Water SCADA System
Exeter, NH
Conceptual Design

TECHNICAL MEMO (DRAFT)
October 21, 2008

1.0 INTRODUCTION AND BACKGROUND

The Town of Exeter plans to construct a SCADA system for its drinking water system. Representatives from the Town – Jennifer Perry, Public Works Director, and Paul Roy, Water Treatment Plant Chief Operator – met with Underwood Engineers, Inc. (UEI) and SMR Engineering, PC, (SMR) in two work sessions (September 16, 2008 and November 7, 2008) to investigate available options, select an overall SCADA system architecture, and develop a "roadmap" for design and construction.

2.0 OVERVIEW OF EXISTING SYSTEM

2.1 Water SCADA System

The current communication system (Figure SK-I1 attached) consists of a combination of:

- One WTP and six remote pump stations and tanks,
- Alarm dialers (3 total) that call the Town's dispatch center, and
- EOS ProControl units at remote sites (4 total) with Proview software at the WTP that provide some status indicators and limited remote control. (Note: A fifth EOS unit is currently being added at Hampton Road Tank. For the purpose of the following discussion, this fifth EOS unit is considered to be existing.)
- Leased telephone lines at tanks, stations, and the WTP (at least 7 leased lines total).

Future remote sites may include a new water source at Gilman and Stadium Wells or elsewhere.

WTP process control currently consists of individual control panels for raw water pumps, clarifiers, filters, finished water pumps, and chemical feed systems with almost no communication between these components. An outdated supervisory control panel in control room provides a limited number of status indicators and alarms (because most are inoperable) and logs some process variables on strip charts. Operators can adjust finished water pump set points but have no direct control over other process components from the control room.

2.2 Wastewater SCADA System

The wastewater SCADA system was upgraded in 2001 and consists of nine PLC-based (Modicon Momentum) RTUs at remote pump stations with leased line telephone communications to the MTU at the WWTF. Software is Intellution's FIX Dynamics. At this time, the wastewater and water SCADA systems are entirely independent of one another.

3.0 NECESSITY OF IMPROVEMENTS / GOALS FOR SCADA PROJECT

3.1 Necessity of Improvements

An improved SCADA system is necessary to optimize management of the water system due to scheduled improvements. The Town is currently constructing a 1.5 million gallon elevated water storage tank at Epping Road, which will raise the hydraulic gradeline (HGL) in the main service zone by 30 feet. The complexity of the system will increase because all three storage tanks in town will have different overflow elevations (Figure 1, attached). New instrumentation and process controls are needed to provide adequate pressure and fire flows to all users, turn tanks over to prevent water quality degradation, and minimize tank overflows (see "Distribution System Improvements DESIGN SUMMARY", attached).

To raise the HGL, the following infrastructure projects are currently under design and/or construction. All are scheduled to be complete and online December 2008.

- Installation of new booster pumps at Hampton Road Tank to pump up to higher HGL.
- Replacing booster pumps at Kingston Road Station with a control valve (Cross Road tank will have lower overflow elevation than new Epping Road Tank).
- Replacing the booster pumps and high service (fire protection) pump at Epping Road Tank.
- Replacing VFDs on finished water pumps at the Water Treatment Plant (WTP).
- (No improvements are needed to the Lary Lane well pump at this time because it can supply approximately 260 gpm under the new HGL, if the Town puts it into service.)

The existing communications system will need to be upgraded at a minimum (and possibly replaced with a system built on industry standard architecture) for the various pumps and control valves in the proposed system to operate based on tank levels, time, and/or remote control by WTP operators. Operation of the new Hampton Road booster pumps will depend on production rate at the WTP, Hampton Road tank level, and Epping Road tank level. Operators will require accurate information in real time and flexibility in controlling the WTP finished water pumps and Hampton Road booster pumps.

In addition to the increased complexity of the distribution system after raising the HGL, the following deficiencies necessitate improvements to the water SCADA system:

- Existing system lacks ability for detailed data acquisition in real time.
- Existing system does not allow for communication between remote locations.
- No integration between Water and Wastewater systems.
- Existing system allows only limited remote diagnosis.
- Improvements in monitoring and control can greatly improve efficiency in the areas of:
    - labor – increased automation, remote diagnosis, and potentially fewer alarms,
    - energy – automated pump operation and pacing to run pumps only when needed,
    - wasted water – fewer tank overflows, no wasted pumping from the river to the reservoir, and
    - overhead costs – monthly leased line fees can be avoided by using radio.
- System reliability cannot be ensured with present system (e.g. alarm telemetry not available for all critical equipment).

