service providers.

There has already been an agreement in place with Flagstaff County to share existing band-width from their high-speed data connection.

In addition, a dedicated telephone connection would be requested at central location (Flagstaff County office) for dialling-out the alarms.

To communicate signals (Pump Fault and High Level Alarm) from Sanitary Lift Station, we made some reasonable assumptions:

- Typical short distances (up to 2 km) between Lift Stations and local Water Treatment facility
- Mostly plain topography with low-level buildings in-between Lift Stations and local Water Treatment facility
- Direct line-of-sight from 5 m height between Lift Stations and local Water Treatment facility

We believe that the most cost-effective way, to transfer data from Lift Stations to local Water Treatment facility, would be to set-up a local private radio network using un-licensed frequency radios. With this type of network, the initial capital costs and on-going maintenance costs would be manageable, and there would be no additional user-costs such as costs associated with using cellular network.

The radio signal strength would have to be verified in field at the time of construction, which may impact the final height of antennas to establish direct line-of-sight between Lift Stations and local Water Treatment facility. But, it is reasonable to expect the feasibility of a reliable connection.

6.0 SCADA System Software and Hardware

The Study recommended the use of FactoryTalk View SE Edition of SCADA software, for this project. We agree with the findings of the Study regarding the choice of software platform.

However, since the central location has been proposed to be entirely new location, instead of being one of the remote sites, eleven (11) Client licenses would be required to implement the system.

The Study does not mention any requirements of alarm management and notification solution. We recommend that a third party alarm management and notification software package, such as WIN 911 from Specter Instruments, should be integrated with the SCADA software. This package would enable the central location SCADA Computer to automatically dial-out to remote locations in the event of alarms. Also, the WIN 911 software features include ready compatibility with FactoryTalk View SE software, voice annunciation of alarms, 2-way communications, reporting etc… In addition, the central location SCADA computer would also be provided with Virtual Connection host software.

The SCADA hardware would include a Desktop Computer (PC) at each of ten (10) remote sites as well as the central location. Each site will be updated with real-time information (with network communication delays).

In addition, three (3) laptops running Virtual Connection software, to connect with central location PC Host software, would be provided for sharing among municipalities. This connection would allow remote monitoring of system plus any necessary configuration changes from time to time.

7.0 Price Estimate and Schedule

For purposes of this report, we have retained the unit pricing estimates from the Study, but adjusted it for quantities and changes in design configuration. Our opinion of cost estimates for construction with the proposed configuration is shown in Table 4 below:

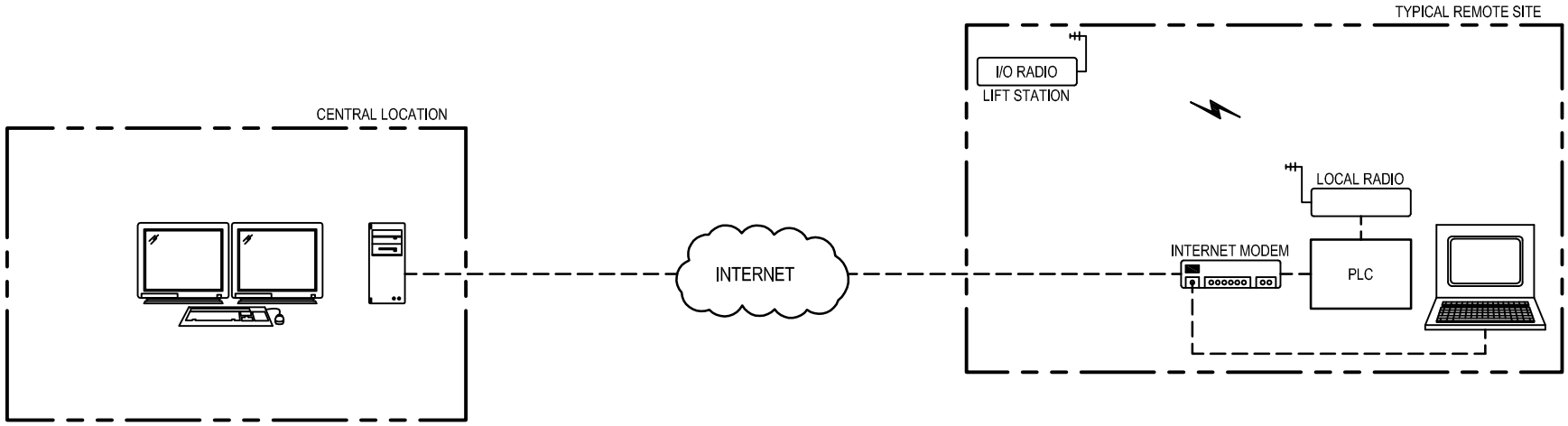
Table 4: Construction Cost Estimate

Cost Description	**Cost Estimate**
Pressure Transmitters (8 x 2000)	$16,000
Level Transmitters (8 x 3500)	$28,000
Temperature Transmitters (10 x 2000)	$20,000
pH Analyzers (9 x 2000)	$18,000
Residual Chlorine Analyzers (4 x 4500)	$18,000
Flow-meters (8 x 3200)	$25,600
Full Automation PLC (5 x 27056)	$135,280
Modifications in existing PLC (5 X 10000)	$50,000
Lift Station Remote Connect Hardware (16 x 8000)	$128,000
SCADA Software and Hardware (11 x PC + License)	$38,500
Laptops with Virtual Connection Software (3)	$7,500
SCADA Programming	$11,700
Alarm Notification Software and Configuration	$15,000
Contractor Labour Cost	$580,000
Base Cost	**$1,091,580**
Contingency	20 %
Total Construction Estimate	**$1,309,896**

Estimated schedule for the proposed configuration is shown in Table 5 below:

Table 5: Proposed Schedule

Activity	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Detailed Design Completion										
Tender										
Equipment Procurement/ Fabrication										
Equipment Installation and Wiring										
Programming										
Commissioning										



FIP SCADA SYSTEM UPGRADES

COMMUNICATION ARCHITECTURE

FIGURE 1

N.T.S.

March 9, 2012

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