November 10, 2016

Wastewater Treatment Plant Review

Crosslake, Minnesota

B11.111502

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Certification

for

Wastewater Treatment Plant Review

City of Crosslake, Minnesota
BMI Project Number B11.111502

November 10, 2016

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

By: ______________________________
John Graupman, P.E.
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Date: November 10, 2016

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I. INTRODUCTION

We welcome the opportunity to work with the City of Crosslake on review of its wastewater system. This report will review the system's capacity, design rating and current utilization. It will also review in detail the itemized list of improvements highlighted in the WSN report dated April 2016 along with other possible modifications and improvements suggested by City staff. We have met twice with staff to review the facility, issues and potential modifications in development of this report.

II. WASTEWATER TREATMENT FACILITY CAPACITY

The City of Crosslake Wastewater Treatment Plant (WWTP) was constructed in 2004. It is designed and permitted for an average daily flow of 0.150 million gallons per day (MGD). This is based on averaging flows over the peak 30-day period and is referred to as the average wet weather flow (AWW). The WWTP must also be able to handle the peak day flows and more importantly the peak flow received at the lift station. This is referred to as the peak hourly wet weather flow (PHWW) and would typically be seen during a heavy precipitation event. Figure 1 shows a typical daily flow graph highlighting the average and peak flow difference.

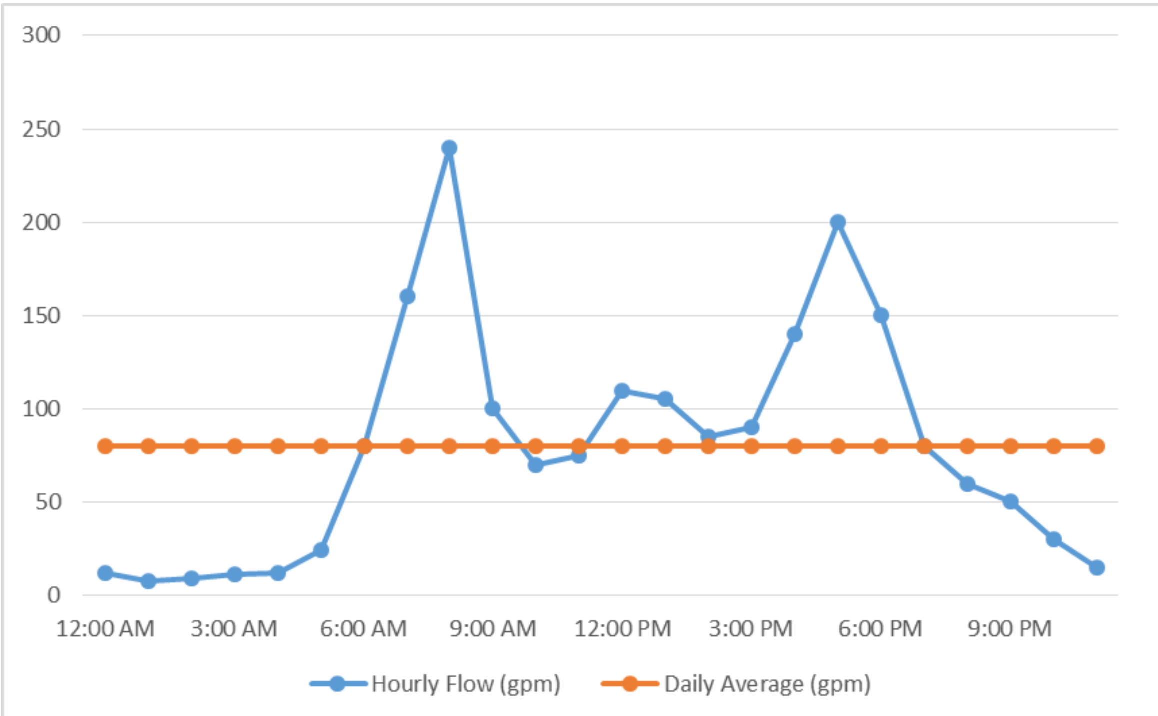

Figure 1 - Typical Daily Flow Variations

The main lift station receives flow from a 12-inch gravity line. It is pumped through a 6-inch forcemain to the pretreatment facility. All piping and treatment processes downstream of the lift station need to be able to handle the peak flows to prevent overflowing structures. Any overflow is considered a bypass and would require notification of the Minnesota Pollution Control Agency (MPCA) duty officer and associated documentation of this violation. The lift station currently pumps up to 500 gpm. This is the peak flow the WWTP should be able to handle. (Note City staff currently is working to replace the pumps with smaller pumps. While this is acceptable for the short-term while the plant is operating at partial capacity, this is considered a short-term fix and reduces the plants overall capacity.)

