VOLUME I
Chloramine Audit

Of

Cross Gates and Meadow Lake Public Water Supplies
St. Tammany Parish

Cross Gates PWS ID: LA 1103053
Meadow Lake PWSID: LA 1103146

For

Tammany Utilities

October 22, 2021

By

Owen & White INC.
CONSULTING ENGINEERS

8755 Goodwood Boulevard
Baton Rouge, LA 70806
225-926-5125

STATE OF LOUISIANA
PETER R. HOLLIS
License No. 24452
PROFESSIONAL
ENGINEER
IN
CIVIL ENGINEERING

10/22/2021

FORWARD

Proper analysis, proactive adjustments, and consistency are three key elements to getting the Cross Gates and Meadow Lake water systems in order. While this study found no reportable water quality violations (during the time frame of this work) this does not mean that improvements can be postponed. Several changes to the testing, chemical feed, and operations are paramount to avoid possible infractions in the future. These will be explained in detail.

The recommendations in this report are solely from Owen and White, Inc. based on experience with numerous water system throughout the southeastern United States. No person or persons influenced the recommendations in this report. This report represents our independent review and analysis of the Cross Gates and Meadow Lake potable water systems located in St Tammany Parish, Louisiana.

Information for this report was obtained from site visits and from data provided by Tammany Utilities. Interviews were conducted with the operators of the water system, St Tammany public officials, Tammany Utility officials, Mr. Bill Travis of Thornton Musso and Bellemin (TMB), Mr. David Binder, a private citizen who receives water from the Cross Gates water system, and with operators from other potable water systems. I especially want to thank Aaron Davis, the operator who assisted me during each visit. Aaron was extremely helpful and exhibited a sincere desire to do what is best for each person served by the water system. Aaron did not influence my report in any way but was a shining example of a hard-working employee wanting to do what is right for everyone.

INDEX

VOLUME 1

SCOPE OF WORK/EXECUTIVE SUMMARY

This investigation included a review of the operations, physical features, and limited water quality data of the Cross Gates Potable Water Supply (PWSID LA 1103053) and the Meadow Lake Potable Water Supply (PWSID LA 1103146).

The Cross Gates potable water system is supplied by two wells, the Steele Road well and the Willow Wood well. The Meadow Lake potable water system is supplied by only one well. Recent information shows that the Cross Gates water system has 2,114 customers with an average usage of 210 gallons per day per customer. The Meadow Lake water system has 464 customers with the average usage as computed for the overall system of 210 gallons per day. Cross Gates highest usage in a single day was recorded at 784,168 gallons which is equal to 371 gallons per customer per day. Meadow Lakes highest usage in a single day was recorded at 170,000 gallons which calculates to 366 gallons per customer per day. All of these usage values are well within the normal usage values for typical potable water systems in this geographical area.

This report is broken down into the key aspects of this investigation.

1. Site visits were made to inspect each facility to review the condition of the equipment and to ascertain if certain key issues were contributing to any poor water quality problems.

2. A water quality analysis was performed to determine if existing feed rates of sodium hypochlorite were close to the optimum feed rates for monochloramine formation since the systems are being operated to utilize raw water ammonia to form chloramines as the primary disinfectant.
3. Chemical feed pumps were analyzed to determine if the existing pumps could provide adequate chemical dosing for monochloramine formation and for dosing to achieve free chlorine throughout each water system in the event that a "burn out" is required.
4. Critical aspects of chemical storage were reviewed with recommendations developed to improve the storage and feeding of sodium hypochlorite.
5. Auxiliary generator sizing for each well site was investigated by a professional engineer with recommendations provided.
6. Operational procedures were reviewed and compared to the current industry standards for water treatment in this geographical area, and with state and federal guidelines.

Based on the factors evaluated in this report, a list of recommendations is included to improve operations significantly. The first and foremost recommendation is to submit an application to the Louisiana Department of Health to convert the system to free chlorine for 60 days. We feel that this conversion is paramount to restore consumer confidence in the water system and to set the system up for optimum chloramine operations. This is our recommendation. There are no water quality issues that make the conversion to free chlorine mandatory, but we feel that the conversion to free chlorine will help to resolve some of the issues that are dividing the residents, water system managers, and public officials.

Free chlorine is a highly acceptable method of providing disinfection of a potable water system and we strongly believe that a short term conversion to free chlorine (60 days) would be beneficial to everyone.

WATER QUALITY REVIEW

Limited water quality data was provided for the months of May, June and July 2021. For the Cross Gates system the data included the point of entry (POE) sampling at the Steele Road well, Willow Wood well and sampling data from the MRT site. For the Meadow Lake system the data included the point of entry (POE) sampling at the Meadow Lake well plus the sampling data from the MRT for the Meadow Lake system.

The data was compared to the values in the approved Tammy Utilities nitrification plan that include targets for specific parameters plus alarm levels and trigger levels that require specific action to be taken if trigger levels are reached.

First, we would recommend the reduction in the level of free ammonia that is stated in the nitrification plan. The nitrification plan requires a target level of free ammonia at the POE of between 0.03 and 0.1 mg/l. Any level in excess of 0.1 mg/l is listed as an alarm level and any concentration recorded in excess of 0.15 is considered a trigger. It is our opinion that the lower limit of 0.03 mg/l should be eliminated or at least reduced to 0.01 mg/l. Many exceedances were listed in the data due to the free ammonia concentration being reported as less than 0.03 mg/l. We do not believe that a minimum level of free ammonia is required and that it is best, in our opinion, to operate the system with as little free ammonia as possible. The discussion below will therefore not address issues where the free ammonia was recorded as less than 0.03 mg/l. Including those exceedances will overshadow the more important parameters in our opinion. In addition, the accuracy and repeatability of some tests at the extreme lower ranges can vary; hence, we recommend that lowering of the lower limit for free ammonia to 0.01 mg/l. We prefer not to have any free ammonia at the POE, but the accuracy and repeatability of some tests many indicate the presence of free ammonia regardless.

First, a review of data for the presence of coliform bacteria during the three months of data shows that there were no positive indicators of coliform for all samples collected and reported by LDH.

Second, a review of disinfection byproduct samples reveals that all samples collected from Cross Gates and Meadow Lake for TTHM and HAA5 are well below the limits for each composite compound. Levels of TTHM were reported from a low of 1.2 ug/l to a high of 2.8 ug/l. The MCL for TTHM is 80 ug/l. Levels of HAA5 were reported from a low of 1.2 ug/l to a high of 3.2 ug/l with a MCL of 60 ug/l. Clearly the concentrations of these disinfection byproducts in the water systems are well below limits set by EPA.

TMB has performed a number of both field and laboratory bench tests. Numerous studies and correspondence with LDH have included recommended total chlorine residual target levels of 2.7 mg/l for Steele Road, 3.0 mg/l for Willow Wood, and 2.7 mg/l for Meadow Lake. A review of the total chlorine residual levels at the POE for each well site for the months of May, June and July 2021 revealed the following adherence to the target levels of total chlorine residual.

Steele Road well – 25 of 114 samples met the recommended total chlorine residual level of 2.7 mg/l, an adherence rate of only 22%.

Willow Wood well – 1 of 113 samples met the recommended total chlorine residual target level of 3.0 mg/l, an adherence rate of less than 1%.

Meadow Lake well – None of the total chlorine residual samples met the recommended target level of 2.7 mg/l.

For the Steele Road well the following overall observations were made concerning water quality

- Free chlorine residuals were below the target level of 0.1 mg/l for 35% of the samples collected and above the maximum target level of 0.3 mg/l 19% of the time.
- Total chlorine met the minimum target requirement of 1.75 mg/l as listed in the Nitrification Plan in 89% of the samples collected.
- Samples failed to meet 1.75 mg/l in 7% of the samples recorded and failed to meet the trigger level of 1.2 mg/l 4% of the time.
- On June 6th, 2021 a level of 0.00 mg/l total chlorine was recorded at this site. Monochloramine levels were also reported as 0.00 mg/l at this same site.

For the Willow Wood well the following observations were made -

- Free chlorine residuals were below the target level of 0.1 mg/l for 42% of the samples collected and above the maximum target level of 0.3 mg/l 11% of the time.
- Total chlorine met the minimum target requirement of 1.75 mg/l in 91% of the samples collected.
- Samples failed to meet 1.75 mg/l in 9% of the samples recorded and failed to meet the trigger level of 1.2 mg/l 2% of the time.

For the Cross Gate MRT site, the following observations were made:

- Target levels of Free Chlorine fell below the minimum target level 19% of the time. Free chlorine levels exceeded the maximum alarm target level 15% of the time and the trigger level 3% of the time.
- Total chlorine residuals were met 99% of the time. On one occasion, June 6, 2020 the chlorine residual failed to meet the target level and was recorded as 0.0 mg/l. Monochloramines also were recorded as 0.0 mg/l on this same date.
- Nitrites exceeded the alarm level 11% of the time at the MRT site and the trigger level on one sample.

The Meadow Lake well POE and MRT were more consistent and provided better results overall. However, as stated earlier, no total chlorine residual samples met the target level of 2.7 mg/l.

- Free chlorine fell below the minimum target level of 0.1 mg/l 32% of the time and exceeded 0.3 mg/l 7% of the time.
- Total chlorine met the minimum requirement of the nitrification plan 88% of the time, but fell to the alarm level 12% of the time.

The MRT at Meadow Lake revealed compliance with total chlorine of greater than 1.0 mg/l 99% of the time. Free chlorine failed to meet the level of 0.04 18% of the time and exceeded the level of 0.15 mg/l once. Nitrites were higher in this MRT site than in any other site with levels greater than 0.05 mg/l 30% of the time and trigger levels greater than 0.1 mg/l 30% of the time. This assumes a raw water nitrite level of 0.01 mg/l or less.

Overall the data from this system shows that while concentration of chemical levels fluctuate, we do not believe that there was any significant water quality issue other than on June 6th, 2020. On this date both the Steele Road well site POE and the MRT for Cross Gates reported chlorine residuals for total chlorine and monochloramines as 0.00 mg/l. This information is very concerning and in our opinion a Boil Water Advisory (BWA) should have been issued for the entire Cross Gates system if this data is correct. While the Willow Wood well did not record a low chlorine residual, water from the Steele Road well could have traveled to the distribution system close to the Willow Wood well site if the Willow Wood well was out of service or if the Steele Road well was acting as the primary well for that day. We can find no explanations offered for this issue. A review of the data for the POE at the Steele Road Well and the Honey Island MRT sites on the St. Tammany Website does not reflect any low chlorine residuals on June 6, 2021. This should be investigated and corrections made as necessary.

The variances in the testing parameters are in our opinion linked to poor bulk storage of sodium hypochlorite, the failure to make chemical feed adjustments routinely, and the failure to be able to test the water immediately after chemical injection and before the hydropneumatics tanks. We cannot state that the water quality was so poor as to cause any health issues. Overall chlorine levels were good, just not optimum, during most of this time frame. We certainly hope that the recommendations in this report will be useful in producing a more consistent and better water quality for all concerned.

