SECTION 40900 SCADA INSTRUMENTATION & CONTROL

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1.1 Scope of Work

Provide a complete control system for the remote operation and monitoring of the pump, tank, control valve, pressure regulating and flow stations. The control system will utilize a **SCADA Control Panel (RTU)** in connection with a **Communication Control Panel**. Data will be communicated to and from the North Fork Water Treatment Plant. This outline lists the required items with details contained in the **SCADA Instrumentation Details** document:

1.2 Tank Level Transmitter

The transmitter shall be a Siemens HydroRanger 200 with ST 15 ultrasonic transducer or approved equal. The transducer shall be attached to a minimum 4-inch (4”) flange. The transducer shall be positioned as near as possible to the external access ladder taking care to avoid close proximity to the

walls, internal ladder, fill pipe and associated water surface disturbance. The transmitter shall convert readings from the transducer to a 4-20 mA analog signal. The transmitter should be able to read the entire span of the tank in ft/H2O. The transmitter display will be protected from the sun with sunshields or mounting in such a way as the sun will not directly hit it. Metal or metal lined conduit will be run between the transmitter and the transducer. Any conduit running underground will be PVC-coated ridged conduit Ocal – blue. An LB will be used at the transducer to facilitate future service. The transducer cable will be of sufficient length no splice will be needed.

1.3 Pressure transmitters

Pressure transmitters will be Rosemount 3051S transmitters or approved equivalent. The lightning protection module option will be installed on all transmitters.

1.4 Flow transmitters

Flow transmitters will be manufactured by Neptune and include a 4-20ma sensor option.

1.5 Level / Flow Control Actuators

When ever flow or level is controlled by SCADA an actuator manufactured by Auma will be used to position the associated valve.

1.6 SCADA Control Panel (RTU):

Furnish a single Control Panel for the location and mounting of the PLC, DSU, and associated equipment, indicators and controls. All pump controls and associated equipment will be located in a separate enclosure unless authorized by the Water Information Systems Manager. The SCADA Control Panel shall consist of:

A. RTU Enclosure

Indoor installations:

- A wall mounted enclosure, rated NEMA 12, of minimum 14 gauge steel construction, with a continuous piano-style door hinge and three-point latch with lockable handle, ground smooth, painted gray and finished in accordance with City standard practice;

Outdoor installations:

- A wall or stanchion-mounted enclosure, rated NEMA 4X, of minimum 14 gauge 304 or 316 stainless steel construction, with screwed door clamps and padlock hasp;
- Sun shields will be provided for all sides located with direct exposure to the sun.
- A minimum 3 foot clearance will be maintained in front of the enclosure and associated mounting structure.
- The area around the enclosure will be graded to provide adequate drainage.
- The ground will be covered in gravel or paved so safe, clean access is available in all weather conditions.
- The area surrounding the enclosure will be secured with a six foot fence with a lockable gate.
- Adequate parking will be provided for service vehicles.

All enclosures:

- No enclosures will be mounted underground unless the room has sufficient space, is dry and climate controlled.

- A rear subpanel constructed of minimum 10 gauge steel will be provided for the secure mounting of all components;
- A document storage pocket on the inside door with all associated schematics/drawings included
- No equipment will be mounted or stored directly on the floor of the enclosures

B. Communications Interface

Cellular networking equipment (If cellular networking is available)

Cellular Modem

Sierra Wireless EVDO Modem & IP Router with Verizon Plan
Airlink LS300

Protocol Converter

MGate MB3180 1 Port RS-232/422/485 Modbus TCP to Serial

Misc Equipment (determined on a site by site basis)

Antenna, mounting and cabling
Transient protection
Signal booster

Wired networking equipment (if no cell service is available)

Data Services Unit (DSU)

A Data Services Unit (DSU) will be provided to receive and transmit data on a communications link, in Modbus protocol, between the PLC and the City's central SCADA system located at the North Fork Water Treatment Plant. The system shall utilize a leased data line to be provided by AT&T. The developer will be responsible for communicating the site address to the Water Information Systems Manager. The Water Information Systems Manager will contact AT&T and order the required service. The DSU will be mounted in the RTU and will be set at 4800 baud, asynchronous, 11 bit operation, and shall utilize 120VAC power. The DB25 primary connector will be wired to a RJ45 modular connector and routed to the PLC. The DSU shall be Adtran model DSU III AR part number 1202.011L1 or approved equivalent. A Cat 5 cable will be routed between the DSU and the Network Interface Unit (NIU) in the Communications Enclosure.

