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Wastewater Treatment Plant Facility Plan Update

Report

City of

North Liberty, IA

April 2025

STRAND ASSOCIATES®

Report for

City of North Liberty, Iowa

Wastewater Treatment Plant Facility Plan Update

Prepared by:

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April 2025

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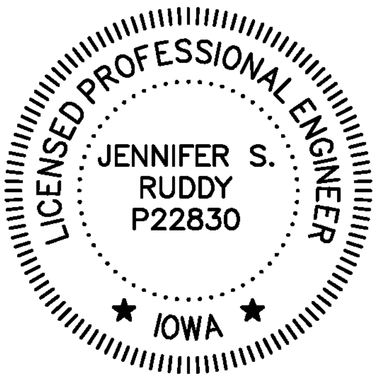
CERTIFICATION PAGE

CITY OF NORTH LIBERTY, IOWA
WASTEWATER TREATMENT PLANT
FACILITY PLAN UPDATE



I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Jennifer Ruddy 4/3/2025

JENNIFER S. RUDDY, P.E. DATE
License number P22830

My license renewal date is December 31, 2026.

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Executive Summary

Background and Scope

The City of North Liberty, Iowa (City) currently operates a membrane bioreactor (MBR) wastewater treatment facility (WWTF). The system was originally constructed at its present location in 1998, with major expansion projects occurring in 2004, 2007, and 2018. The 2004 expansion added a flow equalization (EQ) basin and pumping station. The 2007 expansion, referred to as Phase I, converted the sequencing batch reactor process to the currently used MBR, which has been operating since August 2008. Phase II, which expanded the MBR facilities, added nutrient reduction capability, and improved solids handling facilities, was completed in 2018.

Because of the City's geographical location between the Cities of Iowa City and Cedar Rapids, the community has experienced extremely rapid growth. The population of the City increased from 5,367 in 2000 to 13,374 people in 2010 and to 20,479 in 2020. The population projections for this report are based on the 2021 estimated population, which is approximately 20,875.

Planning for and assisting this rapid growth has been a priority for community leaders and City staff. To help keep pace with rapid growth and plan for future wastewater treatment needs, Strand Associates, Inc.® (Strand) has been retained by the City to prepare a facility plan for the plant. Previously, a facility plan was completed in June 2013 (revised January 2014 by FOX Engineering, Inc. [now Strand]). The plan identified several phases for expanding the plant. Phase II, completed in 2018, was designed to handle a population of 27,800. Phase III was intended to serve a population of 55,000 and Phase IV would serve a population of approximately 80,000. Because Phases III and IV were projecting decades into the future, they were high-level evaluations that identified potential needs and space requirements. The 2014 facility plan also recognized that these would likely be broken into additional phases. This facility plan includes updating the existing and projected wastewater flows and loadings, a review of the capacity and performance of the WWTF, and updating the plan for expansion of the facility for Phases III and IV.

Basis of Evaluation and Design

The City's 2021 population is estimated to be approximately 20,875. Projections provided by the City show that the population is anticipated to grow to around 28,890 by 2030, 40,750 by 2040, and 57,480 by 2050. The WWTF will need to be expanded to keep pace with community growth.

Current wastewater flows and loads average approximately 1.8 million gallons per day (MGD) and 3,100 pounds per day (lb/day) of 5-day biochemical oxygen demand (BOD_5). Per capita flows average 90 gallons per capita per day (gpcd), and per capita BOD_5 loading averages around 0.16 pounds per capita per day (ppcd). To project future wastewater treatment needs based on population growth, flows were projected assuming 100 gpcd and BOD_5 loading was projected assuming 0.17 ppcd. These values are somewhat higher than the existing data shows, but using these more conservative values does provide some factor of safety and flexibility in meeting future needs. Existing data was used to develop peak flow and loads relative to average. Projected flows and loadings are presented in Table 1.

Because of the rapid growth rate, WWTF flows and loads were prepared based on target populations rather than a specific year and divided into phases. Phase IIC proposed improvements are needed to provide treatment for a design population of 28,890 (projected to be reached by approximately year 2030). Phase III would be designed to provide treatment for a maximum population of 40,750 (projected to be reached by approximately year 2040). Phase III Improvements would need to be completed by 2030. Phase IV would be designed for a population of 57,480 (projected to be reached by approximately year 2050). Phase IV improvements would need to be completed by 2040. The projected flows and loads for Phases IIA, III and IV, along with the current flows and loads, are presented in Table 1.

Table 1. Current and Projected Wastewater Flows and Loads

Parameter	Current	Phase IIC	Phase III	Phase IV
Average Daily Flow (MGD)	1.77	2.89	4.08	5.75
BOD_5 (lb/day) (maximum month)	4,245	5,848	8,220	11,566
TSS (lb/day) (maximum month)	5,070	7,074	10,039	14,222
TKN (lb/day) (maximum month)	657	1026	1,571	2,341
TP (lb/day) (maximum month)	111	191	310	477

Notes:
TSS=total suspended solids
TKN=total Kjeldahl nitrogen
TP=total phosphorus

Existing Facilities

The existing facilities were evaluated in terms of capacity, physical condition, and performance relative to projected wastewater flows and loads. Several needs were identified to meet the projected Phase IIC, Phase III, and Phase IV wastewater treatment needs. These are summarized in Table 2.