SITE VISITS

During the initial site visits a number of concerning issues were noted with the water systems. A review of correspondence with the Louisiana Department of Health (LDH) reveals that some of these issues have been brought to the attention of the water system before. It is encouraging that during this study some of the issues were being addressed. One example is the implementation of a Supervisory Control and Data Acquisition (SCADA) System. However, while the implementation of this system is a great step forward, additional modifications to this system are needed to allow the operators to "Control" each station remotely. The current system is monitoring only and has no remote control features. Any modifications to the recently installed SCADA system must continue to have full local control capabilities such that if communication to the central monitoring and operations center is lost, the well sites will continue to operate normally until communication is restored. Many potable water centralized SCADA systems have successfully used encryption and other technics to protect against intrusion into the control network such that remote control of facilities is absolutely possible. But, if the Parish does not want to implement a system of remote control from a central location, then other alternatives are available. For example, PLC's can be installed at each well site that can be programmed such that one well is designated as the primary well for that date. The other wells would be designated as the secondary well to start and then the last well to start. The primary site would be programmed to start first and operate as the primary site for that day. The other sites would monitor system pressures and would only be called to run should system pressures drop to specific set points, or should the primary well be removed from service. This could occur should the primary well site fail to run for any reason, should demands in the system increase such that a second well is required, such as a fire event, or should the primary well be removed from service by the automated controls for reasons such as a low level in the sodium hypochlorite day tank. After 24 hours of operation each PLC would automatically change the order of operation such that the second well site becomes the primary site. Other well sites would then become the second and last wells to run. Likewise, if all three wells are connected hydraulically, then on the third day the last well would become the primary site. If spacing the well sequencing run times to 24 hours is too long, then the PLC's can be reprogrammed to run for any selected time frame as the primary site, such as 12 hours instead of 24. The implementation of programable PLC's is just one example. There are ways to ensure that wells are run routinely without worry of stagnant water in the hydro tanks because one well is overpowering the others. We strongly recommend some method of control to ensure tank turnover at each well site.

The following concerns were noted at each site during the site visits:

1) Well flowmeters are not working. The flow measurement from each well is critical to be able to dose chemicals properly. Flow meters were being replaced as this study progressed.

2) Chemical feed is not flow paced. The output of the Steele Road well varied more than 15% from starting until the time that it turned off. When the well turns on the system pressure is low. The well output is higher at this lower discharge pressure. Just prior to the well turning off the output decreases significantly due to the higher system pressure. Higher discharge pressures on a pump will force the pump to run "back on its curve", thereby decreasing the pump output. While this variation in flow can be handled within the well's normal operating range, the dosage of chemicals will not be uniform when constant speed chemical feed pumps are utilized. The utilization of an output signal from the flow meter to a flow proportioning chemical feed pump will resolve this issue.

3) Chlorine residuals were not being collected immediately after the chemical feed. Chlorine samples are required at the POE (Point of entry) into the system for recordation and reporting. But, with a large hydropneumatic tank, and if the well is not cycling, the chlorine residual collected after the tank could represent water that was treated

many hours or days before. To properly adjust chemical feed, samples must be collected downstream from the chemical injection point but prior to the hydropneumatic tank. The sampling point should be downstream from the check valves since these valves will enhance the mixing of the chlorine with the raw water. Due to the short piping distances from the wells to the hydropneumatic tanks, injection points for the sodium hypochlorite and sample ports for analysis may have to be moved until consistent results are obtained. Injectors that incorporate a diffuser may also be necessary to achieve good uniform dispersion of the sodium hypochlorite throughout the flow stream. To reiterate, sampling of the water for control and adjustment must be made prior to the storage tanks. The need for sampling points immediately before the hydropneumatic tanks was recognized by Tammany Utilities and previously considered critical. This need was expressed in a letter dated December 17, 2017 written from Tammy Utilities to LDH by Jay Watson, PE, Lead Development Engineer, St Tammany Parish.

4) Piping into the hydropneumatic tanks appeared to be set up to achieve a good flow path through each tank. The Steele Road tank is properly set up such that water enters one end of the tank and exits at the opposite

end. Piping into the Willow Wood and Meadow Lake hydropneumatic tanks also appears to be set up correctly. Theoretically, one of the two pipes that enters the same end of the tank will run to the opposite end of the tank and discharge there. The water must then travel the length of the tank before it exits providing as much contact time with the chlorine as possible before the water enters the distribution system. Discussions with the operations and maintenance staff reveal that no pipe extends to the opposite end of the tanks at both Willow Wood and Meadow Lake. This must be confirmed. Both pipes placed adjacent to each other create a number of problems. First, water short circuits the tank which reduces the contact time with the disinfectant to provide little to no contact time at all. Second, water levels do not fluctuate that much in hydropneumatic tanks. Hence, water that is stored in the far reaches of the tank could become stagnant and could lose chlorine residual. A disruption of the water held in the tank could occur when the well is off, pulling some of the less than desirable water quality toward the outlet before the wells starts again.

In the near future each hydro tank should be taken out of service and inspected. Inspections of tanks are required every 5 years so this inspection can be utilized to fulfill that requirement. If it is found that one of the pipes does not extend to the far reaches of the hydropneumatic tank, then modifications to the piping should be made. Since the Willow Wood well is hydraulically connected to the Steele Road well, then taking the Willow Wood hydropneumatic tank out of service should not pose a problem as long as the Steele Road well is in normal operation. Recent pressure recorders placed around the system show very little differential pressures across the system indicating that either well should be capable of supplying the system from their site.

The Meadow Lake hydropneumatic tank is piped identical to the other wells and may also suffer from short circuiting and stagnant water. Unfortunately, the Meadow Lake well and hydropneumatic tank are the single source of water for those customers. In order to inspect the Meadow Lake hydropneumatic tank, several options must be explored. First, investigate the closest connection to either the Cross Gates system or to the City of Slidell system to supply water. The distinct advantage to this is that this connection could remain as an emergency backup, something that is desperately needed and is strongly recommended. Second, a temporary hydropneumatic tank can be rented and piped to the well to provide service until the existing tank is returned to service. Third, pressure relief valves can be installed on hydrants. The well would be placed on manual and forced to run continuously until the tank is returned to service. This is the least desirable option because any disruption in the well operation, even momentarily, will cause the water system to lose pressure and result in the issuance of a Boil Water Advisory (BWA).

5) Lack of communication between the Steele Road and Willow Wood well sites results in one well site becoming the primary site with the second site off for extended periods of time. This is a significant problem.

The Steele Road and Willow Wood sites are hydraulically connected, but their controls are independent. Attempts had been made to set the controls such that the wells would operate in tandem. However, with good hydraulic connectivity, any attempt at getting the pressure switches to allow the wells to run in tandem has been and will be extremely difficult. Only during high peak usage events would this be possible. During the first site visit the Willow Wood well was cycling normally. Observations at the Steel Road well revealed that just before the pressure could drop low enough to call for the well to run, the Willow Wood well would turn on and start driving the pressures higher. After several cycles waiting for the Steele Road well to start, operations staff turned off the Willow Wood well. Pressure in the hydropneumatic tank at Steele Road finally fell to the point that the well started and ran normally. After observing the operation, the Willow Wood well was returned to service and began to carry the system again. This set up can result in one well acting as the primary well with the second well idle for extended time frames.

Fine tuning the pressure switch settings to get both wells to run in tandem will be extremely difficult. In the current operation, the primary well is essentially filling both hydropneumatic tanks. The run time for the primary well is already extremely short. Attempting to get both wells to run in tandem will reduce the run times and increase the cycles per hour for each well site, which is not recommended.

We strongly recommend modifications to the SCADA system such that either the Willow Wood or the Steele Road well sites can be selected as the primary well site for 24 hours. After 24 hours of operation, the control will switch, and the second well site will become the primary site. Water age at each site will be reduced to no more than 24 hours. The controls should also call for the backup well should the primary well fail to run for any reason, or should pressures drop such that the second well is required. We strongly recommend these SCADA modifications be implemented immediately.

6) Observations showed that the hydropneumatic tank differential pressure between starting and stopping a well is 10 psi. This is a tight pressure difference that can lead to well short cycling. We recommend a 15 psi differential pressure to help reduce short cycling of the well and pump motor. Short cycling can cause damage to an electric motor. In addition, each time the well starts the aquifer is stressed to provide the water demanded. Wells typically operate and produce better water quality the longer they run. This recommendation will also be discussed later with the benefit of adding an elevated tank to the system.

CHEMICAL FEED

The raw water that supplies the Cross Gates and Meadow Lake systems includes naturally occurring ammonia. This raw water ammonia can be oxidized such that it no longer reacts with chlorine, or otherwise it can be utilized as part of the disinfectant. When the ammonia is fully oxidized and there is no ammonia left to react or combine with the chlorine, the system operates as a free chlorine system. The presence of chlorine in the finished water can readily be detected by the familiar "swimming pool" chlorine odor. Free chlorine has strong disinfecting ability but can dissipate rapidly depending on local conditions such as temperature and water age. Some systems elect to utilize the natural ammonia with the chlorine to form chloramines. This combined chemical will also disinfect the raw water. Two advantages of chloramines are that the smell of chlorine is usually non-detectable, and the combined chlorine-ammonia compound will stay in a water system much longer than free chlorine providing long term disinfection capabilities. One of the disadvantages to chloramines is that ammonia remains in the water. Any imbalance in the chlorine to ammonia ratio can lead to free ammonia in the water system. Bacteria in the water system can then utilize this free ammonia to thrive. An out of control growth of bacteria can exert extreme pressure on the remaining chlorine causing residuals to plummet. Hence, if chloramines are utilized, the proper ratio of chlorine to ammonia must be utilized at all times to maintain a consistent water quality throughout the system. To aid in this effort, flushing stations placed strategically around the system can and should be used to reduce water age. Testing for nitrites, nitrates, HPC, and ATP can also be utilized to ensure that the chlorine to ammonia ratio is being maintained and that the growth of bacteria is limited. Should test results show non-compliance with established target levels, then steps can be taken to return the water system to acceptable levels. Tammany Utilities has a Nitrification plan that addresses these issues in detail and sets specific concentrations where specific action must be taken (Triggers). The Nitrification Plan is acceptable and has been approved by the Louisiana Department of Health and Hospitals. We discovered that the transfer of the target levels to the daily field sheets was not done correctly in that the daily sheets do not match the Nitrification Plan. These sheets should be reviewed and corrected to match the Nitrification Plan. While some of the differences are minor, the Plan and the field sheets should match.

If the Cross Gates or Meadow Lake chloramine system exceeds specific target limits the current nitrification plan calls for a burn out of the system using free chlorine. The target, alarm and trigger parameters are listed in the nitrification plan and state that "if trigger points are hit on two or more parameters at four or more locations in the same sampling event system wide remediation should be implemented. This would consist of a conversion to free chlorine at all points of entry." The conversion to free chlorine is commonly referred to as a burn out. The nitrification plan continues with stipulations that the distribution system should be unidirectionally flushed until free chlorine is reached at all points and that a residual of at least 0.75 ppm (free chlorine) should be a goal. While the duration of the "burn out" is not specified in the current Tammany Utilities nitrification plan, recent events with Louisiana chloramine water systems dealing with Naigleria fowleri were required to achieve 1 ppm free chlorine for 60 days at all points in the distribution system. While nitrification issues are not nearly as severe as a water system dealing with Naigleria fowleri, this duration and concentration of free chlorine are good goals to begin with. LDH should be consulted given their experience with other water systems dealing with nitrification events, but we agree with the duration of 60 days and the free chlorine residual goal of 1.0 ppm throughout the entire distribution system.

Because free chlorine dissipates faster than chloramines, flushing at key points may be required to lower the age of the water (the time the water is retained in the system after disinfection). In addition, the level of chlorine will have to be raised at the point of entry possibly up to the maximum allowable concentration limit of 4.0 mg/l.

Both free chlorine and chloramines are approved as disinfectants in potable water systems in Louisiana. We know of no detrimental consequence nor detrimental health effects for using either disinfectant as long as each disinfectant is applied correctly and as long as the water system is maintained properly within specific parameters as called for in the approved Tammany Utilities nitrification plan. However, customers, hospitals, dialysis units, aquaculture business, and other compromised individuals must be notified in advance of any changes in the method of disinfection both when going to a "Burn Out" with free chlorine and especially when returning to chloramines. A change in water chemistry can affect the end users especially individuals on dialysis and medical facilities and those customers with aquariums or aquaculture businesses. Free chlorine can dissipate using open containers and long holding times. Chloramines may not be removed by carbon filters and will not dissipate quickly by boiling nor holding water in open standing containers. Hence, it is important to notify customers of the change in disinfectant so that appropriate precautions can be taken in advance. Normally, a 14 day notification time frame is used to allow customers to prepare for the change.