Integration of WTP process control in a centralized SCADA system would improve reliability and efficiency of water treatment. It is also desirable for all alarms and status indicators to be centralized and integrated into the SCADA system.

In its most recent sanitary survey (August 30, 2007), NHDES identified the communications system as a major deficiency and stated the need for "a comprehensive means of communicating operating status and alarm conditions from remote pumping stations and tanks to system operators at the treatment plant".

3.2 Goals

During Work Session #1, the Town prioritized goals for consideration in SCADA improvements as follows (1 = low priority, 5 = high priority):

- Reliability **(5)**
- Low O&M Cost **(5)**
- Process Control – Automation of Distribution System **(5)**
- Process Control – Automation of WTP **(5)**
- Remote Control of Distribution System **(5)**
- Remote Instrument Monitoring / Datalogging **(5)**
- Scalability **(5)**
- Improvements to Wastewater SCADA [as part of this project] **(4/5)**
- Open Architecture **(4/5)**
- Security **(4/5)**
- Water & Wastewater SCADA on same system **(3/4)**
- Low Capital Cost **(3/4)**
- Wide Area Network (WAN) **(3)**
- Short Implementation Schedule **(3)**
- Integration with Emergency Services **(1)**
- Workforce Automation **(1)**

3.3 Areas of Improvement (Phases)

We recommend the SCADA Project be considered as four phases, based on areas of the system requiring improvement. These phases may be implemented concurrently to reduce overhead cost.

- Phase I – Critical Equipment Lacking Redundancy or Alarms

  Based on our limited investigation, the following improvements must be made immediately to restore a minimum acceptable level of WTP reliability. Depending on the long-term solution implemented for other phases, the short-term improvements to these pieces of equipment may or may not be replaced.

  - WTP Filter Console
    - One of two filter consoles is not operational in automatic mode.
  - Finished Water VFD and Golden-Anderson (GA) Control Valve Integration
    - VFD #1 enters sleep mode when the GA valve limits pump head.
  - River Pumping Station Alarms
    - No current alarm telemetry.
  - Clarifier Building Alarm Interface

        - No current alarm if clarifier pumps fail.
- Phase II – Water Distribution System
    - Interfaces between the WTP and remote tanks and pump stations.
- Phase III – Water Treatment Plant
    - Process control and monitoring at the WTP, including clarifier controls, filter controls, chemical feed systems, pumps, and instrumentation.
- Phase IV – Additional Elements
    - Integrate WW and Water SCADA systems.
    - Wide Area Network, including WTP, WWTF, and Public Works.
        - Future fiber optic direct connection between Town departments.
    - Future sites (scalability).

4.0 ALTERNATIVES EVALUATION

4.1 <u>Alternative 1 – No Action</u>

As described in Section 3.1, "No Action" is not a feasible alternative because of deficiencies in the existing system.

4.2 <u>Alternative 2 – Patch Existing System</u>

4.2.1 Description

General

- Maintain existing architecture using leased telephone lines and EOS ProControl units.
- Maintain existing supervisory control panel at the WTP.

Phase I – Critical Equipment Lacking Redundancy or Alarms

- Replace Golden Anderson (GA) valves with swing check valves.
- Enable alarm telemetry at existing River Pumping Station EOS ProControl unit.
- Repair/replace the PID controller and auxiliary devices/wiring on existing filter control console #1 to make the console functional.
- Reconfigure the existing EOS Proview computer so that it will shut down the River pump station pumps when the plant clearwell high level alarm is activated. Currently the clearwell high water alarm closes the raw water valve and shuts the plant down, but the River pumps continue pumping (to the pond) until manually turned off locally or at the EOS computer, wasting energy and water supply resources.
- Transmit the low head pumps (located in Clarifier building) run status signals along with other critical alarms such as the splitter box low level alarm to the EOS computer. As is, the operator would not know if the pumps have failed without walking to the clarifier building. This will require additional physical I/O modules (or a separate local EOS panel similar to those at the remote sites) for connection to EOS computer.

Phase II – Water Distribution System

- Maintain existing EOS ProControl units.
- Maintain leased telephone lines.
- Add a phone line to transmit Epping Road tank level as an input to Hampton Road EOS ProControl.