C. Programmable Logic Controllers (PLC)

The RTU shall contain a Programmable Logic Controller (PLC) capable of stand-alone operation of the associated station.

The following will apply:

- Modicon Momentum PLC modules will be used in all RTU's with no exceptions.
- A battery will be installed in the PLC.
- Programming will be flashed into the nonvolatile memory.
- The PLC shall have at least two (2) Modbus communication ports for interfacing with the Communication Equipment and peripheral devices such as programmer's terminal.
- The PLC shall be capable of handling the required number of process inputs and outputs plus 20% spares.
- The unit shall include self-diagnostics to indicate low battery power, I/O malfunction, and forced output status. A watchdog status shall supervise operation of data lines, control lines, and address lines. Upon major error, inputs

and outputs shall be capable of being set either to remain in last state or to turn off, until error is cleared.

- The unit shall be capable of being monitored and controlled by the SCADA Master Computer via the data circuit.
- All process control set points will be modifiable from the SCADA Master Computer.
- I/O modules
  - Discreet Input
    - All modules will use 24 vdc input
  - Discreet Output
    - All modules will use 24 vdc or relay contact output
  - Analog Input
    - All modules will use 4-20 ma DC input
  - Analog Output
    - All modules will use 4-20 ma DC output
- Preferred modules
  - The following modules will be used when ever possible:
    - I/O Bases
      - 170 AMM 090 00
      - 170 ADM 350 10
      - 170 AAI 030 00
      - 170 ADM 390 30
    - Communication Adapters
      - 170 INT 110 00
    - Option Adapters
      - 172 JNN 210 32
    - Processor Adapters
      - 171 CCS 760 00
      - 171 CCC 960 20
- One spare module will be provided for each type of module that isn't listed.

D. Logic

The PLC will contain a fully debugged and operating system before the project will be considered complete. Programming will be written in 984 or IEC Ladder Logic written with Concept programming software version 6.0 or newer. All registers will conform as close as possible to current register assignments. Contact the Water Information Systems Manager for a list of register assignments. A CD or other approved media containing the PLC program will be provided at the conclusion of the project. The archive of the program will contain designators for each component and descriptions for each network. A printout of the program, key to the designations and descriptions, and a theory of operation will be provided as well.

E. I/O

The following I/O will be provided:

- Tanks
  - Discrete In:
    - Building/enclosure door open/closed
    - Alarm key switch armed/disarmed
    - Generator run status [4]

- Generator fault status [4]
- Generator service status [4]
- Transfer switch position [4] (Utility/Generator)
- AC Power loss
- UPS battery status
- PLC battery status (if program not flashed in memory)

Discrete out:

- Communication failure [1]

Analog In:

- Tank Level

Analog out:

- Tank Level [1]

Pumps

Level Controlled

Discrete In:

- Pump Run Status (one for each pump)
- Pump Fault Status (one for each pump)
- Pump Auto/Hand (one for each pump)
- Pump Station Alarm Status
- Control valve(s) position status open/closed (if control valves used)
- Building/enclosure door open/closed
- Alarm key switch armed/disarmed
- Generator run status
- Generator fault status
- Generator service status
- Transfer switch position (Utility/Generator)
- Flood status
- AC Power loss
- UPS battery status
- PLC battery status (if program not flashed in memory)

Discrete out:

- Pump Run (one for each pump)
- Local / Remote mode
- Communication failure [1]

Analog In:

- Suction pressure
- Discharge pressure
- Station Flow

Analog out:

- Tank level [1]
- Suction pressure [1]
- Discharge pressure [1]
- Station flow [1]

Pressure Controlled

Discrete In:

- Pump Run Status (one for each pump) [2]
- Pump Fault Status (one for each pump) [2]
- Pump Auto/Hand (one for each pump) [2]
- Pump Station Alarm Status [2]