Many systems operate successfully as Cross Gates and Meadow Lake do with chloramines as the primary disinfectant. The key to successful operations is **consistency** and taking action when needed.

The deep well water that provides the raw water to Cross Gates and Meadow Lakes contains ammonia. Rarely, if ever, have we witnessed any significant changes in the quality of water in deep wells. Normally the constituents found in the water stay the same for years, including ammonia. Consequently, if there is anything that will change the chlorine to ammonia ratio, it is not feeding chlorine in a consistent manner.

Unfortunately, that is exactly what was found as this investigation unfolded. First, no adjustments were being made to chemical feed rates for extended periods of time even though finished chlorine residuals varied considerably. Chemical feed pumps were being checked to ensure they were feeding sodium hypochlorite, but no adjustments to the feed rate were being made even though the POE chlorine residual fluctuated greatly. The daily data sheets for the month of May, 2021 are included in the Appendix. The Steele Road well photograph shown on picture 17 of the Steele Road section shows that the total chlorine residual varied from a low of 1.31 ppm to a high of 3.01 ppm. Two data points show total chlorine residuals of 0.30 and 0.34 ppm but these numbers may have been transposed incorrectly on the form with the values for free chlorine. However, a high value of 5.75 ppm is listed which we understand is correct and was the result of an overfeed from the chemical feed pump. Even if these outliers are discarded, the change from a low of 1.31 ppm to a high of 3.01 ppm shows that the total chlorine residual was not consistent. Unfortunately, even after these readings were recorded, no change to the chemical feed rate was made.

The monthly data sheet for the Willow Wood well can be found in the Appendix under the Willow Wood well section on picture 18. A low of 1.50 ppm can be seen with a high reading of 2.61 ppm, a difference of 1.11 ppm. Again, no change in the chemical feed rate was made for the entire month.

The monthly data sheet for the Meadow Lake well can be found in the Appendix on picture 18 of the Meadow Lake well section. The data appears to be slightly more consistent but with a low reading of 1.76 ppm and a high of 2.42 ppm only several days later. The more consistent results are more than likely due to the single well and single hydropneumatic tank for the Meadow Lake system such that the well and tank have no backup and are used daily.

One explanation could be that residuals taken after the hydropneumatic tanks would reflect the time that the water was retained in the tank. Tanks that sat stagnant due to the well acting as the secondary well could have lower residuals due to higher water age and non-use. Piping configurations in the tanks that promoted short circuiting and stagnant water could also affect the chlorine residuals depending on when the samples were collected. Samples collected after the tanks rather than immediately after chemical injection could also show fluctuating results unless the tanks are in fact short circuiting which would then result in very similar inlet and outlet values.

But, all of these possibilities pale in comparison, in our opinion, to the poor management of the bulk sodium hypochlorite at all three well sites. The current bulk storage of sodium hypochlorite uses a single tank at each site that is topped off each week. While this may be common practice at other systems, we do not agree with this procedure. We strongly recommend two bulk storage tanks at each site so that the contents of one tank are fully consumed and the tank rinsed out before it is refilled. This is our recommendation.

It is well known that sodium hypochlorite will degrade rapidly with increasing temperature and excessive age. Therefore, testing of the bulk storage tanks was conducted to investigate field concentrations. The results of this testing revealed that the concentration of sodium hypochlorite was 9% at Steele Road, 10.5% at Willow Wood, and almost 13% at Meadow Lake. Delivery concentrations were reported to be 12.5%. Clearly degradation of the sodium hypochlorite was occurring, but little explanation could be found for the 13%. There is no doubt that better QA/QC should be conducted on the bulk deliveries and the storage of the sodium hypochlorite.

New wood frame buildings were built for the sodium hypochlorite bulk tank storage and feed systems. Small window type air conditioning units were installed in each building although one was found to be out of service. The building walls were constructed of plywood with no insulation. Vents located near the roof of each building might have allowed hot air to exit but also greatly reduce the effectiveness and efficiency of the window air conditioning units. The temperature inside one building was recorded at 104ºF, well above any recommended storage temperature for sodium hypochlorite.

New controls had been installed along with diaphragm chemical feed pumps. A day tank is installed at each site and is manually filled by the operators from the bulk tanks each day. Bulk tanks are "topped off" weekly as the chemical supplier makes his rounds. Only one bulk tank is available at each site so fresh sodium hypochlorite is added to the old sodium hypochlorite from previous loads. The combined new and old sodium hypochlorite is not mixed. Consequently, there could be significant stratification of the chemical with varying strengths as it is transferred to the day tank.

The operators vigilantly check chemical feed rates using the equipment they have been provided. Unfortunately, the graduated cylinders utilized for calibrating the pumps are too small and the calibration is a guess, in our opinion, at best. Much larger calibration chambers should be provided to achieve a good result so that a good measurement of the drawdown in the cylinder over time can be recorded.

The existing chemical feed pumps are diaphragm pumps that can work well in many applications. We would recommend larger chemical feed pumps as outlined in the following sections to provide better accuracy and reliability of chemical feed rates. The diaphragm chemical feed pumps are impacted by the discharge pressure they are pumping against. The higher the discharge pressure, the less they will pump. Checking the feed rate using properly sized calibration chambers is critical to ensure that the pumps are continuing to pump the feed rate required and they are not losing capacity as they become worn. Some of the pumps have digital readouts that indicate the feed rate electronically. The feed rate displayed can be very misleading in that the feed rate is based on the speed of the pump and does not reflect any decrease due to a higher discharge pressure where the sodium hypochlorite is being injected. The pump curves for the pumps show the impact on the pumps at higher discharge pressures. Adjustments to the pumps should be made based on the total and free chlorine readings just prior to the hydropneumatic tanks and on the feed rate from the calibration chambers. The electronic feed rate shown on the display is good to record, but the reading displayed may not truly reflect the actual pumping capacity of the pump. Please see the additional explanation below concerning the chemical feed pump capacities.

Duplication of chemical feed pumps is paramount, especially at the Meadow Lake well site with only one source for that system.

The Steele Road site was found to have <u>a single chemical feed pump</u> with a maximum capacity of 5.34 gallons per hour. (337 mls/min). This capacity is with a discharge pressure up to 145 psi.

The Willow Wood site was found to have two chemical feed pumps with each one having a maximum capacity of 2.65 gallons per hour (167 mls/min) according to the electronic readout on the pump. A review of the manufacturers literature confirms the maximum pump output of 167 ml/min, but at an average discharge pressure of 43 psi. At a discharge pressure of 58 psi the maximum output decreased to 114 ml/min. At a discharge pressure of 116 psi the maximum output decreased to only 63 ml/min, only 38% of the pumps maximum output rating. Since the Cross Gates and Meadow Lake systems operate between 60 and 70 psi, the maximum output that can be expected from these pumps is only 114 ml/min, not the electronic reading of 167 ml/min. The discharge just prior to the well turning off at 70 psi will be less than the 114 ml/min and if the decrease in capacity is linear would be approximately 103 ml/min. The average pump capacity between a discharge pressure of 58 psi to 70 psi would therefore be 109 ml/min for the existing Magdos LK pumps.

The Meadow Lake well site was found to have two chemical feed pumps with each one having a maximum capacity of 2.65 gallons per hour (167 mls/min). Since these chemical feed pumps are identical to the chemical feed pumps at Willow Wood, then the same reduction in capacity with increased discharge pressure will hold true. Hence, the output of the existing Meadow Lake chemical feed pump is also calculated to be 109 ml/min.

The Steele Road chemical feed pump was found to be problematic in that one of the adjustment knobs would not stay in position. The daily record from May of

2021 reveals that at one time the chlorine feed pump ramped up to its maximum level due to a loose control knob causing the chlorine residual to reach a level of 5.75 mg/l, well above the MCL of 4.0 mg/l (May 12, 2021). A temporary fix by the operators securing the knob with a "zip tie" was implemented.

Calibration chambers of only 100 ml capacity have been installed at each site. A typical feed rate of (4 of 10/4 of 10) calculates to a feed rate that is 16% of the maximum pump capacity at the Steele Road site. This calculates to a feed rate of 54 mls/minute. Attempting to time a drawdown to accurately check the feed pump at this rate with a 100 ml chamber is very difficult.

This problem was even more exaggerated at the Willow Wood and Meadow Lake sites where higher pump speeds were recorded.

Clearly, larger calibration tubes are needed to check the actual feed rates accurately.

CHLORINE DEMAND AND DOSAGE RATES

Testing by TMB, the current water quality consultant to the parish, was conducted to provide the optimum dosage of chlorine to obtain the best level of monochloramines. For the Steele Road site, a dosage of 3.0 mg/l was recommended to produce an optimum monochloramine of 2.91 mg/l. Using the bulk chlorine concentration of 9%, and a feed rate of 54 mls/minute, and a well flow rate of 1,050 gpm the actual dosage observed during the site visit calculates to 1.22 mg/l, approximately 41% of the optimum dosage of 3.00 mg/l as determined from the TMB study. At a dosage of 1.22 mg/l, the data from TMB shows that the water could still have free ammonia concentrations of around 0.3 mg/l, a level that is much higher than the allowed level listed in the approved nitrification plan. Clearly, in our opinion, the water was being under dosed for this raw water thereby leaving an excess of ammonia in the final product.

The optimum dosage for the Willow Wood site was established by TMB to be 3.5 mg/l. For a well flow rate of 850 gpm and a sodium hypochlorite concentration of 10.5% and a feed rate of 109 mls/minute, the actual dosage of chlorine calculates to be 3.56 mg/l. This is much better than the Steele Road operation.

The calculations performed above will be affected by the actual bulk chlorine concentration and the actual water well pumpage rates.

The optimum dosage curves developed by TMB, are in the following table:

Steele Road

Well Flow Rate		1,050 gpm
Optimum Dosage	=	3.0 mg/l
Target Chemical Concentrations Prior to the Steele Road Hydrotank		
		Target Levels
Free Chlorine	=	0.3 mg/l
Total Chlorine	=	3.2 mg/l
Monochloramine	=	2.91 mg/l
Free Ammonia	=	0.00 mg/l
Total Ammonia	=	0.54 mg/l

Test results will vary somewhat, depending on the test methods.

With fresh sodium hypochlorite of 12%, the feed rate at the Steele Road well site to achieve a dosage of 3.0 mg/l with a well flow rate of 1,050 gpm should be 99.37 mls/min.

Should the utility consider 6% sodium hypochlorite, this feed rate would double to 198.73 mls/min.

Willow Wood

The optimum dosage curves were also developed by TMB for the Willow Wood well.

Well Flow Rate		850 gpm
Optimum Dosage	=	3.5 mg/l
Resulting Chemical Concentrations Prior to the Willow Wood Hydrotank		
		Target Levels
Free Chlorine	=	0.2 mg/l
Total Chlorine	=	2.63 mg/l
Monochloramine	=	2.53 mg/l
Free Ammonia	=	0.00 mg/l
Total Ammonia	=	0.45 mg/l

With fresh sodium hypochlorite of 12%, the feed rate at the Willow Wood well site to achieve a dosage of 3.5 mg/l with a well flow rate of 850 gpm should be 93.85 mls/min.

Should the utility consider 6% sodium hypochlorite, this feed rate would double to 187.70 mls/min.

The target concentration listed above are based on the Bench Study performed by TMB. Field testing should be conducted to verify actual results. The data above also assumes 12% sodium hypochlorite. The poor management of the bulk chemical storage, with the resulting degradation of the chemical concentration, can affect the feed rates shown significantly. In addition, field verification of optimum feed rates for the sodium hypochlorite must be conducted to verify the laboratory demands reported by TMB. While some water systems may operate with single bulk storage tanks, it is our recommendation based on numerous studies that two bulk storage tanks be utilized, that the sodium hypochlorite be kept cool, and that a bulk storage concentration of 6% be used.

