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Wastewater Treatment

And Collection System Facility Plan

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City of Leeton, Missouri

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Leaving a Legacy of
Enduring Improvements to
Our Communities

Lamp Rynearson Purpose Statement

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1 Introduction

1.1 Planning Objectives

The City of Leeton (City) received a grant through the Small Community Engineering Assistance Program (SCEAP) from Missouri Department of Natural Resources (MDNR). The grant consists of the City receiving matching funds from MDNR for $50,000 but must provide 20% of the funds to match the 80% contributed by MDNR. This report incorporates the requirements of the grant and was presented to the City of Leeton for review.

This document includes an evaluation of the City's Wastewater Treatment Facility (WWTF) which included an evaluation of the current flow and organic loading. The review analyzed historical data and projected these parameters to 2040 using population projections. The 2040 data will be used to evaluate alternates that will be most beneficial to the community.

The purpose of this report is to evaluate the effectiveness in the City's ability to meet the upcoming Operating Permit, effective on December 1, 2022, and to evaluate the financial impacts for any improvements. The report presents engineering solutions to allow the City of Leeton to continue to effectively treat the systems wastewater influent. The report will also present improvements for improving the existing collection system infrastructure including lift stations and sewer lines.

1.1.1 Ammonia Related Limits

The City of Leeton currently monitors Ammonia as Nitrogen, but final effluent limitations will become effective on December 1, 2022. These limits are as follows:

- Daily Maximum (April 1 to September 30) – 3.6 mg/L
- Daily Maximum (October 1 to March 31) – 7.5 mg/L
- Monthly Average (April 1 to September 30) – 1.4 mg/L
- Monthly Average (October 1 to March 31) – 2.9 mg/L

The City currently has a three-celled lagoon that will not provide consistent treatment for Ammonia. This report will analyze alternatives to efficiently reduce Ammonia from the effluent discharge and remain within the permitted limits.

1.1.2 *E. coli* Limits

E. coli is currently monitored, but final effluent limitations will become effective on December 1, 2022. The effluent limitations and monitoring requirements for *E. coli* are only applicable during the recreation season, April 1 through October 31. The final effluent limitations are as follows:

- Weekly Average – 1030 colonies/100mL
- Monthly Average – 206 colonies/100mL

The monthly average limit for *E. coli* is expressed as a geometric mean. The weekly average for *E. coli* will be expressed as a geometric mean if more than one (1) sample is collected during the week.

The City currently has no means to disinfect their wastewater effluent. Any improvements will include a disinfection approach for the treatment of *E. coli.*

1.1.3 Inflow and Infiltration Reduction

Minimal improvements have been made to the City's original collection system infrastructure. The report will analyze the average flowrate throughout the system and compare it to wet-weather events. Industry standard guidelines will be used to determine the severity of I/I in the collection system. Improvements will be prioritized based on efficiency for upgrades. Missouri Rural Water (MRW) was also contacted to perform smoke testing in the City to identify unapproved connections to the sanitary system, cracks in pipelines or manhole deficiencies. These areas were noted within the report to assist in the reduction of influent flow to the respective lift stations and WWTF. This test was conducted on June 20, 2019 and the raw data is shown in Appendix C.

1.1.4 Lift Station Evaluation

An evaluation to the two lift stations inside the City limits (Northeast Lift Station and Northwest Lift Station) will be evaluated for efficiency and capacity to meet the current and future projected flow. Any improvements are intended to provide additional reliability and efficiency to the collection system.

1.2 PLANNING AREA

The City of Leeton, Missouri is in Johnson County, Missouri and is approximately 17 miles south of Whiteman Air Force Base and 75 miles southeast of Kansas City, MO.

The City of Leeton's WWTF serves the 554 residents (per the US Census data) in the City which includes approximately 283 sewer connections (per permit). The WWTF serves the area inside the City limits which covers one half square mile. All the residents inside of the City limits are serviced by the City's collection system. There are two lift stations as part of the collection system, but the influent to the plant is a gravity sewer. A collection system map was developed for the City that includes the service area for the City and gravity sewers lift stations. A reduced version of this map is shown in Figure 1.1.

Figure 1.1-- Sewer System

1.3 Facilities Plan Approach

The planning process includes an evaluation of the existing loading data to the treatment facility and develops current baseline loading rates for the lagoon. This includes values for flow, BOD_5, TSS, *E. coli* and Ammonia. Each of these parameters, with the exception of flow, have effluent limitations included in the facility's future discharge permit. Currently only the effluent for BOD_5 and TSS have permitted limits, but *E. coli* and Ammonia limits will occur during the next permit cycle.

The report estimated the projected loads for a twenty-year evaluation period (to 2040). Future loading increases were based on population projections, future land use, and consideration of future industry to the community. This was done using information from the City and available data from government agencies.

Upon completion of the loading parameters it is possible to determine alternates for consideration for the WWTF as well as upgrades to the existing collection system infrastructure. The alternates presented were evaluated with City staff to make efficient use of existing infrastructure and minimize the cost impact to City sewer users.

2 EXISTING CONDITIONS

2.1 DESCRIPTION OF PLANNING AREA

2.1.1 Climate

Typical of the Great Plains region, the City experiences cold and snowy winters, hot summers, and moderate springs and autumns. The temperature ranges from an average high temperature of 37°F in January to 89°F in July. The average annual precipitation is 42.9 inches, the majority of which falls in May through September. Typically, the month of June is the wettest, receiving an average of 5.6 inches of precipitation, and January is the driest, receiving only 1.7 inches of precipitation.

2.1.2 Physical Setting

The facility plan will evaluate the entire City collection system and the City's WWTF. The collection system is noted in Figure 1.1 and the WWTF is detailed in subsequent sections of the report. The WWTF is located immediately to the south of the City at the southwest corner of SE 1200 Road and Highway 2.

2.1.3 Soils

The area is primarily underlain by Permian, Pennsylvanian, and Mississippian sandstone, shale, and limestone bedrock – with a possibility of a thin mantle of loess. Approximate average elevation of the City is 948 feet above mean sea level (AMSL). The dominant soil orders in the Cherokee Prairies (MLRA) are Mollisols and Alfisols. The MLRA also has small areas of Vertisols.

Area soils are related to the physical geography, climate, and vegetation. By reviewing soil maps and geotechnical information it is possible to determine the best uses for a particular area or determine if soils are suitable for a particular development. Over time, human activity affects soil formation by altering and accelerating natural soil processes. Clearing, burning, cultivating, and urbanization can affect soil structure, porosity, and soil nutrients.

The Natural Resources Conservation Services (NRCS) soil resource report for the existing WWTF site and the vicinity is included in Appendix D, along with typical soil profile information from the WWTF site. Generally, soils in this area can be classified as

Hartwell silty loams on slopes ranging from 1% to 3%, with some areas of steeper slopes.

2.1.4 Water Resources

The existing WWTF Lagoon is located at 294 Southeast 1200 Street in Leeton and discharges into an unnamed tributary to Wade Creek. There is currently no information of the flow rate of the receiving stream. Influent tests are taken upstream of lagoon cell one, and effluent tests are taken downstream of lagoon cell three. Topographic information is shown in Figure 2.1.

Table 2.1 -- Leeton Historical Population

Year	Population	Change over Previous Decade	Average Annual Change
1970	425		
1980	604	42.12%	3.58%
1990	632	4.64%	0.45%
2000	619	-2.06%	-0.21%
2010	566	-8.56%	-0.89%
2017*	554*	-2.12%	-0.31%
1970 to 2017 Average		**6.80%**	**0.53%**
*** Census estimated value**			

Table 2.1 shows there has been a slight decrease since 2000. The overall change since 1970 has been a slight increase in average annual population, equating to a 0.53% increase in population. There is potential for some development within the City limits in the north west and east side of the City and discussions with a commercial developer could impact future growth. This development could impact the growth rate but should not dramatically impact the 2040 design population and flowrate.

To gain additional perspective of the possible growth for the City, the population of the county in which Leeton is located (Johnson) was gathered. This information was gathered from Census data to gain an understanding of how the City's population compares with the county and to compare the trends. Table 2.2 shows the historical population of Johnson County since 1970.

Table 2.2 -- Johnson County, Missouri Historical Population

Year	Population	Change Over Previous Decade	Average Annual Change
1970	34,172		
1980	39,059	14.30%	1.35%
1990	42,514	8.85%	0.85%
2000	48,258	13.51%	1.28%
2010	52,595	8.99%	0.86%
2017 *	53,897	2.48	0.35
1970-2017 Average		**9.62%**	**0.94%**
*Census estimated value			

The population of Johnson county shows consistent increase since 1970 and the average of 0.94% is slightly above the City growth rate. There are a few larger City's within the county that may be skewing this data. It is believed the City growth rate more accurately represents the potential population.

This report will assume the average annual increase of 0.53% from 1970 to 2017 and project this information to 2040 for use in design alternates.

2.1.5 Income

The Median Household Income (MHI) for Leeton is reported as $42,813 per the 2017 Census estimate. The Housing and Development (HUD) reports a Low-to-Medium

Income (LMI) limit of $51,600 for Johnson County, Missouri. This income level will be used in the application process for several grants and/or loans that could be available to the City. There is no income survey currently anticipated based on the stated LMI.

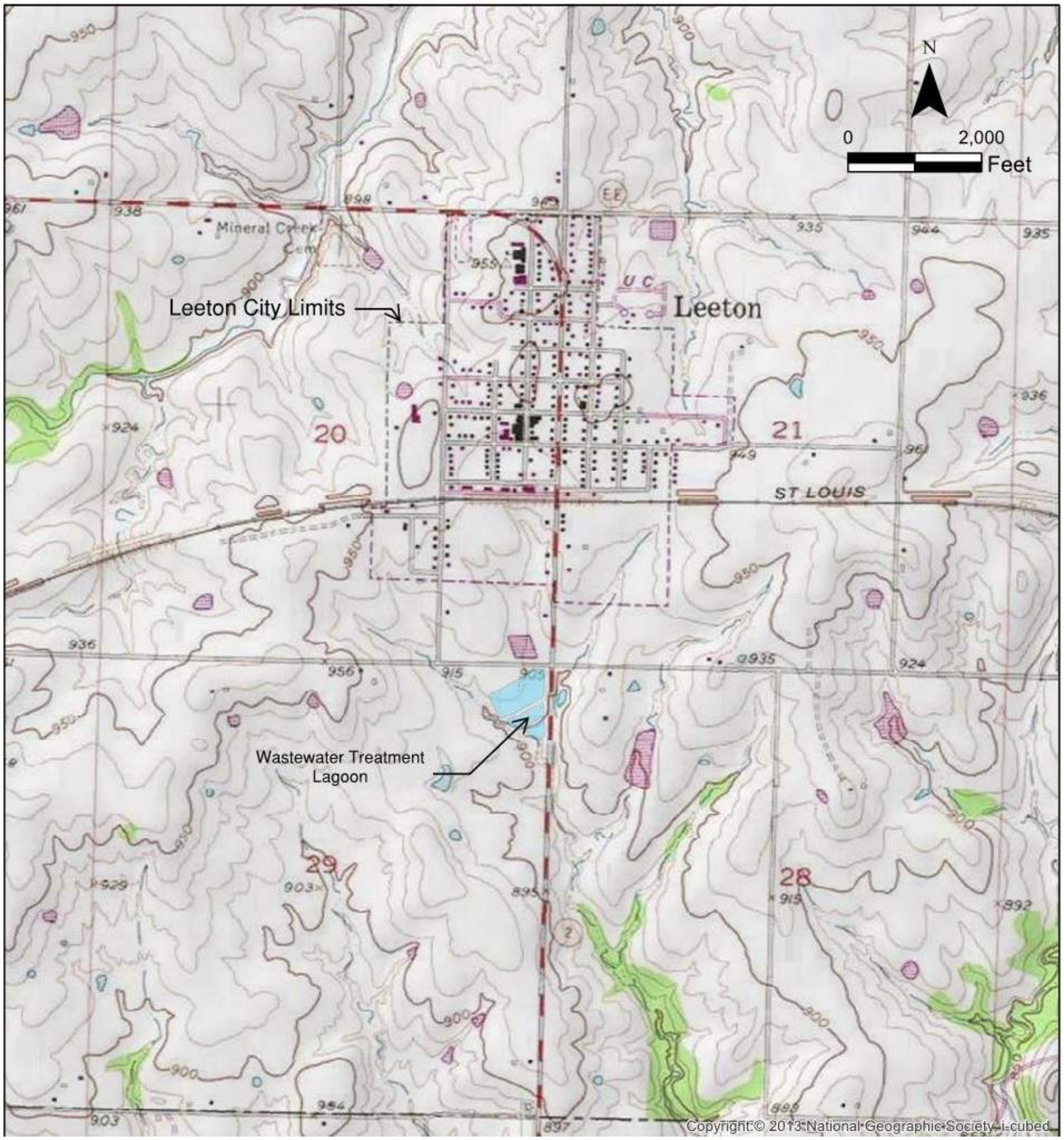

Figure 2.1 -- Topographic Map

2.1.6 Floodplain Surveys

Flood Hazard Boundary Maps produced by the Federal Emergency Management Agency (FEMA) are available for the region. There is no base flood elevation for the immediate area surrounding the lagoon. The lagoon is located in an area of minimal flood hazard as indicated in the figure below. The flood plains are located northwest and south of the WWTF lagoons. To avoid potential flooding problems, all new structures should be constructed at or above the existing lagoon berm elevations.