Table 2. Summary of Deficiencies

Flow EQ

- Increase EQ pumping capacity for Phase III.
- Monitor peak flow rates to determine whether additional pumping capacity is needed before implementation of Phase III.
- Increase standby generator capacity to accommodate increased pumping capacity.
- Provide additional EQ basin volume.

Preliminary Treatment

- Provide additional screening capacity for Phase IV.
- Provide additional grit removal capacity for Phase IV.
- Replace the existing grit unit and classifier in Phase III as they are nearing the end of their useful life.
- Provide additional raw wastewater pumping capacity for Phases III and IV.
- Provide additional wet well capacity Phase IV improvements as the wet well is undersized for the WWTF flows.

Secondary Treatment

Fine Screens

- Additional fine screening capacity will be required for Phase IV.
- Consider relocating the fine screens to a new preliminary treatment building to eliminate the issue of flooding the membrane building.

Biological Basins

- Provide additional basin capacity for Phase III and Phase IV.
- Install submersible mixers in Basins 1A and 2A.
- Consider partially blocking off the opening between the anoxic and aeration basins.

Aeration System

- Expand the aeration system for Phases III and IV.
- Provide separate air pipe headers to each train to allow more precise dissolved oxygen (DO) control.
- Replace the existing diffuser membranes.

Waste Sludge System

- Replace the existing waste activated sludge (WAS) pumps.

Mixed Liquor (ML) Recirculation Pumps

- Provide additional pipes for ML return to reduce velocity in the pipe.

Membrane Trains

- Provide additional membrane capacity for Phase III and IV flows.
- Replace the existing membranes in Phase III.
- Replace the coating on the membrane tanks when the membranes are replaced.

Secondary Treatment (continued) ***Permeate Pumps*** • Pump capacity may be adequate for Phase III. • Additional permeate pumping capacity will be required for Phase IV. ***Backpulse Tank*** • Improve redundancy of effluent metering, which is specifically required by the National Pollutant Discharge Elimination System permit. ***Membrane Aeration System*** • Additional membrane aeration capacity will be required as more membranes are added in Phase IV. • Evaluate with membrane supplier adding variable frequency drives (VFD) and air flow meters to each membrane blower or train to monitor membrane aeration. ***Chemical Feed Systems*** • No deficiencies are noted at this time. ***Compressed Air System*** • No deficiencies are noted at this time.
Ultraviolet (UV) Disinfection System • Remove the UV system from service and demolish it.
Solids Handling Facilities ***Aerobic Digesters*** • Replace the belts and sheaves on the existing blowers to increase blower output if additional aeration capacity is required before Phase III. • Evaluate whether the blower pressure relief valves need to be replaced if the blower discharge pressure changes. • Provide additional digester capacity for Phases III and IV. ***Sludge Dewatering*** • Extend the existing dewatered sludge conveyor through the east wall of the structure in Phase IIC to allow for additional operational flexibility. • Install a second six-channel dewatering fan press in Phase III to expand dewatering capacity. ***Dewatered Biosolids Storage*** • Provide additional sludge storage capacity for Phase IIC by installing a gate to close off the end of the structure. • Provide additional sludge storage buildings for Phases III and IV.
Control Building • Not deficiencies are noted.

Electrical System and Emergency Power • Retire or replace all cable feeders and gear from original plant construction. • Convert power system to three-phase, three-wire 480-volt (V) high resistance ground. • Create a “Secondary Selective” redundant power system as expansions allow. • Replace older generation VFDs that are not related to process upgrades. • Provide consolidated documentation of detailed control wiring MBR.
Separation Requirements and Land Acquisition • Obtain separation waivers from any individuals that wish to build inhabitable structures within 1,000 feet of the property lines of the existing facilities.
Collection System Lift Stations ***Cedar Springs Lift Station*** • Install a new davit crane sized to lift the pumps from the wet well. • Construct a building to house the control panel electrical gear. • Level the transformer pad. • Replace pump controller and add data path to plant supervisory control and data acquisition (SCADA) system. ***230th Street Lift Station*** • Replace pump rails and re-coat piping in the wet well. • Replace manhole steps in the valve vault and add valve extension stems. • Replace the valves that are not functioning. • Construct a building to house the control panel electrical gear. • Replace pump controller and add data path to plant SCADA system. ***Progress Park Lift Station*** • Replace pump rails and re-coat piping in the wet well. • Construct a building to house the control panel electrical gear. • Replace pump controller and add data path to plant SCADA system.

Proposed Improvements

To address the identified needs, proposed improvements for Phases IIC, III, and IV were developed. These proposed improvements, along with the associated opinion of probable cost (OPC), are shown in Tables 3, 4, and 5.

