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Mr. Chris Siegfried
Hollis School District – SAU41
PO Box 1588
Hollis NH 03049

Via: US Mail and E-mail: siegfriedc@sau41.k12.nh.us

Reference: Overall Water Supply System Evaluation and Recommendations
<u>Public Water Supply – Hollis School District, Hollis, New Hampshire</u>
Project No. PE181.01 (SAU41 PO#1000977)

Dear Mr. Siegfried:

In accordance with section 1.3 of our July 17, 2009 proposal, authorized by you on September 17, 2010 via the above PO#, we submit herein, this evaluation of the existing water supply system with an outline of recommendations to consider for implementation of a future water supply master plan. We also enclose the 30x42 inch color plan entitled "Overall Water Distribution Plan", which depicts a compiled as-built layout of the water distribution system's components location, material, size, etc., as it is known to exist from record data and from descriptions from professionals knowledgeable and experienced in the system's location, installation, and / or maintenance. Specifically, I met with Scott Boggis of Skillings & Sons, Inc. and with Jeff Babel of the Hollis DPW on September 24, 2010; and we walked over essentially the entire water distribution system (i.e. school portion and town portion), and I made notes of locations of the lines, service connections, and pipe sizes and materials, where that information was made available. Where information is not clear, notes were made accordingly on that attached plan. The following is a description of the water supply system, from the Rocky Pond Well source, through the distribution system as mapped on the enclosed plan.

<u>Rocky Pond Well:</u>

The source of the water supply system originates from the Rocky Pond Well located off of and to the east of Rocky Pond Road between Deacon Lane and Willoughby Lane. The well consists of one 52-inch diameter concrete caisson well casing installed into the existing surficial aquifer beneath the floor of the Rocky Pond Well Pump Station. Two 8-inch diameter steel well casings are installed within the concrete caisson well, and both well casings have one submersible well pump. Therefore, two well pumps located within the same well provide the source of water and pressure in the distribution system.

Flow from both wells combines into one pipe, and all of the well water is treated for pH adjustment (increase) by injection of soda ash, and for corrosion inhibition by injection of orthophosphate. These two chemicals each include their own chemical storage tanks and injection pumps in the pump station. The treatment goal is to reduce the corrosion potential of the water so that copper and lead minerals in the walls of the distribution system piping materials, and in serviced building plumbing systems and faucets does not dissolve into the drinking water because of corrosive water. Treatment for corrosion control was mandated by the Department of Environmental Services (DES) after routine samples indicated elevated copper and / or lead in the drinking water.

The Rocky Pond Pump Station does not include any atmospheric or hydropneumatic water storage tanks, nor any emergency backup generator power. A pressure transducer senses the water pressure in the distribution system inside the pump station, and activates and speeds up or slows down one or both well pumps to maintain a target system pressure of 120 pounds per square inch (PSI) in the pump station. The well pumps need to vary output to match the variable demand in the distribution system, and that is done electronically with variable frequency drives (VFDs).

The chemical injection rate also varies with the flow rate system demand. A layout detail of equipment, piping, and floor plan of the Rocky Pond Pump Station is depicted on the enclosed plan. Following chemical injection, the treated water distribution system splits into two branches, the north branch and the south branch, and each branch leaves the pump station through separate lines through the floor.

The Distribution System – North Branch:

The north branch follows a path through the woods up a hill to the Hollis Upper Elementary School (HUES). There is an underground vault with a pressure tank adjacent to HUES. A service connection line leaves that vault and enters and supplies water to HUES. The pressure tank was installed to provide the necessary pressurized water storage to buffer the operation of the well pumps to reduce rapid on-off pump start-stop short-cycles. However, with both well pumps now operating on VFDs, that pressure tank is no longer necessary.

We also note that the high voltage 3-phase, 480-volt power to the Rocky Pond Pump Station is provided from HUES through an underground electrical conduit down the same path adjacent to the north branch water line. Rocky Pond Pump Station also has a separate low voltage single-phase, 230-volt power supply off of Rocky Pond Road.

From HUES, the north branch then leaves the vault and travels up to its termination at the Primary School. The location, size, and material of this line between HUES and the Primary School is unknown. At the Primary school, there is a larger pump station building with an underground basement (vault) as detailed on the plan. The Primary School Pump Station is described below.