The first process after the main lift station is the pretreatment facility. This consists of a screen to remove solids and an aerated grit tank to separate grit. These processes are capable of handling the peak flows. Following the pretreatment process, the wastewater flows to the oxidation ditch. The piping between these structures is not large enough to handle the lift station flow and additional return activated sludge (RAS) recycle flow and a plant drain lift station flow. The piping is 6-inch diameter gravity line to each ditch. The system needs to handle peak flows with one ditch off-line. The line is taking flow from a 12-inch gravity line and two 4-inch forcemains. This flow is being forced into one 6-inch gravity line. This does not have capacity for peak flows and has resulted in overflows at the flow control structure at the pretreatment facility. The pipe capacity is limited to approximately 200 gpm lift station flow when combined with the RAS and drain flow. Capacity increases to approximately 450 gpm when both ditches are online, which is still below the lift station capacity.

The oxidation ditches are able to handle both the PHWW and AWW flows and loadings with no issue. The piping from the oxidation ditch to the downstream clarifiers is also capable of handling the PHWW flow.

The secondary clarifiers (settling tanks) are rated for a maximum design flow of 0.458 MGD or 317 gpm at PHWW. This is significantly less than the lift station capacity. At higher flows settling is compromised and can result in poor treatment. Staff has observed significant issues at peak flows with solids not settling. The clarifiers are currently a limiting factor to the plant capacity.

After clarifiers the water is filtered in two sand tertiary filters. The original operating concept for the filters involved an upward flow with a continuous backwash. This technology did not work and the filters have been subsequently renovated to a more traditional downward flow with periodic backwashes. Staff worked with a more traditional filter supplier, Tonka, to make this change. The renovated filters would typically be rated at 264 gpm total. Again this is a limiting capacity for the facility and prevents it from achieving its design capacity.

Subsequent to the filters is the ultra-violet (UV) disinfection process. This appears to be adequately sized for peak flows.

A summary of each treatment process or pipeline is presented in Figure 2 below. As can be seen the facility has significant deficiencies at the oxidation ditch feed piping, secondary clarifiers and tertiary filters on a PHWW flow basis.