Control valve open limit (one for each valve if control valves used) [2]
Control valve closed limit (one for each valve if control valves used) [2]
High Pressure relief valve closed limit status
Building/enclosure door open/closed
Alarm key switch armed/disarmed
Generator run status
Generator fault status
Generator service status
Transfer switch position (Utility/Generator)
Flood status
AC Power loss
UPS battery status
PLC battery status (if program not flashed in memory)

Discrete out:
All pumps shutdown
Communication failure [1]

Analog In:
Suction pressure [2]
Discharge pressure [2]
Station Flow [2]

Analog out:
Suction pressure [1 / 3]
Discharge pressure [1 / 3]
Station flow [1 / 3]

Note: The Pump Control Panel should be able to control all aspects of the pumps without input from the SCADA RTU. The only control connection is the ability to shutdown the pumps if necessary.

Control Valves

Discrete In:
Valve open limit
Valve closed limit
Building/enclosure door open/closed
Alarm key switch armed/disarmed
Generator run status
Generator fault status
Generator service status
Transfer switch position (Utility/Generator)
AC Power loss
UPS battery status

Discrete out:
Valve open
Valve closed
Local / Remote mode
Communication failure [1]

Analog In:
Valve position
Suction pressure

Discharge pressure
Station Flow
Analog out:
Valve position [1]
Suction pressure [1]
Discharge pressure [1]
Station flow [1]
Pressure Regulators
Discrete In:
Building/enclosure door open/closed
Alarm key switch armed/disarmed
Generator run status [4]
Generator fault status [4]
Generator service status [4]
Transfer switch position [4] (Utility/Generator)
AC Power loss
UPS battery status
PLC battery status (if program not flashed in memory)
Discrete out:
Communication failure [1]
Analog In:
Suction pressure
Discharge pressure
Analog out:
Suction pressure [1]
Discharge pressure [1]
Flow Monitoring
Discrete In:
Building/enclosure door open/closed
Alarm key switch armed/disarmed
Generator run status [4]
Generator fault status [4]
Generator service status [4]
Transfer switch position [4] (Utility/Generator)
AC Power loss
UPS battery status
PLC battery status (if program not flashed in memory)
Discrete out:
Communication failure[1]
Analog In:
Flow
Analog out:
Flow [1]

F. Functions

The PLC / SCADA system shall be programmed to perform the following minimum functions where applicable:

All Sites

Send the following status to the SCADA Master Computer when polled:

- The position of the Transfer switch; either Power Utility or Generator power. [4]
- The generator run status. [4]

Display when Communication is lost between PLC and SCADA Master Computer.

Send an alarm to the SCADA Master Computer if:

- The PLC has a low battery charge
- AC power from the utility is lost.
- The generator needs service. [4]
- The generator has a fault. [4]
- The security switch isn't set from Armed to Silenced within a preset entry delay time.

Tank Sites

Convert the 4-20 mA analog signal from the reservoir pressure or level transducer to feet and transmit the data to SCADA Master Computer when polled.

Send an alarm to the SCADA Master Computer when reservoir level rises above preset high set point.

Send an alarm to the SCADA Master Computer when reservoir level falls below preset low set point.

Pumps

Level Control Sites

Indicate to the Scada Master Computer if the RTU is operating in Local or Remote mode as set by the Local / Remote switch

Operate the Local / Remote relay as set by the Local / Remote Switch. Relay is off in Local mode.

Start and stop pumps automatically based on preset reservoir level set points.

Start and stop individual pumps manually upon command from SCADA Master Computer.

Start the next available pump when a requested pump fails to start within programmed time, lock-out the failed pump and alarm SCADA Master Computer.

Automatically alternate pump sequence with each pump cycle.

Store cumulative run time (hours) of each pump.

Confirm run status of each pump (running or stopped) and transmit to SCADA Master Computer when polled.

If control valves are used, send the open or closed status to the SCADA Master Computer.

Convert the following 4-20 mA analog signals and transmit them to the Scada Master Computer when polled:

- Suction and discharge pressure in PSI.
- Station flow in MGD.