Phase III – Water Treatment Plant

- Maintain existing main console and individual process control panels.
- Communication between unit processes and individual pieces of equipment is not possible under this alternative.
- New WTP instrumentation as needed to replace existing (level and pressure transmitters, flow meters, analyzers, motor operated valves, alarm detection devices, etc.).

Phase IV – Additional Elements

- Integration with WW system is not possible under this Alternative.
- WAN linking WTP, WWTF, Public Works, and possibly other Town offices is not possible under this Alternative.
- Maintain existing leased telephone lines for WW system.
- Add EOS ProControl units at future water distribution system sites.

4.2.2 Advantages

- Most distribution system processes (pump and valve operations) are automated with some operational flexibility.
- Remote control of most distribution system pumps and valves is possible.
- Future distribution system sites can be added with remote control and monitoring capability.
- System mostly complete at present time. (Short implementation schedule.)
- Low capital cost.
- Phase I solutions are long-term.

4.2.3 Disadvantages

- Low reliability:
  - Phone lines subject to environmental risks. Town relies on phone company to maintain and repair communications lines.
  - Limited number of technicians available for emergency repairs of hardware or software.
- High O&M costs:
  - Leased telephone lines. At least 7 leased lines are necessary for the water system and at least 10 leased lines for the WW system.
  - Wasted pump energy and water. Even if automatic river pump station shutdown capability is added as recommended under this Alternative, WTP production rate cannot be coordinated from source through all treatment processes to storage, so inefficient pumping will still occur periodically. Finished water pumps do not shut off automatically and run longer than necessary, overflowing tanks.

- Staff productivity. Staff must respond to alarms that could be avoided if WTP process control and distribution system operation could be coordinated and automated more fully. Staff must enter data by hand. Troubleshooting is hindered by limited historical data, especially for distribution system equipment.
- Chemical use. Without a central supervisory control center, each chemical feed unit must be adjusted manually whenever a change in operation occurs. Chemical feed cannot be adjusted remotely at Kingston Road and Lary Lane, so chemical use is not optimized.

- Limited efficiency / process control at WTP and in distribution system (also see O&M costs above).
  - WTP processes cannot be controlled from control room. Operational adjustments must be made manually at each process's control panel.
  - Operators must dial up through modem connection to access remote EOS ProControl units to access equipment status or use remote control.
- No real time data logging capability.
- Limited flexibility and scalability:
  - WTP supervisory control panel is obsolete. Expensive to wire alarms and indicators to supervisory control panel. Hardware modifications required (e.g. EOS units) to add process control capability from control room.
  - Individual pieces of equipment cannot communicate with one another, so programming automatic operation is extremely limited.
- Closed architecture and outdated hardware – limited number of technicians who can work on system.
  - Repair costs are expensive – as witnessed by the high cost currently needed to repair Filter Console #1.
- Remote video monitoring with security cameras is not possible.
- Integration with WW system not possible.
- WAN not possible.
- Workforce automation not possible.
- Integration with Town's GIS not possible.

4.3 Alternative 3 – Replacement System

4.2.1 Description

General

- Open architecture – PLC (Programmable Logic Controller)-based SCADA hardware.
- Intellution HMI (Human-Machine Interface) SCADA software.
- Replace leased telephone lines with radio-based communication. An RF Propagation Study by TCS Communications Corp. of Salisbury, MA in 2003 concluded that "reliable performance could be achieved with a UHF licensed wireless radio network" to serve all water and wastewater remote sites and treatment facilities with a repeater on Epping Road tank.

Phase I – Critical Equipment Lacking Redundancy or Alarms, Short-Term Solutions
At a minimum, the Town should implement the following steps immediately to restore a minimum acceptable level of WTP reliability:

- Replace Golden Anderson (GA) valves on finished water pumps with swing check valves.
- Enable alarm telemetry at existing River Pumping Station EOS ProControl unit.
- Repair/replace the PID controller and auxiliary devices/wiring on existing filter control console #1 to make the console functional.