The Phase III improvement OPC in Table 4 is presented as Alternative A–Flow EQ or Alternative B–Peak Flow Treatment. The difference between these two alternatives is how flows greater than the capacity of the mechanical treatment process are stored or treated as they enter the WWTF. Alternative A includes adding additional flow EQ basins and treating the stored water after peak flows subside. Alternative B includes adding a sidestream treatment process dedicated to treating flows in excess of the mechanical treatment plant capacity. Additional discussion on these two alternatives is presented in Section 4 of this report. Alternative A–Flow EQ is recommended for Phase III.

The Phase IV improvement OPC in Table 5 is presented as Alternative A–Grit Removal Before Pumping or Alternative B–Grit Removal After Pumping. The difference between these two alternatives is the location of grit removal in the treatment process. Alternative A requires the grit removal capacity to be larger than Alternative B because all wastewater would be routed through grit removal as it enters the WWTF. The grit removal system in Alternative B has a smaller capacity because it is sized to only treat the capacity of the secondary treatment process and would not treat any influent that is pumped to EQ. The potential for grit to accumulate in the EQ basin in Alternative B is higher than Alternative A. There is less than a 3 percent difference between Alternatives A and B, which is considered to be equivalent in a study-level OPC. Improvements for Phase IV are not projected to be needed until approximately 2040. Proposed Phase IV improvements alternatives are recommended to be re-evaluated in a facility plan update before Phase IV design. This would provide the City with updated information to decide which alternative best meets City goals and to evaluate improvements in treatment technologies and changes in population growth that could occur before 2040.

Table 3. Phase IIC Improvements–OPC

Description	Cost Opinion
Biosolids Dewatering Improvements	$499,000
Dewatered Biosolids Storage	$21,000
Sitework and Seeding	$17,000
Subtotal	**$537,000**
General Requirements (15%)	$81,000
Electrical and Controls (30%)	$162,000
Mechanical and HVAC (0%)	$0
Painting (5%)	$27,000
Undefined Scope (20%)	$108,000
Construction Subtotal	**$915,000**
Contingencies (10%)	$92,000
Construction Total	**$1,007,000**
Engineering, Legal, and Administration (18%)	$182,000
Total Project Cost	**$1,189,000**

Note: HVAC=heating, ventilation, and air conditioning

Table 4. Phase III Improvements–OPC

Description	Alternative A EQ Basin	Alternative B Peak Flow Treatment
Existing Preliminary Treatment Improvements	$270,000	$270,000
EQ Pumping Station and EQ Basin	$4,786,000	$5,522,000
Secondary Treatment Improvements	$6,392,000	$6,392,000
Solid Handling Facility Improvements	$10,735,000	$10,735,000
UV Demolition	$26,000	$26,000
Lift Station Improvements (excluding electrical)	$288,000	$288,000
Subtotal	**$22,497,000**	**$23,233,000**
General Requirements (15%)	$3,375,000	$3,485,000
Sitework (10%)	$2,250,000	$2,324,000
Electrical and Controls (20%)	$6,750,000	$6,970,000
Mechanical and HVAC (10%)	$2,250,000	$2,324,000
Painting (2%)	$450,000	$465,000
Undefined Scope (20%)	$4,500,000	$4,647,000
Construction Subtotal	**$42,072,000**	**$43,448,000**
Contingencies (10%)	$4,208,000	$4,345,000
Construction Total	**$46,280,000**	**$47,793,000**
Engineering, Legal, and Administration (15%)	$6,942,000	$7,169,000
Total Project Cost	**$53,222,000**	**$54,962,000**

Table 5. Phase IV Improvements–OPC

Description	Alternative A Grit Removal Before Pumping	Alternative B Grit Removal After Pumping
Raw Wastewater Pumping and Preliminary Treatment	$9,603,000	$9,002,000
Secondary Treatment Improvements	$7,656,000	$7,656,000
Solid Handling Facility Improvements	$4,251,000	$4,251,000
New Control Building and Demolish Existing	$2,887,000	$2,887,000
Subtotal	**$24,397,000**	**$23,796,000**
General Requirements (15%)	$3,660,000	$3,570,000
Sitework (10%)	$2,440,000	$2,380,000
Electrical and Controls (30%)	$7,320,000	$7,139,000
Mechanical and HVAC (20%)	$4,880,000	$4,760,000
Painting (2%)	$488,000	$476,000
Undefined Scope (20%)	$4,880,000	$4,760,000
Construction Subtotal	**$48,065,000**	**$46,881,000**
Contingencies (10%)	$4,807,000	$4,689,000
Construction Total	**$52,872,000**	**$51,570,000**
Engineering, Legal, and Administration (15%)	$7,931,000	$7,736,000
Total Project Cost	**$60,803,000**	**$59,306,000**

Summary and Recommendations

As the City continues to grow, expansion of the WWTF should be implemented to keep pace with demands. In order to meet the projected increases in wastewater treatment needs of the community, Phases IIC and III are proposed to increase the design population to 40,750.

Based on the evaluations presented in this plan, the following recommendations are offered:

1. The City should consider implementing the Phase IIC improvements in the near term to address operational deficiencies with the current solids handling facilities.