Output 4-20 ma signals or data to a local display for:

- Suction and discharge pressure in PSI.
- Station flow in MGD
- Tank level in FT

Alarm SCADA Master Computer when:

- A pump thermal or power related fault occurs

- Suction pressure falls below a preset low pressure set point.
- Discharge pressure exceeds a preset high pressure set point.
- A flood occurs in the pump building.

Store cumulative flow data (MGD) in the PLC and transmit data to SCADA Master Computer when poled.

Constant Pressure Control Sites

Monitor the run and fault status of the Variable Frequency Drives (VFD) and send the status to the SCADA Master Computer.

Provide a discreet output to shutdown all pumps when a signal is sent from the SCADA Master Computer.

If control valves are used send the open or closed status to the SCADA Master Computer.

Convert the following 4-20 mA analog signals and transmit them to the Scada Master Computer when polled:

- Suction and discharge in PSI.
- Flow meter in MGD.

Output 4-20 ma signals or data to locally display:

- Suction and discharge pressure in PSI.
- Station flow in MGD
- Tank level in FT

Alarm SCADA Master Computer when:

- A pump thermal or power related fault occurs
- Suction pressure falls below a preset low pressure set point.
- Discharge pressure exceeds a preset high pressure set point.
- A flood occurs in the pump building.

Store cumulative flow data (MGD) in PLC and transmit data to SCADA Master Computer when poled.

Control Valve Sites

Monitor the valve open and closed limit switches and send the status to the SCADA Master Computer.

Send a discreet outputs to open and close the valve.

Convert the following 4-20 mA analog signals and transmit them to the Scada Master Computer when polled:

- Valve position sensor
- Suction and discharge in PSI.
- Flow meter in MGD.

Output 4-20 ma signals or data to a local display for:

- Suction and discharge pressure in PSL.
- Station flow in MGD
- Valve position in percent open.

Alarm SCADA Master Computer when:

- A pump thermal or power related fault occurs
- Suction pressure falls below a preset low pressure set point.
- Discharge pressure exceeds a preset high pressure set point.

- A flood occurs in the pump building.

Store cumulative flow data (MGD) in PLC and transmit data to SCADA Master Computer when poled.

Pressure Regulator Sites

Convert the 4-20 mA analog signals from the suction and discharge of the pump station to PSI and transmit the data to the SCADA Master Computer when polled.

Output 4-20 ma signals or data to locally display suction and discharge pressure in PSI.

Flow Monitoring Sites

Convert the 4-20 mA analog signal from the flow sensor to MGD and transmit the data to the SCADA Master Computer when polled.

Output 4-20 ma signal or data to locally display flow in MGD.

G. Process Interface

The process interface will occur via terminal blocks. Barriers or physical separation will be provided between terminals with dissimilar voltage or potential. Separate wire ways and terminal block rows will be provided for analog and discreet control wiring.

The process interface shall be capable of accepting the following types of inputs and outputs:

Discreet Input:

The RTU will furnish power to the field contacts. Interposing relays will be used on all discreet inputs originating outside the RTU enclosure. The relays will indicate their status with an LED indicator. Separate fuses, in indicating fuse holders, will be supplied on the power legs for each circuit leaving the RTU enclosure.

Discreet Output:

Will be capable of providing dry contact or solid state switches in momentary or latched mode to control AC or DC powered loads. Interposing relays will be furnished for any loads exceeding 0.5 A or where the destination of the output is outside of the RTU. The relays will indicate their status with an LED indicator and include a test button.

Analog Input:

Shall accept 4-20 mA DC current loops. Separate fuses, in indicating fuse holders, will be supplied on the power legs for each circuit leaving the RTU enclosure. Transient protectors will be provided on all inputs originating from outside the RTU. A proportionate number of transient protectors will be mounted and wired as spares for future expansion.

Analog Output:

Shall provide 4-20 mA DC current loops. Separate fuses, in indicating fuse holders, will be supplied on the power legs for each circuit leaving the RTU enclosure. Transient protectors will be provided on all outputs destined for outside the RTU. A proportionate number of transient protectors will be mounted and wired as spares for future expansion.

20% spares will be provided with capacity to expand to include another 40%. The spare I/O will be wired, through the process interface components, to the field terminal blocks.

