2016 WATER REPORT

Stantec

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January 15, 2016
File: 195111235

Mr. Stephen Brewer, PE
Director of Public Works
Public Works Department
4 Epping Road
Raymond, NH 03077

Reference: Raymond, NH,
Municipal Water Supply Capacity Evaluation

Dear Mr. Brewer,

The purpose of this report is to present the results of our evaluation of the capacity of the Town's Municipal Water supply consisting of both the raw water well supply and the treatment plant. A major component of this report is to evaluate the present capacity of the municipal water supply system especially as impacted by the water treatment plant and compare this capacity to the existing and projected future water system demands for the Town of Raymond.

Water Supply Wells

The municipal water supply for the Town of Raymond consists of three gravel packed wells located off Cider Ferry Road. Well No.1 is an18"x24" gravel packed well 61 feet deep with a 10 foot long screen installed in 1963. Well No.2 is an 18"x24" gravel packed well 58 feet deep with an 8 foot long screen installed in 1989. Well No. 3 is an 18"x10" gravel packed well 52 feet deep with an 11 foot long screen installed in 2003. These wells have significant capacity but require treatment for concentrations of iron and manganese above the Secondary Maximum Contaminate Level (SMCL).

Water Treatment Plant

The Town's Water Treatment Plant (WTP) was completed in 2004 to treat the water from the three existing gravel packed wells located off Cider Ferry Road as described above and as shown on Appendix A the Town of Raymond Water Distribution System service area plan. The filtering system is Tonka's Dualator VI gravity greensand filtering system with an aeration tower. The water from the wells that supply water to the WTP contain levels of iron and manganese which are above the State Secondary Maximum Contaminant Level (SMCL) standards, which are primarily set for aesthetic purposes. The elevated levels of these metals cause discoloration of the water and nuisance complaints.

The facility was designed with a maximum hydraulic capacity of 600,000 gallons per day (gpd). The actual treatment capacity is based on the raw water levels of iron and manganese received for treatment. During the first year the plant was operated, the average iron and manganese levels were 0.29 mg/L and 0.75 mg/L, respectively. These values have increased over the years. The recommended SMCL standards for iron and manganese are 0.3 mg/L and 0.05 mg/L, respectively.

Plant Operations

The treatment plant is normally operated at a flow rate of 250 gallons per minute (gpm) in the winter months and a flow rate of 350 gpm in the summer. These flow rates require the plant to run for approximately 18 hours a day all year to produce 255,000 gpd in the winter and 336,000 gpd in the summer. The run time includes two hours to complete a backwash, which requires the continued operation of the wells and treatment system with no discharge to the distribution system. At the current raw water concentrations of iron and manganese with the plant operating at 250 gpm, a backwash is required once every other day. When the plant is operating at 350 gpm, a backwash is required daily.

For the calendar year 2014 the highest monthly average raw water iron and manganese levels were 1.31 mg/L and 1.49 mg/L, respectively. These values are significantly higher than experienced back in 2004 when the plant was first started. As the iron and manganese levels in the raw water increased since the plant first came on line the backwash frequencies have almost doubled. Plant staff are currently conducting additional testing to check the iron and manganese levels at each individual well.

The operator has the weekly time clock in the Filter Control Panel programmed to automatically backwash during the low demand periods. The water used for backwash is the filtered water from the other three cells in the filter. Therefore, no water is pumped to the distribution system during the two hour backwash period, which reduces the total volume of treated water entering the distribution system.

Historical Water Usage

Stantec has completed an analysis of water use data for the three complete years of 2012, 2013 and 2014. The results of this analysis are shown on Figure 1 below.