In addition, the Town should consider implementing two additional changes to improve efficiency and reliability until long-term solutions are implemented:

- Reconfigure the existing EOS Proview computer so that it will shut down the River pump station pumps when the plant clearwell high level alarm is activated. Currently the clearwell high water alarm closes the raw water valve and shuts the plant down, but the River pumps continue pumping (to the pond) until manually turned off locally or at the EOS computer, wasting energy and water supply resources.
- Transmit the low head pumps (located in Clarifier building) run status signals along with other critical alarms such as the splitter box low level alarm to the EOS computer. As is, the operator would not know if the pumps have failed without walking to the clarifier building. This will require additional physical I/O modules (or a separate local EOS panel similar to those at the remote sites) for connection to EOS computer.

Phases I & III - Critical Equipment Lacking Redundancy or Alarms and Water Treatment Plant, Long-Term Solutions (Figure SK-I2)
Under Alternative 3, long-term solutions for Phases I and III are combined because Alternative 3 calls for a complete replacement of the existing SCADA architecture, and it will be more efficient and cost effective to design and construct all elements of the new SCADA system at the WTP as a complete system rather than piecemeal.

- New MTU (Master Terminal Unit, PLC-based) at WTP. The MTU will control and monitor plant processes and will communicate with the Phase II PLC-based RTUs (Remote Terminal Units).
- New PLC –based filter consoles (2) complete with OIT (Operator Interface Terminal) and manual backup. (Note: These consoles will supercede the short-term Phase I improvements.)
- New SCADA workstation computers (not redundant) and peripherals with Intellution HMI for control and monitoring of plant processes and remote sites under Phase II.
- LAN (Local Area Network) between the new MTU, new filter consoles, and the new computers.
- Convert the Clarifier Building AB PLC SLC-503 processor to SLC-505 to allow LAN connectivity (or use DH-485 to Ethernet converter) so that control and monitoring of the Clarifiers, blowers, etc. can be performed from the new SCADA system. (Note: These improvements will supercede the short-term Phase I improvements.)
- Integrate the remaining process equipment into the SCADA system (finished water pumps, chemical feed system, alarms, etc.).
- New utility software (report manager, maintenance program, alarm pager).
- New laptop for remote access.

- Remove the existing obsolete supervisory control panel, which houses the strip chart recorders, indicators, analog controllers, switches, alarm annunciator panels, etc. and the associated wiring. The field wiring from the equipment that must remain will be reconnected to the new MTU.
- New WTP instrumentation as needed to replace existing (level and pressure transmitters, flow meters, analyzers, motor operated valves, alarm detection devices, etc.).
- Under this phase, the existing EOS remotes and Proview machine will remain in place to continue monitoring remote sites until replaced under Alternative 3 Phase II. (Note: Implementing Phase II concurrently with Phases I & III would improve efficiency in design and construction of the system.)

Phase II – Water Distribution System (Figure SK-I3)

- New PLC-based RTUs with radio equipment at remote sites, including River Pumping Station. Epping Road Tank will be the repeater site. (Note: The RTU at the River Station will supercede the short-term Phase I improvements.)
- New radio and antenna assembly at WTP with connection to the MTU.
- Remove the existing EOS panels and associated telephone services. All existing I/O wiring to the EOS panel and each site will be reconnected to the new replacement RTUs.
- Additional distribution system instrumentation and alarm detection devices as required.
- Abandon leased telephone lines.

Phase IV – Additional Elements (Figure SK-I4)

- Upgrade WW SCADA HMI software to be compatible with the water system.
- Convert WW remote sites to a radio-based communications.
- Install WAN (Wide Area Network) to allow communication and data exchange between WTP, WWTF, and Public Works SCADA computers over high speed DSL. (DSL over phone lines, cable TV or future fiber optic medium.)
- Add RTUs with radio at future sites.

4.2.2 Advantages (Compared to Alternative 2)

- NHDES has recommended a comprehensive SCADA system.
- High reliability.
  - Town owns communications network.
  - Radio communications are less susceptible to environmental threats than telephone (downed wires, damaged poles).
- Low O&M costs.
  - No leased telephone lines.
  - Less wasted pump energy and water (easier to optimize process control at WTP and in distribution system).
  - Higher staff productivity.
  - Efficient chemical use by coordinating chemical feed pacing with WTP production rate or distribution system flow rates.
- Improved efficiency and reliability:
  - Integration of WTP processes, chemical feed systems, pumps, and distribution system.
  - Centralized control.