Primary School Pump Station:

The north line enters the basement (vault) of the Primary School Pump Station and fills an underground atmospheric steel water storage tank. The storage tank is a horizontal cylinder buried behind the pump station and one end of the tank partially penetrates into the inside of the pump station basement. Level controls inside the storage tank control the inflow into the tank from the north branch. When the water level in the tank drops, a normally-closed motorized ball valve (MBV) on the north branch main opens, and allows water to slowly flow into and fill the Primary School's storage tank. When the tank is full, the MBV closes.

Inside the Primary School Pump Station, there are two booster pumps which activate when there is water demand in the Primary School to maintain water pressure into the school. The booster pumps draw the stored water from the storage tank and pump into the Primary School. In this configuration, the north branch actually does not normally provide direct pressure into the Primary School, and instead normally only fills the storage tank. The booster pumps normally provide the direct pressure into the school. However, if both booster pumps in the Primary School Pump Station were to be taken off line, it is possible to open up a normally-closed storage tank by-pass line inside the pump station, which would allow the Rocky Pond north branch waster main to provide pressurized water into the Primary School.

The benefit of this system configuration is redundancy. There is always stored water on hand in the Primary School storage tank, so if the Rocky Pond pump station goes off-line for any reason, the Primary School can continue to operate as long as the Primary School Pump Station remains on-line, and until the storage tank is depleted, which may be up to one or two days, while the Rocky Pond Pump Station is brought back on-line. Additionally, having a storage tank allows the ability for water to be delivered from a tanker truck to refill the storage tank.

The Distribution System – South Branch:

The south branch leaves the Rocky Pond Pump Station, travels westerly along the access drive, then turns south and runs along the eastern shoulder of Rocky Pond Road towards, and eventually crossing, Proctor Hill Road and then running southeasterly up the hill across a stream on the south side of Proctor Hill Road. The south branch continues across open fields and across an estate property and driveway through an easement, and eventually crosses an existing wetland / pond area. Located in this wetland area is a former (now abandoned) well which is located inside an underground vault. The south branch between this abandoned well and the Rocky Pond Pump Station consists of 3-inch schedule 80 PVC. From this abandoned well up to the Middle School, the south branch was upgraded to 4-inch C-900 PVC, which is more appropriate and typical for a water distribution system. The south branch line and pipe transition is actually located just outside the abandoned well vault, and no active piping is located inside that vault.

From this abandoned well vault area, the south branch runs easterly up the hill behind, and directly into the Middle School. Near the top of the hill before the Middle School, there are three branches (tees) off of the south branch main. One tee supplies the irrigation water for the athletic fields, and the second tee is a second service connection to the Middle School addition. The third branch is a dead-end abandoned line that served the former mobile classrooms.

The south branch main enters and passes through the Middle School building, leaves the Middle School, then runs northeasterly into an underground vault located at the corner of the access drive and parking lot to the northeast of the Middle School. This vault includes a service connection to a private residence on Main Street. The south branch main leaves this vault, enters into, serves, and passes through the Farley Building to the north; and then runs southeasterly into, serving, and passing through the Old Fire House.

On the immediate north side of the Old Fire House, the south branch includes a service connection to the Block Building located directly across Monument Square from the Old Fire House. The south branch main then crosses Monument Square and enters another underground vault off the south shoulder of Monument Square. This vault includes a service connection to the north across Monument Square, through the ball field that serves the residence to the immediate north of the Block Building on Main Street. From the Monument Square vault, the south branch main runs easterly along the south shoulder of Monument Square. There is another service connection that provides water to the town square triangular area between Monument Square and Depot Road.

The south branch main then crosses Depot Road and enters into an underground vault located off the east side of Depot Road immediately south of the Town Hall. From this vault, a service connection serves the Town Hall, and the south branch main then leaves the vault, and runs south along the eastern shoulder of Depot Road, all the way down to its termination at, and serving Lawrence Barn at Nichols Field.

<u>Recommendations Outline For Future Water Supply Master Plan:</u>

Based on the above assessment of the water supply system, as well as more recent discoveries and repairs of system leaks and increased drawdown at the Rocky Pond Well, we have identified several issues that could be considered for overall improvement of the system. They are outlined as follows.