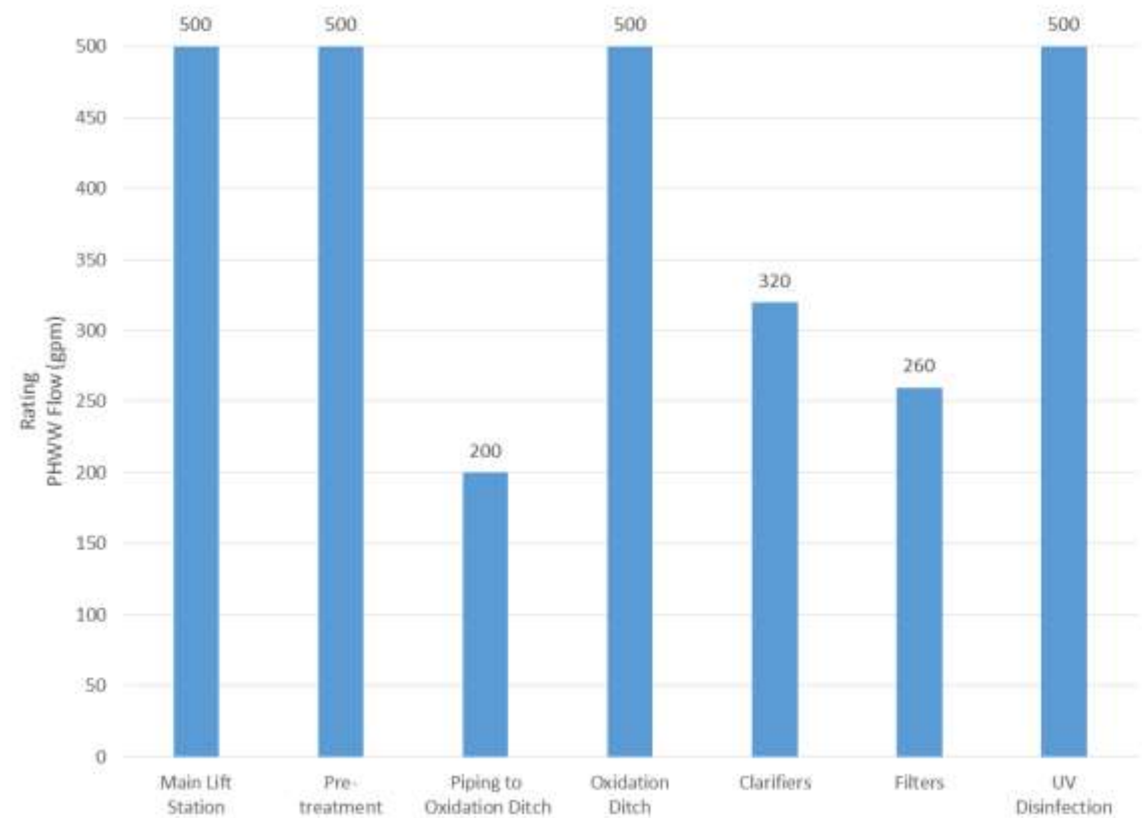

Figure 2 - Crosslake WWTP PHWW Capacity

III. CURRENT FLOWS AND REMAINING CAPACITY

The current daily flows peak at approximately 100,000 for maximum day with the 30-day AWW flows peaking at around 55,000 gpd. This is approximately 35% of the WWTP permitted capacity and shows significant growth capacity and would allow nearly tripling the number of connections. However, the facility must handle both the 30-day AWW flow along with the PHWW flow. The WWTP is essentially at capacity with current peak flows and has limited capacity for growth. It is critical to address the deficiencies to allow the plant to utilize its full treatment capacity.

Ultimately to meet the permitted design flow of 150,000 gpd the facility would need expand the secondary clarifiers and tertiary filters or provide significant equalization storage. Typically expanding the clarifiers and filter capacity would be the best alternative to treatment reliability, however, given the constraints of the building layout, the addition of a clarifier or filter would be difficult. Flow equalization provides temporary storage of peak flows, slowly metering this flow back through the WWTP during low flow periods. This is a more complicated process requiring additional pumps and controls but may fit the site better than expansion of the clarifiers.

IV. WSN RECOMMENDATIONS

The following itemized review is numbered as appearing in the WSN report. The wastewater treatment plant is in generally good physical condition. Most improvements discussed are corrections to or upgrades of the original design and construction. These do not address the inherent hydraulic deficiencies of the wastewater treatment plant.

A. Control Building

1. Item No. 1 discussed expansion of the control building office and lab area. This has already been completed.

2. The current facility was designed with limited automation and central control. Many of the processes are manual (filter backwashing, sludge wasting, etc.) or controlled by proprietary vendor provided panels. Most facilities of this size would have all daily operations fully automated. It is also preferred to have all operations monitored by a central operating system. This allows staff to monitor all operations from a common location giving an overview of the system critical for operations and troubleshooting. The proposed SCADA (supervisory control and data acquisition) upgrades are recommended. These typically would have been included in the original construction for projects of this size and complexity.

   Note that many of the SCADA improvements will require additional automation components (motorized valves, flow paced chemical pumps, etc.) to fully utilize the SCADA potential. Most of these improvements are discussed in other items in this report.

B. Preliminary Treatment

1. The pretreatment facility utilizes a blower for the aerated grit tank and an air lift pump. One positive displacement (PD) blower currently serves both purposes. The construction plans did not have any blower piping shown. It is unsure how the pipe size was determined since it is not shown on the plans, but the pipe appears to be undersized at 1-inch diameter as it increases to a larger pipe at the aeration equipment connection, creating excess headloss and premature where on the blower. PD blowers are quite noisy, and become significantly louder at higher pressures (as caused by the undersized pipe). Therefore staff's idea to move this outside of the building is well founded. Air piping sizes should be reviewed and properly designed with this change.