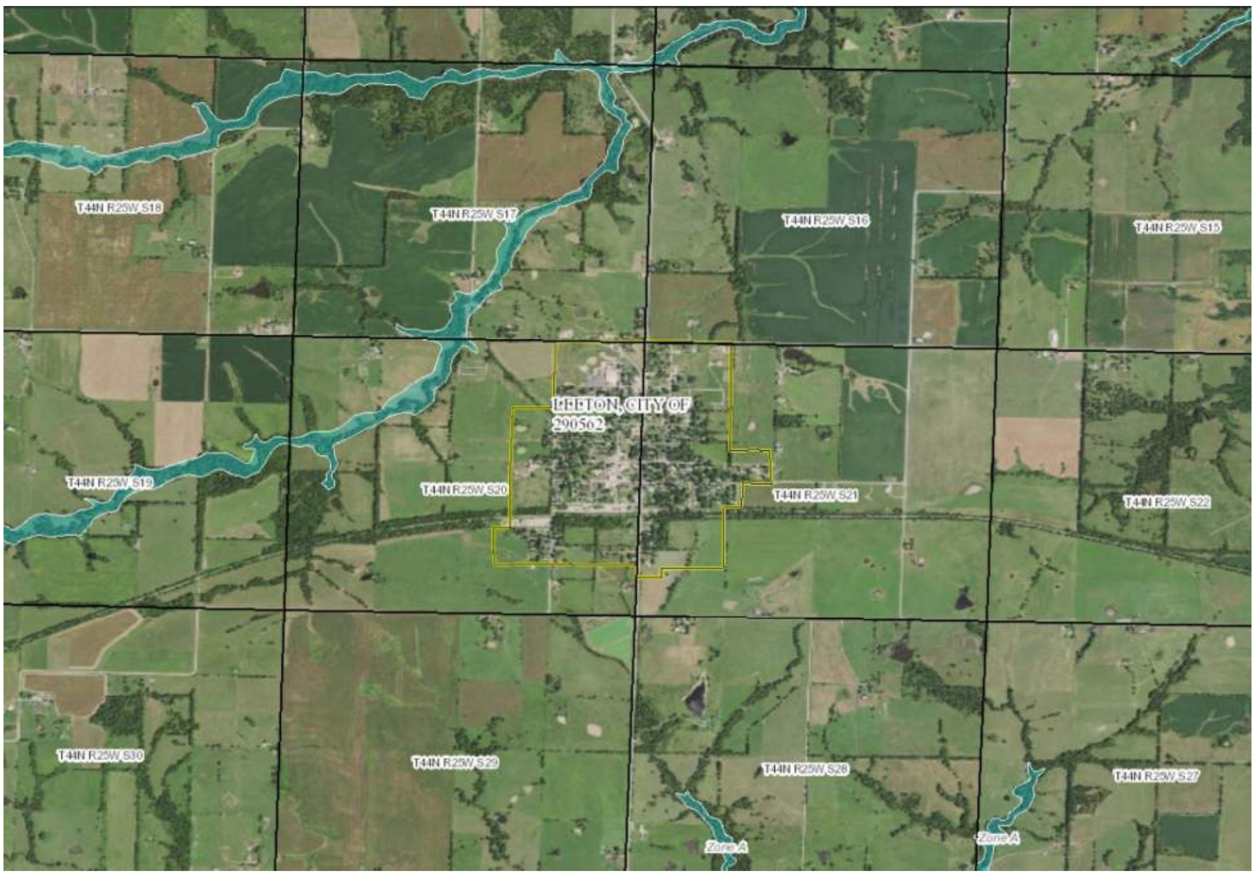

Figure 2.2 -- FEMA Flood Plain

2.1.7 Groundwater

The City of Leeton has one well at 207 N. Graham St. It is approximately 4000 ft. north of the WWTF lagoon. There is minimal concern the impact from any WWTF improvements will impact the water supply source for the City.

2.1.8 Population and Land Use

Population for the City of Leeton was evaluated to gain an understanding of the relationship of current flows and organic loadings and to extrapolate to the design year of 2040. Table 2.1 shows the historical population of Leeton, based upon census records since 1970.

2.2 WASTEWATER FLOWS AND LOADINGS

2.2.1 Wastewater Flow

Flow to the City's lagoon was gathered from the City and is reported through daily monitoring reports. Table 2.3 shows monthly effluent average and maximum flowrates from the lagoon with full MDNR data included in Appendix B. The flow data submitted to MDNR indicates flow from 2010 to 2017 of 3,000 gpd. This flowrate is replicated throughout the available data and is not considered accurate. The standard assumption of 100 gallons per day per capita would result in a flow of 55,400 gpd in 2017. Therefore, a flowrate of 100 gallons per day per capita (gpcd) will be used to estimate the current and future flowrates.

Table 2.3 – Wastewater Treatment Facility Flow Data

	2014		2015		2016		2017		2018	
Month	**Daily Max (MGD)**	**Monthly Avg. (MGD)**	**Daily Max (MGD)**	**Monthly Avg. (MGD)**	**Daily Max (MGD)**	**Monthly Avg. (MGD)**	**Daily Max (MGD)**	**Monthly Avg. (MGD)**	**Daily Max (MGD)**	**Monthly Avg. (MGD)**
January			0.003	0.003	0.003	0.003	0.0030	0.003	0.0001	0.0001
February			0.003	0.003	0.003	0.003	0.0030	0.003	0.2867	0.1102
March					0.003	0.003	0.0030	0.003	0.0514	0.0169
April	0.003	0.003	0.003	0.003	0.003	0.003	0.0030	0.003	0.0007	0.0003
May	0.003	0.003	0.003	0.003	0.003	0.003	0.0030	0.003	0.0017	0.0008
June			0.003	0.003	0.003	0.003	0.0030	0.003	0.0007	0.0003
July	0.003	0.003	0.003	0.003	0.003	0.003	0.0030	0.003	0.0001	0.0001
August	0.003	0.003			0.003	0.003	0.0030	0.003		
September	0.003	0.003			0.003	0.003	0.0030	0.003		
October	0.003	0.003			0.003	0.003	0.0030	0.003	0.0030	0.0030
November	0.003	0.003	0.003	3						
December	0.003	0.003	0.003	0.003			0.0001	0.0001		
Average	**0.003**	**0.003**	**0.003**	**0.378**	**0.003**	**0.003**	**0.0027**	**0.0027**	**0.0431**	**0.0165**
Max	**0.003**	**0.003**	**0.003**	**3**	**0.003**	**0.003**	**0.0030**	**0.0030**	**0.2867**	**0.1102**
Min	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**	**0.0001**	**0.0001**	**0.0001**	**0.0001**

As previously noted, the actual flow submitted to MDNR appears to be incorrect as the data shows a majority of the flows from the facility to have a value of 3,000 gallons per day. Future design considerations will use a flowrate of 100 gpcd for all alternate analysis.

2.2.2 Biological Oxygen Demand (BOD_5)

The National Pollutant Discharge Elimination System (NPDES) permit that will be effective starting December 1, 2022 limit effluent BOD_5 to a weekly average of 65 mg/L, with a monthly average of 45 mg/L. In addition, the facility must provide a BOD_5 removal efficiency of 65%. Missouri 10 CSR 20-8.200(3)(A) states that flow through a three-cell stabilization pond shall not exceed 34 pounds per acre per day at the three-foot operating level. The lagoon cells have a surface area in Cell One of 4.68 acres and Cell Two of 1.44 resulting in a total area of 6.12 acres. This results in the facility having a theoretical capacity of 208 pounds of BOD_5 per day.

Using the current population estimate of 554, and an assumed BOD_5 load of 0.17 pounds per person per day, per Section 11.252 of the Recommended Standards for Wastewater Facilities, 2014 ed., the current BOD_5 load of the facility can be estimated to be 94 pounds per day (ppd). Using a BOD_5 loading of 94 pounds per day and a flowrate of 55,400 gpd results in an estimated BOD_5 influent of 204 mg/L. Records since November 2013 indicate the effluent BOD_5 has varied between 2 mg/L and 66 mg/L, with an average of 20 mg/L. There have been three violations for monthly average BOD_5 concentration and one violation for weekly average BOD_5 concentration. Using an estimated influent BOD_5 loading of 204 mg/L and the average 20 mg/L, the BOD_5 removal efficiency can be estimated to be 90%. Using the estimated influent loading of BOD_5, the City could have had zero violations in the past five years where they did not have a removal efficiency of at least 65%. There is limited influent data from this period to confirm this assumption.

Table 2.4 – Influent BOD_5

Month	2014 Daily Max	2014 Monthly Avg.	2015 Daily Max	2015 Monthly Avg.	2016 Daily Max	2016 Monthly Avg.	2017 Daily Max	2017 Monthly Avg.	2018 Daily Max	2018 Monthly Avg.
March			216	216	60	60	100	100	44	44
June			80	80	124	124	44	44	104	104
September	188	188			144	144	84	84	100	100
December	52	52	60	60	64	64	220	220		
Average	**120**	**120**	**119**	**119**	**98**	**98**	**112**	**112**	**83**	**83**
Max	**188**	**188**	**216**	**216**	**144**	**144**	**220**	**220**	**104**	**104**
Min	**52**	**52**	**60**	**60**	**60**	**60**	**44**	**44**	**44**	**44**

2.2.3 Ammonia

Leeton began testing effluent ammonia prior to November of 2013, but this report will only analyze the data since November of 2013 to remain consistent in the analysis. Since 2013, the average effluent ammonia for April 1 through September 30 is 0.96 mg/L, which is below the regulated limit of 1.4 mg/L. During this period there were two violations for exceeding the daily max, and four violations for the monthly average. The average value during October 1 through March 31 is 0.71 mg/L, which is below the regulated limit of 2.9 mg/L. During this period there was one violation for monthly average.

There are no influent ammonia records available for Leeton, but according to *Metcalf & Eddy*, domestic wastewater typically has influent ammonia levels from 12 mg/L to 45 mg/L.

Ammonia nitrogen removal can occur in facultative lagoons through three processes: gaseous ammonia stripping, ammonia assimilation in algal biomass, and biological nitrification [Middlebrooks, Reed, Abraham and Adams, 1999 - *Nitrogen Removal in Wastewater Stabilization Lagoons]*. Factors affecting nitrogen removal include temperature, pH, detention time and mixing. For estimating purposes, the plug flow model (Reed, 1984, 1985, Reed, et al. 1995) will be used here:

$N_e = N_0 e^{-K_T[t+60.6(pH-6.6)]}$

Where: N_e = effluent total nitrogen, mg/L

N_0 = influent total nitrogen, mg/L

K_T = temperature dependent rate constant

$K_T = K_{20}(\Theta)^{(T-20)}$

K_{20} = rate constant at 20°C = .006496

Θ = 1.039

T = lagoon water temperature (assume 27°C based on average ambient temperatures)

pH = pH of near surface bulk liquid

t = detention time in system, days (180 days at future design)

With a summer temperature of 27°C, average pH of 7.7, full cells and an influent ammonia level of 28.5 mg/L (mid-point of the *Metcalf & Eddy* range),

$N_e = 28.5e^{-.00849[180+60.6(1.1)]} = 3.51$ mg/L

There is insufficient data to calibrate the model to the Leeton lagoons. However, the example above does provide an indication of the level of ammonia removal taking place in the lagoon, and the effect of environmental factors and operating practices on the level of removal.