BURN OUT (Free chlorine disinfectant)

The need for a "burn out" of the water system was discussed in the previous sections including the section titled Chemical Feed. We will not repeat the need for a burn out in this section, but rather what it may take to achieve a burn out when necessary by applying enough disinfectant to achieve a free chlorine residual throughout the entire distribution system. The conversion to a free chlorine system will require significantly more disinfectant daily. Before the system is converted to free chlorine, sufficient bulk quantities should be confirmed as well as supply chain quantities to ensure that the conversion to free chlorine can continue for as long as needed.

To achieve a finished water with little to no free or combined ammonia, the study by TMB determined that a dosage of approximately 7 mg/l of chlorine will be required at the Willow Wood well leaving a finished water free chlorine residual of 1.65 mg/l with a total chlorine residual of 1.9 mg/l. Increasing dosages of chlorine should result in higher levels of free and total chlorine if needed to maintain greater than 0.5 mg/l of total chlorine throughout the system, or up to 1.0 mg/l if desired. This must be determined in the field with active and frequent testing at the POE and MRT sites. All calculations below reflect the feed rate to achieve up to a 7.0 mg/l dosing rate based on the TMB study.

The feed rate for 12% sodium hypochlorite to achieve a free chlorine residual of 1.65 mg/l with a well flow rate of 850 gpm at the Willow Wood well would be 187.7 mls/min.

The feed rate of 6% sodium hypochlorite to achieve a free chlorine residual of 1.65 mg/l with a well flow rate of 850 gpm would be 375.4 mls/min at Willow Wood.

The feed rate for 12% sodium hypochlorite to achieve a free chlorine residual of 2.21 mg/l at the Steele Road well site with a well flow rate of 1,050 gpm would be 225.24 mls/min.

The feed rate using 6% sodium hypochlorite would be approximately 451 mls/min at Steele Road.

The existing Steele Road chemical feed pump has a maximum capacity of 337 mls/minute. To achieve a dosage of 3.0 mg/l for monochloramines with a fresh sodium hypochlorite solution with 12% concentration, the pump would be set to run at 29% speed. At 6% concentration the pump would be set to run at 59% speed. To achieve a free chlorine residual with 12% fresh sodium hypochlorite, the pump would have to be set to run at 67% speed. Unfortunately, the existing pump cannot produce 451 mls/min to achieve burn out with 6% bulk sodium hypochlorite.

The existing Willow Wood pumps are limited to 109 mls/minute. To achieve optimum monochloramine the pumps should be set for 86% speed with fresh 12%

bulk sodium hypochlorite. These pumps cannot pump enough sodium hypochlorite into the system if 6% sodium hypochlorite is utilized nor if a burn out of the system is desired even with 12% bulk sodium hypochlorite.

Existing Chemical Feed Pumps

SITE	EXISTING PUMPING CAPACITY	12% NaOCl Feed Rate for Monochloramines	12% NaOCl Feed Rate for Free Chlorine
Steele Road • 3.0 mg/l dosage for monochloramine • 7.0 mg/l dosage for free chlorine	337 mls/min	99 mls/min (29%)	225 mls/min (67%)
Willow Wood • 3.5 mg/l dosage for monochloramine • 7.0 mg/l dosage for free chlorine	109 mls/min**	94 mls/min (86%)	188 mls/min (OCOP)
Meadow Lake* • 3.5 mg/l dosage for monochloramine • 7.0 mg/l dosage for free chlorine	109 mls/min**	62 mls/min (57%)	124 mls/min (OCOP)

* No detailed testing was conducted to establish a chlorine dosage. 3.5 mg/l assumed. Well flow rate of 560 gpm from daily data sheets.

** Existing pump capacity from manufacturers literature and reflects a reduced output at discharge pressures of 58 to 70 psi.

OCOP – Over Capacity of Pump

Existing Chemical Feed Pumps

Site	10% NaOCl Feed Rate for Monochloramines	10% NaOCl Feed Rate for Free Chlorine	6% NaOCl Feed Rate for Monochloramines	6% NaOCl Feed Rate for Free Chlorine
Steele Road	119 mls/min (35%)	270 mls/min (80%)	198 mls/min (59%)	451 mls/min (OCOP)
Willow Wood	113 mls/min (OCOP)	226mls/min (OCOP)	188 mls/min (OCOP)	375 mls/min (OCOP)
Meadow Lake	74 mls/min (68%)	148 mls/min (OCOP)	124 mls/min (OCOP)	248 mls/min (OCOP)

(OCOP)– Over Capacity of Pump

Proposed Chemical Feed Pumps

SITE	PROPOSED PUMPING CAPACITY	12% NaOCl Feed Rate for Monochloramines	12% NaOCl Feed Rate for Free Chlorine
Steele Road	337 mls/min - max	99 mls/min (29%)	225 mls/min (67%)
Willow Wood (1)	337 mls/min	94 mls/min (28%)	188 mls/min (56%)
Meadow Lake (1), (2)	337 mls/min	62 mls/min (18%)	124 mls/min (37%)

(1) Identical chemical feed pumps to the existing Steele Road pumps recommended for Willow Wood and Meadow Lake with a firm pumping capacity of 337 ml/min with a discharge pressure of 55 to 70 psi. Verify with manufacturer before purchase.

(2) No detailed testing was conducted to establish a chlorine dosage. 3.5 mg/l assumed. Well flow rate of 560 gpm from daily data sheets.

Proposed Chemical Feed Pumps
10% and 6% Sodium Hypochlorite

Site	10% NaOCl Feed Rate for Monochloramines	10% NaOCl Feed Rate for Free Chlorine	6% NaOCl Feed Rate for Monochloramines	6% NaOCl Feed Rate for Free Chlorine
Steele Road	119 mls/min (35%)	270 mls/min (80%)	198 mls/min (59%)	451 mls/min (3) (OCOP)
Willow Wood (1)	113 mls/min (34%)	226 mls/min (67%)	188 mls/min (56%)	375 mls/min (3) (OCOP)
Meadow Lake (1), (2)	74 mls/min (22%)	148 mls/min (44%)	124 mls/min (37%)	248 mls/min (74%)

(1) Identical chemical feed pumps to the existing Steele Road pumps recommended for Willow Wood and Meadow Lake with a firm pumping capacity of 337 ml/min with a discharge pressure of 55 to 70 psi. Verify with manufacturer before purchase.

(2) No detailed testing was conducted to establish a chlorine dosage. 3.5 mg/l assumed. Well flow rate of 560 gpm from daily data sheets.

(3) To conduct a free chlorine burn out with a dosage of 7 mg/l, 12% or 10% sodium hypochlorite will have to be utilized, or a larger chemical feed pump employed.

BULK STORAGE TANKS

It is strongly recommended that two bulk storage tanks are placed at each well site. All sodium hypochlorite in one bulk storage tank should be used before the tank is rinsed and refilled. The empty tanks should be refilled when the in-service tank reaches a level of 10 days of stored chemical. This will result in up to 22 days of storage when the tank is refilled which will drop to 10 days of storage when the empty tank is refilled.

The size of the bulk storage tanks depends mostly on the concentration of sodium hypochlorite to be utilized. A 6% concentration is strongly recommended to reduce chemical degradation. However, this will result in larger bulk storage tanks.

The sizing of bulk storage tanks for each site is as follows:

Cross Gates	784,168 Gallons/Day	Assume 12 days storage. 10 days per LDH 2 days for delivery	
		Monochloramines	
Steele Road 3.0 mg/l			
		12% Bulk	**6% Bulk**
1,050 gpm pumping rate	747 minutes/day	99 mls/min	198 mls/min
		74 L/Day	148 L/Day
	12 Days	888 Liters	1,776 Liters
		245 Gallons/Tk	469 Gallons/Tk
		2 – 250 Gal Tks	2 – 500 Gal Tks
		Free Chlorine	
		12% Bulk	**6% Bulk**
		225 mls/min	451 mls/min
		168 L/Day	337 L/Day
	12 Days	2,016 Liters	4,043 Liters
		533 Gallons/Tk	1,068 Gallons/ Tk
		2 – 500 Gal Tks	3 – 500 Gal Tks
			Or 2 – 1,000 Gal Tks

Willow Wood	784,168 Gallons/Day	Assume 12 days storage. 10 days per LDH 2 days for delivery	
850 gpm pumping rate	923 minutes/day		
		Monochloramines	
		12% Bulk	**6% Bulk**
1,050 gpm pumping rate	747 minutes/day	94 mls/min	188 mls/min
		87 L/Day	174 L/Day
	12 Days	1,044 Liters	2,088 Liters
		276 Gallons/Tk	552 Gallons/Tk
		2 – 250 Gal Tks	2 – 500 Gal Tks
		Free Chlorine	
		12% Bulk	**6% Bulk**
		188 mls/min	375 mls/min
		174 L/Day	346 L/Day
	12 Days	2,088 Liters	4,154 Liters
		552 Gallons/Tk	1,097 Gallons/ Tk
		2 – 500 Gal Tks	3 – 500 Gal Tks
			Or 2 – 1,000 Gal Tks

Meadow Lake	170,000 Gallons/Day		
Well = 560 gpm			
Running time = 304 Minutes/Day			
		Monochloramines	
		12%	**6%**
		62 mls/min	124 mls/min
		19 L/Day	38 L/Day
	12 Days	226 Liters	452 Liters
		60 Gallons/Tk	119 Gallons/Tk
		2 – 60 Gal Tks	2 – 100 Gal Tks
		Free Chlorine	
		12%	**6%**
		124 mls/min	248 mls/min
		38 L/Day	75 L/Day
	12 Days	452 Liters	905 Liters
		119 Gallons/Tk	239 Gallons/ Tk
		2 – 100 Gal Tks	2 – 250 Gal Tks

	Tank Size Summary	
	12% Bulk	6% Bulk
	Monochloramines	
Steele Road	2 - 250 Gal Tks	2 – 500 Gal Tks
	Free Chlorine	
	2 – 500 Gal Tks	2 – 1,000 Gal Tks
Willow Wood	**Monochloramines**	
	2 – 250 Gal Tks	2 – 500 Gal Tks
	Free Chlorine	
	2 – 500 Gal Tks	2 – 1,000 Gal Tks
Meadow Lake	**Monochloramines**	
	2 – 60 Gal Tks	2 – 100 Gal Tks
	Free Chlorine	
	2 – 100 Gal Tks	2 – 250 Gal Tks

Tanks purchased and sized for 6% bulk can be filled to 50% level if 12% bulk sodium hypochlorite is purchased. Plus, the volume of sodium hypochlorite stored may vary seasonally as more disinfectant will normally be used in the hot summer months with less during the colder fall, winter and spring months.

To reduce the size of the bulk storage tanks at all sites, it may be possible to set up a central bulk storage facility within St. Tammany parish such that bulk storage tanks can be filled as needed. Two bulk storage tanks are still required at each site with complete emptying and rinsing of each tank between refilling. This would also hold true for the central bulk storage facility. The utilization of a central bulk storage facility would need to be approved by LDH since each individual well site will not have the (10) days storage.

In addition, gas chlorine can be considered that will reduce the large air conditioned space required for sodium hypochlorite. Plus, chemical deliveries will be reduced significantly due to the large quantities of chlorine that can be stored. The implementation of secondary containment for the gas cylinders provides an elevated level of safety and security if gas chlorine is considered.

MAPS, PIPELINES, VALVES AND DEAD ENDS

Existing plans of the multiple phases were reviewed with all waterlines combined into a consolidated map. Water valves were located based on these maps. The consolidated map references each detailed phase map. Valves have been shown in their approximate location based on these maps. No precise nor detailed measurements to monuments are shown on any of these drawings. In addition, it is obvious that not all detailed maps were provided due to the lack of connection from the wells to several service areas.