  - Real-time data logging and trending.
  - Automatic report generation in formats acceptable by the regulatory agencies.
  - Automatic alarm reporting and paging system.
  - Remote access for control and monitoring.
  - Early warning to prevent process upsets.
  - Latest technology.
  - Single source responsibility (one integrator responsible for entire system troubleshooting and maintenance).
- Serviceability:
  - Open architecture allows many integrators/suppliers to provide maintenance and repair services.
  - Modular hardware.
  - Intellution is most common software in Northeast. Integrators are familiar with it and have standard databases.
- Scalability:
  - Proposed system easier to adapt to changes in WTP or distribution system operation through reprogramming because control is centralized. Existing system (Alternative 2) requires hardware changes and reprogramming of multiple units individually any time an operational change is made.
  - Easier and less expensive to add alarms or indicators to proposed MTU than to existing supervisory control panel at WTP.
- Security hardware (e.g. alarms and cameras) can be easily integrated into centralized control and monitoring (MTU).
- Can integrate Water and WW systems.
  - O&M cost savings can be realized for WW system by replacing leased lines with radio.
- Town uses Intellution software currently for WW SCADA.
- WAN capable.
- Workforce automation possible.
- Integration with Town's GIS possible.

4.2.3 Disadvantages (Compared to Alternative 2)

- Higher capital cost.
- Longer implementation schedule.
- More initial training and education required.

5.0 CONCLUSIONS

Based on the preceding, Underwood Engineers concludes the following:

- Short-term SCADA improvements are needed for certain alarms, filter controls, and pump controls, to provide a minimum acceptable level of reliability.
- Long-term SCADA improvements are needed because:
  - Raising the main service zone HGL will require greater control of the water distribution system, and
  - Exeter's existing water SCADA system (Alternative 1) is not adequate to provide an acceptable level of reliability and efficiency.

- Patching the existing system (Alternative 2) does not meet the Town's highest priority goals – reliability, low O&M cost, process control, datalogging, and scalability.
- Alternative 3, a new SCADA system with PLC-based hardware, HMI software, and radio communications meets the Town's goals.
- The existing system with or without patching (Alternative 1 and 2) is obsolete and expensive to maintain as equipment fails.
- Potential cost savings by abandoning leased lines is:
    - Water = 7 lines x $30 / mo. x 12 = $2520 / year
    - WW = 10 lines x $30 / mo. x 12 = $3600 / year
- Potential cost savings from reducing tank overflows is approximately:
    - $1200 / year for pumping (assuming tanks currently overflow 1 night (8 hours) per month, and one 150 hp finished water pump is pumping during overflow),
    - Plus the cost of treating water that is currently wasted due to overflows.
- Potential cost savings from reducing wasted pumping from river pump station into reservoir is approximately:
    - $1200 / year (assuming a reduction of 1 hour of unnecessary pumping per day by one 75 hp pump for 6 months of the year).
- Additional cost savings will be realized by improving staff efficiency and chemical feed system efficiency through implementation of a new comprehensive SCADA system (Alternative 3).

6.0 RECOMMENDATIONS

Based on these conclusions, Underwood Engineers recommends the following:

- Implement Phase I steps immediately as short-term fixes to provide minimally acceptable operation of the water system until Alternative 3 can be designed and constructed.
- Implement Alternative 3, a new SCADA system with PLC-based hardware, Intellution HMI software, and radio-based communication as a long-term solution.
- Design and construct Alternative 3 Phases I & III and Phase II as a single project to avoid redundancy in engineering and bidding and to ensure single source responsibility from the integrator.
- Design Alternative 3 Phases I, II, and III with consideration for adding Phase IV in the future.
- Perform further study to evaluate needs and priorities for Phase IV.
- Perform further study to evaluate needs and priorities for replacing individual instruments and equipment (pumps, motor operated valves, alarm detection devices, etc.)

7.0 FUNDING AND IMPLEMENTATION

7.1 Opinion of Cost

A summary opinion of cost for the recommended long-term alternative – Alternative 3 – is provided here. A more detailed breakdown of construction costs for the long-term solution is attached.

BASE COST	
Short-Term Solution (incl. engineering and contingency)	
Phase I recommended minimum steps	$15,000
Long-Term Solution, Construction (incl. installation)	
Phases I & III, Long-Term Solution	$186,000
Allowance for WTP instrumentation and devices (Phase III)	$25,000
Phase II	$145,000
Long-Term Solution, Engineering (20%)	$71,200
Long-Term Solution, Contingency (20%)	$71,200
TOTAL BASE COST	**$513,400**
ADDITIVE ALTERNATES / FUTURE PHASES	
Additional short-term fixes (optional)*	$15,000 to $30,000
Phase IV, Construction, Engineering & Contingency	$115,000
TOTAL ADDITIVE ALTERNATES / FUTURE PHASES	**$120,000 to $135,000**

* Only necessary if completed prior to long-term solution.