This value also indicates an average effluent that is approximately equal to the daily maximum value during the summer months. Removal of ammonia by the facultative lagoons to consistently meet the effluent limits without violations and cannot be consistently relied upon. Therefore, upgrades for ammonia removal are required.

2.2.4 Total Suspended Solids

The future NPDES permit requires TSS removal of 65 percent or more as a monthly average, with a weekly average limit of 110 mg/L and a monthly average limit of 70 mg/L. Operating data since November 2013 shows monthly average effluent TSS levels that vary from 0 mg/L to 126 mg/L, with an average effluent TSS of 52.44 mg/L. There were nine violations of the monthly average and three violations of the weekly average.

The influent data on this parameter is not sufficient to provide a removal efficiency, but the MDNR recommendation of using 0.2 pounds/capita/day will be used to generate a theoretical influent TSS quantity. Using a population of 554 results in 111 pounds of TSS, or 240 mg/L at 55,400 gpd. Using these values results in an average TSS removal efficiency of 78%. For an influent of 240 mg/L, there would have been five violations for removal percentage under this assumption.

2.2.5 Oil and Grease

The discharge permit includes quarterly test for monthly average and daily maximum oil and grease concentration (O&G) limits of 10 and 15 mg/L respectively. The City began testing for O&G prior to November 2013. The data in Appendix B shows that since that time the highest value recorded was 5.19 mg/L and is below both the average and maximum requirement noted in the permit.

2.2.6 *Escherichia Coli (E. Coli)*

The NPDES permit includes a future monthly effluent limit (expressed as a geometric mean) of 206 colonies/100mL and 1030 colonies/100mL as a weekly average. These limits will only be applicable during the recreational season from April 1 through October 31. The effluent monthly and weekly average since April 2014 is 508 mg/L. During these months, there would have been two weekly average violations and four monthly average violations if the effluent limit was in effect.

2.3 Wastewater Collection System – Pipelines

The collection system consists of approximately 5.3 miles of gravity sewer and force main. This report does not include a sewer modeling. The map that was previously provided by Missouri Rural Water has been updated.

Smoke testing was performed to identify sources of Inflow and Infiltration (I/I) to the sanitary system, such as cracks in pipelines, uncapped cleanouts, or manhole deficiencies. The City staff have indicated there are ongoing measures that should start to reduce the I/I, which include cleanout capping and manhole repairs. See Section 4.2 for additional information.

2.4 Wastewater Collection System – Lift Stations

There are two (2) lift stations in the collection system. Currently, the flow at the Northeast Lift Station, at manhole 54C, is estimated to have an Average Daily Flow (ADF) of 25,290 gpd (18 gpm). A photograph of this lift station is shown in Figure 2.3. The Northwest Lift Station, at manhole 87, ADF is 8,730 gpd (6.0 gpm). This information is based on an assumption of each person using 75 gallons per day. A photograph of this lift station is shown in Figure 2.4. The evaluation also divided the City population by the recorded number of user connections to get an average of approximately four (4) residents per household. This value is likely a little high based on typical design standards, but it should not greatly impact the flowrate analysis to each lift station.

Figure 2.3 -- Northeast Lift Station

Figure 2.3 shows the Northeast Lift Station site is in fairly good condition and is protected by a locked gate.

Figure 2.4 -- Northwest Lift Station

Figure 2.4 shows the Northwest Lift Station includes an on-site davit crane but does have a lot of corrosion on the equipment. The fence at this location is not as secure and should be replaced as part of any pump station improvement project.

Using a peaking factor of 4.0, and a general assumption of Qin = Qout/2, results in lift station capacity that would need to have the following capacity:

- Northeast Lift Station – 144 gpm
- Northwest Lift Station – 48 gpm

The head of these pump stations is not able to be accurately determined from the available data. Any costs associated with the upgrades of the pumps will assume a conservative value for the head and further analyzed in the final design.

2.5 Wastewater Treatment Facility

The Leeton treatment facility, shown in Figure 2.5, was constructed in 1994 and consists of three facultative lagoon cells in series. Influent enters the facility at a manhole located to the north of Cell No. 1. Sewage then flows to the southwest corner of the cell before entering a 12” PVC line and into the northwest area of Cell No. 2. Flow discharges Cell No. 2 at the southeast end and is discharged into the polishing Cell No. 3 before being discharged. The complete set of existing plans are attached in Appendix F for reference.

Cell No. 1 has a water depth of five feet (5’), a surface area of 4.89 acres at five feet (5’), of 4.68 acres at three feet (3’), and a volume of 7.97 million gallons.

Cell No. 2 also has a water depth of five feet (5’); a surface area of 1.60 acres at five feet (5’), of 1.44 acres at three feet (3’), and a volume of 2.61 million gallons.

Cell No. 3 has a water depth of three feet (3’), a surface area of 0.71 acres at three feet (3’), a volume of 0.69 million gallons; and is triangular in shape.

Figure 2.5 -- Lagoon Cells Looking Southwest

Lagoon cells have transfer piping and an effluent weir box structure that allows the City to adjust the operating water surface level. The WWTP has a total surface area of 7.20 acres and a resultant volume of 11.27 million gallons. However, the lagoon must use 3.13 acres to treat BOD_5 and a minimum pool, typically of two feet (2’) is to be maintained. The effluent weir allows manual reading of flow over a v-notch weir and the current elevation is set at approximate elevation 899.50.

3 FUTURE DESIGN CONDITIONS

3.1 CITY GROWTH

The 2017 population estimate is 554 which would result in a 2040 population of 625 using an annual growth rate of just 0.53%. Discussions with the City and the regional planning commission identified two potential growth areas in the northwest section of the City and a minor development area in the eastern area of the City. The two areas discussed are identified on Figure 3.1.

Figure 3.1 -- Future Development Areas

There may be additional areas where City expansion occurs, but these two areas will be analyzed to confirm there is adequate infrastructure.

3.1.1 Income

The median household income for Leeton is reported as $42,813 per the 2017 Census estimate. The Housing and Development (HUD) reports a Low-to-Medium Income (LMI) limit of $51,600 for Johnson County, Missouri. This is expected to stay fairly constant through the design period.

3.2 COLLECTION SYSTEM

3.2.1 Peaking Factor

For design purposes, peak flow is projected as four times the average daily design flow. The average design flow for 2040 is 62,500 gpd or 43 gpm, resulting in a daily peak flows of 174 gpm. Any future improvements should be sized to meet a 2040 average design flow of 62,500 gpd. Any equipment shall be sized to meet 62,500 gpd as the average design process flow but should have a design hydraulic flow of 250,000 gpd.

3.2.2 Inflow and Infiltration Estimation

To gain an understanding of potential I/I issues, the gallons per day per inch of diameter per mile of pipe (gpd/idm) was analyzed. To determine gpd/idm, the current average daily flow (55,400 gpd) is divided by the total inch miles. The total inch miles are found by multiplying the length of pipeline (in miles) by the associated diameter (in inches). The City has 43.32 idm in their system which equates to a rate of 1,279 gpcd/idm.

Metcalf & Eddy's *[Wastewater Engineering: Collection and Pumping of Wastewater]*, suggests that infiltration rates for whole collection systems (including service connections) that are lower than 1,500 gpd/idm are not usually excessive. Even when using the maximum average for the City of 62,500 gpd, the rate is under this recommended value. However, this assumption is based on the City using 100 gpd and this value cannot be verified. Any recommendations for I/I reduction improvements will be based on issues noted during the smoke testing evaluation.

3.3 Future Flow Projections

Leeton has a projected population growth of 0.53% (see Section 3.1.7). The standard assumption of 100 gallons per day per capita would result in a flow of 55,400 gpd in 2017 with the population of 554. The peak flow is projected as four times the average daily design flow. Table 3.1 shows the average daily flow, and peak daily flow rates, up to 2040. The design year for design is set at 2040 and results in an average daily flow rate of 62,500 gpd. For design purposes, peak flow is projected as four times the average daily design flow which is 250,000 gpd. The current facility is permitted for 87,000 gpd with a design population equivalent of 870.

Table 3.1 -- Future Flow Projection

Year	Population	Average Daily Flow (gpd)	Peak Flow (gpd)
2017	554	55,400	221,600
2020	563	56,300	225,209
2025	578	57,800	231,356
2030	594	59,400	237,670
2035	610	61,000	244,157
2040	625	62,500	250,000

This study will use an ADF rate of 62,500 gpd for the design of any improvements and a peak flow of 250,000 gpd (179 gpm) for pumping capacity and hydraulic plant capacity.

Currently, the flow at the Northeast Lift Station, at manhole 54C, is estimated to have an average daily flow of 25,290 gpd. The Northwest Lift Station, at manhole 87, is 8,730 gpd. The total average daily flow entering the WWTF is estimated to be 56,000 gpd. In 2040, the flow at the Northeast Lift Station is estimated to be approximately same as currently delivered. The Northwest Lift Station will increase flow to 11,010 gpd. As previously noted, the total flow entering the lagoon will 62,500 gpd. This results in 26,200 gpd of flow that discharges into the lagoon without being pumped.

3.4 Future Nutrient Loadings

The nutrient loadings for 2040 are anticipated to remain fairly constant with mg/L data remaining equal to historical data. The pounds per day values are anticipated to increase due to population projections. Table 3.2 shows the projected organic capacity for BOD_5, TSS, Ammonia and *E. Coli*.

Table 3.2 -- 2040 Projected Organic Influent Loading

Parameters	Influent Average Daily		Effluent Average Daily	
	mg/L	ppd	mg/L	ppd
BOD_5	204	106	37**	19
TSS	240	125	57**	30
Ammonia (4/1-9/30)	28.5	15	1.4***	0.7
Ammonia (10/1-3/31)	28.5	15	2.9***	1.5
E. Coli	Unknown		206 #/100 mL	

*Influent Ammonia data is assumed as 28.5 mg/L from literature.

**BOD_5 and TSS required minimum 65% removal on permit.

***Final ammonia effluent limits on permit.

The permitted level for the City beginning in 2023 is achieved by each of the loading rates shown in Table 4.1. Any designed improvements will be designed to meet the permitted level at a minimum, but upgrades to the facility should result in further improvements in the effluent quality. The addition of an additional treatment process and a disinfectant will only improve the projected 2040 values.

3.5 Design Summary

The 2040 design parameters are as follows:

Average Daily Flow

- To Lagoon – 62,500 gpd
- To Northeast Lift Station – 25,290 gpd (18 gpm)
- To Northwest Lift Station – 11,010 gpd (8 gpm)

Peak Flow

- To Lagoon – 174 gpm
- To Northeast Lift Station – 70 gpm
- To Northwest Lift Station – 31 gpm

Organic Loadings (Influent Design)

BOD_5 - 204 mg/L,106 lbs per day

TSS - 240 mg/L, 125 lbs per day

Ammonia – 28.5 mg/L, 15 lbs per day

Organic Loadings (Effluent Design)

BOD_5

- Weekly average – 37 mg/L
- Monthly average – 37 mg/L

TSS

- Weekly average – 57 mg/L
- Monthly average – 57 mg/L

E. coli

- Weekly average – 1030 colonies/100mL
- Monthly average – 206 colonies/100mL

Ammonia

- Daily maximum – 3.6 mg/L (April 1-Sept 30)
  7.5 mg/L (Oct 1 – Mar 31)
- Monthly average – 1.4 mg/L (Apr 1 – Sept 30)
  2.9 mg/L (Oct 1 – Mar 30)

4 Project Alternatives

4.1 Overview

Appendix A shows the effluent limits from the existing permit, MO-0116076, for the Wastewater Treatment Facility, which became effective on October 1, 2016 and expires on November 30, 2022. The updated effluent permit levels are shown in Table 4.1. In addition to the BOD_5 and TSS effluent limits in the Table, the permit requires a minimum removal efficiency of 65%, which as shown in Table 3.2, may require lower effluent BOD_5 & TSS value.