Recommendations include:

1) Researching files to find the missing maps so that all pipelines are shown.

2) Locating all valves in the field as depicted on these maps.

3) Preparing valve details sheets showing measurements from each valve to permanent monuments so that valves can be located in the future. Permanent monuments can be manhole lids, storm drain inlets, power poles, right of way markers, etc. Water valves can easily become buried under asphalt, grass, or landscaping making it very difficult to locate the valve in the future, especially in an emergency. While some systems have used GPS equipment to locate valves, the valve

coordinates must be well documented in order to locate the valves in the future.

4) Valves should be exercised at least annually, in our opinion. Valves that remain in open position for many years can become inoperable due to corrosion, debris trapped in the guides of the valve, or deposits of minerals on the working parts. Exercising the valves annually helps to ensure that valves will operate when needed, especially during an emergency, and helps to ensure that the valves can be located easily.

5) Valves that are found to be damaged or inoperable should be scheduled for repairs. In many cases valve boxes can shift making it very difficult if not impossible to operate the valve, Valves or the components such as valve boxes, that are found damaged or inoperable should be noted and flagged for repairs. The listing of valves that are inoperable should be published so that during an emergency time is not wasted on valves that do not work. The list of valves that are inoperable should be reviewed monthly with repairs scheduled timely. Valves are a critical component of every water system, and their proper operation is important.

6) Tracking Closed Valves.

Valves must be closed from time to time during emergencies and during some routine maintenance activities. It is critical that the operators maintain a list of every valve that is closed for any reason. During an emergency, operators can close numerous valves, especially if critical valves cannot be found or if they are inoperable. It is paramount that once the event is over and all pipelines have been cleared, disinfected, tested, and approved that all valves are reopened. Tracking every valve closed during the event is critical to ensure that each and every valve is reopened after the event. There are many ways to track valves that are closed, but tracking must be written documentation and not mentally in the operator's brain. Too many times valves are not reopened due to the failure to "Remember" all valves that were closed. Documentation of valves closed can be as complex as identifying the valves in a GIS electronic data base, or as simple as writing the valve number on a clothespin and attaching the clothespin to the sun visor of the operator's truck. Using either technique a written list of valves closed will be readily available after the event to ensure that all valves closed "in the heat of the moment" are reopened.

FREE CHLORINE as an ALTERNATE DISINFECTANT

A concern was raised that utilizing free chlorine might cause elevated levels of disinfection byproducts in the Cross Gates system. Mr. Bill Travis treated samples of the water until he reached a free chlorine residual of 3.0 mg/l. Mr. Travis held the samples for three days and then had the samples analyzed for both TTHM and HAA5. The results are as follows:

	TTHM			HAA5	
	EPA/MCL	RESULT		EPA/MCL	RESULT
Steele Road	80	49.7		60	27.4
Willow Wood	80	50.1		60	29.8

All results are shown as ug/l.

The testing, although a single data point for each well, shows that the utilization of free chlorine will not cause disinfection byproduct concentrations to exceed the MCL as established by EPA. The formation under these conditions is approximately 63% of the maximum allowable concentration for TTHM and 50% for HAA5.

These samples were run utilizing a free chlorine residual of 3.0 mg/l. This level may be higher than what is necessary in the distribution network. A holding time of three days was utilized to simulate the water age in the system. This water age is possible with close monitoring of the flushing. Computer modeling of the system or the utilization of a tracer such as sodium fluoride could be used to verify water age and to help make adjustments.

Previous correspondence with the Louisiana Department of Health and Hospitals shows that a move to free chlorine was disapproved. A close examination of the correspondence will show that the disapproval was not due to water quality concerns including disinfection byproducts. The reason for the disapproval was the failure to submit details plans and specifications for the proper chemical feed equipment to reach a free chlorine residual and because the existing chemical feed pumps lacked the capacity to feed enough sodium hypochlorite.

Should Tammany Utilities switch to free chlorine to accomplish a burn out, it is our opinion that with the proper feed equipment and with proper flushing and with proper system operation approval from LDH can be obtained. Many other systems in the same geographical area utilize free chlorine with similar groundwater quality.

Furthermore, if a decision is made to switch to free chlorine permanently, then the utilization of chlorine gas in lieu of sodium hypochlorite should be investigated.

Finally, the effectiveness of chlorine as a disinfectant varies with the pH of water. This disassociation is important when the form of chlorine is taken into consideration. Since the raw water has a high pH (>8.0), and no pH adjustment is made, remaining with chloramines may allow better overall disinfecting capabilities in the finished water with better stable operations than utilizing free chlorine.

EMERGENCY GENERATORS

During the site visits it was noted that several of the sites had emergency generators. Based on our experience with water operations, we speculated that the generators might be undersized. To substantiate this concern, St. Tammany Utilities contracted with Nesbit and Associated, LLC to visit each site, to obtain all loads that would be placed on the generators, to determine if the existing generators are adequate, and if found deficient, to make calculations to determine proper sizing.

Nesbit visited each site and found that generators at each site are undersized, and they would not recommend attempting to run any of the wells on any generator. Attempting to run the wells on the generators could damage the well motors, controls, or the generators. Larger generators at each site will be required.

In addition to new generators, Nesbit based their recommendations on the assumption that all existing "across the line" starters will be replaced with "soft start" type starters. "Soft start" type starters lower the initial load on a generator substantially such that a smaller generator can be utilized. Hence, the replacement of the motor starters with "soft start" type starters is paramount to utilize the generator sizes recommended. Attempting to utilize the existing "across the line" starters should not be attempted unless the calculations are reworked, and larger generators are installed than those proposed by Nesbit.

Mr. Nesbit's recommendation can be found in the Appendix to this report.

ADJUSTMENTS TO THE NITRIFICATION PLAN

The drafted and approved Nitrification Plan included specific target, alarm, and trigger concentrations. When specific actions are to be taken, overall, we agree with many of the levels that are listed. However, we do believe that an adjustment to the plan should be made based on compliance data collected from the system. Each water system is unique given many variables including raw water pH, temperature, storage retention time, water age, and system demands. At this time the data collected continues to show wide swings in the residuals although no violations of water quality were noted during the time frame of this study, except for the date of June 6, 2021 where no chlorine residual was recorded at the Steele Well POE or the MRT for Cross Gates. We relate the significant fluctuations to the bulk sodium hypochlorite, lack of sampling following chemical addition, excessive storage time in the hydrotanks due to poor cycling and short circulating, and the failure to make daily adjustments to the chemical feed rates. Hence, attempting to "fine tune" the Nitrification Plan with the significant fluctuations that are currently being experienced is premature until actions are taken to correct the deficiencies outlined above. Once corrective actions are taken and stable data is recorded for an extended period of time, adjustments to the plan can be recommended. We do recommend reducing or removing the free ammonia limits as stated. Requiring no less than 0.03 mg/l free ammonia is not our recommendation. We would prefer to see no free ammonia in the system as long as all other parameters are within specifications. This is our opinion and discussions with LDH must be held to change the limits in the approved nitrification plan. Countless exceedances were recorded because the free ammonia was less than 0.03 mg/l. We recommend removing this limit from the action plan, or lowering the level to as low as 0.01 mg/l.

Mr. Bill Travis with TMB has done an outstanding job of assisting the parish with the chemical feed systems. We strongly recommend that the parish continue to utilize Mr. Travis after all physical modifications are made to fine tune the chlorine feed to achieve the optimum monochloramines at each site.

BULK STORAGE OF SODIUM HYPOCHLORITE

The degradation of bulk sodium hypochlorite is well documented. Elevated temperatures, long storage times, and higher concentrations are all factors that will cause sodium hypochlorite to lose its strength rapidly and to form byproducts that are undesirable. Given these conditions, storing sodium hypochlorite at lower temperatures (60ºF), diluted strengths (6%) and reducing the time the liquid is stored until used with all help in maintaining a fresh and stable disinfectant.

Another key factor in maintaining a good quality supply is to consume 100% of the sodium hypochlorite held in the bulk storage tank and rinsing the tank out before refilling with new sodium hypochlorite. Mixing new sodium hypochlorite with old sodium hypochlorite, as is done when the bulk tanks are "topped off", is like mixing fresh milk with tainted old milk. The mixture created is still tainted milk and is undesirable. The same holds true for sodium hypochlorite.

Following this procedure will require the use of two bulk tanks at each site with each tank piped to the single day tank. While the single day tank will be refilled each day, refilling the tank to just over the amount estimated to be consumed will help to prevent excessive age. The newly installed SCADA system, with controls added or other control schemes such as PLC's at each site as discussed under the previous section titled SITE VISITS, will allow the operator, or an automated control, to switch from the Steele Road site to the Willow Wood site, or vice-versa, should one of the day tanks drop to an unsafe level due to higher than anticipated production levels. Unfortunately, because Meadow Lake has no backup well, a low level in the sodium hypochlorite day tank would require an immediate response by an operator to manually refill the day tank. Or a remote control valve could be installed such that the operator could refill the day tank remotely. Again, this will only be possible with modifications to the SCADA system to add remote control or other control methods.

While the concept of day tanks is favored by some operators, the use of day tanks is no longer a requirement by the Louisiana Health and Hospitals. Hence, chemical feed pumps could be piped directly to the bulk tanks, thereby greatly reducing the likelihood of running out of sodium hypochlorite in any one day. The issue of running out of chemical would still remain when the bulk tank gets low. Automated valves on two bulk tanks would allow the operator to switch tanks in the event one tank gets too low for comfort.

Rinsing a bulk tank before refilling is also strongly recommended to prevent contamination of the fresh sodium hypochlorite by old stale low strength disinfectant.

The State requires a maximum of 10 days storage on site of disinfectant. Therefore, when the online bulk tank reaches a level of 10 days plus delivery time, an order should be placed to fill the second tank. Deliveries should be halted to "top off" bulk tanks following a certain time schedule. While this may not be the most economical solution, it will help to ensure that the chemicals are only replenished when required.

The current deliveries are for 12.5% sodium hypochlorite. Testing on site revealed bulk storage concentrations of 9%, 10.5%, and 13%. The low concentrations of 10.5% and especially the 9.0% reveal that degradation of the sodium hypochlorite is occurring. The highest reading of 13% is odd in that this reading was taken from the storage room with the highest ambient temperature (104ºF) and according to the operators had the longest storage life of all three sites. Stratification of the sodium hypochlorite may have caused the high results since some crystallization was noted and because the day tank is refilled from the bottom of the bulk tank. The concentration was checked twice.

Given the high degree of differences found in the bulk samples and the elevated room temperatures, we strongly recommend that the utility consider 6% sodium hypochlorite. Insulating the buildings and getting all air conditioner units functional will help as well. The 6% solution should be obtained from a certified commercially available manufacturer with NSF approval. We do not recommend purchasing 12% and attempting to dilute the concentration to 6%. Dilution water should be carefully prepared with no metals (Fe, Mn, Co, etc.). in the water what-so-ever. The introduction of metals as part of the dilution water, even very slight amounts, could begin the rapid degradation of the stored sodium hypochlorite.

CHEMICAL FEED PUMPS

Chemical Feed pumps for 6% sodium hypochlorite will have to be able to pump twice the rate of sodium hypochlorite as currently being used. The recommended chemical feed pumps as outlined previously in this report for chloramines as well as free chlorine can pump up to 337 mls/min in continuous operation. Pump speed for 6% NaOCl at Steele Road to produce chloramines will be approximately 59%. To achieve free chlorine for a burn out or for permanent operation 12% or 10% sodium hypochlorite will have to be purchased or larger chemical feed pumps purchased.

The same pump can be utilized for the Willow Wood and Meadow Lake sites with the pump seeing a range of 37% up to 56%, all acceptable levels of operation utilizing 6% sodium hypochlorite and chloramines.