7.2 Funding

Consider using balance of previous appropriations for this work:

1. $8.26 million warrant article for distribution system,
2. Previously authorized SCADA appropriations.

SCADA improvements are Drinking Water State Revolving Fund (SRF) eligible. The Town may apply for an SRF loan – new or amended.

The Water Department will retire debt of $153, 957 in 2008 and $273,900 in 2009, freeing funds to upgrade the SCADA system.

7.3 Implementation

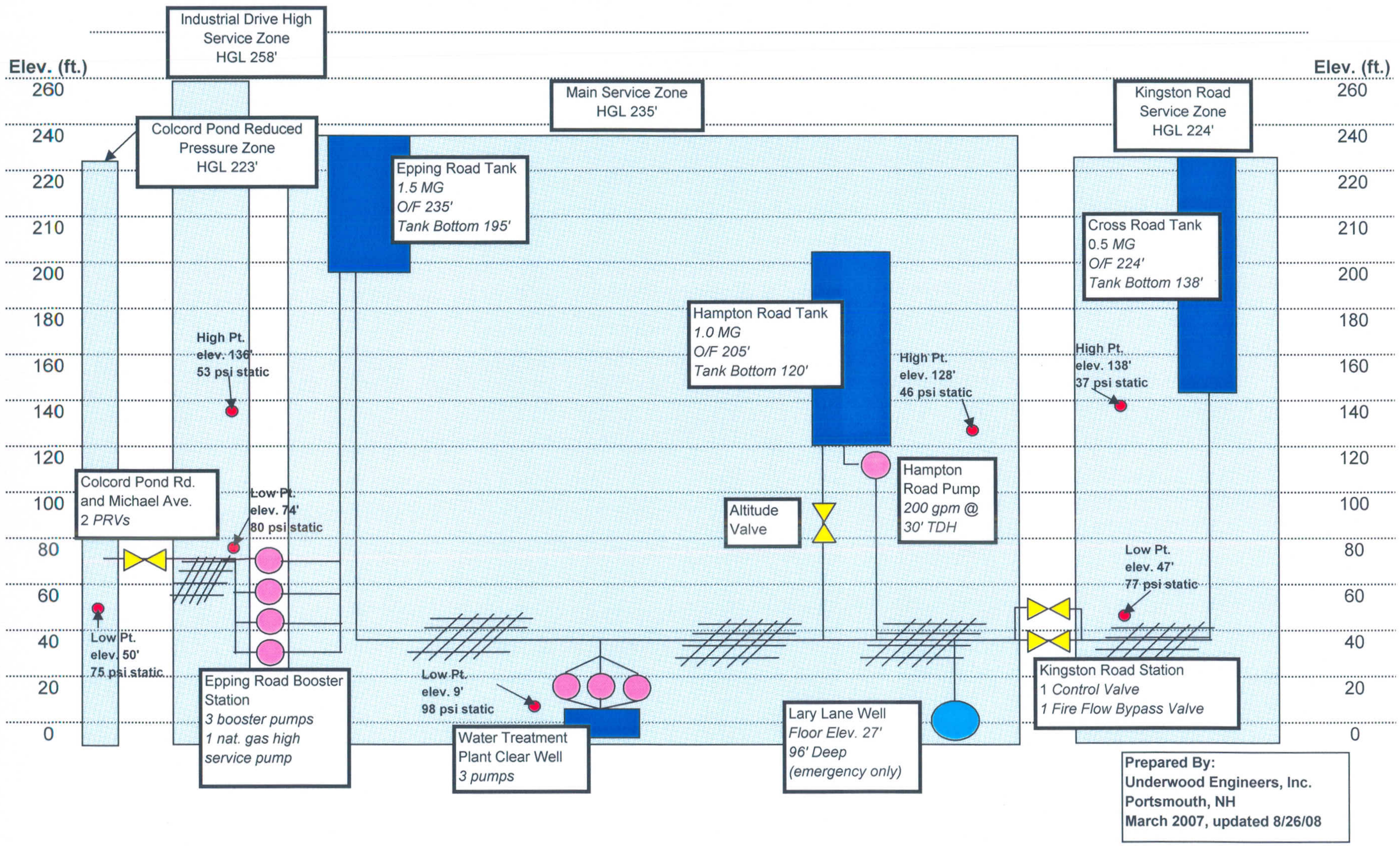
Short-term fixes (Phase I) can be implemented immediately by the Town through direct purchase using WTP emergency or operating funds. For long-term solutions, we recommend design-bid to facilitate a comprehensive design prior to construction.