Table 4.1 -- Final Effluent Limitations & Monitoring Requirements Effective Dec. 1, 2022

Effluent Parameters	Units	Daily Maximum	Weekly Average	Monthly Average
BOD_5	mg/L		65	45
TSS	mg/L		110	70
E Coli (4/1 to 10/31)	#/100		1030	206
Ammonia (4/1 to 9/30)	mg/L	3.6		1.4
Ammonia (10/1 to 3/31)	mg/L	7.5		2.9
Oil & Grease	mg/L	15		10

Currently the facility consistently fails to meet BOD_5 removal but does meet Oil & Grease. There have also been some violations of the TSS. If the permit limits were final, Ammonia and *E. Coli* would have violated permit.

Five alternates are noted within in this section and the MDNR Publication 02587 was used as a reference guide. Each alternate is presented with an approximate layout, sizing and associated costs. The selected alternate will be further developed during a preliminary design phase.

4.2 Collection System Upgrades

4.2.1 Pipelines

Flow through pipelines has a recommended maximum velocity of 8 ft/s and a minimum velocity of 2 ft/s. All current pipelines have flows between 2 and 8 ft/s so no changes to pipeline sizes is needed as it relates to capacity.

Smoke testing was conducted on June 20th, 2019 to identify locations of I/I. Test results were documented concerning the origin of I/I, nearest address, and physical location. There was a total of thirteen (13) locations with positive smoke test in the City, as shown in Figure 4.1 and summarized in Table 4.2.

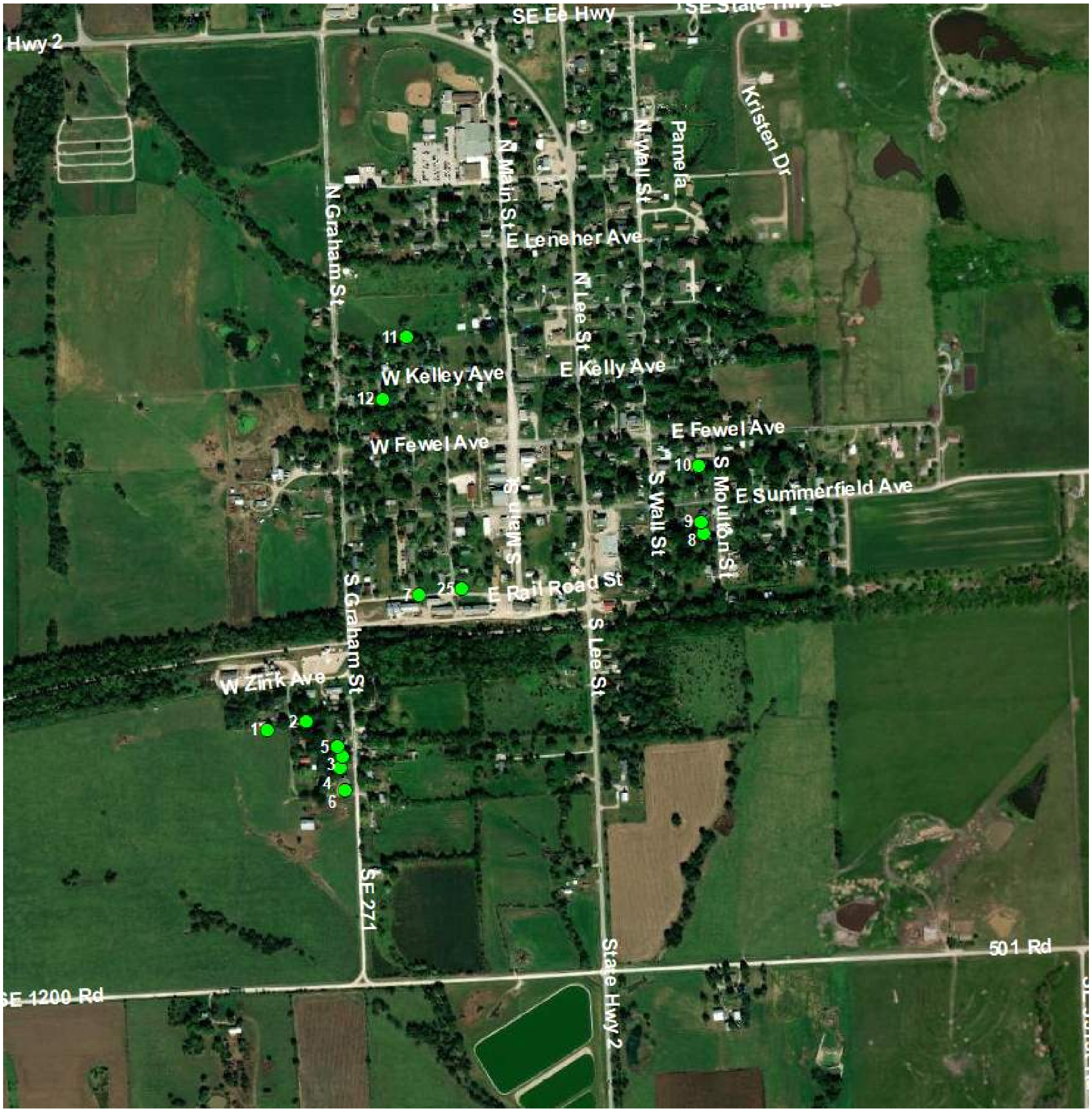

Figure 4.1 -- Inflow & Infiltration Map

Table 4.2 – Positive Smoke Tests

ID	Type	Address	Comment	Location
1	Ground	412 S Marcella St	Smoke coming from ground in yard	38.579111 N 93.701047 W
2	Cleanout	417 S Marcella St	Round stone used as a cover	38.579187 N 93.700286 W
3	Vent	418 S Graham St	Smoke from vent on side of house	38.578630 N 93.699615 W
4	Cleanout	420 S Graham St	Cleanout in yard	38.578456 N 93.699690 W
5	Cleanout	416 S Graham St	Round stone used as a cover	38.578784 N 93.699715 W
6	Ground	Spring St	Smoke coming from ground near house	38.578113 N 93.699630 W
25	Ground	98 W Rail Rd St	Three holes in drainage ditch	38.580937 N 93.697063 W
7	Manhole	101 W Rail Rd St	Large hole on side of MH 15 next to storm water path	38.580981 N 93.697910 W
8	Cleanout	204 S Moulton St	Rock was used as a cover	38.581609 N 93.692339 W
9	Cleanout	200 S Moulton St	Pipe sticking 2' out of ground	38.581783 N 93.692368 W
10	Pipe	104 S Moulton St	Smoke coming from top and bottom of pipe	38.582643 N 93.692333 W
11	Manhole		Crack in in concrete rim	38.584916 N 93.697800 W
12	Ground	203 E Kelly Ave	Smoke coming from ground	38.583997 N 93.698350 W

Figure 4.2 -- Manhole 15 Damage

Figure 4.3 -- Manhole 3 Roots

Table 4.2 shows a range of defects throughout the City that should be repaired. The City should review the cleanout deficiencies and contact the homeowner to determine corrective measures. The deficiencies in the ground along main sewer pipes are recommended to be investigated using Close Circuit Television (CCTV) to determine the pipe condition.

There were two instances of smoke detected near the intersection of South Nickerson and Railroad street where the defect was not immediately known. These two defects were located in the bottom of a drainage ditch and may likely be major contributors to I/I to the system (see Figure 4.2). It is recommended the City have a CCTV review performed for these two areas to determine the severity of the defect. This project could include a replacement of pipeline segments, point repairs cured in place pipes (CIPP). Without additional field investigation, it is not possible to recommend repairs.

There were two instances where cleanouts were leading to the I/I of the system. Manhole 3, seen in Figure 4.3, needs repair due to damage caused by roots. Capping cleanouts is recommended for these locations.

The cost for each of these items is considered minor and is assumed to occur as part of the yearly maintenance budget.

4.2.2 Lift Stations

The Northwest Lift Station is anticipated to receive an average influent flow of approximately 11,000 gpd in 2040 with a peak rate of 31 gpm. The exact capacity of the existing lift station is not currently known and it’s not possible to determine its adequacy based on design flow.

The Northeast Lift Station has an average design influent flow of 25,290 gpd with a peak rate of 70 gpm. The design capacity of these pumps is not currently known and it’s not possible to determine the adequacy of this station.

While the adequacy of these lift stations to meet the current and future design is not able to be determined, the condition of the lift stations was able to be analyzed. Industry standards note a lift station should have a design life of 20 to 30 years depending on maintenance and influent flow conditions.

Both lift stations were installed in 1994 and are twenty-five (25) years old. Field visits to each of these stations identified heavy corrosion to the internal equipment and electrical equipment. It is likely each of the lift stations are approaching the end of their useful life based on their age and the excessive corrosion noted.

Each of the proposed alternates for the City will include upgrades to each of the stations which will include the following:

- Pump Replacement (Two per station)
- Pump Railing Replacement
- Electrical Control Panel Replacement
- Davit Crane Replacement and/or Addition
- Fence Repair to the Northwest Lift Station
- Flow Meters for each Lift Station
- Remote Monitoring on each Lift Station

Figure 4.4 -- Northeast Lift Station Interior

The head capacity for each of the pumps is not immediately known but assumed to be fifty (50') feet for this study to determine and approximate replacement cost. During preliminary design, flow to the pump stations, based on upstream connections and potential growth should be determined to reconnect the design flow for each station.

4.3 Wastewater Treatment Plant Upgrades

4.3.1 Alternate A - Regionalization

The nearest municipalities to Leeton are Calhoun, Chilhowee, and Windsor, MO. All three of these towns are approximately 10 miles from the Leeton Wastewater Treatment Facility. Ten miles of force main would be over two million dollars with additional cost of a lift station, land easement, and potential upgrade to the other community's systems, make this not a valid option. Past experience shows costs becomes prohibitive for regionalization past five miles, so this option was not explored any further.

4.3.2 Alternate B – No Discharge with Land Application

Surface land application is defined as the application of wastewater to the land surface at a controlled rate. Surface land application benefits the crop, soil, and eliminates a discharge to waters of the state. A no-discharge facility would be a long-term solution for the community.

The publication "No-Discharge Alternative Evaluation MDNR PUB 2665" outlines several options to consider when reviewing the feasibility for land application and was used in the preparation of this section.

The acreage required for land application was determined based on a designed maximum loading of 24-inches per year, as noted in the Missouri Wastewater Guidelines and Standards Document (Section 11.5.4). These guidelines were finalized in February 2019 and are used as a basis for this design.

Land application requirements are based upon the following:

- Average daily flow (ADF) = 62,500 gpd
- Effluent applied at a maximum rate of 24-inches (i.e. 2 feet) per year per acre.
- City must adequately treat the influent prior to irrigation.

- The MDNR guidelines allow for a minimum storage of one hundred and five days (105) days

Given the above assumptions, the acres required for land application is calculated as follows:

At ADF: *62,500 gpd × 365 days / (7.48 gals/ft^3 × 2-ft × 43,560 ft^2/acre) = 35 acres*

The design flow results in a spray radius of 700 feet for a single unit, 490 feet for two units, or 350 feet for four units. Figure 4.5 shows possible land applications areas for a single spray unit and two-unit spray diameters.