The size of the bulk tanks will depend on the running time for each well at each site. As recommended earlier, the Steele Road and Willow Wood sites will share the demands of the system with each well supplying water to the system for 24 hours before switching control over to the other well for 24 hours. The Meadow Lake well will have sole responsibility since it is the only source of water for those customers.

ELEVATED STORAGE

The existing hydropneumatic tanks allow the wells to cycle as needed to provide water to the utility. Unfortunately, the size of the tanks limits the water available during a power outage and causes significant fluctuations in the distribution system pressure. Currently no generator is sized properly for any well site. Damage could be done to the well motor, controls, and generator if the existing generators are pressed into service during an emergency. The actual water stored in each hydropneumatic tank is approximately 50% of its volume. For the 20,000 gallon tank approximately 10,000 gallons is stored water. A fire flow of 1,500 gallons per minute to a commercial business would exhaust the entire supply from one of the tanks in just over 6 minutes if the well were out of service. A house fire of only 500 gallons per minute would empty the tank in exactly 20 minutes. Given the history of hurricanes and related tornadoes, there is a very strong possibility that an event such as a fire could occur with utility power lost during a major event. Hydrotanks are acceptable for domestic demands but do little to assist with major demands such as a fire flow, especially during the loss of utility power.

Hydropneumatic tanks also cause wells to cycle frequently due to the small volume of water stored in the tank. Wells providing water to hydropneumatic tanks can fill the storage volume rapidly and will then idle until low pressures call for the well to start again. Wells can start and stop up to six times per hour, each time slamming the aquifer as water is rapidly pulled into the screen. This slamming of the aquifer can cause fine sand and silt particles to be pulled from the water bearing sands only to be deposited in the bottom of the hydropneumatic tanks and distribution pipelines. When high demands in the system occur, these deposits can become dislodged and move toward and into customers services and homes. Flushing of the mains and in the residential services can remove this particular matter, if done properly.

Hydropneumatic tanks are designed to operate based on a low pressure to start a well and a high pressure to stop the well. The current settings in the Cross Gates systems provides for a 10 psi pressure differential from a low pressure of 60 psi to a high pressure of 70 psi. This 10 psi differential can result in a high amount of cycling of the well starting and stopping the motor more often than recommended and slamming the aquifer each time. A pressure differential of 15 psi is typical, and it is recommended that the current settings be changed to turn the well on at 55 psi and off at 70 psi.

Unfortunately, this pressure fluctuation of 15 psi will affect each customer systemwide, although it is doubtful that many people will notice the change. Pressure monitoring conducted by TMB showed little pressure variation across the system, consequently it does not appear that this change will create any problems. Computer modeling or additional field monitoring at remote sites in the system can be used to confirm any concerns of low pressure created by this 5 psi pressure setting change.

The concept of an elevated tank to serve the Cross Gates (and Meadow Lake system) was presented in meetings with parish officials. An elevated tank of 500,000 gallons would resolve numerous issues. First, the tank would provide between 375,000 and 500,000 gallons of stored water when operated between 75% and 100% full. A normal fluctuation of 10 feet in the elevated tank would result in a pressure differential of only 4.3 psi instead of the recommended 15 psi differential. Well operation would change dramatically. Filling of elevated tanks during night time hours is ideal. Typically, we recommend a window of six (6) hours to refill 125,000 gallons with some night time usage. A fill rate of approximately 850 gallons per minute is estimated. Consequently, a well would run for no less than 3 hours continuously when refilling the tank. This run time would increase significantly when the tank was refilled during the day. This changes the well operation from cycling several times per hour, slamming the aquifer each time, to running for many hours per cycle with only a couple of cycles per day during normal demands. Alternating the Steele Road and Willow Wood wells will help to reduce the cycle time per well to as low as one cycle per day and possibly only three cycles per day during peak demands. There is no doubt water quality from this change in operations would improve.

Fire protection from an elevated tank would improve dramatically with fire flows in excess of 3,000 gallons per minute close to the tank. One of the main benefits is the duration that fire flows could be sustained even if both wells were out of service. For a commercial fire flow of 1,500 gpm and the tank at 75% fill, a fire flow could be sustained for almost 3 hours with 25% of the tank reserved for domestic consumption. A house fire of 500 gpm could be sustained for up to 9 hours under the same conditions.

It is unusual to see such a large population base served by no elevated storage. We strongly recommend pursuing funds to erect an elevated tank for the Cross Gates and Meadow Lake systems.

Funding provided under the American Recovery Plan and the State of Louisiana may allow for up to $5MM per system for consolidation. To consolidate the Cross Gates and Meadow Lake systems up to $10MM might be available. This would be more than adequate to construct pipelines to connect those two systems and to construct an elevated tank to supply water to the consolidated network. We strongly encourage Tammany Parish to submit an application for funds to accomplish this goal.

SCADA from the elevated tank to each well site would be required such that the wells would be called to run and stop based on the level of water in the elevated tank. Dedicated fiber optic lines from the elevated tank to each well site could be utilized to protect the control system from unauthorized persons.

CUSTOMER PARTICIPATION

Tammany Utilities has a unique group of customers who actively participate in discussions concerning water quality and operations. Their knowledge of water testing and water quality is certainly unique among most water utility customers. We appreciate their concerns for better water quality and improvements to the systems.

Customers also play a role in the overall delivery of water quality to each person served by the water system. While the responsibility for delivery of the water by Tammany Utilities ends at the meter, there are a number of actions that each customer can take to assist in improving water quality.

Water filters on faucets, in refrigerators, on water pitchers, and on whole home units have a limited service life, especially if they are single one time use carbon units. Once the carbon is exhausted then no additional treatment can be expected. Over time these filters can begin to harbor bacteria and provide a perfect environment for bacteria to thrive and grow. If given enough time, the water quality coming out of these filters can be much worse than the water quality entering them. For this reason, each customer should pay close attention to the recommendations from the manufacturer for replacement. A close examination of a packaged water pitcher filter reveals a recommended replacement every two months. Clearly this may seem excessive for pristine waters, but without extensive testing the cost of bacteriological or chemical tests could easily exceed the cost of replacement filters. Unfortunately, there is no simple way to determine if this recommended change is excessive or not. Hence, if customers are going to utilize filters, then the customers should follow the manufacturer's recommendations for changing or cleaning the units.

Potable water has a certain shelf life just like many products that consumers purchase every day. Many products lose taste and can become sour and can cause illness once they have exceeded the recommended shelf life. Potable waters shelf life can be measured by its chlorine residual. Unfortunately, the shelf life of potable water varies greatly with usage in a potable water distribution system. Hence, operators use flushing and other techniques to try and maintain acceptable water quality throughout the distribution system.

Usage in customers resident (premise) piping can greatly affect water quality. Guest bathrooms or remote faucets that are used infrequently can allow water to be stored in the plumbing systems for days, weeks, or months. Water quality in systems that remain stagnant for these durations will degrade. Hot water heaters will drive the growth of certain bacteria and any residual chlorine that was in the water when it entered the home will dissipate rapidly. The best solution for situations where water has remained in plumbing lines for excessive time is to flush the lines thoroughly and to flush out hot water heaters as recommended. It should become a standard practice that before guests arrive, the hosts should routinely flush all fixtures. While they may not be necessary in all locations, it's just one way for customers to assist in providing the best water quality in their home.

WATER BOWLS – PETS

The author of this report has lived in an area with a potable water system that has utilized chloramines for many years. Personal observations are that slime growth in open water bowls can develop rapidly. Based on the limited water quality data provided for the St Tammany systems during this study it appears that water quality was in compliance with State and Federal Guidelines, except for the secondary standard of pH and for the dates of June 6^{th} where no chlorine residual was reported at the Steele Well POE nor at the Cross Gates MRT. But the holding of water in an open bowl which can be exposed to sunlight allows chlorine to dissipate allowing bacteria to thrive. Each time a pet drinks from the bowl, bacteria are added to the bowl exacerbating the problem. Personal observations are that a heavy slime growth can develop in as little as one to two days. Food particles from the pet can also contribute to the growth of bacteria. Hence, to assist in the health of pets, it is strongly recommended that water bowls be washed and rinse thoroughly and frequently.

HOW TO IMRPOVE OPERATIONS

The standard operating procedures for the parish are very clear, a boil water advisory shall be issued wherever a distribution pressure of less than 20 psi is recorded. This requirement mirrors the requirements of the Louisiana Department of Health and Hospitals. While issuance of a Boil Water Advisory (BWA) is time consuming and inconvenient, there are no latitudes that leave this to the discretion of the operators. The basic fact is that the recording of a system pressure of less than 20 psi triggers a BWA. Clearly, the BWA can be issued for only the area affected. Therefore, to document the specific area impacted, pressures must be taken and the customers in the affected area must be notified immediately. This could be difficult to document if operators cannot trace all low pressure points in a timely manner, such as the short term loss of utility power to a well site. Hence, notification should be conservative and customers well beyond the suspected area should be included in the BWA. The recording of a pressure of less than 20 psi at the wells will signify a loss of 20 psi throughout the entire distribution system, resulting in a notice to all customers. The recently installed SCADA system will be very useful to determine if a system wide BWA should be issued due to pressures at the well falling below 20 psi. The Standard Operating Procedures for Tammany Utilities includes instructions for the issuance of a BWA and we agree with those procedures.

The recording of a chlorine residual of less than 0.5 mg/l is in our opinion also cause for the issuance of a BWA. Again, the issuance of the BWA can be, in our opinion, for only the area affected. Samples of chlorine taken throughout the distribution system will help to identify the areas impacted. Many parts of the distribution system are interconnected with a lattice of piping that creates a matrix where water can flow to numerous areas. Hence, the recording of a low chlorine residual in one location must be immediately followed up with samples collected in each direction that water could flow. The initiation of flushing in the area of the low chorine residual location should help to bring better quality water to the area. We strongly recommend that whenever a chlorine residual of less than 0.5 mg/l is recorded, that a BWA be issued for the area that was impacted. In our opinion the level of 0.5 mg/l is the limit where the BWA must be issued. It should not be left up to the discretion of the operators to opine of how much below the 0.5 mg/l is acceptable. It is our opinion and our recommendation that any recorded residual of less than 0.5 mg/l for any moment of time should result in a BWA for that area. Producing a stable consistent good quality water with consistent flushing at key points in the system should be enough to avoid a boil water notice caused by a low chlorine residual. In addition, it can be argued that the maintenance of pressures in the distribution system of greater than 20 psi should protect the system from contamination such that even if chlorine residuals drop below 0.5 mg/l that the possibility of contamination is low. We agree with this, but we cannot review every situation to determine when the issuance of a BWA is warranted or not. We believe and strongly recommend a strict set of guidelines that leaves little to the discretion of the operators. Specifically, whenever system pressures drop below 20 psi **OR,** in our opinion, if a chlorine residual of less than 0.5 mg/l is recorded, a BWA shall be issued for the area affected. This is if either issue occurs, whether both occur at the same time or not.

It is our opinion that the failure to alert customers of a low chlorine residual or low water system pressures in their service area represents the failure of a fiduciary responsibility of the water system to provide safe reliable drinking water to its customers whether there was any actual contamination of the water or not.

We must point out that the issuance of a BWA is not a requirement of LDH when chlorine residuals fall below 0.5 mg/l. Instead, the State regulations simply require increased sampling until a residual of 0.5 mg/l is restored. We do not agree with this approach and it is our opinion that any chlorine residual recorded less than 0.5 mg/l should result in a BWA for the are affected.

PFOS, PFOA and Free Chlorine

A review of raw water samples collected in 2020 by LDH from the Steele Road and Willow Wood wells reveal that the raw water is in compliance with EPA primary standards for drinking water. Although LDH has not tested for PFOS and PFOA in the Cross Gates system as of yet, recent communication with LDH indicates that they will test for these chemicals in October of this year.

The most likely location where these chemicals could enter the water supply is at the Steele Road well where the well sits adjacent to a fire station. Foaming agents used by many fire departments contained these chemicals and contamination of water sources can be traced to the chemicals.