2. As growth continues, the City should plan to complete Phase III, Alternative A improvements before reaching a population of 28,890. Improvements would need to be completed by 2030 to provide sufficient treatment capacity through 2040.

3. The concepts presented in this facility plan should be reviewed and discussed and decisions made regarding the specific features and components to be included in the selected plan.

4. Part of the decision process will include deciding how quickly to expand the facilities to meet the growing needs of the community. The City should concur with the concepts as presented or direct that revised analyses be made.

5. Following acceptance by the City, the facility plan should be submitted to the Iowa Department of Natural Resources (IDNR) for review and approval.

6. Following comment by the IDNR, the preliminary design phase of the selected project should be initiated, as appropriate.

Once a decision is reached, then discussions can proceed on various preliminary design aspects associated with the selected plan. Some of the recommendations and analyses discussed in this plan may merit more detailed examination. During the design development stage, numerous decision points will arise regarding specific features of the proposed project. It can then be decided which of the recommendations to include in the selected plan and which deviations to make from the concepts proposed by this analysis.

Schedule

The following schedule is proposed for completing the Phase IIC and III improvements as outlined in this report, presuming population growth is as projected. The City should continue to monitor population growth and adjust the schedule accordingly.

Table 6. Proposed Project Schedule

Project Milestone	**Month and Year**
Receive revised Wasteload Allocation from IDNR	June 2025
Issue Antidegradation Alternatives Analysis for Public Comment	July 2025
Submit Antidegradation Alternatives Analysis to IDNR	August 2025
Submit Facility Plan to IDNR	August 2025
IDNR Facility Plan Review	August through December 2025
Phase IIC	
Project Design	January through May 2026
IDNR Review and Permitting	June 2026 through September 2026
Bidding and Construction	October 2026 through December 2027
Phase III	
Project Design	January 2026 through June 2027
IDNR Review and Permitting	July 2027 through December 2027
Bidding	January 2028 through February 2028
Construction	March 2028 through August 2030

1–Introduction

1.01 Background and Scope

The City of North Liberty, Iowa (City) currently operates a membrane bioreactor (MBR) wastewater treatment facility (WWTF). The system was originally constructed at its present location in 1998, with major expansion projects occurring in 2004, 2007, and 2018. The 2004 expansion added a flow equalization (EQ) basin and pumping station. The 2007 expansion, referred to as Phase I, converted the sequencing batch reactor (SBR) process to the currently used MBR, which has been operating since August 2008. Phase II, which expanded the MBR facilities, added nutrient reduction capability, and improved solids handling facilities, was completed in 2018.

Because of the City's geographical location between the Cities of Iowa City and Cedar Rapids, the community has experienced extremely rapid growth. The population of the City increased from 5,367 in 2000 to 13,374 people in 2010 and to 20,479 in 2020. The 2021 estimated population is approximately 20,875.

Planning for and assisting this rapid growth has been a priority for community leaders and City staff. To help keep pace with rapid growth and plan for future wastewater treatment needs, Strand Associates, Inc.® (Strand) has been retained by the City to prepare a facility plan for the WWTF. Previously, a facility plan was completed in June 2013 (revised January 2014 by FOX Engineering, Inc. [now Strand]). The plan identified several phases for expanding the plant. Phase II, completed in 2018, was designed to handle a population of 27,800. Phase III was intended to serve a population of 55,000, and Phase IV would serve a population of approximately 80,000. Because Phases III and IV were looking decades into the future, they were high-level evaluations that identified potential needs and space requirements. The facility plan also recognized that these would likely be broken into additional phases. This facility plan includes updating the existing and projected wastewater flows and loadings, a review of the capacity and performance of the WWTF, and updating the plan for expansion of the facility for Phases III and IV.

1.02 General Description of the Facilities

The existing WWTF is an MBR facility consisting of the following items:

- Preliminary treatment including flow monitoring, screening, grit removal, and raw wastewater pumping.
- Flow EQ basin and pumping station.
- The MBR facility including two biological trains (consisting of anaerobic, anoxic, and aeration zones) and four membrane tanks.
- Disinfection facilities using ultraviolet (UV) light technology (currently not in operation).
- Two aerobic sludge digesters with mixing and aeration.
- Biosolids dewatering facility.
- Dewatered biosolids storage.

2–Basis of Evaluation and Design

2.01 Planning Period and Population Projections

The size and operation of WWTFs are heavily dependent upon residential, commercial, and industrial wastewater contributions, as well as inflow of stormwater and infiltration of groundwater to the system. Because WWTFs are capital intensive and not easily expandable, it has become necessary to develop a long-term plan regarding expansion of the existing WWTF to deal with future community growth.