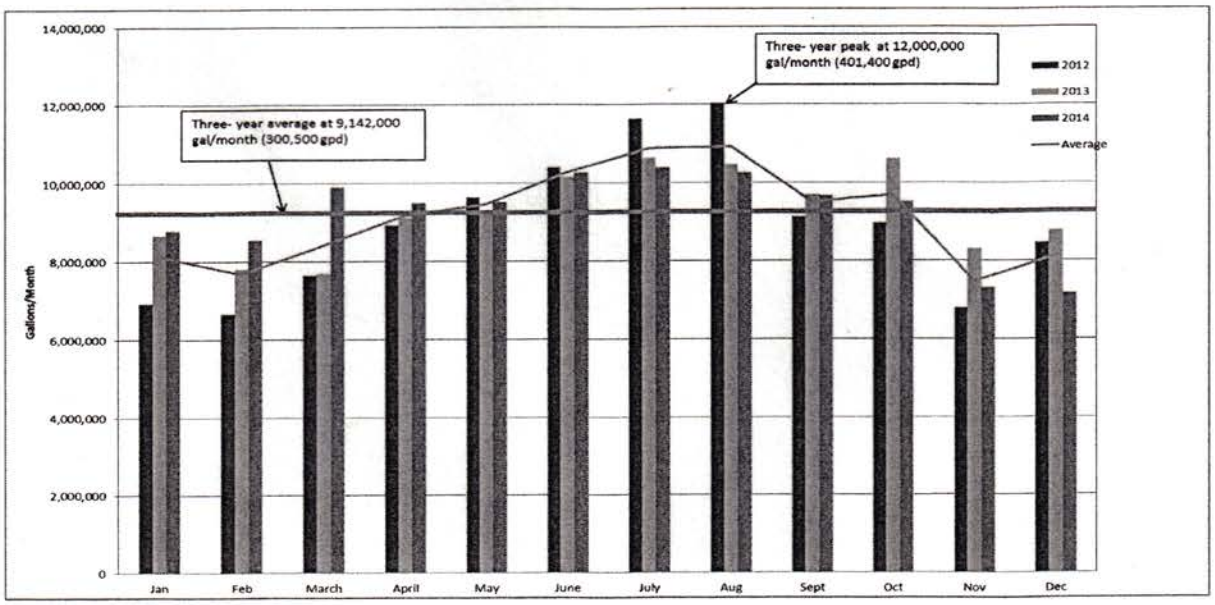

Figure 1- Historic Water Use in Raymond NH

Based on these three years of data, the yearly average water used is 9.142 million gallons per month which equates to approximately 300,500 gallons per day. The data also shows that peak monthly water demand occurs in July and August of each year and lower demand occur in winter months.

Peak water demand for July and August for all three years is above 10 million gallons per month (333,300 gpd) with 12 million gallons per month occurring in August of 2012, which equates to approximately 401,400 gpd of water usage. There are days within a typical peak month when the peak gpd usage is above the peak monthly gpd value. This information is important because the existing wells and treatment plant must be able to produce enough water to meet these demands even when there are system related maintenance issues.

Historical Well Redevelopment Records

The Town's three groundwater supply well sites are currently permitted as public water supplies. These wells (Well #1, Well #2 and Well #3) supply raw water to the WTP since its construction in 2004. Treatment is required due to elevated levels of iron and manganese that must be removed. A fourth well site is currently in the process of being added to the system. Based on preliminary analysis, the raw water quality from this 4th well is such that it will not require treatment at this time. A summary of the information for these four wells is listed in Table 1 below.

Table 1- Water Supply Well Data

Well #	Depth (ft)	Screen Length (ft)	Year Installed	Design Point(1)
1	62.2	10	1963	207 gpm @ 79'
2	58.3	8	1989	385 gpm @ 117'
3	52	10	2003	330 gpm @ 90'
4 (future)	New Bedrock Well is anticipated to supply 225 gpm. (currently in final permitting)			

(1) Actual well capacity has decreased over the years after multiple cleaning and redevelopment events.