1. Develop a leak detection program
2. Develop a water loss assessment program
3. Assess Rocky Pond Well Source
4. Separate out irrigation water from the system / develop separate irrigation source
5. Replace and upgrade portions of the distribution system
6. Provide more atmospheric storage and pumping redundancy in the system
7. Evaluate Interconnecting the North and South Distribution Systems
8. Provide emergency backup generator power at Rocky Pond Pump Station
9. Investigate a fee-based system for residential and municipal connections
10. Develop a Water Supply Capital Improvement Fund

The following is a description of each of the above ten Options:

1. **Leak Detection Program:**
   There are various tools that can be implemented in a leak detection program. First, using the existing flow meter in the Rocky Pond Pump Station, a Telog flow recorder could be purchased and permanently installed, and the flow data could be periodically downloaded (monthly or quarterly) and graphed to identify if there is any change in minimum night-time flow leaving the pump station. Second, a one-time night-time leak detection field investigation could be implemented with proper notice provided to all users that water will be turned off during a selected evening when the field investigation is planned. This is done by turning off various gate valves and service connections in the system, and then reading the corresponding system pressure and flow rate at the Rocky Pond Pump Station. If flow and a drop in pressure are observed with closed gate valves and service connections, it could suggest that leakage might be present up to that given segment of water main. This could refine and identify potential pipe segments to be further investigated using sonic leak detection methods, or could identify priority segments of piping to be replaced.

2. **Water Loss Assessment Program:**
   Existing water meters and new water meters can be read from strategic locations on a weekly or monthly basis, preferably all on the same date, and as close as possible at the same time of day so that a mass balance of overall water usage can be calculated to identify locations in the system where water may be leaking. Strategic locations to implement and read meters would be at every service connection, at the Rocky Pond Pump Station, at each of the three schools at every service connection, at the irrigation branch, at the Old Fire House, at the town square, at the Farley Building, at the Town Hall, and at the Lawrence Barn. The goal in a water loss assessment is to select water meters that are accurate and precise enough to measure low flows, and to make sure that there are no connections that are not metered.

3. **Assess Rocky Pond Well Source**
   As you are aware, the Rocky Pond Well has a minimal saturated thickness depth of available aquifer (i.e. depth of water between the static water table and the well pumps intake). Historically, this well has consistently provided water, and despite a minimal saturated thickness, may be adequate to continue to provide water consistently. Over this past summer, the water levels declined to the point of concern. Unfortunately, due to a lack of historic water level data at the Rocky Pond Well and surrounding aquifer, it is unclear whether the water level decline was due to declining well yield capacity, environmental drought conditions, or a result of system leaks which might have developed to the point of overtaxing the aquifer. Developing a new well will be a costly endeavor and could present challenges with permitting with the DES. We recommend assessing the cause of the drawdown of 2010 before investigating a new well source. This assessment could include the following two-part assessment.

   First, a water level recorder (transducer) could be installed in the Rocky Pond Well to continuously monitor and record the well's water levels to determine any overall declining or rebounding trends in the well's water levels. Next, one or two new monitoring wells, or perhaps existing monitoring well points already in place (if available) could be installed adjacent to the Rocky Pond Pump Station and read periodically for water level, so that the aquifer water level can be compared to the Rocky Pond Well water level to determine if any well draw down concerns are regional / aquifer related, or well-specific. If well-specific draw down occurs but the regional aquifer data does not indicate depletion, rehabilitation of the Rocky Pond Well, or a new well source at the Rocky Pond site could be considered. If regional aquifer depletion is observed at that location, then a new source may be considered at another location further away from the Rocky Pond Well site.

4. **Separate Out Irrigation Water from the System / Develop Separate Irrigation Source**
   Without knowing exactly how much irrigation water is used at the Middle School, we can assume as typical, that irrigation demand is substantial as compared to domestic water demands. Irrigation is also at its peak when wells and aquifers are typically at their lowest seasonal levels. The Rocky Pond Well water is now treated with costly chemical injection, yet there is no need to treat irrigation water. Consequently, separating the irrigation system from the Rocky Pond Well water system and developing a separate irrigation source at the Middle School would benefit water quantity impacts to the Rocky Pond Well while reducing costs associated with treatment chemicals by also reducing the chemical usage.

   The first step is to confirm the irrigation usage, which could be done by installing a water meter on the irrigation branch off of the south distribution system. The goal is to determine how substantial the irrigation demand is. A new irrigation source could originate from a new well, either a deep drilled bedrock well, or a shallower sand & gravel well located in the vicinity (adjacent to) the wetland area where the current abandoned well vault is located behind the Middle School. It might even be possible to re-activate that abandoned well for irrigation purposes.