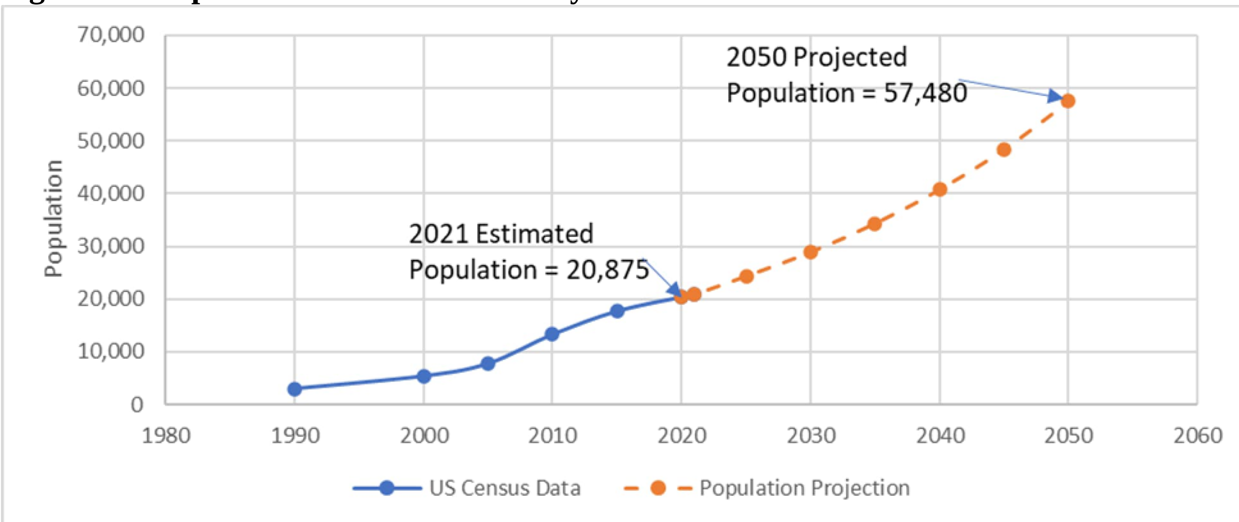
Typically, a planning period of 20 years is used when planning improvements to WWTFs. However, the population of the City is expanding at an exceptional rate. The population grew from 2,926 in 1990 to 5,367 in 2000, which is an average annual rate of 6.25 percent. From 2000 to 2004, the population increased from 5,367 to 7,224, or an average annual rate of 7.7 percent. The average annual growth rate from 2004 to 2007 was nearly 15 percent, and from 2007 to 2010 was approximately 6.8 percent. With such an exceptional growth rate, developing accurate population projections for the next 20 years and beyond becomes difficult. Projected population data through the year 2040 was based on an estimated population growth of 840 persons per year in accordance with information provided by the City. This results in a modest population growth rate of 2 to 5 percent per year through the year 2040. Table 2.1 and Figure 2.1 show the historical and projected population data.

Table 2.1. Historical and Projected Population

Year	Population
1990	2,926
2000	5,367
2010	13,374
2020	20,479
2021	20,875*
2030	28,890
2040	40,750
2050	57,480

*Estimate provided by the City.

Figure 2.1. Population Growth for the City



Because of the rapid growth rate, this facility plan will present recommendations for improvements based upon selected target populations. The year in which the actual population targets occur will ultimately be dependent upon the rate of population growth. To help distribute some of the capital cost over a larger population base, it is anticipated that the necessary improvements will be constructed in phases. The previous facility plan identified Phases II and III to expand the WWTF for a population of 27,800 and 55,000, respectively. Phase II construction was completed in 2018. This facility plan will re-evaluate Phase III for an intermediate population, develop Phase IV improvements, and evaluate at a high-level Phase V improvements for an ultimate population of approximately 80,000.

2.02 Wastewater Treatment Standards

The City's WWTF is subject to the provisions of the Clean Water Act and to regulations issued by the Iowa Department of Natural Resources (IDNR) and the United States Environmental Protection Agency. The WWTF's current National Pollutant Discharge Elimination System (NPDES) permit was issued on November 1, 2020. These permits are typically issued for 5 years, and the current permit expires October 31, 2025. The current permit was amended on June 1, 2021, to include total nitrogen (TN) and total phosphorus (TP) raw waste monitoring requirements and on November 1, 2021, to remove monitoring requirements, final limits, and compliance schedule for chloride.

The NPDES permit also required that a nutrient reduction feasibility study be submitted by November 1, 2022. This report was submitted to IDNR in September 2022, and concluded that the facility meets the goals of the nutrient reduction strategy. On June 1, 2023, an amendment was issued add annual average mass limits for TN of 167 pounds per day (lb/day) and TP of 60 lb/day.

The receiving stream, Muddy Creek, is classified as Class A1 (primary contact recreational use) and Class B (WW2) (aquatic life uses). Further impacting the water quality standards of the receiving stream for the City's WWTF discharge are downstream uses of Muddy Creek and the Iowa River, including the City of Iowa City and University of Iowa water supply. Muddy Creek also flows through residential neighborhoods and is near an elementary school. Concerns with student contact with Muddy Creek have led to disinfection limits being imposed. In the past, the City's wastewater discharges into Muddy Creek have come under public scrutiny. However, since the implementation of the MBR, the WWTF has put out exceptionally high-quality water, with no effluent permit violations. Reports indicate that the water quality in Muddy Creek has improved substantially.