   The grit is currently pumped with an air lift pump from the grit tank to the grit classifier. Air lift pumps can be high maintenance and have limited pumping ability, particularly when trying to pump grit. Therefore we would recommend using a self-priming style pump for this application. These pumps are designed for challenging conditions and well suited for this. The use of a pump would allow the blower to be size specifically for the aeration equipment and improve performance of this process.

2. This item refers to replacing corroded hinges and door hardware in the pretreatment facility. This is a corrosive environment and repair of these components will be required periodically. Many of these are not available in aluminum or stainless steel. These items would be most cost-effectively handled by staff to avoid a general contractor markup.

3. The fine screen and grit system are controlled by a proprietary vendor provided control panel. This is not readily adjusted by the operator and not operator friendly. The proposed control panel would be tied into the new SCADA system as part of that equipment with both local and central monitoring available.

4. This item refers to replacing the influent flow meter with one that can be connected to the SCADA system. Monitoring of the influent flows is critical to effective operations and required as part of the MPCA permit. Replacement of the meter and connecting the output to the SCADA system is critical and recommended.

5. This item refers to increasing the height of the flow control structure to prevent it from overflowing. It is our opinion this is a short sighted modification designed to overcome an undersized pipe. The splitter box has a 6-inch gravity flow effluent pipe to each oxidation ditch. The splitter box receives flow from the 12-inch gravity main to Lift Station F which is pumped in a 6-inch forcemain, a 4-inch RAS forcemain and a 4-inch plant drain forcemain. Funneling these three lines into one small 6-inch line is not feasible. This is one of the larger hydraulic limitations of the WWTP as discussed earlier. The lines from the control structure to the oxidation ditches should be replaced with a 10-inch pipe to allow the system to handle the design flows.

   It is also noted the system could be controlled to limit how much is pumped to this control structure to prevent overflows. This is also a very temporary solution to a pipe sizing problem. This would ultimately reduce the WWTP's overall capacity.

   The fine screen is significantly oversized and has operational issues related to this. It should be downsized with a different style better suited for low flows.

C. Oxidation Ditches

1. The brush guards appear to be a maintenance item and can be purchased and replaced by City staff. This would save general contractor mark-up.

2. The proposed concept is upgrading the oxidation ditches with an anoxic zone tank to provide denitrification and better pH control. This is a significant process upgrade and may result in a higher operating classification, increasing staff license requirements, sampling and monitoring. It is possible the pH issue may be better addressed by flow pacing the chemical feed at the clarifiers. The ferric chloride used to treat phosphorus is acidic and can reduce pH. This will be discussed more under item D.

   Denitrification may be required in the future and space for this process should be maintained. However, until this is mandated by the MPCA we would caution the City about voluntarily adding this treatment process as it will likely be eligible for a Point Source Implementation Grant (PSIG) once required by permit, but may not be grant eligible if done voluntarily.

D. Final Clarifiers

1. This item refers to providing cladding of the clarifier building insulation. The insulation was not part of the original design but was added after the original construction. The cladding will protect the insulation. This work is maintenance work and would not require plans for MPCA review. It may be more cost effective to hire this direct than to bid as part of a larger project and incur general contractor markup.

2. This item is related to repairing the clarifier skimmer are and internal aluminum skirting. The skimmer arms have been damaged and require repair. Note any metallic metal will be corroded by a ferric chloride overdose, therefore ferric chloride feed rate control as discussed in the next item is critical.

3. This item discusses flow pacing the ferric chloride used for phosphorus treatment. The WWTP sees widely varying flows, both between day and night, and weekend to weekday. It is difficult to manually adjust the pumps for each condition. The manual setting typically ends up overdosing ferric chloride. Overdosing ferric chloride wastes money, corrodes metal, increases biosolids volume and results in pH issues. Conversely underdosing results in risks of permit violations. For facilities with highly variable flows

from either tourism or industry, flow pacing is standard design. The flow pacing requires the SCADA improvements also be completed as these are inter-related.

4. This item is in regard to the scum pit. Clarifier scum is difficult to pump and is prone to plugging. The original design had a flat bottom pit that does not mix well and has plugging issues. The proposed improvements appear to be a viable solution.

   Another alternative may be to slope the floor of the pit and add a small submersible mixer. These mixers are fractional horsepower and designed specifically for scum and other hard to pump solutions.