5. **Replace and Upgrade Portions of the Distribution System**
   As described above, portions of the distribution system are either small diameter potentially restricting flow or are old and susceptible to leakage. Assuming that additional service connections are not anticipated and that additional system expansion is not anticipated, we recommend replacing and upgrading segments of the system based on a priority of those segments that is leaking, most susceptible to leak, and are restricting flow and pressure. This would require a leak assessment, and may be affected by other actions. For example, if irrigation of the athletic fields is eliminated from the system, it may not be required to upgrade any lines between the Middle School and the Rocky Pond Pump Station if that results in adequate flow and pressure at the Middle School. Based on the results of identified leakage in specific locations, it may be prudent to replace and upgrade distribution lines to prevent future leakage in those areas. Recently, leakage was identified and repaired along Monument Square and adjacent to the Old Fire House. Consequently, it might be prudent to plan to replace the segment between those locations, and further towards the Town Hall. Subsequent to those upgrades, we would recommend that further upgrades be based on further analysis and leak detection in the existing system, so that resources are focused on priority areas.

6. **Provide more atmospheric storage and pumping redundancy in the system**
   The Rocky Pond Pump Station operates at a very high atypical pressure of 120 PSI, which is necessary to provide adequate pressure at the Middle school. Google Earth indicates an approximate elevation at the pump station of 269 feet (above mean sea level), and 423 feet at the Middle School. This 154-foot elevation change represents a static pressure drop of approximately 67 PSI between those two locations. That means that the pressure at the Rocky Pond Pump Station needs to be 67 PSI higher than the pressure at the Middle School. Therefore, to maintain a typical 50 PSI system pressure at the Middle School, the Rocky Pond Pump Station needs to operate at 67 PSI higher, or a minimum of 117 PSI, which is essentially where it does operate (i.e. 120 PSI). This implies that the Rocky Pond Pump Station operating pressure can not be lowered if direct pressure is to continue to be provided to the Middle School from that pump station. Similarly, considering the Primary School approximate elevation of 390, an elevation difference of 121 feet results, for a corresponding pressure difference of 52 PSI; and HUES with an approximate elevation of 380, results in a pressure difference of 48 PSI compared to the Rocky Pond Pump Station.

   Two options exist to provide additional storage and / or pumping redundancy. First, a new storage tank and pump station with booster pumps could be installed at either the Rocky Pond Well site or at the Middle School. The benefit of the Rocky Pond site is that the entire water system would enjoy the redundancy benefits. The Rocky Pond site, however, is closer to residential butters, and potential wetland areas, and may present more challenges. Any new pump station at the Rocky Pond Well site would also have to maintain the high 120 PSI system pressure. If a new future well site might ever be considered, it would not be prudent to construct a new storage tank and pump station at the Rocky Pond well site.

   Second, locating a new storage tank and pump station with booster pumps at the Middle School would provide redundancy benefits to the Middle School, as well as to the remaining south branch of the distribution system, including the private residences, Town Hall, etc., if the remaining system is also connected. Water would remain available, at least temporarily with auxiliary tanker truck water deliveries, in the even that the Rocky Pond Well was off-line. There would likely be no abutter objection, but there could be challenging site conditions of shallow bedrock to be considered in the design of a new storage tank and booster pump station at the Middle School.

7. **Evaluate Interconnecting the North and South Distribution Systems**
   Simple distribution system hydraulics analysis always suggests that looping (connecting) dead end systems together to create a connected piping network is optimal. The existing system with separate north and south branches is presently configured completely opposite of this. Connecting the two systems would require installing a new water main between the Primary and Middle Schools. This could be done within the existing right-of-way in Main Street, which would require a significant utility survey, and / or by procuring easements from private land owners. Either option would incur significant costs.

The benefit is that system flow capacity is essentially doubled, greatly reducing friction pressure losses, and system redundancy is enhanced. For example, if a major leak occurred in the south branch between the Rocky Pond Pump Station and the Middle School, that section could be isolated for repairs while the new line provides water to the system. It could also be possible for the Primary School's pump station to provide temporary water to the rest of the system (perhaps with the exception of HUES) if the Rocky Pond Well went off-line for emergency repairs.