Due to the elevated and increasing levels of iron and manganese in Wells 1-3, it has been necessary to clean and redevelop each well periodically to regain its capacity. Since the installation of each well, the Town has monitored the specific capacity of each well to determine when cleaning and redevelopment are needed. Based on these records, the following is the status of each existing well:

1. Well#1 which was installed in 1963 has been cleaned and redeveloped seven (7) times since the year 2000 (approximately once every 2 years). Typically, after each cleaning, the specific capacity returned to or above the well's original capacity except for the most recent cleaning in 2014. After the most recent cleaning and redevelopment in 2014 the well capacity did not return, and it was noted that the top of the well screen has buckled. The Town is in the process of securing funding to allow for the replacement well for Well #1. Well#1 had been taken out of service after the last cleaning for a short time but is currently back on line at a reduced capacity of 100 gpm.

2. Well#2 has been cleaned and redeveloped six (6) times since being installed in 1989. After each cleaning, the specific capacity returned to 90% of the original capacity or better between the years of 2002-2010. The two cleanings since 2010 have resulted in specific capacities in the 65-69% range, with the most recent occurring in March of 2015. This well should be TV inspected in order to determine the cause of this loss in capacity. It was noted that a new pump and motor were installed in 2015. Alternative well redevelopment methods should be considered to improve the specific capacity of the well.

3. Well#3 has been cleaned and redeveloped three (3) times since being installed in 2003. After each cleaning, the specific capacity returned to 90% of the original capacity or better. The last cleaning was completed in June of 2013. The most recent capacity test indicated a specific capacity of 82% of the original capacity. This well should be cleaned and redeveloped again in 2016 or 2017 based on historical trends. In addition, it appears that the pump is operating 42% below its performance curve and should be evaluated.

The frequency of well cleaning and redevelopment is typically based on the reduction in well capacity experienced over time and is generally related to the iron and manganese content of the well water. Generally the higher the iron and manganese content the more frequently the well will need to be cleaned and redeveloped. A typical cleaning interval for a well with iron and manganese is 2-5 year.

Conventional well cleaning is performed using a chlorine treatment followed by an acid treatment with surging and pumping and a final chlorine treatment for disinfection. Most other cleaning methods involve the use of proprietary systems such as injection of CO_2 into the well and aquifer or the used of specific chemicals in place of the acid treatment. These methods could give improved results over conventional cleaning under various conditions. They would require an evaluation of condition of each well and the desired results before their implementation.

Historical Water Deficits/Incidents

During the week of July 4th in 2010 a large demand was placed on the water distribution system, which was greater than the capacity of the treatment plant.

This additional demand caused the storage tanks to drop to levels greatly below normal operating levels, which resulted in a low water pressure in the distribution system. The low water pressure caused the pumps in the treatment plant to operate above the design flow for the WTP. This caused the pressure differential across the filters to increase to the level that shuts down the plant. This is a safety feature that is intended to prevent media failure. If the differential pressure across the filter media reaches 10 pounds per square inch (psi) or greater, it will result in damage to the media that requires the media to be replaced. After this incident, a back pressure sustaining valve was installed in the discharge piping of the plant to maintain normal operating pressure. This will prevent the pumps from operating above the design capacity of the WTP.

There have also been reported incidents of water main breaks that have resulted in the capacity of the treatment plant to be exceeded and caused the storage tanks levels to drop below normal operating values.

There are two events when high water demands required the Town to truck in water to keep the storage tanks filled to an acceptable level. The first event occurred in July of 2010 and resulted in the addition of 15 truckloads of water (90,000 gallons) added to the system at a cost of approximately $5,000. A second event occurred in July 2012 and resulted in the addition of 6

truckloads of water (36,000 gallons) added to the system at a cost of approximately $2,000. These types of events are expected to increase as the demand increases and capacity stays the same.