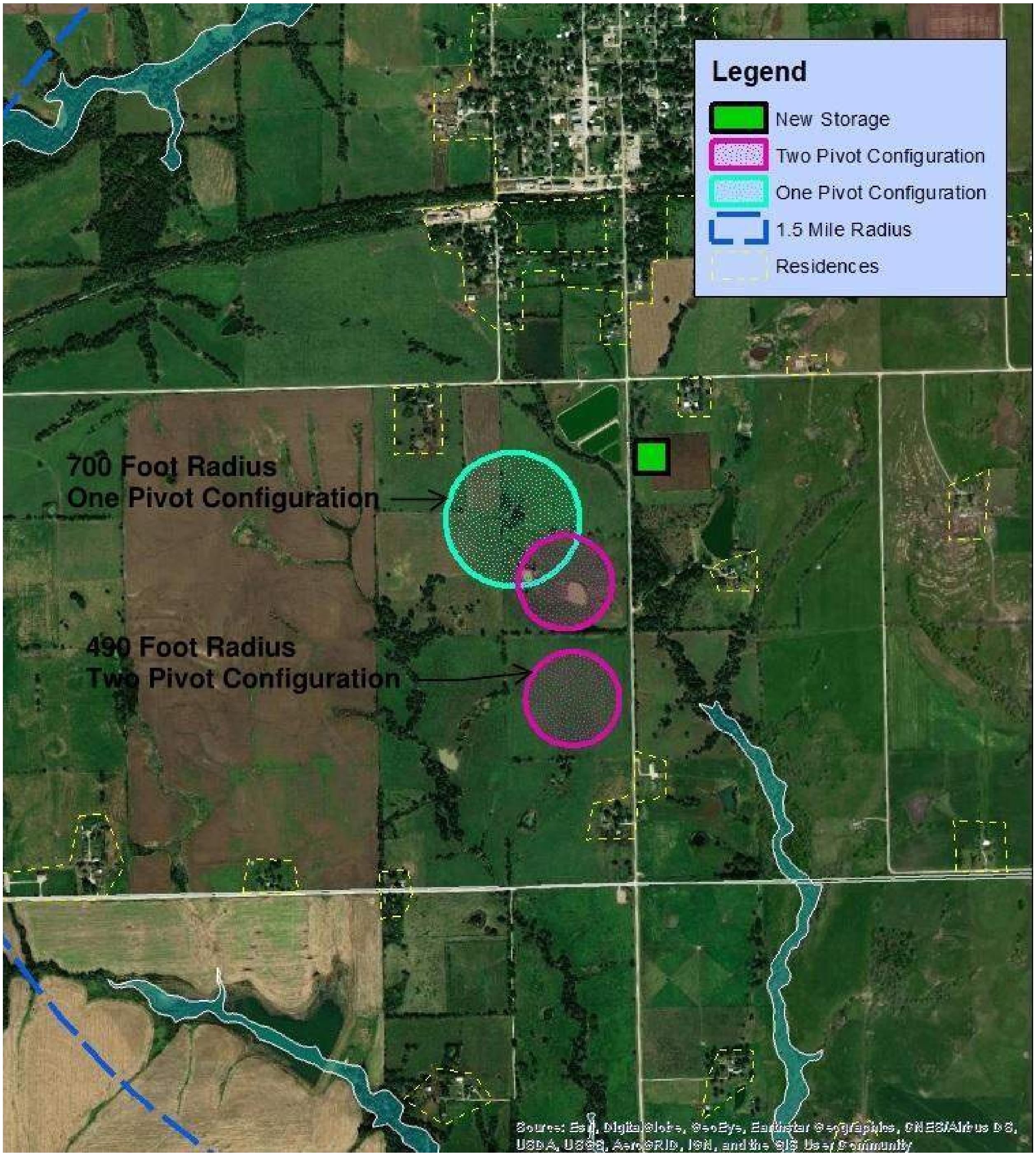

Figure 4.5 -- No Discharge with Land Application

Storage Volume

Land application is not possible when the ground is frozen or during wet-weather periods. Missouri's Department of Natural Resources requires a minimum of 105 days for cities within Johnson County.

The current lagoons have storage available to accommodate 63 days of storage which is not adequate. An additional 42 days of storage are needed which would be equivalent to approximately 2.71 additional acres assuming an operating depth of three feet.

A center pivot irrigation system would be used to apply the lagoon effluent. An effluent pump would be required to use an irrigation system. The pump would be sized to apply the wastewater during an eight-hour work day, five days per week, over a thirty-seven-week period. At a flowrate of 62,500 gpd, the total annual volume of water would be 23 million gallons per year. The required pumping rate is found by:

$$\frac{23{,}000{,}000\ gallons}{37\ weeks * 5\ days * 8\ hours * 60\ minutes} = 260\ gpm$$

The installation of a single center pivot unit would be difficult to control and would present several challenges in the event a section of land was not available for land application. It is our recommendation that a two-system unit would present the City with the best overall approach and is noted in the cost estimate provided in Section 5.

4.3.3 Alternate C – NitrOx

Triplepoint Environmental's NitrOx Process is designed to remove ammonia from lagoon effluent by heating up the basin contents during low temperature periods to achieve rapid nitrification. This process can also be tailored to improve BOD_5 and Total Nitrogen removal. The influent is thermally regulated and insulated to a minimum of 39-42 °F by either heat exchanger or optional geothermal heat source. Complete-mix aeration system creates continuous contact between bacteria, oxygen, and ammonia, removing "dead-zones." The units include self-cleaning media, coarse bubble aeration and automated temperature control with a projected life of over 20 years. Figure 4.6 shows the aeration grid, Figure 4.7 shows the layout next to the lagoon cells.

Figure 4.6 -- NitroOx Aeration Grid

The footprint for each tank is ten-feet by ten-feet with a side water depth of twelve feet. This results in a volume of approximately 9,000 gallons for each tank. The system includes two, 150 standard cubic feet per minute (scfm) blowers. This unit is capable of meeting, or exceeding, the stipulated ammonia requirements.

This will provide some additional BOD removal, but essentially functions to reduce the ammonia in the effluent. The removal of the E. Coli will need to occur through the addition of a disinfectant. Ultraviolet (UV) is the preferred method and will be discussed in subsequent sections.

This technology has at least four installations across the state, but currently is still considered a new/innovative technology. Additional reporting will be necessary for this option if new facilities are not brought on-line prior to the startup of this facility.

The layout for this alternate is shown in Figure 4.7 for reference, and project cost estimate in Section 5.

Figure 4.7 -- NitrOx Layout

The figure shows the flow path and location of the proposed equipment. It is assumed the three-phase power for this unit will be provided from a pole located parallel to Highway 2. A standby generator will also be provided with this solution to ensure treatment occurs during a power outage. This installation will have minimal impact to the current operation of the facility and no additional measures will be required to maintain functionality of the system.

Project cost estimate is provided in Section 5.

4.3.4 Alternate D - SAGR

Ammonia removal, or nitrification, may be accomplished by the addition of a technology that adds polishing cells after the lagoon. This technology is referred to as a submerged attached growth reactor. There are two manufacturer's that provide a system that use this process, SAGR® by Nexom and SMART™ by Environmental Dynamics International. SAGR® system has more installations and a longer track record of success and was reviewed as part of this analysis.

However, for competitive bidding, both systems could be included as part of the final design process with similar functionality.

The submerged attached growth reactor is designed to provide nitrification after the existing lagoons provide primary BOD removal. For the nitrifying bacteria to dominate and be effective, the influent BOD to the submerged growth reactor must be 25 mg/L or less. If not, additional volume is required in the submerged growth reactor for BOD removal in addition to nitrification.

The addition of six (6) 1.5HP surface aerators are also recommended to increase the dissolved oxygen (DO) in the system. This will allow the system to produce a better removal of the BOD in the system and limit the removal required from the SAGR® units at a minimal cost. The depth of the lagoon cells requires aeration equipment with a shallow operating depth. This report analyzed the use of the Aquarian Professional (AQP-15) unit which had a minimum operational depth of 24-inches. These units can deliver an oxygen transfer rate at 3.0 pounds per hour per unit.

The post-lagoon SAGR® treatment basin will include a lagoon liner, gravel media, blowers, and diffusers installed below the media. This design provides an environment where the nitrifying bacteria can attach to the gravel media, grow, and remove ammonia through nitrification. A standby generator is also recommended to keep the facility operational during an outage.

Note that these submerged attached growth reactors are only designed for nitrification, that is the conversion of ammonia (NH_3) to nitrite and nitrate ions. Total nitrogen removal requires denitrification, which is the conversion of the nitrite (NO_2) and nitrates (NO_3) to nitrogen gas (N_2). If a total nitrogen (TN) effluent limit is added to the discharge permit in the future, additional upgrades would be required. The SAGR proposal does not address modifications for total nitrogen removal, but it's possible to modify the existing process in the future to account for these regulations. This would be accomplished by recirculating a significant percentage of the flow to the front of the system, or by adding a second reactor that operates in the anoxic mode (without oxygen). The modification to this process would require additional carbon to drive nitrate removal. Figure 4.8 shows the size and possible locations of the SAGR grid.

Figure 4.8 -- SAGR® Location Options

The implementation of this option will minimally impact the current function of the facility and no major improvements are required to ensure operational effectiveness during construction.

4.3.5 Disinfection Alternate - Ultraviolet Disinfection (UV)

The addition of each of Alternates C and D is effective with the removal of ammonia but does not adequately remove *E. coli*. Disinfection is needed to reduce this potential pathogen. The addition of an UV system is recommended due to its simplicity and the elimination of chemical addition to the effluent.

Ultraviolet light kills bacteria and viruses by destroying their genetic material. The performance of a UV system to disinfect wastewater is expressed in terms of reduction of bacteria, or "kill". The system will be designed to reduce bacteria counts to an allowable level, which is indicated in the NPDES permit issued to the facility. The design is for a maximum of 206 colonies per 100 mL of E. coli on a monthly average basis, and 1,030 colonies per 100 mL of E. coli on a weekly average basis.

The dose of UV light available to kill bacteria is measured in microwatt-seconds per cm^2, which is equivalent to the product of the light intensity and the duration of exposure, or retention time. Any factor that affects light intensity or retention time will affect performance.

UV Dose =	UV Intensity x	Exposure Time
[J/m2]	[W/m2]	[s]

Ultraviolet light is energy-rich light with a wavelength of 200 – 400 nanometers (nm), see Figure 4-9. UV light is very versatile and can be used for disinfecting water, destroying harmful microorganisms in other liquids, on surfaces, and in air. The intensive UVC radiation, most strongly in the wavelength range of 254 nm, reaches the microorganisms and impacts directly on their DNA, see Figure 4-10. By changing the DNA, the cell division of the microorganism is interrupted, no longer can reproduce itself and thus loses its pathogenic effect. With UV technology destruction of more than 99.99% of all pathogens within seconds, without addition of chemicals, nor harmful side effects are possible, and the process is highly efficient and reliable.

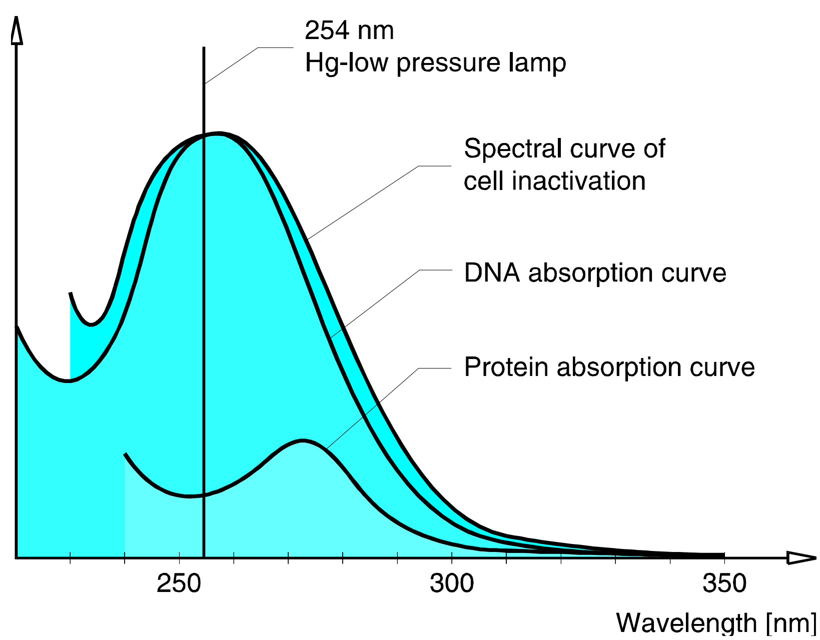

Figure 4.9 -- UV Microorganism Inactivation Curve

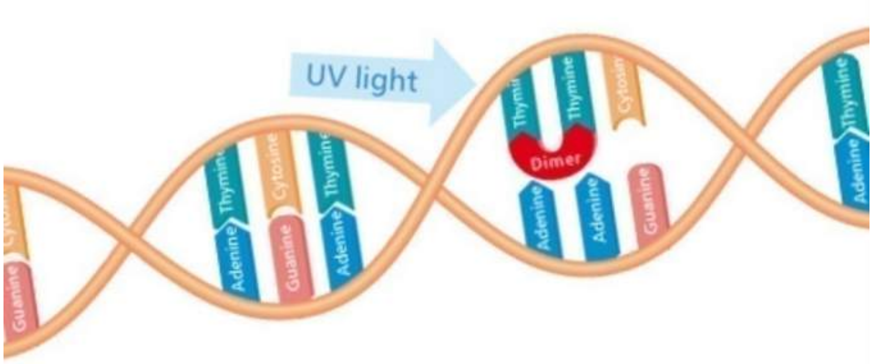

Figure 4.10 -- UV Radiation Effect on DNA

UV disinfection is a purely physical process. The light necessary for UV disinfection is generated in special UV lamps. A watertight tube made of quartz glass which allows the UV light to pass through surrounds each lamp. The liquid to be disinfected runs past the quartz tubing, being irradiated by the UV light. The number of UV lamps employed varies according to flow rate and transmittance of the medium. UV systems are suited for the disinfection of drinking water, process water, wastewater, salt water, ultrapure water and other translucent fluids, e.g. sugar syrup."