A summary of permitted discharge limitations is included in Table 2.2. A copy of the NPDES permit is included in Appendix A.

Table 2.2. Summary Permitted Discharge Limitations

Parameter	30-Day Average Concentration (mg/L)	30-Day Average Mass Loading (lb/day)
CBOD	25	923
TSS	30	1,108
Ammonia–January	3.4	125.8
Ammonia–February	4	146.0
Ammonia–March	3.4	125.8
Ammonia–April	1.5	56.3
Ammonia–May	1.7	62.4
Ammonia–June	1.3	48.4
Ammonia–July	1.0	37.1
Ammonia–August	1.0	35.3
Ammonia–September	1.1	39.0
Ammonia–October	1.6	57.5
Ammonia–November	2.3	85.7
Ammonia–December	2.5	91.4
DO	5.0 (daily minimum)	
pH	daily minimum 6.5; daily maximum 9.0	
***E. Coli* (March to November)**	126 #/100 mL (geometric mean)	

Notes:
CBOD=carbonaceous biochemical oxygen demand
TSS=total suspended solids
mg/L=milligrams per liter
DO=dissolved oxygen
#/100 mL=colonies per 100 milliliters

In addition to the effluent parameters shown in Table 2.2, the City must monitor various influent parameters and must meet other effluent criteria including:

- A 7-day average effluent limitation for 5-day carbonaceous biochemical oxygen demand ($CBOD_5$) and TSS.
- A daily maximum effluent limitation for ammonia.
- A "non-toxic" effluent limitation for Ceriodaphnia and Pimephales acute toxicity.

New and modified WWTFs must also meet the latest design standards established by the IDNR. The design standards establish flow and loading requirements for unit processes, reliability criteria for redundancy, and various other requirements established to avoid operational problems.

2.03 Antidegradation

Antidegradation refers to federal regulations designed to maintain and protect high quality waters and existing water quality in other waters from unnecessary pollution. IDNR has adopted an antidegradation policy and implementation procedure to protect the State of Iowa's (Iowa) waters from activities which have the potential to lower water quality. The antidegradation policy and implementation procedure applies to all new or expanded discharges.

An applicant proposing any regulated activity that would degrade water quality is required to prepare an evaluation of alternatives to the proposed activity. The purpose of this evaluation is to determine whether the proposed degradation is "necessary," that is, no reasonable alternative(s) exist to prevent degradation. These alternatives are compared (in terms of practicability, economic efficiency, and affordability) to the controls required to protect existing uses and to achieve the highest statutory and regulatory requirements (i.e., the more stringent between the water quality-based effluent limits to protect an existing use and the applicable technology-based effluent limits). Following the evaluation of pollution control alternatives, the least degrading alternative that is practicable, economically efficient, and affordable should be considered the preferred pollution control alternative. If this alternative results in degradation, the applicant must then document the social and economic importance of the activity.

Because of growth in the City, an antidegradation alternatives analysis will be required for an expansion of the WWTF.

2.04 Wastewater Effluent Quality

The City's NPDES permit requires that the wastewater effluent quality be monitored on a regular basis. Since the MBR started operation in August 2008, the WWTF has been producing exceptional high-quality effluent. For example, the permit requires that $CBOD_5$ and TSS concentrations average 25 and 30 mg/L, respectively. Between 2017 and 2022, the WWTF consistently produced effluent with less than 3 mg/L $CBOD_5$ and less than 1 mg/L TSS. Additionally, effluent turbidity is consistently less than

0.04 nephelometric turbidity unit (NTU). While turbidity is not a permit requirement, this is an indication of very high-quality effluent (drinking water standard is 0.3 NTU). Table 2.3 shows the effluent wastewater characteristics compared to NPDES permit requirements.

Table 2.3. Wastewater Effluent Quality

Parameter	Avg. Effluent Quality	NPDES Permit Limits
$CBOD_5$	<3 mg/L	25.0 mg/L
TSS	<1 mg/L	30.0 mg/L
Ammonia	<0.2 mg/L	1.0–4.0 mg/L
pH	7.2 to 7.7	6.5 to 9.0
E. coli	<13 #/100 mL	126 #/100 mL
Turbidity	<0.04 NTU	NA

Note: NA=not available

2.05 Biosolids Management Rules

Land application and disposal of wastewater biosolids (primarily organic solids produced by wastewater treatment processes) are governed by federal and state regulations. Current federal regulations for the use or disposal of biosolids and biosolids products are found in 40 Code of Federal Regulations (CFR) Part 503: *Standards for the Use or Disposal of Sewage Sludge.* Part 503 regulates land application, surface disposal, and incineration of biosolids.

Iowa Administrative Code (IAC) Chapter 67 establishes standards for the land application of biosolids. IAC Chapter 67 provides for three classes of sludge based on pollutant levels, pathogen requirements, and vector attraction reduction requirements. Class I sludge criteria include more limiting pollutant levels and a higher level of pathogen reduction. However, Class I sludge has less management practice restrictions for disposal due to its excellent quality. Class I biosolids may be applied to lawns and home gardens in addition to agricultural land.