8. **Provide emergency backup generator power at Rocky Pond Pump Station**
Given that the Rocky Pond Well is the sole source of water in the system, that there is no atmospheric storage redundancy at that location, and that the well pumps are the sole means of providing direct pressure into the water distribution system, it follows that whenever grid power is lost, there is also a near immediate loss of water service in the entire distribution system. Perhaps that is not a major concern if the schools are dismissed as a result of a power outage. However, there may be more severe consequences should any users of the system, such as the Town Hall or any of the schools be considered as an emergency shelter. We are uncertain whether any system connections are designated as emergency shelters. There is also concern that no water would be provided to residences served by the system in a power outage. If it is desired to alleviate the above loss of power concerns, an emergency generator could be installed at the Rocky Pond Well site so that water could be provided during loss of grid power. An emergency generator can be powered preferable by natural gas if available in the area, or by a liquid propane gas storage tank. A diesel generator is not preferred due to concerns with storing that fuel in a well head protection area.

Alternatively, an external auxiliary portable generator connection plug could be installed so that a portable generator could be delivered and connected to provide emergency power in the event of loss of grid power. This alternative is entire limited, however, to having a clear contract in place with a portable generator provider, or having a portable generator available during a power outage. Portable generators are often scarce when they are needed most.

9. **Investigate a fee-based system for residential and municipal connections**
Currently, there are several residential service connections on the system which we understand are not metered and whom do not pay for the use of their water. This is not typical. We understand that there was an historic agreement between a previous land owner where land for the present Rocky Pond Pump Station and one or more schools was granted in exchange for the provision of free water service to properties owned and / or developed by that land owner. We recommend that that agreement be reviewed by legal council to determine if there is an expiration date or other conditions which would allow the school district to recover usage costs for that water used by those residences. That result, coupled with an estimate of the amount of water used by those residences, and the costs to implement the administration for billing for that usage can then be calculated to determine if it is worth implementing. Experience and intuition suggests that there is no incentive for water conservation if there is no accountability to pay for its usage.

10. Develop a Water Supply Capital Improvement Fund

Regardless of which improvements are proposed, a capital improvement fund is a way to set money aside to buffer the large costly system improvements which may develop as a result of an emergency, or as planned upgrades. A water supply system is typical infrastructure that is never fully complete requiring no maintenance. Even a brand new system should include a capital improvement fund, so that when the new system becomes used and requires maintenance and replacement, funds have been collected and are in place to fund the work. Those funds can also collect some interest, as opposed to paying out interest on a bond to fund improvements. What is typically done is to essentially itemize each major component of a water system and identify its total replacement cost and its estimated design life. Then, an average annual contribution amount, adjusted for inflation, can be calculated so that the funds to replace that component can be collected annually and be available by the end of that component's design life.

Summary and Immediate Recommendations:

It is obvious that a number of options exist to improve the overall water system, and that combinations of the above options also exist. Before determining the best course of action, we recommend that some basic data of the existing system be collected and evaluated, so that further options can be based on better data. Presently, there is extremely limited data on the system. For example, it is unknown if the Rocky Pond Well draw down of 2010 is typical or not, nor whether it is well specific or also consistent with the aquifer. It is unknown how much irrigation water is used. It is unknown if there are still more leaks in the existing system.

Consequently, we recommend pursuing a leak detection program (option #1 above) initially. This could identify and prioritize distribution system replacement segments in option #5 above. We also recommend following that with developing a water loss assessment program (option #2 above); which we believe a portion of that assessment may already be underway. Then, we recommend assessing the Rocky Pond Well Source as presented in option #3 above. Next, prior to next summer irrigation, we recommend installing a meter to measure irrigation demand at the Middle School. If it important to disconnect irrigation from the system not just to reduce demand from the Rocky Pond Well, but also to reduce treatment chemical consumption, then we recommend pursuing a new irrigation well source over this winter. Otherwise, we can wait and see what irrigation demand looks like after next year's data, assuming it is a representative year.

The outcome of the above would potentially drive the course of action for either providing more atmospheric storage and pumping redundancy, for interconnecting the north and south distribution Systems, or for providing emergency backup generator power at the Rocky Pond Pump Station (items #6-8 above).

Lastly, we also recommend investigating a fee-based system for residential and municipal connections and developing a Water Supply Capital Improvement Fund. We recognize that an improvement fund will require a clear outline of what course of action is proposed. However, any course of action will require additional funding.

We trust this evaluation is sufficient to meet your current needs. We would be happy to answer any questions or to meet with you to further discuss these matters.

Very truly yours,

PROVENCHER ENGINEERING, LLC

Donald A. Provencher, PE
President / Member

Enclosure:

"Overall Water Distribution Plan", 30x42 inches, 11/4/2010, by Provencher Engineering, LLC

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