7.4 Schedule

September 2008	Work Session #1
October 2008	UEI issue Opinion of Cost for budgetary purposes
October 2008	Work Session #2
October 2008	UEI issue final Technical Memo
November 2008	Town implement short-term patches
November 2008	Town retain consultant for design of long-term solution
November 2008 – March 2008	Design
March 2009	Town Meeting; Warrant Article for SCADA Improvements (Construction Phase)
April – May 2009	Bid
June – December 2009	Construct

FIGURE 1

Exeter Water System Profile
(Proposed for December 2008)



Exeter WTP SCADA Upgrade
I&C & SCADA Systems - Alt #3-Phase I & III
Opinion of Construction Cost

SMR ENGINEERING

Item No.	Description	Qty	Unit	Amount Including Installation
D1	PLC-based MTU complete with OIT and application programming	1	EA	$ 20,000
D2	PLC-based filter consoles complete with OIT and application programming	2	EA	$ 50,000
D3	Managed Ethernet switch	1	EA	$ 1,000
D4	Workstation computers & peripherals, printers, UPS, furniture, etc.	2	EA	$ 10,000
D5	I/O wiring including interfacing to exisitng panels and field instruments		LS	$ 40,000
D6	HMI software, full function and run time versions, paging and report manager software		LS	$ 20,000
D7	SCADA HMI data base configuration		LS	$ 25,000
D8	Upgrade exisitng AB SLC-503 processor to 505 processor at Clarifier bldg		LS	$ 5,000
D9	Laptop computer		1	$ 3,000
D10	SCADA start-up, training and O&M manuals		LS	$ 10,000
D11	Demo of exisitng supervisory panel and filter consoles		LS	$ 2,000
	Subtotal for WTP I&C & SCADA systems			**$ 186,000**

Exeter Dist SCADA Upgrade
I&C & SCADA Systems - Alt #3-Phase II
Opinion of Construction Cost

SMR ENGINEERING

Item No.	Description	Qty	Unit	Amount Including Installation
D1	PLC-based RTU panels complete with OIT and application programming	6	EA	$ 90,000
D2	Radio equipment and antenna assembly	7	EA	$ 20,000
D3	I/O wiring including interfacing to exising panels and instruments		LS	$ 18,000
D4	Additional SCADA HMI data base configuration to include the remotes	4	EA	$ 10,000
D5	Start up, training and O&M manuals		LS	$ 5,000
D6	Demo exsitng EOS panels	1	LS	$ 2,000
	Subtotal for distribution I&C & SCADA systems			**$ 145,000**

Exeter WWTP & WAN SCADA Upgrade
SCADA Systems - Alt #3-Phase IV
Opinion of Construction Cost

SMR ENGINEERING

Item No.	Description	Qty	Unit	Amount Including Installation
D1	Radio equipment and antenna assembly (9 RTUs, 1 MTU)	10	EA	$ 30,000
D2	Radio repeater	1	EA	$ 10,000
D3	Upgrade the existng HMI to Intellution iFix		LS	$ 8,000
D4	Additional MTU PLC configuration for radio communication		LS	$ 5,000
D5	WAN routers, DSL connections and configuration		LS	$ 10,000
D6	Demo exsiitng phone lines		LS	$ 2,000
D7	Misc		LS	$ 10,000
	Subtotal for WWTP& WAN SCADA systems			**$ 75,000**

1383 Distribution System Improvements
Exeter, NH

DESIGN SUMMARY
October 16, 2007
(Updated March 11, 2008; August 26, 2008)

Hampton Road:

- **Basis of Design**
  - Install pump to pump into system with new Epping Road tank online (HGL = 235') from Hampton Road tank (o/f = 205').
  - 20% turnover of Hampton Road tank daily (200,000 gallons).
- **Current Design**
  - Install new booster pump – duplex pitless can pump
    - 210 gpm @ 48 ft. TDH (each pump)
      - 210 gpm x 16 hours = 200,000 gpd
      - 48 ft. average head loss including friction losses
    - Hampton Road pump is on during day.
    - Hampton Road tank draws down during day because demands exceed WTP (and possibly well) production. At night, Epping Road tank draws down to fill Hampton Road tank.
  - Replace 10" altitude valve with new 6" valve.
  - Install new electric actuated 6" butterfly valve ("Inlet Isolation Valve"). Closes when pump runs, opens when pump is off.
  - Improve tank overflow drainage.
  - Include provisions for future building over vault.
  - Include connection for portable generator.
  - Install new chlorine analyzer.
- **Control Sequence**
  - Proposed pump shall start at 7:00 AM (adjustable by operator to time when demand exceeds WTP production).
  - Pump shall run until midnight (adjustable by operator) or until Hampton Road tank level falls below 68 feet (20% drawdown) (also adjustable).
    - Pump shall stop temporarily if Epping Road tank is full and restart (only between 7:00 A.M. and midnight) when Epping Road tank falls below adjustable setpoint (e.g. 39.0 feet).
  - Allow remote control from WTP.

Kingston Road:

- **Basis of Design**
  - Create low pressure zone (Kingston Road Pressure Zone) to allow Cross Road Tank to turn over (overflow elev. of 224').
  - Maintain booster chlorination at station.
  - Minimum tank level = 71 feet to prevent low pressure at services.
- **Current Design**
  - Locate all control valves and flow meter above ground in existing building.
  - Install new electric actuated 3" butterfly control valve ("Main Valve").
  - Install new 6" electric actuated valve ("Bypass Valve") to provide hydrant flows through station in both directions.
  - Salvage existing pumps, motors, and controls.
  - Relocate existing flow control valve.
    - Set to 300 gpm to control flow for consistent chlorine boost. (Valve manufacturer's recommended operating range is 30 to 460 gpm, continuous).
  - Relocate existing flow meter.
  - Install new chlorine analyzer.
- **Control Sequence**
  - Control valve normally closed.
  - Main Valve opens when Cross Road tank level falls below 71 feet (adjustable by operator).
  - Main Valve closes when Cross Road tank is full.
  - Bypass Valve closes when pressure on either side of valve drops below setpoint (intial = 45 psi, operator adjustable).
  - Bypass Valve closes based on adjustable pressure setpoints different for each side of station:
    - Cross Road side: close Bypass Valve when pressure exceeds 77 psi (Cross Road Tank full).
    - Downtown side: close Bypass Valve when pressure exceeds 81 psi (Epping Road Tank full).
  - Allow remote control from WTP.

Lary Lane:

- **Basis of Design**
  - Maintain well as emergency backup supply
  - Provide min. 180 gpm
- **Recommendations**
  - Continue using existing pump.
    - UEI estimates ~260 gpm available at new HGL of 235'. (See attached pump curve.)
    - Confirm available flow with pump test.
  - Long-term: replace with pump sized for treatment or off-site blending in accordance with Town's long-term groundwater plan (new motor and VFD may be needed).
  - Inform NHDES of changes to approved arsenic mitigation schedule.
- **Control Sequence**
  - N/A

WTP:

- **Basis of Design**
  - Meet maximum day demands with one pump out of service.
  - CDM projected Max Day 2020 Demand = 3.26 MGD
  - Finished water pumps run 23 hours per day (1 hour down for filter backwash).
  - Required finished water pump capacity to meet CDM's projected 2020 max day demand = 2360 gpm with one pump out of service.
  - Current pump capacity under new HGL = 1230 – 1450 gpm for each pump (see attached pump and system curves).
- **Current Design**
  - Use all three existing finished water pumps. With largest pump out of service, two remaining pumps can provide at least 2460 gpm under new HGL (meets CDM's projected 2020 max day demands).
  - Replace VFD #2.
- **Control Sequence**
  - Adjust setpoints for proper pump pacing using one or two pumps.
    - For example, run one pump until it cannot maintain clearwell level by itself, then run two pumps each at 50% required flow.

SCADA:

- SCADA conceptual planning pending.
- Hampton Road will require significant SCADA improvements (e.g. pump control by Epping Road tank level).
- Existing SCADA at Kingston Road can be modified for use with proposed control valve.