One factor affecting UV sizing is flow rate. Increasing the rate of effluent flow through the UV channel decreases the retention time, resulting in lower kill. The UV system will be designed to treat an average daily flow of 62,500 gpd.

Effluent quality is another important factor in UV efficacy. The two aspects of effluent quality that most affect performance is ultraviolet transmittance and level of suspended solids. The ultraviolet transmittance of an effluent sample is defined as the percentage of UV light not absorbed after passing through 1 cm of effluent. Transmittance depends on dissolved and suspended matter in the effluent. Reduced transmittance lowers the intensity of the light reaching the bacteria, resulting in decreased kill. The visual clarity of an effluent sample is not always a good indicator of its UV transmittance since effluent that is clear to visible light may absorb invisible ultraviolet wave lengths. Suspended solids consist of any filterable particles in the effluent. They are measured in parts per million or mg/L. Suspended solids lower the UV transmittance by scattering and absorbing the light. TSS materials can also reduce kills by encapsulating bacteria which shields the organisms from exposure to the UV light.

Effluent treated with UV light is chemically unchanged by the treatment. There is no increase in toxicity to humans or the natural environment. This, along with low operation and maintenance cost, makes UV disinfection a favorable alternative to chlorination or other forms of disinfection. Chlorination requires dichlorination prior to discharge which adds another chemical to store and feed.

Each lamp in the UV Treatment System is a powerful source of UV light. UV light can cause considerable damage to unprotected eyes and skin but is safe when the proper precautions are taken. The best protection is to prevent exposure to UV light. The UV modules pose no health threat when submerged and in their support racks because exposure to UV light is greatly reduced. If working on an open source of UV light becomes necessary, gloves, protective long clothing, and UV face shield should be worn. Ordinary eyeglasses, safety glasses with plastic lenses, or goggles that do not cover the entire face, are not adequate protection. No part of the body should be exposed to UV light.

The UV lamps will be located in an open concrete channel or flume. The control panel will be located adjacent to the UV channel. A length of the weir located downstream of the lamps will assist in maintaining a nearly constant water level through the UV channel. A UV detection system will be provided with the lamps, which will indicate if the lamps should be replaced.

Modern UV systems are available in multiple configurations with several options, each having their own positive and negative attributes:

- Horizontal or vertical lamp orientation.
    - Horizontal lamps require a longer, but shallower, channel.
    - Removing and maintaining modules is easier with a horizontal configuration.
    - Vertical lamps can be changed without removing modules from the channel.
    - Vertical lamps require a smaller footprint and deeper channel.
    - Vertical systems create larger head loss.
    - Algae catching on vertical systems can create a large moment load on the glass sleeves.

- Ballasts can be located either in the UV banks in the channel or in the control panel.
  - There are electrical advantages to locating ballasts close to the bulb.
  - Ballasts located in the channel are subject to flooding and are difficult to maintain.
- Low or medium pressure, and low or high intensity, lamps.
  - Low pressure, low intensity lamps have high efficiency, but low output.
  - Medium pressure, high intensity lamps have low efficiency and high output. Medium-pressure lamps reach temperatures of 600 - 800°C.
  - Low pressure, high intensity lamps have high efficiency and high output. These lamps may also be operated with varying intensity. Lamps reach a temperature of just 100°C in operation and are less susceptible to varying water temperatures. Surface deposition on the quartz sleeves as well as lamp ageing is both considerably lower than with alternative UV lamp technologies. No liquid mercury is used.
- Cleaning systems consisting of wipers, wipers with chemical addition or air scour.
  - Air scour systems are of questionable benefit.
  - Wiper systems perform well and reduce the need to clean the sleeves outside of the channel.
  - Wiper systems with chemical addition may further reduce the need to remove the sleeves from the channel for cleaning.
- Water level control can be accomplished with weighted gates, electrically operated downward opening weirs or serpentine weirs.
  - Serpentine weirs are the simplest and surest method of level control.
  - Due to the maximum desired head variation of 1.5”, serpentine weirs may become very long.
  - Weighted gates do not require an excessive amount of space but are the least positive of the options and subject to leakage.

- Downward opening gates offer positive control and require little space but are complicated and maintenance intensive. Downward opening gates require a deeper downstream structure to provide for movement of the gate.

Project costs estimate for disinfection is included in each of the treatment alternates in Section 5.

5 ALTERNATES COST COMPARISON

5.1 GENERAL

A capital construction cost, Operation and Maintenance (O&M) cost are developed for Alternates B, C, and D. Alternate A was not considered to be practical and will not be developed. Each of the costs presented represent data from recently completed projects or were determined after receiving information from equipment suppliers. The costs are a Level 4 estimate per the Association for the Advancement of Cost Engineering (AACE). This level of estimate has an expected accuracy range of -15% to +50% for any alternate and this facility plan will use a 40% contingency.

5.2 CAPITAL COSTS

5.2.1 Alternate B – Land Application

The cost for Alternate B is based on the design criteria noted in previous sections and will also include the removal of existing sludge in the cells and the addition of an HDPE liner for the additional storage cell.

Table 5.1 – Alternate B Capital Cost – Capital Cost

Land Application	Quantity	Unit	Unit Cost	Amount
Clearing and Grubbing	1	LS	$25,000	$25,000
Storage Cut	7,969	CY	$10	$79,700
Storage fill	5,313	CY	$5	$26,600
Crushed rock	1070	CY	$15	$16,100
HDPE Liner	131,763	SF	$1.30	$171,300
Pumps	2	EA	$35,000	$70,000
Lift Station Structure	1	LS	$50,000	$50,000
Lift station 8" inlet	10	LF	$70	$700
6" Gate valve	2	EA	$1,200	$2,400
6" Flow meter	1	LS	$7,000	$7,000
Connect to existing effluent	1	LS	$2,000	$2,000

Land Application	Quantity	Unit	Unit Cost	Amount
Center pivots	2	EA	$100,000	$200,000
Removal of Sludge*	1	LS	$200,000	$200,000
6" PVC Pipe to Center Pivot	2500	LF	$40	$100,000
Electrical Service	15	%		$142,600
Instrumentation and Controls	10	%		$95,100
			Sub total	$1,188,500
Bonds, Ins, Mobilization (5%)				$59,500
			TOTAL CONSTRUCTION	$1,248,000
Contingency (40%)				$499,200
			Total	$1,747,200
Engineering (10%)				$174,800
Land	90	AC	5000	$450,000
			TOTAL PROJECT	**$2,372,000**
The removal of sludge assumes a sludge depth of 6-in.				

Table 5.1 shows the estimated cost of a land application system is approximately $2.37 million.

This cost estimate is based upon the ability to purchase only enough land as is needed for center pivots and the additional lagoon and on an estimated cost of $5,000 per acre. If the current owner will sell only the entire parcel, the costs would be higher. Appendix D includes USDA NRCS Soil Resource Reports for the preferred application area to the west of the current wastewater facility. This area consists of 92% of various silt loams, which are rated as very limited for use as a wastewater irrigation site. The soils are rated as such due to slow water movement, shallow depth to ground water, and surface slope. The proposed center pivot irrigation system is capable of operating at a slope up to 15%.

However, the shallow ground water and slow water movement may result in a system that performs poorly and that would possibly need to be oversized. Extending the search to a wider area does not result in more favorable conditions.

The NCRS rating would appear to make the soil unsuitable for land application. However, the NCRS data also notes that the capacity of the most limiting layer in the site to transmit water varies from 0.06 inches per hour to 0.20 inches per hour (for soils that comprise more than 2% of the area of interest). At a maximum application rate of 24 inches per year, applied during nine months per year, four weeks per month, five days per week, and eight hours per day, the maximum application rate would be 0.017 inches per hour, which is less than the estimated capacity of the soil.

In addition to unfavorable soil conditions, there is no City-owned land large enough for a land application site. MDNR recommends evaluating locations within 1.5 miles of the current wastewater facility. Figure 4.5 shows the obstacles within this 1.5-mile radius. The northwest portion of the evaluated area falls within the 100-year floodplain.

Residences require a 150-foot setback from potential land application sites. This restriction only eliminates the northern portion of the evaluated area. There are several configurations that would work within the 1.5-mile radius as in Figure 4.5. A dual center-pivot irrigation system would most likely be needed to avoid residences and on un-desirable topography. This area is primarily pasture land, reducing the clearing costs and environmental impacts.

5.2.2 Alternate C - NitrOx

Alternate C reviews the capital costs associated with the NitrOx® system in addition to costs associated with improving the existing lagoon.

Table 5.2 - Alternative C – NitrOx Capital Cost

	QTY	UNIT	UNIT COST	TOTAL
Current Lagoon Improvements				
6-In Gate Valve	6	EA	$3,000	$18,000
18-In Riprap	100	CY	$65	$6,500
HDPE Baffle Walls *	1	LS	$25,000	$25,000
Removal of Sludge	1	LS	$200,000	$200,000
NitrOx System Improvements				
Excavation	250	CY	$30	$7,500
Backfill	225	CY	$25	$5,700
Seeding	1	LS	$5,000	$5,000
Concrete-Walls	100	CY	$1,200	$120,000
Concrete-Slabs	30	CY	$900	$27,000
NitrOx System Equipment *	1	EA	$120,000	$120,000
Misc. Piping, Fittings, and Valves *	1	LS	$25,000	$25,000
Transfer Structures *	2	EA	$15,000	$30,000
UV Equipment *	1	LS	$40,000	$40,000
UV Electrical Enclosure *	240	SF	$120	$28,800
Equipment Installation (* Included equipment)			50%	$134,400
Instrumentation and Controls	10	%	$440,200	$54,400
Electrical Service - 3P/460V	15	%	$440,200	$81,600
Subtotal				**$928,900**
Bonds, Insurance, Mobilization (5%)				$46,500
Total Construction				**$975,400**
Contingency (40%)				$390,200
Total				**$1,365,600**
Engineering (Design & Construction Admin)			15%	$204,900
TOTAL PROJECT COST				**$1,570,500**

Table 5.2 shows the total capital costs associated with improvements to the City's lagoon system are anticipated to be approximately $1.57 million. The engineering cost for this alternative is estimated to be a little higher due to the process design and proper configuration of the baffle walls.

5.2.3 Alternate D - SAGR®

Alternate D includes the capital costs associated with the SAGR® unit, but similar costs for the SMART™ system are also available.