E. Wet Well

1. This item refers to adding a submersible transducer in the drain lift station. The proposed equalization tank/backwash holding tank would provide the improvements needed and eliminate the need for improvements to this structure.

F. Sludge Pumps, Measurement and Process Piping

1. These meters should be tied to the SCADA and are necessary improvements. These should be installed as part of the SCADA upgrade.

2. The original design required manual operation of valves to waste sludge. Wasting should be done daily and preferably multiple times per day. Motorized valves or a dedicated pump should have been included in the original design. The proposed improvements will bring this system up to typical design standards which allow automated operation nights and weekends when the plant is not staffed.

   Replacing the RAS pumps with smaller pumps is reasonable. The current pumps are sized for peak flow conditions while the WWTP is operating at less than 50% capacity. The smaller pumps may need to be replaced again at some point in the future as flows increase.

G. Aeration Tank Modifications (Biosolids Storage Tanks)

1. The original design did not provide air piping risers and isolation valves on the air piping. This allowed biosolids to flow back into the pipe when the blowers shut off which over time plug the pipe. The normal design standard is to provide a riser above the HWL so biosolids cannot flow backwards towards the blowers. The original layout also did not have adequate mixing around the pumps. The proposed aeration improvements appear to correct these original deficiencies.

   The pump loadout pumps were designed with a common discharge pipe with no isolation valves. The heat exchanger lines are also common with the discharge pipe. This limits operational flexibility. The proposed improvements would provide independent control of each tank and improve operational flexibility. This is a normal piping configuration typical to the industry as proposed.

2. Additional biosolids storage is beneficial. This is a good concept, however it is key to make sure adequate pumping and piping provisions are provided to operation of this additional tank. The tanks would also require mixing. This can be challenging on above grade tanks in cold climates due to freezing issues. We are concerned the tanks would be of limited use in the winter months and be at risk of freeze damage as proposed. Insulation and heating of the inlet and outlet piping would need to be considered.

   We would recommend the City review the cost of the tanks, pumps, mixers, insulation and heating against custom hauling and treatment options. The City is currently hauling biosolids to the Pine River Area Sewer District (PRASD). It may be possible to haul more frequently to PRASD or other facility rather than construct additional storage. The

City should review the long-term options and costs of biosolids treatment before spending money on a potentially short-term tank project.

The original plant was designed with provisions for future reed drying beds. Costs of these beds and space requirements were reviewed in a 2010 Biosolids Report. This should be updated with current costs and compared to the current needs of the facility to ensure these are a cost effective choice and would not occupy space required by other essential plant expansion items.

H. Final Filter Modifications

1. The original filter design concept did not work. City staff has done a great job of retro-fitting these filters to be more effectively operated and backwashed. However the filters require manual washing and require extensive staff time to wash multiple times per day during high flow periods. The backwash system should be converted to an automatic system utilizing the proposed SCADA controls to determine when to backwash and to control the proposed mechanical valves. It should be noted the filters are size limited and therefore frequently hydraulically overloaded. This increases the frequency of backwashing and makes an automated system a higher priority.

   The filters backwash with treated effluent pumped from a holding tank. The tank is not large enough to backwash both filters at once. This increases staff time required to wash the filters. A larger holding tank to provide wash water to the filters is recommended.

   The water source for backwashing can be either treated effluent or well water. Recycling treated water is common. This water is often used as utility water for non-potable water uses throughout the WWTP in addition to filter backwashing. The report also mentioned drilling of a supply well to serve as a source for backwash water and possible other City uses. This concept may have multiple benefits to the City. However siting the well and storage tank may be difficult and impact future expansion. We would recommend the well be designed and sited as a municipal well to provide the City with the most future use of the well. Siting this as a municipal well does increase setbacks. In summary, both options of washwater supply have benefits but a decision should be based on long-term goals of the City.

   The filter backwash water currently drains to the plant drain lift station. This station's flow, combined with the main lift station can exceed the capacity of the clarifiers and other facility processes. Therefore a backwash holding tank or flow equalization tank is critical to allow the backwash water to be slowly metered back through the WWTP and prevent overloading the clarifiers. This is discussed in more detail below.