We recommend that the Steele Road well water be tested for PHOS and PHOA as soon as possible. The results should be reviewed carefully with the hope that no PFOA or PHOS is detected at all. Should samples detect any levels of PFOS or PHOA, then the water supply from that well should be shuttered until an investigation into the water quality is conducted.

Chlorine Burn

Should the test results come back negative for PFOA and PFOS, then we believe that raising the level of chlorine in the system to achieve a free chlorine residual, and consequently a chlorine burn, can be considered and is recommended. Should samples show positive results for PFOA and PFOS, then we would not recommend a chlorine burn until the reaction between free chlorine and PFOA or PFOS is investigated. Free chlorine may create complications if these compounds are found in the water.

Free chlorine for a chlorine burn will require more chlorine than can be pumped by the existing equipment. New chemical feed pumps will be required as outlined in the section on chemical pumps. In addition, we would also recommend the Parish look into 6% sodium hypochlorite to provide a more stable disinfectant. The heat during this time of year will certainly have an adverse effect on 12% sodium hypochlorite given the uninsulated buildings and failure of the air conditioners to work properly.

The elevated chlorine levels during a chlorine burn can continue as long as the operators would like to do so. While there is no minimum nor maximum time frame for switching from chloramines to free chlorine; we recommend a time frame of 60 days as discussed earlier in this report. LDH must be notified of the change in disinfectant. In addition, plans and specifications must be submitted to LDH before the move to free chlorine is made since the switch will require larger pumps and more chemical storage. Any change in the physical equipment in a water system must be approved by LDH before the change is made.

Disinfection byproducts will certainly increase if the switch to free chlorine is made. Historical data shows that the levels of disinfection byproducts have been extremely low. We attribute these low levels to the use of chloramines as the primary disinfectant. Laboratory testing by TMB reveals that the levels of disinfectant byproducts with the use of free chlorine will increase to approximate 50% of the maximum contaminate levels as established by EPA for potable drinking water. We believe that the very low levels of TTHM that have been reported in the past are the result of the system having been operated as a chloramine system for many years, while actually being thought it was a free chlorine system. Flushing of the water system to keep the water age low should help to keep the disinfection byproducts in check with the use of free chlorine. The system currently uses three automatic flushing devices. Fourteen additional flushing devices on dead ends is recommended with the locations found in the appendix to this report. The actual number of units may vary depending on the extent of flushing and the results obtained once additional devices are added. Testing of the system to see how it responds to free chlorine and additional flushing is paramount. The levels of disinfection byproducts with free chlorine in these two systems is not well documented. While the levels may not approach or exceed limits set by EPA, bench testing by TMB shows that free chlorine will cause disinfection byproduct levels to be much higher than current levels with the use of chloramines. The magnitude of the increase in disinfection byproducts with the use of free chlorine should be documented such that the use of free chlorine, or the continued use of chloramines, can be evaluated for the good of the public. Free chlorine has been shown to create much higher levels of disinfection byproducts as measured by TTHM and HAA5. Chloramines has effectively demonstrated in the St Tammany system to effectively limit the exposure of health issues by limiting the elevated levels of disinfection byproducts.

Not all water pipes in the St. Tammany network have been identified due the lack of information about parts of the distribution system. A more detailed review can be made once data on all pipes is provided. In addition, should the Parish wish to have a computer model built of the system, then optimum locations for flushing devices can be selected based on the theoretical water age throughout each system.

The use of free chlorine as the primary disinfectant is common in many locations in St. Tammany Parish. Should the Parish elect to install equipment and obtain LDH approval for a free chlorine burn, as recommended in this report, then the system should be monitored carefully, and customer input requested. It is likely that the St Tammany system may be more stable with a good and consistent chloramine residual due to the high temperature of the raw water. Extensive testing during implementation of a free chlorine burn will help to determine the stability of the system using free chlorine and the amount of flushing that will be required to maintain a good residual to all parts of the system. Good records to document the chlorine burn must be kept in order to fully evaluate the effectiveness and stability of the system.

SUMMARY

It is not possible to summarize this entire report in a couple of paragraphs. The entire report must be read and studied to understand the concept behind each and every recommendation.

The most important recommendations we can make are that modifications to the piping systems must be made to allow the treated water to be tested post chemical addition and prior to the hydropneumatics tanks, the water produced must be tested frequently if parameters are not in line with the approved nitrification plan, chemical feed adjustments must be made frequently as needed to achieve target residual levels in the treated water, the bulk chemicals must be stored in properly controlled atmospheres, the utilization of 6% sodium hypochlorite should be given strong consideration, new chemical feed pumps should be purchased, duplicate bulk chemical feed tanks should be installed, the SCADA system must be modified or other control mechanisms added to allow control of each well site, SCADA must be added to Meadow Lake, a backup supply to the Meadow Lake system must be provided, properly sized generators must be purchased and installed along with new soft starters for each major piece of equipment, and additional flushing units throughout the distribution system must be installed.

An entire list of recommendations follows. This list is not meant to be totally inclusive of every improvement that might be required, but it does incorporate the correction to the many deficiencies that were uncovered during this investigation.

Consistency is the key to proper operations once all improvements are made. If the improvements recommended in this report are implemented, then water quality should improve, and customer confidence restored.

Customer confidence in a water system is paramount such that each customer feels that the water they are drinking is safe. Many statements have been made publicly about concerns of the water quality that customers are receiving from the Cross Gates system. We believe that consumer confidence must be restored as soon as practical by correcting the physical issues outlined in this report. More importantly, some of the customers are pushing hard for a "burn out" of the water system believing that the water they are receiving has been contaminated from a previous event. The previous event was a combination of events that occurred during Easter weekend during 2021 that may or may not have caused contamination to enter the water distribution system. Too many unknowns exist for this report to conclusively state what might have happened or if contamination did or did not occur. Hence, we cannot comment on that event other than test data from LDH did not show any positive signs of bacteria following the event. But, we understand that a number of people in the area are continuing to suffer from what they believe are health issues as a result of that event and are asking for a chlorine burn to rid the water system of any possible residual contaminates.

RECOMMENDATIONS

Given the events and concerns of this water system the following are Owen and White's immediate recommendations for moving forward:

1. Add sampling taps prior to the hydropneumatic tanks.
2. Adjust sodium hypochlorite feed rates to achieve the optimum monochloramine concentration at each well site. Use the bench scale data and recommended total chlorine residuals, monochloramine residuals, free chlorine residuals, and free ammonia residuals to adjust chemical feed rates each day at each well site to achieve a stable optimum chloramine residual throughout the systemwide network.
3. As soon as possible submit to LDH calculations and documentation, along with a permit application, to request free chlorine application.
4. When an approved permit is received immediately complete all equipment modifications, if necessary, to comply with the LDH permit for free chlorine.
5. Once all modifications are made immediately notify all customers and LDH of the intent to change from Chloramines to Free Chlorine. The notification should be sent no less than 14 days before the switch to free chlorine is made.
6. Change to a free chlorine disinfectant. We strongly recommend that chemical application be made under the watchful eye and guidance of TMB

so that the proper concentrations are achieved at the POE. TMB should also instruct the operators on the frequency and testing to ensure a consistent feed and finished water chlorine concentration. Carefully monitor the application of sodium hypochlorite to ensure that the maximum recommended dosage for the product is not exceeded.

7. Flush the water system using a unidirectional flushing program to exchange all chloraminated water to free chlorine.

8. We recommend feeding enough chlorine at the POE to achieve a minimum free chlorine residual of no less than 1.0 mg/l throughout all parts of the distribution system. Additional flushing or an increase in sodium hypochlorite dosing may be required to maintain this level of free chlorine throughout the system. Do not exceed a total chlorine application of 4.0 mg/l at the POE nor the approved maximum dosage of sodium hypochlorite. Adjust chemical feed as often as necessary to maintain a stable free chlorine residual at all times. Chemical feed should be governed by the free chlorine residual monitored at the POE but also throughout the distribution system and at the MRT. As the system is purged, the demand for chlorine throughout the distribution system may decrease. Hence, as the demand decreases less chlorine may need to be fed at the POE. Monitor and adjust the chlorine

feed per guidance from TMB to maintain a level of free chlorine of 1.0 mg/l at all distribution sampling points and at the MRT.

9. Continue to operate the system as a free chlorine system for at least 60 days.

10. Collect disinfection byproduct samples throughout the distribution system to determine the impact on TTHM and HAA5 concentrations. LDH may collect and sample these constituents if this sampling falls within their normal sample schedule.

11. After 46 days of continuous free chlorine operation, and with no issues encountered, notify all residents of a change back to chloramines.

12. On the sixtieth day, switch back to chloramines with guidance from TMB about chlorine feed rates and optimum chlorine operation.

13. Notify LDH that the system has returned to chloramine operation.

14. Collect all data and evaluate the impact on the switch to free chlorine. Evaluation criteria should include the stability of the operation, chlorine usage over the 60 days, TTHM and HAA5 sampling data, customer input, and any other factors that may or may not influence decisions to stay with chloramines or to consider a permanent switch to a free chlorine system.

15. Utilize TMB to provide guidance and instruction to operate the system utilizing chloramines.

16. Begin on all recommended improvements that were not addressed during the initial stages of preparing to switch to free chlorine or improvements that were made during the 60 day free chlorine burn.

17. Make chemical feed adjustments as often as necessary to maintain a consistent water quality throughout each distribution system.

SYSTEM DEFICIENCIES AND RECOMMENDED MODIFICATIONS

Note, before any modifications to a water system are made, submittals of all improvements and modifications must be submitted to the Louisiana Department of Health and Hospitals with approval obtained before the modifications are implemented. This also holds true for any change in chemical feed and if a change is made in the primary disinfectant from chloramines to free chlorine.

The following items are listed in priority as recommended by Owen and White. The first item is listed as the most important followed by others in order of importance. A very rough budgetary estimated cost has been shown for each item where a Capital expenditure will be required. These costs should be refined as details for each item are fully developed.

1.	Install samples taps at each hydropneumatic tank inlet for chemical adjustment. Currently there are no sample taps following chemical addition and BEFORE the hydropneumatic tanks. Samples must be taken after the tanks to record the POE chlorine levels for regulatory reporting. But, as in the case of the Steele Road well, the water in the tank at the POE could be stagnant and aged. Sample taps before the tanks will allow for fresh samples to be collected and allow the operators to make chemical feed adjustments immediately. ($15,000)
2.	Adjust sodium hypochlorite feed rates to achieve target levels for optimum monochloramine level. Bill Travis with TMB developed theoretical dosages to achieve optimum monochloramines. Feed rates in the field will vary depending on bulk sodium hypochlorite concentrations. Testing revealed that these concentration levels varied greatly. Consequently, feed rates will vary until a consistent concentration of bulk sodium hypochlorite is maintained. Mr. Travis has performed extensive testing of the water for both Cross Gates and Meadow Lake and should consult with the operators concerning testing of the water before it enters the hydropneumatic

	tanks to ensure that optimum monochloramine levels are achieved. Optimum levels will help to control nitrification in the distribution system and will produce the best water quality while using chloramination. Theoretical calculations show that the Steele Road water was being underdosed for optimum chloramine formation. Optimum target total chlorine residuals as determined by TMD and as presented by Tammany Utilities to LDH are 2.7 mg/l for the Steele Road and Meadow Lake wells and 3.0 mg/l for the Willow Wood Well. (No Capital equipment cost)
3.	Purchase new sodium hypochlorite feed pumps with greater capacity (337 ml/min). New pumps should be variable speed via a 4-20 Ma input from the flow meter. The current feed pumps cannot achieve a free chlorine residual in the event that a "burn out" of the system is needed. This report includes pumps sized that can be used for normal feed rates to obtain optimum chloramines but that also have the capacity to feed enough sodium hypochlorite to achieve a good free chlorine residual even with 6% bulk sodium hypochlorite. All sites should have duplicate chemical feed pumps and all chemical feed pumps should be flow paced. "Step" chemical feed pumps may be required if the JESCO pumps are found to provide inconsistent feed rates at the discharge pressures of 55 to 70 psi. ($15,000)
4.	Conduct a free chlorine burn as soon as adequate chemical feed equipment has been installed and as soon as approval from LDH has been obtained. Once the system is purged and returned to chloramines and evaluated, an annual burn out of the system can be considered. Proper notification must be given to all customers and LDH whenever a change in disinfectant is done. The decision to change to free chlorine for a burn out should be based on system stability, demand of chlorine at the POE versus monochloramine