Class II sludge criteria provide for sludge of normal quality that may not meet one of the more stringent requirements for Class I. Class II biosolids may be land applied to agricultural land but cannot be applied to lawns or home gardens. In addition, more stringent management practice limits are imposed in the regulations for Class II sludge to further protect the public.

Class III sewage sludge is any sewage sludge that does not meet the criteria for either Class I or Class II sludge. Class III sludge cannot be land applied for beneficial use and must be disposed of according to the surface disposal or incineration requirements contained in the Federal Part 503 regulations.

In Iowa, very few municipal WWTFs produce Class I or Class III biosolids. Class I biosolids are generally not produced due to the relatively high cost of treatment required to generate such a high-quality sludge. Because Class III biosolids cannot be land applied, they are generally avoided due to their high disposal costs. Given these factors and the ample agricultural ground available for land application, Class II biosolids are produced by most municipal WWTFs in Iowa. Because of the factors discussed above, alternatives associated with producing Class I or Class III biosolids were not developed for the purposes of this report.

2.06 Current WWTF Flows and Loadings

To establish current wastewater flows and loadings, plant operational data was collected and evaluated for the period of January 2017 to April 2022. Information from this data set was used in conjunction with other general design criteria to establish current and projected design flows and loadings for the established planning period. Current flows and loadings are addressed in this section, while projected flows and loadings and biosolids demands are addressed in the sections that follow. A more detailed description of current and projected flows and loads can be found in Appendix B.

Current flows were established based on the flow metering data included in the WWTF's records and as defined in the IDNR Design Standards. Table 2.4 shows a summary of current flow data. WWTF flow and loading data is included in Appendix B.

Current loadings were established for the average day, maximum month, and maximum day using the available data included in the WWTF's records for the period of January 2017 to April 2022. Current loadings were established for 5-day biochemical oxygen demand (BOD_5), TSS, total Kjeldahl nitrogen (TKN), and TP, which are included in Table 2.5.

Table 2.4 Current WWTF Flows

Hydraulic Demands	Flow (MGD)	Peaking Factor
ADF[(1)]	1.774	1.00
ADW Flow [(2)]	1.694	0.95
AWW Flow[(3)]	2.767	1.56
MWW Flow[(4)]	5.088	1.83
Peak 7-Day Wet Weather Flow[(5)]	3.765	1.36
PHWW Flow[(6)]	6.081	1.20

Note: MGD=million gallons per day

(1) ADF=Average Daily Flow–The average daily flow for the year.

(2) ADW=Average Dry Weather–The daily average flow when groundwater is at or near normal. This was determined by averaging flows during January and February.

(3) AWW=Average Wet Weather–The daily average flow for the wettest 30 consecutive days on record. The maximum month flow occurred during May and June 2019.

(4) MWW=Maximum Wet Weather–The maximum flow received in a 24-hour period during wet conditions. The peak day flow occurred on October 6, 2018. The peaking factor is a ratio of MWW:AWW.

(5) Peak 7-Day Wet Weather Flow–The wettest recorded 7 consecutive days. The peak 7-day flow occurred on between October 6 and 12, 2018. The peaking factor is a ratio of peak 7-day:AWW.

(6) PHWW=Peak Hourly Wet Weather–The total maximum flow received in 1 hour during wet conditions. PHWW was determined from plant flow data. The peaking factor is a ratio of PHWW:MWW.

Table 2.5. Current WWTF Loadings

Parameter	BOD_5 (lb/day)	TSS (lb/day)	TKN (lb/day)	TP (lb/day)
Average Day	3,102	2,864	475	90
Maximum Month	4,245	5,070	657	111
Maximum Day	6,620	10,056	738	178

The IDNR has established guidelines for determining flow and wastewater strength on a per capita basis. Wastewater flows and loadings (biochemical oxygen demand [BOD], TSS, and TKN) on a per capita basis are presented in Table 2.6, along with corresponding IDNR guidelines for comparison (TKN loading per capita is based on common practice). The flow is less than the IDNR guidelines due to recent dry years. The TSS loading per capita is less than the IDNR guidelines. The BOD_5 loading per capita is less than the IDNR guidelines. The TKN and phosphorus loadings per capita are also on the low end of the range expected in typical domestic wastewater.

Table 2.6. Historical WWTF Flows and Loadings on per Capita Basis

Parameter	Data From 2017 to 2022	IDNR Guidelines
Population[1]	20,479	---
ADF (gpcd)	90	100 to 120
BOD_5 (ppcd)[2]	0.16	0.17 to 0.20
TSS (ppcd)[2]	0.14	0.20 to 0.25
TKN (ppcd)[2]	0.023	0.03 to 0.04[3]
TP (ppcd)[2], [3]	0.0043	0.007 to 0.010[3]

Note: ppcd=pounds per capita per day; gpcd=gallons per capita per day
[1] 2020 census population.
[2] BOD_5, TSS, and TKN loadings are average month.
[3] TKN and phosphorus loadings per capita are based on common practice and have not been established by the IDNR.