Projected Water Usage

Based on our analysis of water use for 2012, 2013, 2014 and information available for 2015, we have prepared an estimate of projected water use up through 2035. The proposed 35 home subdivision to be completed between 2016 and 2020 has been included in this projection along with an estimate of an additional 5 homes per year starting in 2020 through 2035. Water use is based on an average of 3 persons per home at 70 gallons per person per day. The projected water use is shown on Figure 2 below. 210 gallons per day

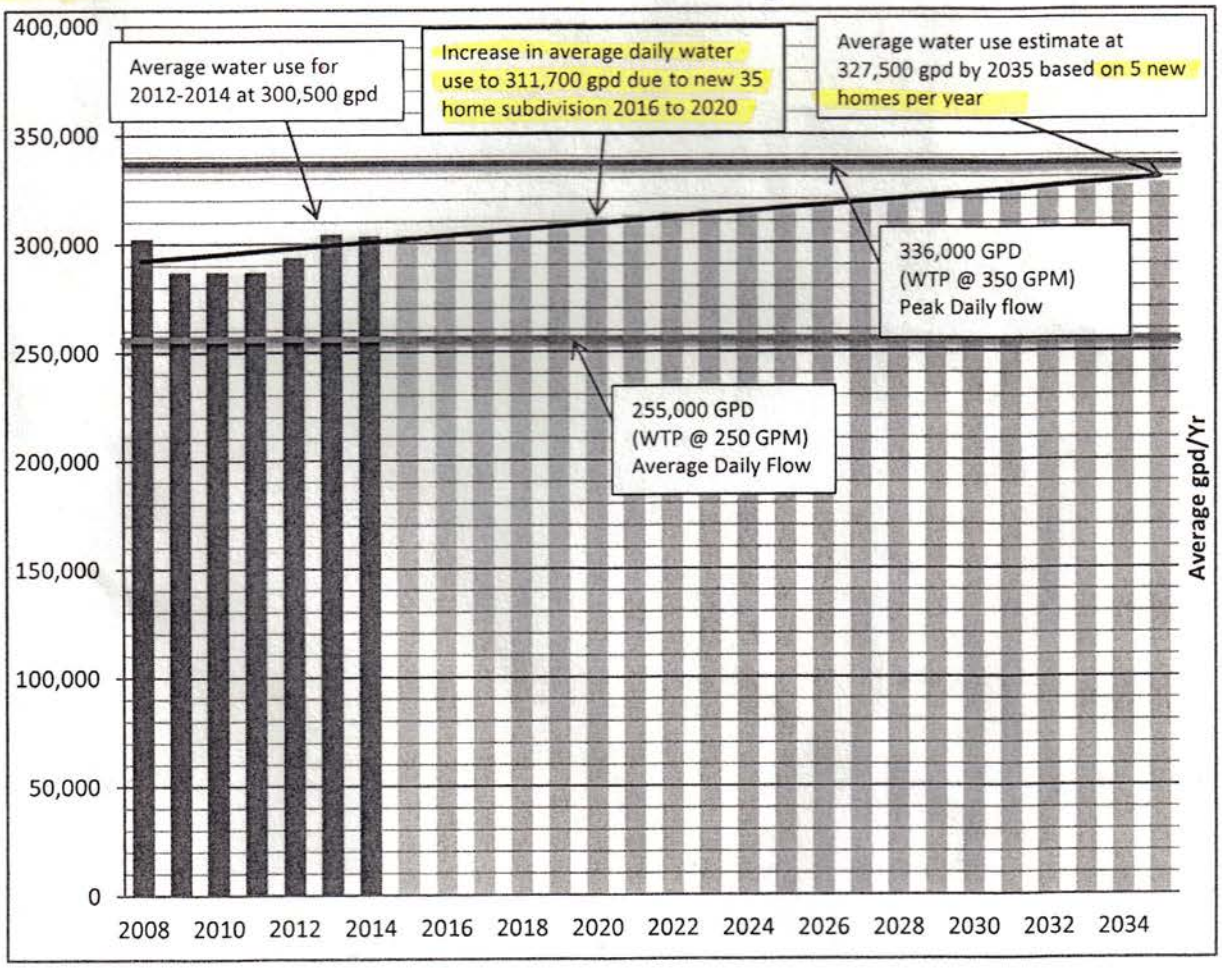

Figure 2- Projected Water Use for Raymond NH

The information on Figure 2 shows that in 2035, we estimate a yearly average daily water use of 327,500 gpd. If you apply the average peaking factor, we would expect that the average daily flow during a peak month would be estimated at 437,500 gpd. Peak daily flows would be even higher.