Terminals

Terminal blocks will use screws to secure the wires and be capable of accepting 14 AUG stranded wire. They will be manufactured by Allen Bradley, Phoenix or an approved equivalent vendor.

Relays

Relays will be manufactured by Allen Bradley or approved equivalent.

All I/O components shall be of the same series to reduce spare parts inventory.

H. Human Interface

Standard Interface

All hand switches and pilot lights will be mounted through a 30.5 mm keyed hole.

All pilot lights will include replaceable LED bulbs with Push to Test function.

Switches and pilot lights will be Allen Bradley, Cutler Hammer or approved equivalent.

Analog panel meters will be Red Lion or approved equivalent. They will be scaled in the appropriate engineering units, mounted on the panel front for local indication of 4-20mA input signals. A selector switch can be used to display various values.

Operator Interface Terminal (OIT)

With prior approval from the SCADA Manager a flat panel touch screen display may be used. If one is used the following applies:

- All programming will be review prior to installation.
- Software for programming the interface and training for using the software will be provided.
- A quality anti-glare screen protector will be properly installed and a spare screen protector for each display provided.

I. Time Clocks

Pump and control valve stations running on level control will require a time clock to operate the pumps or valve when communication with the SCADA system is lost.

- The time clock should be capable of 24 hours programming in at least 15 minute increments and any day or days of the week. The Omron H5L or an approved equivalent should be used. The time clock will be installed outside of but near to the SCADA RTU.
- A pump selector switch and relay (if needed) will be installed and wired in such a way as to allow one and only one pump to run when the time clock signal is being used.
- Pump run signals and Time clock signals will be routed through the Local/Remote relay.
- The PLC will deenergize the Local/Remote relay when Local is selected or automatically one hour after communication is lost.
- The pumps will maintain what ever state they are in when communication is lost until transfer to the time clock is initiated.
- When power is removed from the Local/Remote relay the time clock signal(s) will be routed to the Pump Control panel.

J. Power

A single breaker will be provided at the electrical panel to remove power from the RTU.

Each piece of equipment will be protected by individual breakers or fuses in indicating fuse holders.

A commercial-grade convenience receptacle will be provided.

K. Battery Backup Power

Battery backup power will be provided for all functions except climate control. The battery backup will allow the SCADA RTU to operate for a minimum of one hour.

Battery backup power will also be provided to the devices in the Communication Equipment Enclosure.

L. Grounding

A ground bus will be mounted near the bottom of the RTU back plane.

A 4 AUG insulated stranded copper wire will be run between the ground bus and a bonded copper ground rod.

All equipment grounds will be attached to the common grounding bar.

M. Surge and Transient Suppression

Surge Protection

Edco model SPF-121BT-1RU or approved equivalent will be supplied for surge suppression on incoming power lines.

Transient Protection

Kamikaze II, Edco PC642 or approved equivalent will be supplied for all analog input and output circuits with origins or destinations outside the RTU. A proportionate number of transient protectors will be mounted and wired for future expansion

N. Wiring and Termination

The following wiring colors will be used:

Black – 110 AC Line
White – 110 AC Neutral
Green – AC Ground
Purple – 24 VDC positive
Orange – 24 VDC negative
Red – AC control
Blue – DC control
Yellow – External power.
Black/White shielded cable – Black signal negative / White signal positive

All wiring will be stranded copper. The following wire sizes will be used:

12 AWG – Branch Power
14 AWG – Supplemental Power
16 AWG – AC/DC Control
16 AWG – Analog Power
16 AWG – Discrete Power
18 AWG – twisted pair shielded – Analog Loop

O. Labeling

- Clear printed or engraved labeling shall be provided adjacent to all components.

- All terminals and wires shall be labeled with a unique identification number corresponding to the rung and page number of the drawings. The first digit(s) will correspond to the appropriate page number and following digit(s) to the appropriate rung in the diagram.
- The wire labels will be secured to the wires in such a way as to not fall off if the wire is disconnected
- Name plates will be provided for all switches, displays and indicators. They will be engraved with white letters on black laminated plastic.
- Name plates will be provided for enclosures clearly indicating their location and function. ¼" White letters on Black laminated plastic will be used.