Table 5.3 -- Alternate D Capital Cost

		QTY	UNIT	UNIT COST	TOTAL
Current Lagoon Improvements					
6-In Gate Valve		6	EA	$3,000	$18,000
18-In Riprap		100	CY	$65	$6,500
Baffle Walls		1	LS	$25,000	$25,000
Removal of Sludge		1	LS	$200,000	$200,000
SAGR® System Improvements					
Excavation		700	CY	$30	$21,000
Backfill		717	CY	$25	$18,000
Insulating Rubber Mulch		130	CY	$12	$1,600
SAGR® Media *		1350	Ton	$30	$40,500
Non-Woven Geotextile (8oz.) *		12,870	SF	$0.15	$2,000
HDPE Liner (60 mil) *		8,480	SF	$1.75	$14,900
Wall Framing and Sheathing *		490	LF	$13	$6,400
Influent Flow Splitter Structure *		1	EA	$7,500	$7,500
Effluent Level Control MH *		2	EA	$5,000	$10,000
Misc. Piping, Fittings, and Valves *		1	LS	$10,000	$10,000

		QTY	UNIT	UNIT COST	TOTAL
Equipment (SAGR®) *		1	SET	$168,500	$168,500
Transfer Structure *		2	EA	$10,000	$20,000
Pump Station *		1	EA	$20,000	$20,000
4-inch Forcemain to SAGR® System		1400	LF	$40	$56,000
6-inch Gravity Line from SAGR® System		1400	LF	$60	$84,000
Manhole		4	EA	$5,000	$20,000
UV Equipment *		1	SET	$40,000	$40,000
UV Electrical Enclosure		240	SF	$120	$28,800
Equipment Installation **(* Included equipment)**				50%	$182,400
Instrumentation and Controls		10	%	$948,000	$100,200
Electrical Services		15	%	$948,000	$150,200
				Sub Total	$1,251,500
Bonds, Ins, Mobilization (5%)					$62,600
				Total Construction	**$1,314,100**
Contingency (40%)					$525,600
				TOTAL	**$1,839,700**
Engineering (Design & Construction Admin)				15%	$276,000
				TOTAL PROJECT	**$2,115,700**

Table 5.3 shows costs just above $2.1 million for the installation of this alternate.

5.2.4 Pump Station Upgrades

In addition to the work being performed at the WWTP, it is also recommended the two pump stations within the City be upgraded to account for the deterioration that has occurred since their initial installation. These upgrades will be included in the present worth analysis for each alternate.

Table 5.4 - Pump Station Capital Cost

	QTY	UNIT	UNIT COST	TOTAL
Northeast Lift Station				
Pump Replacement	2	EA	$ 15,000	$30,000
Electrical Replacement	1	LS	$ 15,000	$15,000
Pump Controls Upgrade	1	LS	$ 10,000	$10,000
Valve Replacement	1	LS	$ 7,500	$7,500
Davit Crane Addition	1	LS	$ 2,500	$2,500
Pipe Replacement	1	LS	$ 2,500	$2,500
Northwest Lift Station				
Sitework Restoration	1	LS	$ 5,000	$5,000
Pump Replacement	2	EA	$ 15,000	$30,000
Electrical Replacement	1	LS	$ 15,000	$15,000
Pump Controls Upgrade	1	LS	$ 10,000	$10,000
Valve Replacement	1	LS	$ 7,500	$7,500
Davit Crane Addition	1	LS	$ 2,500	$2,500
Pipe Replacement	1	LS	$ 2,500	$2,500
			Sub Total	$140,000
Bonds, Ins, Mobilization (5%)				$7,000
			Total Construction	**$147,000**
Contingency (40%)				$58,800
			TOTAL	**$205,800**
Engineering (Design & Construction Admin)			15%	$30,900
			TOTAL PROJECT	**$236,700**

5.3 Operation and Maintenance Costs

To determine the present worth costs for each alternate the O&M for each must be determined. The capital costs will be analyzed along with the applicable operation and maintenance costs to determine the actual impact to the City's sewer users.

5.3.1 Alternate B – Land Application

The land application alternate includes operation costs associated with the mechanical equipment needed for operation and the associated maintenance items are noted in Table 5.5.

Table 5.5 – Alternative B – O&M Cost

Description	Qty	HP	kW	Hours/Yr	kWHr/Yr	Unit	Unit Price	Item Total
Irrigation Pumps	2	15	11.2	740	16,555	$/kWHr	$0.10	$1,700
Center pivots	2	2	1.5	740	2,207	$/kWHr	$0.10	$200
Lift Station Pumps	4	7.5	5.6	730	16,331	$/kWHr	$0.10	$1,600
							TOTAL POWER COST	**$3,500**
Irrigation Pump Maintenance (10-year interval)	2						$35,000	$7,000
Lift Station Pump Maintenance (10-year interval)	4						$15,000	$6,000
Center Pivot Maintenance (10-year interval)	2						$17,500	$3,500
					TOTAL REPLACEMENT COST			**$16,500**
Winter cover crop (35 acres at $40/acre)								$1,400
Income from Land Lease (35 acres at $100/acre)								$(3,500)
							ANNUAL O&M COST	**$17,900**

Table 5.5 makes a few assumptions in regard to pump operation and costs associated with crop planting and harvesting but should provide a reasonable assumption for comparison between alternates. The table indicates annual operation and maintenance costs of approximately $18,000.

5.3.2 Alternate C – NitrOx

Table 5.6 -- Alternate C O&M Cost

Item	Qty	Kw-hr/ Bulb	HP	kW	Hrs/Yr	Kw-hr	Unit	Unit Price	Item Total
POWER									
Blowers (24-Hr Operation)	1		5.5	4.1	8,760	35,928	$/ Kw-hr	$0.10	$3,600
Lift Station Pumps	4		7.5	5.6	730	16,331	$/ Kw-hr	$0.10	$1,600
UV Disinfection (24-Hr Operation, 7-months/yr)	4	0.088			5,112	1,789	$/ Kw-hr	$0.10	$200
REPLACEMENT									
Mechanical Seal Replacement - Every 4 years	2						LS	$1,000	$500
Belt Replacement – Every 4 years	2						LS	$1,000	$500
Oil and Filter Replacement – Every 3 years	2						LS	$1,000	$700
Blower Rehabilitation – Every 5 years	2						LS	$2,000	$800
Lift Station Pump Maintenance (10-year replacement interval)	4						LS	$15,000	$6,000

Item	Qty	Kw-hr/ Bulb	HP	kW	Hrs/Yr	Kw-hr	Unit	Unit Price	Item Total
UV Replacement Fund[1]	1						LS	$300	$300
Laboratory Supplies	1						LS	1,000	$1,000
Miscellaneous Equipment Repair	1						LS	1,000	$1,000
TOTAL YEARLY OPERATION COSTS									**$16,200**
1. Replace UV lamps every 12,000 hours, April 1 through October 31 = 213 days/yr; 213 day / yr* 24hr/day=5112hr/yr = 12,000/5,112 = 2.3 yr. Replace UV lamps $150 per lamp x 4 lamps = $600; Total replacement cost for replacement every 2.3 years = $600 / 2.3 years = $261 per year. Estimate $300 per year replacement fund for UV.									

Table 5.6 shows total yearly operation costs of $16,200. These costs are slightly less than the land irrigation alternate due to only four pumps and one blower required for maintenance.

5.3.3 Alternate D – SAGR®

Alternate D includes the operation and maintenance costs associated with the SAGR® equipment.

Table 5.7 -- Alternative E O&M Cost

Item	Qty	Kw-hr/ Bulb	HP	kW	Hrs/ Yr	Kw-hr	Unit	Unit Price	Item Total
POWER									
Blowers (24-Hr Operation)	1		4.2	3.1	8,760	27,436	$/K w-hr	$0.10	$2,700
Pumps (3-Hr Operation/Pump)	2		5	3.7	1,095	8,165	$/K w-hr	$0.10	$800
Lift Station Pumps	4		7.5	5.6	730	16,331	$/K w-hr	$0.10	$1,600
UV Disinfection (24-Hr Operation, 7-months/yr)	4	0.0875			5,112	1,789	$/K w-hr	$0.10	$200

Item	Qty	Kw-hr/ Bulb	HP	kW	Hrs/ Yr	Kw-hr	Unit	Unit Price	Item Total
REPLACEMENT									
Mechanical Seal Replacement - Every 4 years	3						LS	$1,000	$800
Oil and Filter Replacement - Every 3 years	3						LS	$1,000	$1,000
Electric Motor Rewind - Every 5 years	2						LS	$2,000	$800
Lift Station Pump Maintenance (10-year replacement interval)	4						LS	$15,000	$6,000
Laboratory Supplies	1						LS	$1,000	$1,000
UV Replacement Fund[1]	1						LS	$300	$300
Miscellaneous Equipment Repair	1						LS	$1,000	$1,000
TOTAL YEARLY OPERATION COSTS									**$16,200**
1. Replace UV lamps every 12,000 hours, April 1 through October 31 = 213 days/yr; 213day/yr*24hr/day=5112hr/yr = 12,000/5,112 = 2.3 yr. Replace UV lamps $150 per lamp x 4 lamps = $600; Total replacement cost for replacement every 2.3 years = $600 / 2.3 years = $261 per year. Estimate $300 per year replacement fund for UV.									

Table 5.7 shows the O&M costs are similar to the other two alternates due to the similarity of equipment.

5.4 Present Worth

Total present worth of each project were calculated using the United States Department of Agriculture Rural Development loan at 2.75% interest over the next 35 years and the State Revolving Fund loan at 1.67% interest over the next 20 years. Since the regionalization option is not feasible for this project, costs were not calculated for Alternate A. Annual O&M costs, assuming 3% annual inflation were also taken into consideration.

Table 5.8 - USDA Loan Cost

Item	Alt B No Discharge	Alt C NitrOx	Alt D SAGR®
Alternative Cost	$2,372,000	$1,570,500	$2,115,700
Pump Station Upgrades	$236,700	$236,700	$236,700
Loan Amount	$2,608,700	$1,807,200	$2,352,400
Annual Interest Rate	2.75%	2.75%	2.75%
Loan Period (yr.)	35	35	35
Payments/Year	12	12	12
Monthly Payment	$9,657	$6,690	$8,708
Number of Payments	420	420	420
Total Interest	$1,447,260	$1,002,602	$1,305,070
Total Loan Cost	**$4,056,000**	**$2,809,800**	**$3,657,500**
Annual O&M	$17,900	$16,200	$16,200
Annual Inflation	3%	3%	3%
Total O&M Cost	$1,082,300	$979,500	$979,500
Total Project Cost	**$5,138,300**	**$3,789,300**	**$4,637,000**

Table 5.9 – SRF Loan Cost

Item	Alt B No Discharge	Alt C NitrOx	Alt D SAGR®
Alternative Cost	$2,372,000	$1,570,500	$2,003,300
Pump Station Upgrades	$236,700	$236,700	$236,700
Loan Amount	$2,608,700	$1,807,200	$2,240,000
Annual Interest Rate	1.67%	1.67%	1.67%
Loan Period (yr.)	20	20	20
Payments/Year	12	12	12
Monthly Payment	$12,775	$8,850	$10,970
Number of Payments	240	240	240
Total Interest	$457,390	$316,861	$392,745
Total Loan Cost	**$3,066,090**	**$2,124,061**	**$2,632,745**
Annual O&M	$17,909	$16,171	$16,222
Annual Inflation	3%	3%	3%
Total O&M Cost	$481,229	$434,533	$435,895
Total Project Cost	**$3,547,319**	**$2,558,594**	**$3,068,640**

As shown in Table 5.8 and 5.9, the costs for a SRF loan presents a lower total loan cost for each alternate.

5.5 Non-Economic Considerations

The implementation of a non-discharging option, Alternate B, would present some concern due to the proximity of the units to City and the odors that could be associated with the system. The acquisition of land associated with this item could also be problematic due to a majority of the ground surrounding the WWTP currently being used for agricultural purposes.

There are limited concerns with Alternates C and D to meet permits final discharge requirements. As notes, Alternate C, the NitrOx System may be modified to address Total Nitrogen removal. However, the SAGR® System, Alternate C, would require additional upgrades for Total Nitrogen removal.

5.6 RECOMMENDATIONS

It is believed that Alternate C presents the best approach for the City both financially and in terms of effectiveness of the technology. This technology is being used across the country with success, is achieved in a small footprint and is a simplified process for the operator to control.

6 ENVIRONMENTAL IMPACTS

The project will have minor and temporary impacts during construction such as blowing dust, noise from construction activities, and temporary surface disturbance.

The long-term impact to the environment is anticipated to be beneficial as the current discharge quality into the tributary of Wade Creek will be improved.

Coordination with the following agencies is anticipated prior to and during construction:

- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife
- Missouri State Historic Preservation Office
- Missouri Department of Natural Resources Geological Survey
- Missouri Department of Natural Division of State Parks
- Missouri Department of Conservation
- Missouri Office of Administration – Federal Assistance Clearinghouse

A positive environmental impact is anticipated from the project. Without the project, the facility will not be capable of consistently meeting the NPDES permit discharge limits. There are no known historic sites or endangered species within the project area.