	residual concentrations at all sampling points and the MRT, and all other system parameters. It is possible that once all issues are resolved and a very stable monochloramine system is achieved, that no additional burn outs are deemed necessary. It is premature at this time to speculate whether an annual burn out will be necessary. (No Capital cost)
5.	Dual bulk sodium hypochlorite tanks are recommended at each site with a minimum of ten days storage maintained. Sodium hypochlorite in each bulk tank must be used completely before a tank is refilled. Tanks must be washed out thoroughly before refilling with new sodium hypochlorite. It may be possible to construct a bulk sodium hypochlorite storage facility for Tammany Utilities so that the minimum of ten days storage is not required at each site. Approval from LDH will be required to implement this plan. If approved, the size of bulk storage tanks at each site could be greatly reduced along with the time that the chemical is held at each site before it is fed into the raw water. ($10,000 / site = $30,000 Total)
6.	Tammany Utilities should consider switching to 6% bulk sodium hypochlorite. While the use of 6% sodium hypochlorite will require larger feed pumps and larger bulk storage tanks, degradation of the chemical will be greatly reduced with a more consistent feed achieved. 12% sodium hypochlorite will need to be utilized during a burn out or larger chemical feed pumps purchased. (Increased Chemical cost)
7.	Insulate the wooden chlorine and chemical feed buildings. Temperatures recorded in the building were extremely high which is very detrimental to the sodium hypochlorite. A constant and low temperature is needed to properly store sodium hypochlorite. ($15,000/site = $45,000 Total).

8.	Ensure proper operation of the air conditioning units in each building – Room temperatures of 70ºF max. should be maintained but would prefer 62ºF for stabilized sodium hypochlorite. Window units may not be ideal given the corrosive nature of the atmosphere. ($10,000/site = $30,000 Total).
9.	Larger calibration chambers are needed to check the calibration of each chemical feed pump, especially if 6% sodium hypochlorite is considered. ($250/site = $750)
10.	Alternate Steele Road and Willow Wood operation every other day. This will take modifications to the recently installed SCADA system such that control can be added, or the addition of PLC's at each site programmed to alternate wells each day. Currently the Willow Wood site overpowers the Steele Road site such that the Steele Road site remains idle for extended periods of time. Water quality at the Steele Road site will be adversely affected until the wells are alternated. (Cost in Item 11)
11.	SCADA – Manual control of the well pressure settings is needed in order to make one well the primary well and the other well the secondary well. The SCADA system should be modified or PLC's added at each well site to allow control of each well by the operators with set points to achieve primary and secondary operation of the wells. ($20,000)
12.	It is recommended that all call out alarms from the well sites are directed to the sheriff's office first. The sheriff's office is manned 24/7. The sheriff's office can locate an operator to address the issue, rather than calls going to voice recordings. This recommendation was suggested by members of the Council. We request that the council resolve this issue of notification with Tammany Utilities. (No cost)

13.	No SCADA has been added to the Meadow Lake well site. Adding SCADA to this site is extremely critical since this is a single well site. Immediate notification of problems to an operator may allow the operator to rush to the site to resolve a problem before the site loses all stored water and pressure. Chemical feed problems, such as the loss of sodium hypochlorite, might be addressed before the system loses all chlorine residual. ($10,000)
14.	Hydro Tank modifications to the inlet piping at both the Willow Wood and Meadow Lake tanks must be corrected to eliminate short circuiting of the treated water. Each tank must be removed from service, inspected, and the internal piping corrected to ensure that the water entering each tank is directed to the opposite end of the tank to allow full contact time and to change out the water in the tanks each time the tank is used. ($20,000)
15.	Flow meters at the well sites were not working or were not connected to the SCADA. New flow meters were being installed during the course of this study. Each flow meter should be verified for accuracy and each flow meter should be connected to the SCADA. Signals from the flow meters to the chemical feed pumps for flow pacing will help to ensure that a consistent dosage of chlorine is being made as the flow varies. ($15,000)
16.	Connect Meadow Lake system to a backup supply, Cross Gates or Slidell. The existing Meadow Lake system is supplied from a single well with no backup supply whatsoever. The loss of the well, pumping equipment, chemical feed, or any other component could cause a loss of water for an extended time frame. Investigations during this study found that the emergency generator at the Meadow Lake well site is inadequate to provide power to run the site. Hence, a loss of utility power will cause the system fail. (No estimate available due to incomplete piping data for each system)

17.	Target levels on the daily data sheets at each site do not match the levels listed in the Nitrification Plan. These sheets should be corrected so that the operators have the correct target levels and efforts are made to maintain the target levels at all times. (No cost)
18.	During this investigation it was determined by an independent professional electrical engineer that the existing generators were undersized for each site. Recommendations were made for new correctly sized generators. However, the Tammany Utilities instructed the electrical engineer to assume that soft starts would be installed at each site to lower the inrush current. This allowed the generators to be downsized somewhat. Consequently, each site will need to have the electrical starters replaced and new correctly sized generators installed. Until this is done, no site has a generator that will run the site under an emergency condition. Damage to a well motor, a control panel, or a generator could occur if one of the existing generators is used to power a site. (Please consult with an Electrical Engineer)
19.	Install SCADA at the MRT so that chlorine residual readings from the MRT site are "real time". Readings from the MRT must be collected daily, even during weekends. Adding the MRT to the SCADA will help to eliminate manpower of having to go to the site each day of the week to record a reading. ($15,000/site)
20.	We strongly recommend implementing a unidirectional flushing program to flush all pipelines in a logical and effective manner. Unidirectional flushing means that valves must be closed so that flushing is from one direction and not from two directions. We recommend obtaining a velocity of at least 6 feet per second when flushing. This level of scouring velocity cannot be achieved if all valves are left open and the flushing hydrant is fed from several directions.

	Flushing an 8" line requires 938 gpm. This rate of water cannot be provided unless both wells are running for the Cross Gates system. Hence, coordination of well operation will be critical when flushing is conducted. Unfortunately, there is not enough supply from the Meadow Lake well to flush properly. A backup supply will help to resolve this deficiency. Currently No routine system flushing is conducted on either system and unidirectional flushing is never undertaken. ($15,000 modeling)
21.	Install a bypass around the Steel Road tank so that the well can still be utilized whenever the hydropneumatic tank is taken out of service. ($15,000)
22.	Map information provided for each system was not complete. Details for portions of the water systems should be found so that the maps can be completed. (N/A)
23.	Valves that were shown on the maps provided have been shown on a new overall map. Valve details should be developed in the field so that every valve can be identified from known monuments. In addition, each valve should be GPS'd so that coordinates can be used to locate each valve when necessary. (N/A)
24.	Repair broken/inoperable valves immediately. Valves that are inoperable can make isolation of small sections very difficult. Valves that are closed can result in stagnant water in parts of the distribution system. (TBD)
25.	Distribution – Identify and label any valves that open clockwise. Valves normally open counterclockwise, but some valves are

	manufactured to open in the opposite direction. Either label valves that open clockwise in the field or replace the valves with new valves so that all valves in the distribution system open identically. (TBD)
26.	Dead Ends – Evaluate the installation of additional automated flushing units. Test portions of the distribution system to see if any additional flushing units are required. Testing may also prove that some of the recommended flushing units can be turned off during certain seasons of the year, such as during heavy demands when customer demand keeps the water age low. The number of additional flushing units may be lower than the original seventeen units once water quality is optimized and once water age is calculated using a computer model of the distribution system. Initial estimate is four units at $4,000 each = $16,000.
27.	Exercise each distribution valve annually. Record any valves that are broken or inoperable. In many cases the valve box may not have been installed properly such that the placement of a valve wrench on the valve is very difficult. Valve boxes that are off center and make operation of a valve difficult should be excavated and placed correctly. Valve boxes should not bear on the distribution pipe but should be supported independently such that they bear on separate supports. (N/A)
28.	Consider building a computer model of each distribution system to verify system capacity and to review water age. Computer models are also extremely helpful when looking for closed valves and to investigate other water issues. Any computer model should be field verified and calibrated. ($20,000)
29.	The Parish should purchase the latest AWWA M20 manual on chlorination. Each operator should be required to study the manual

	so that they can learn more about the chemistry and details of running a chloramine water system. ($150)
30.	The Parish should engage customers in education about the water system. The Parish should make customers aware of improvements to the water system that stem from this report. Customer should also be educated on items such as home filters. Manufactures recommendations should be followed for water pitches such as those manufactured by Britta. For example, literature from Britta shows that the pitcher filters should be changed every 40 gallons or every 2 months, which ever comes first. Customers should also be educated on stagnant water in their homes caused by low to no usage in portions of their home such as a guest bathroom. Frequent flushing within a home should be stressed to ensure the best water quality at all times. One often overlooked item is pet water bowls. Water bowls for pet should be cleaned each time the bowl is refilled. Customers should be informed of the danger of simply refilling partially full water bowls that should instead be cleaned out frequently. (N/A)
31.	The Parish should inform customers whenever pressure in the distribution system is lost for even a slight period of time. Any time pressure in the distribution system drops below the LDH requirement of 20 psi there is a chance that contamination could occur. With the new SCADA systems alarms can now be generated from the Steele Road or Willow Wood well sites should pressures drop in the water distribution system. An automated notice to all customers could be generated should a low pressure alarm occur from either of these well sites. Unfortunately, until

	SCADA is installed at the Meadow Lake well site no automated notice of a loss of pressure will be available for that system. (N/A)
32.	A loss of chlorine residual (less than 0.5 mg/l) is a significant problem that must be addressed immediately. If the loss is system wide, then a boil water advisory should be issued to all customers until the residual is reinstated and bacteriological samples are taken to ensure that no bacteriological contamination is present. If the loss of chlorine residual is only in a local area, then the extent of low chlorine residual should be established by taking samples that can identify the boundary of the area impacted. Customers should be notified within the boundary of the area of the low chlorine residual of a boil water advisory. Flushing should begin immediately to raise the residual chlorine to acceptable levels. The boil water advisory should not be lifted until bacteriological samples taken within the area per LDH requirements are cleared. Fortunately, water systems where the internal water pressure is maintained but see a loss of chlorine residual can be less susceptible to contamination. But, in our opinion this does not negate the responsibility of the water system to immediately notify customers nor to take appropriate bacteriological water samples to ensure that the water is safe to drink. (N/A)
33.	Ensure that each well site has duplication in chemical feed. During the course of this study only one chemical feed pump was operational at each site. Each site should have complete duplication in chemical feed pumps with either pump fully capable of running at any time. Pumps that are out of service should be given top priority for repairs so that they are returned to service immediately. A common pump for all sites will allow spare pumps to be kept such that a spare pump could be used for any site when needed. (See Item 3)

34.	Strong consideration should be given to the erection of an elevated tank for the Cross Gates system. An extension of waterlines to the Meadow Lake system would allow this same elevated tank to service that area. An elevated tank will provide a large volume of water for fire protection as well as a significant volume of water to sustain the systems during events where the wells are out of service. Well operation will be optimized and improved with an elevated tank. ($2,000,000)
35.	Consider switching disinfectant from liquid sodium hypochlorite to gas chlorine. The implementation of secondary containment is strongly recommended if chlorine gas is utilized. ($600,000)