P. Security

Door Sensors

RTU mounted outside a building

A switch will be installed to sense when the panel door has been opened. This signal will be routed to the PLC though the Process Interface.

RTU mounted inside a building

A switch will be installed to sense when the building door(s) has been opened. This signal will be routed to the PLC though the Process Interface.

Arm/Disarm Control

Key Switch

A 30.5 mm key switch manufactured by Allen Bradley or Cutler Hammer will be mounted in the front door of the RTU. It will be labeled Security on the first line and Silenced on the left side and Armed on the right side of the second line. The switch will maintain both positions. The key will be removable in both positions.

OIT

The OIT interface can be used to arm and disarm the alarm system. See the Water Information Systems Manager for details on how the OIT is programmed to accomplish this.

Q. Climate Control

The RTU shall be provided with suitable environmental control accessories to insure proper operation, including coolers, heaters and dehumidifiers if required. The installation must operate properly at a temperature range between –30 degrees C to +60 degrees C.

R. Lighting

An overhead fluorescent working light will be securely fastened to inside of RTU.

1.7 Communications

A. Communication Equipment Enclosure

A separate enclosure will be supplied to house the Communication Utility equipment. It will conform to the following specs:

- If enclosure is servicing a building it will be mounted on the outside of the building as near to the SCADA RTU as possible.
- If enclosure is servicing an underground facility it will be mounted above ground for easy access by AT&T personnel.
- A minimum size of 24"H x 24"W x 8"D.
- Wall or stanchion-mounted, rated NEMA 4X, of minimum 14 gauge 304 or 316 stainless steel construction, with screwed door clamps and padlock hasp;

- A minimum 3 foot clearance will be maintained in front of the enclosure.
- The area around the enclosure will be graded to provide adequate drainage.
- The ground will be covered in gravel or paved so safe, clean access is available in all weather conditions.
- A rear subpanel constructed of minimum 10 gauge steel will be provided for the secure mounting of all components;
- Two minimum 3/4 inch conduits will be run between the Communication Enclosure and the SCADA RTU.
- A 20 amp dedicated circuit will be routed to a single gang 120 volt AC power receptacle will be mounted it the lower left or right corner.
- A ground bus will be mounted in the lower corner opposite the convenience receptacle.
- Minimum 6 AUG insulated stranded copper wire will be routed from the ground bus to a bonded earth ground rod.
- An NIU and ONIAC lighting protection device will be installed in the communication enclosure by AT&T personnel

B. Tank to Pump Communication

If technically possible a fiber optic cable will be laid between tank and pump / control valve RTU when the water line linking the two is laid. Follow the city specs for this installation.

1.8 Documentation

Documentation will be provided to the Water Information Systems Manager upon completion of the specified job. This is to include but not limited to all panel wiring schematics as finalized, all documentation of components used to assemble the panel and all PLC I/O in spreadsheet format. Documentation must be provided in digital and hardcopy formats along with PLC programs as defined in PLC Logic section. Digital format should be on a CD or other approved media.

1.9 Testing

All status, command, and analog inputs and outputs shall be tested after the installation is completed. The test shall be witnessed by the Water Information Systems Manager or Technician, under actual conditions or by simulating conditions or commands as close to the true source as possible. The programming of the PLC unit shall be fully tested before any interface with the SCADA Master Computer is performed.

1.10 SCADA System Configuration

Scada system configuration shall be performed by the SCADA Systems Manager, Technician or approved vendor assisted by the RTU provider as needed.

1.11 Special Notes

- All requests for deviation from these specifications will be submitted to the SCADA Systems Manager in writing.
- Prior to biding, designing or beginning construction on a job the engineers and contractors should arrange to meet with the Water Information Systems Manager to go over what is expected and to tour an existing facility similar to what is being planned.
- If a deviation from a contractor's standard practice is noticed it will be communicated to the Water Information Systems Manager or Technician prior to proceeding

1.12 Notes Key

[1] This is not needed if the information is displayed on an HMI panel.
[2] If serial modbus or Ethernet communication is used between SCADA and the Pump Control PLC's this I/O point would not be needed.
[3] This is not needed at the SCADA RTU if the information is displayed at the Pump Control Panel
[4] This is not needed if a generator will never be installed.