7 FINANCES AND FUNDING

7.1 AUDITS

To fund future improvements, an accurate representation of current City expenditures must be known. The analyzation of current operating expenditures will allow for the determination of impact to the utility users and provide guidance for finding additional funding sources. This analysis assumes no grants will be awarded to the City and assumes the current interest rates for both the State Revolving and USDA Loans

Tables 7.1 and 7.2 show the 2017 and 2018 average operating expenditures and net income using the category charges as noted in the City's audit report.

Table 7.1 – 2017 Operating Expenditures

Expense	Water Fund	Sewer Fund	Total
Salaries and employee benefits	$25,616.00	$23,946.00	$49,562.00
Telephone and utilities	$4,813.00	$4,698.00	$9,511.00
Repairs and maintenance	$37,299.00	$25,073.00	$62,372.00
Supplies	$2,343.00	$1,390.00	$3,733.00
Insurance	$1,186.00	$156.00	$1,342.00
Travel, training and dues	$1,318.00	$874.00	$2,192.00
Miscellaneous	$-	$48.00	$48.00
Debt Services	$14,058.00	$-	$14,058.00
Total Disbursements	$86,633.00	$56,185.00	$142,818.00
Operating Receipts	$ 94,827.00	$45,321.00	$140,148.00
Net Income (Loss)	**$ 8,194.00**	**$(10,864.00)**	**$ (2,670.00)**

Table 7.2 – 2018 Operating Expenditures

Expense	Water Fund	Sewer Fund	Total
Salaries and employee benefits	$25,182.00	$24,766.00	$49,948.00
Telephone and utilities	$5,174.00	$6,028.00	$11,202.00
Repairs and maintenance	$28,185.00	$18,552.00	$46,737.00
Supplies	$2,897.00	$1,207.00	$4,104.00
Insurance	$2,133.00	$380.00	$2,513.00
Travel, training and dues	$1,070.00	$753.00	$1,823.00
Miscellaneous	$2,503.00	$2,540.00	$5,043.00
Debt Services	$43,811.00	$-	$43,811.00
Total Disbursements	$110,955.00	$54,226.00	$165,181.00
Operating Receipts	$94,780.00	$86,160.00	$180,940.00
Net Income (Loss)	**$(16,175.00)**	**$31,934.00**	**$ 15,759.00**

Table 7.1 shows a loss of approximately $3,000 from the total of the water and sewer fund but shows a net loss of about $11,000 from just the sewer fund. The City transfers funds from the water and sewer funds and they will be evaluated accordingly. Table 7.2 shows a net profit of approximately $16,000 due to increases in the City's sewer rates.

There are several forms of financing available to the City to complete the design and construction of the presented options. These options include the following:

GENERAL OBLIGATION (GO) BONDS FINANCING

As GO bonds are property tax supported, interest rates are generally low. Additionally, GO bonds are less complex than other types of bonds. While passage of the required 2/3 majority bond referendum can indicate voter support, referendums can delay project scheduling. Failure to pass a referendum requires alternate means of financing. With GO bond financing, taxpayers benefiting from the project may not be the same taxpayers paying for the bond.

REVENUE BONDS FINANCING

Revenue bonds can be advantageous in that the costs of the project are more fairly distributed among those benefiting from the project. Self-supporting revenue bonds require only a simple majority and are not counted toward the City's debt limit. Revenue bonds generally have higher interest rates and, as they are more complex than GO bonds, higher in administrative and underwriting costs. Revenue bonds are currently issued at rates between 3-4%.

STATE REVOLVING FUND (SRF) LOAN

SRF funding is popular due to the low interest rates associated with this type of funding. The SRF interest rate, including the 0.5% MDNR administration fee is approximately 1.67% as of August of 2019. Applications are accepted on a continuous basis, and funds are allocated annually. Therefore, obtaining SRF funding will likely take 18-24 months to be conservative.

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA) LOAN

USDA presents the flexibility to the City to extend their loan payments to a 40-year period. This report assumes a 35-year loan rate based on the life expectancy of the equipment. The interest rate for this loan varies based on community MHI, but a rate of 2.75% is expected to occur for this community.

STATE REVOLVING FUND (SRF) GRANT

The Financial Assistance Center (FAC) will award grant funding based on the project's affordability as determined by utilizing the *Clean Water SRF Grant Eligibility form* and the availability of funding. Each grant dollar awarded is offset by a corresponding reduction in the project's loan and also reduces the overall statewide loan funds allocated to the current fiscal year Intended Use Plan (IUP) projects by an equal amount. Grant funds available to each eligible project will not exceed the lesser of $2 Million dollars, 50% of the eligible project cost, or grant funds available to award under the current year's IUP.

MISSOURI RURAL SEWER GRANT

Leeton is eligible for a rural sewer grant since it is less than 10,000 in population. The grants cover up to 50 percent of the eligible costs of a project up to a maximum of

$500,000 or $3,000 per connection, whichever is less. The current permit (MO-0116076) reports 265 households (connections) in the City. At $3,000 per connection, the total cost would exceed the maximum limit on the grant. Therefore, the grant would be for a maximum of $500,000.

COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG)

According to the FY2019 Application and Guidelines for CDBG grants, low to moderate income (LMI) individuals must account for 51% of the users that benefit from the proposed improvements. This objective can be proven through the following methods: 1) area wide benefit, by survey or census, 2) target area benefit by survey, or 3) limited clientele. Option two must be defensible in terms of the type of facility, and this facility does not meet the requirements for this option. Option three is reserved for facilities that address a specific group of beneficiaries and is not applicable for this project. This project will pursue option one as a means of application.

A review of the census data (area wide benefit by census) for Leeton shows that the median household income is $42,878, and the LMI index for Johnson County is $51,600. It is believed the City will meet the income requirements for this funding source. Information regarding this process can be achieved through the Missouri Department of Economic Development. The results from this process can be used in place of the census data in the attempt to gain funding.

The application maximum is $750,000, or $5,000 per household benefitting from the wastewater project. It is believed the City will have a maximum of $750,000 based on the size of their community.

Based on the increased sewer rates since 2017 (see Table 7.2), it is believed the City's current utility rates are sufficient to cover their current expenditures and provided a profit in 2018. Any proposed increase in rates will be the direct result of debt associated with facility upgrades.

7.2 USER RATES

Table 7.3 shows sewer rate ordinance that was implemented in 2017 and the rates from the following three years.

Table 7.3 – Current Sewer User Rates

Effective	January 2018	January 2019	January 2020
Usage	$19.00	$29.50	$40.00
1,001 - 2,000 gallons	$23.00	$34.00	$45.75
2,001 - 3,000 gallons	$27.00	$38.50	$51.50
3,001 - 4,000 gallons	$31.00	$43.00	$57.25
4,001 - 5,000 gallons	$35.00	$47.50	$63.00
5,001 - 6,000 gallons	$39.00	$52.00	$68.87
6,001 - 7,000 gallons	$43.00	$56.50	$74.50
7,001 - 8,000 gallons	$47.00	$61.00	$80.25
8,001 - 9,000 gallons	$51.00	$65.50	$86.00
9,001 - 10,000 gallons	$55.00	$70.00	$91.75
10,001 - 11,000 gallons	$59.00	$74.50	$97.50
11,001 - 12,000 gallons	$63.00	$79.00	$103.25

Based on the 2018 audit, the total receipt value of $86,160 results in the average consuming between 2001 to 3,000 gallons. The report will analyze the average sewer rate needed for all usage rates as defined in the City ordinance for the alternates.

As previously noted, the median household income for Leeton, MO is $42,813. This equates to an average sewer usage rate of $71.36. This approximate rate will be seen for users consuming over 5001 gallons beginning in 2020, but this report will analyze accurate rates based on proposed upgrades to ensure they're sufficient.

Table 7.4 - USDA User Rates

Item	Alt B No Discharge	Alt C NitrOx	Alt D SAGR®
Total Project Cost	$5,138,200	$3,789,300	$4,637,000
Number of Connections	265	265	265
3,000 gal/mo. Annual User Revenue	$85,860	$85,860	$85,860
Base Revenue Needed (2017/18 Avg.)	$55,205	$55,205	$55,205
Additional Annual Revenue Needed	$146,806	$108,266	$132,486
Total Revenue Needed	$202,011	$163,471	$187,691
Average Monthly Rate per User	$63.53	$51.41	$59.02
Increase from 2018 Base	171%	126%	154%

Table 7.5 - SRF User Rates

Item	Alt B No Discharge	Alt C NitrOx	Alt D SAGR®
Total Project Cost	$3,547,100	$2,559,400	$3,200,200
Number of Connections	265	265	265
3,000 gal/mo. Annual User Revenue	$85,860	$85,860	$85,860
Base Revenue Needed (2017/18 Avg.)	$55,205	$55,205	$55,205
Additional Annual Revenue Needed	$177,355	$127,970	$160,010
Total Revenue Needed	$232,560	$183,175	$215,215
Average Monthly Rate per User	$73.13	$57.60	$67.68
Increase from 2018 Base	207%	149%	186%

Based on the information stated above, Alternate C is the lowest cost solution, but a funding comparison example is shown in Table 7.6 to further illustrate this conclusion.

Table 7.6 – Alternate C Funding Comparison

Item	SRF Loan Only	Private Loan Source	USDA Loan
Loan Amount	$ 1,807,200	$ 1,807,200	$ 1,807,200
Annual Interest Rate	1.67%	5.50%	2.75%
Grant	$ 0	$ 0	$ 0
Loan Period (yr)	20	20	35
Payments/Year	12	12	12
Monthly Payment	$ 8,850	$ 12,375	$ 6,690
Number of Payments	240	240	420
Total Interest	$ 316,861	$ 1,162,748	$ 1,002,602
Total Loan Cost	$ 2,124,061	$ 2,969,948	$ 2,809,802

Alternate C is the preferred option in both scenario and the projected user rates for this option are shown in Table 7.7 below.

Table 7.7 – Alternate C Sewer Rates

	USDA	SRF
less than 1,000	$ 23.96	$ 28.32
1001-2000	$ 29.00	$ 34.28
2001-3000	$ 34.05	$ 40.24
3001-4000	$ 39.09	$ 46.20
4001-5000	$ 44.13	$ 52.17
5001-6000	$ 49.18	$ 58.13
6001-7000	$ 54.22	$ 64.09
7001-8000	$ 59.26	$ 70.05
8001-9000	$ 64.31	$ 76.01
9001-10,000	$ 69.35	$ 81.97
10,001-11,000	$ 74.40	$ 87.94
11,001-12,000	$ 79.44	$ 93.90

Table 7.7 has rates that are comparable to the existing 2019 rates and appear to be slightly lower than the projected 2020 rates. However, the City may elect to keep their current 2020 ordinance in place to determine if actual receipts match what is anticipated. The 2020 rates represent a rate of approximately 2% of MHI and is suggested by various agencies.

8 IMPLEMENTATION STEPS AND SCHEDULE

The City's operating permit, provided in Appendix A, includes a Schedule of Compliance for the City to attain compliance with the final effluent limits for ammonia and *E. coli* (disinfection) by December 31, 2022. The following schedule is proposed to meet the Schedule of Compliance.

- Submit Facility Plan to MDNR for review and approval – September 2019.
- Submit State Revolving Fund application, Form MO 780-1951 (12-19) with the facility plan – December 2019.
- Submit the Facility Plan to the Missouri Water and Wastewater Review Committee (MWWRC), if necessary – January 2020.
- Application to USDA, if directed by MWWRC or the City desires to pursue USDA funding – January 2020.
- Placement of Bond Issue on Ballot for Public Vote – File by January 28, 2020 for April 7, 2020 bond election.
- Begin Design of Recommended Alternate – January 2020
- Design Completion – January 2021
- Submittal of Plans and Specifications for review, Construction Permit Application, and modification of current NPDES permit application (note MDNR recommends submittal 180 days before construction begins) – January 2021
- Bidding – May 2021
- Construction Begins – July 2021
- Construction Complete – August 2022
- Compliance with Final Effluent Limits – December 31, 2022