This information is important because the existing wells and treatment plant must be able to produce enough water to meet these demands in 2035 even when there are system related maintenance issues.

Conclusions

The existing well supply and treatment plant produce between 255,000 gpd and 336,000 gpd depending on the loading rate, run times and backwash requirements. This compares to the current and projected future flows as shown in Table 2 below.

Table 2 – Water Supply and Demand Summary

Demand Condition	Existing Well and Treatment Plant Capacity (1) (2)	Current Water Demands	Future Water Demand
Average Daily Flow (Winter)	255,000 gpd	300,500 gpd	327,500 gpd
Peak Daily Flow (Summer) (with wells 1,2&3)	336,000 gpd	401,400 gpd	437,500 gpd
Peak Daily Flow (with wells 1,2,3 & new well 4)	470,000 gpd	401,400 gpd	437,500 gpd

(1) Based on current plant operations running at 18 hr./day
(2) Based on new well #4 operating at 225 gpm for 10 hrs. per day. The capacity can be increased by 81,000 gpd by operating well #4 up to 16 hrs. per day which is 13,500 gpd for each additional hour of operation.

The information in Table 2 shows that the existing water supplied from the existing wells and treatment plant can just barely meet the current demands of the Town with a fairly significant shortfall under peak day conditions. In addition, this arrangement has no standby capability in the event of a major failure or if significant maintenance work must be completed.

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The information in Table 2 shows that the existing water supply cannot meet future water supply demands without some significant modifications and/or additional capacity.

Running the existing wells and treatment plant at a significantly higher water supply capacity may not be practical. Due to the increased levels of the iron and manganese in the raw water, the operator has been required to increase the frequency of the backwashes. When the plant initially came online, backwash frequency was determined by pressure differential. As the manganese levels increased, the frequency of backwashing changed from being determined by differential pressure, to being determined by the finished water manganese level increasing above the SMCL, which is referred to as break through. If the levels of iron and manganese continue to increase, the backwash frequency also must increase and the total plant production will most likely be reduced.

Reference: Municipal Water Supply Capacity Evaluation

The maximum operating rate of the WTP at 350 gpm as currently operated during peak flow periods should not be increased. It may be possible to slightly increase the run times between backwashes because the finished water manganese levels are well below the standard of 0.05 mg/L (the highest monthly average in 2014 was 0.014 mg/L). With this increase the operator will have to be sure to monitor the finished water manganese levels to ensure that level don't exceed 0.05 mg/L. One problem with increasing the flow from the WTP is it will increase the withdrawal from the wells, which will also cause the raw water iron and manganese to increase as it has historically.

Also, the information above does not address the issue of redundancy in the event that a major failure or if significant maintenance work must be completed.

In consideration of this information, we offer the following recommendations to strengthen the system:

1. Secure funding and complete the installation of Replacement Well 1.
2. Complete the permitting and proceed with construction and full operation of future well No. 4.
3. Install a second treatment unit at the existing Water Treatment Plant to allow maximum use of the existing wells and to address the redundancy issue.
4. Start the process of identifying and securing a 5th well site to position the Town to meet its long-term water supply needs.

Based on the deficiency that exists between peak day demands and the system capacity to meet this demand combined with the lack of redundancy, we recommend that a moratorium on new system connections be implemented until two or more of the recommendations listed above are completed.

An important point is that bringing new well #4 on-line will increase the overall system capacity to meet peak daily flows as shown on Table 2 and will reduce but not eliminate the demand on the WTP. Therefore, increasing WTP redundancy per recommendation #3 will still be required.

As always, we appreciate the opportunity to provide engineering services to the Town. We are available to meet to discuss our report and answer questions that you and others may have.

Respectfully,

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