I. Electrical Generator

1. The current emergency power system does not meet MPCA design requirements. It was designed to operate only one train of treatment equipment in event of a power outage. All critical processes must maintained in the event of a power outage. As the generator is currently wired, upon power outage the facility loses treatment in one oxidation ditch. However flow to these will not stop and treatment violations could occur. The pretreatment equipment also does not operate during a power outage.

   A new generator and transfer switch sized to handle 100% of the current WWTP along with potential future loads should be installed to replace the existing undersized unit.

2. The proposed SCADA system can be used to optimize the generator operation. However this does not provide significant enough improvements to offset the original sizing of the generator. This should not be considered a long-term fix for the generator size issue.

V. FLOW EQUALIZATION/BACKWASH HOLDING TANK

The WWTP is currently hydraulically limited and has issues with clarifier and filter performance. While adding a clarifier and filter would be a solution, these options are difficult given the configuration of the existing buildings. A flow equalization tank would provide the ability to store the peak flows, pumping these back for treatment during low flow periods.

The flow equalization tank would also serve as a backwash holding tank for the filter backwash. The filters are currently backwashed with the washwater draining to plant drain lift station where it is pumped back to the head of the plant. This wetwell has limited volume and is pumped back at a fixed high rate. Filter systems are commonly designed with backwash holding tanks that can hold up to 2 backwashes. This is then pumped back a slower rate to the head of the plant. A flow equalization tank could serve a dual purpose as a backwash and flow equalization tank.

A flow equalization tank should be designed with mixers to prevent solids from settling. Provisions to aerate the tanks to prevent odors would also be necessary. The tank would be most effective located between the pretreatment building and the oxidation ditches. Approximate dimensions would be 20-ft by 30-ft with an estimated 50,000-75,000 gallons minimum total storage. It would be recommended to construct this as a buried tank to reduce freezing problems.

The flow equalization tank would buffer the peak flows, allowing the plant to maximize the clarifier and filter capacity and reduce the hydraulic limitations these processes currently have.

VI. LONG RANGE PLANNING AND FUNDING

The WWTP currently serves only a portion of the current businesses and residences within the corporate limits of Crosslake. The WWTP was designed to accommodate a larger share of businesses and residences. As discussed earlier, the facility is operating at about 35% capacity, meaning it could increase the number of connections nearly three-fold. This provides the City of Crosslake with many options and choices for long range planning. We would recommend the City engage in a long range growth plan to determine the options and costs of providing sewer service to currently unsewered areas. Ultimately the City needs to determine if it wants to fully utilize the WWTP capacity and revenue potential by connecting additional homes and businesses and if so identify areas of priority.

The City has limited options for grants or other government subsidies as the median household income is too high for most grant programs. The City would potentially be eligible for the State Revolving Fund (SRF) low interest loans, particularly if unsewered areas were being served. This program offers financing for 20-years at 1-3% interest depending current rates other discounts. SRF program requires submittal of a facility plan by March of each year. The submitted projects are then ranking with funding available the next calendar year. The current project scope would not score high and may not be an eligible project. However the City should continue to consider this program for future projects, particularly any involving unsewered areas.

VII. SUMMARY

We believe the best approach is to address the hydraulic limitations of the system first. One of the higher priorities that was not addressed in the WSN report is the addition of a flow equalization/backwash holding tank. This would help to address the significant hydraulic limitations of the facility and achieve its permitted design capacity. Many of the proposed improvements are intertwined with other items and difficult to separate particularly those that are affected by the proposed SCADA system. With that in mind, we would recommend the priority based on need and benefit is:

- Flow equalization/backwash holding tank and pumps
- SCADA control system
- Filter backwash supply tank and automation
- RAS/WAS valve modifications
- Ferric chloride flow pacing

Constructing all the proposed improvements would offer the best economy of scale for contractor bids. Staging the project would result in some overlap of work and likely incur some additional cost versus one large project. Once a scope of work is established a revised cost estimate should be completed to account for scope changes and inflation. We would estimate the project cost is in the $900,000-$1,200,000 range at this time.

The proposed projects are significant cost and will have impacts on wastewater rates. A rate study should be completed prior to any design to determine user rates increases required to finance the project.

The City has a significant investment and resource in available WWTP capacity. The City has options regarding this capacity and options to gain a return on the investment. This is ultimately a good position for the City and allows for pro-active planning and development.