2.07 Projected WWTF Flows and Loadings

Using historical flow data, projections through Phase IV of the planning period (population 57,480) have been established. While Phase IV is many years in the future, and planning for that far into the future is tenuous at best, the intent of this facility plan is to determine land area requirements for Phase IV and beyond. This will help determine the feasibility of future expansion at the current site beyond Phase III. Future flow projections are heavily dependent upon population growth, and the rate at which the community grows will ultimately determine the rate at which wastewater flows and loads to the plant increase. However, barring a new major industrial contributor, there is generally a direct correlation between population and wastewater flows. Projected flows will most likely occur at their correlating populations, rather than in a particular year.

Because of the City's continued rapid growth, there is a desire to maximize the treatment capacity of the existing facilities while at the same time plan for expansion of the facilities as population growth dictates. To that end, the projected flows and loads and corresponding facilities expansion has been divided into three phases, as shown in Table 2.7. The flows and loads identified for each phase are largely dependent on the capacity of the secondary treatment process, the MBR. Phase II construction has already been completed. For expansion of the membrane system, Phase II was divided into Phase IIC and Phase IIB. Phase IIB involved replacing the existing membranes and fully populating all the trains. This will be completed in July 2023. The Phase IIB design flows are shown in Table 2.7. In this facility plan, a new Phase IIC has been identified. The Phase IIC projected flows and loads are those that the plant can handle without modification based on operational experience. This is discussed further in Section 3.

Table 2.7. Projected WWTF Flows

Hydraulic Demands (MGD)	Phase IIB Design	Phase IIC Design	Phase III	Phase IV
Projected Population	27,800	28,890	40,750	57,480
ADF	3.330	2.889	4.075	5.748
ADW Flow	2.930	2.542	3.586	5.058
AWW Flow	4.429	3.842	5.420	7.645
Peak 7-Day Wet Weather Flow	---	5.226	7.371	10.397
MWW Flow	10.054	9.705	11.484	13.993
PHWW Flow	16.424	15.915	18.833	22.949

The projected ADFs for Phases IIC, III, and IV were estimated by adding a per capita flow rate of 100 gpcd for the estimated population growth from 2021 to the current average flow. This value includes anticipated commercial and industrial contributions, as a function of population. It is higher than the current average per capita demand but does provide a fairly conservative estimate while taking into consideration the variability of the data and provides some factor of safety. An ADW to ADF ratio of 0.88 was used for the projected ADW flows. Projected AWW flows were estimated by multiplying the projected ADFs by a ratio of 1.33. The projected MWW flows were estimated by using the previous flow plus 100 gpcd times the population growth times a peaking factor of 1.5. The projected 7-day wet weather flows were estimated by multiplying the ratio of the current maximum 7-day flow to the maximum 30-day flow by the projected AWW. The projected PHWW flows were estimated by multiplying the projected MWW flows by a peaking factor of 1.64. A more detailed description of how current and projected flows and loads were established can be found in Appendix B.

Projected average day loads were estimated by increasing current average day loads by projected population increase and a per capita loading rate of 0.17 ppcd for BOD_5, 0.20 ppcd for TSS, 0.036 ppcd for TKN, and 0.007 ppcd for TP. Maximum month loads were based on 0.22 ppcd for BOD_5, 0.25 ppcd for TSS, 0.046 ppcd for TKN, and 0.010 ppcd for TP. Projected maximum day loadings were calculated using a ratio of existing maximum day to maximum month. Table 2.8 provides a summary of the projected loadings.

Table 2.8. Projected WWTF Loadings

Parameter		Phase IIB Design	Phase IIC Design	Phase III	Phase IV
BOD_5 (lb/day)	Average Day	3,592	4,464	6,480	9,324
	Maximum Month	4,730	5,848	8,220	11,566
	Maximum Day	7,626	9,265	13,179	18,699
TSS (lb/day)	Average Day	4,343	4,467	6.839	10,185
	Maximum Month	5,560	7,074	10,039	14,222
	Maximum Day	10,638	14,023	19,894	28,175
TKN (lb/day)	Average Day	738	763	1,190	1,793
	Maximum Month	920	1,026	1,571	2,341
	Maximum Day	2,102	1,291	2,110	3,264
TP (lb/day)	Average Day	---	146	229	346
	Maximum Month	---	191	310	477
	Maximum Day	---	306	496	764

2.08 Biosolids Demands

Biosolids quantities were also estimated based on operational data collected from January 2017 to April 2022. A summary of the current and projected biosolids quantities is provided in Table 2.9.

In this table, “Waste Sludge from MBR” refers to the waste activated sludge (WAS) from the MBR basins that is pumped into the digesters. “Digested Biosolids” refers to the quantity of sludge removed from the digesters after digestion. “Biosolids Hauled for Land Application” refers to the quantity of sludge removed from the biosolids storage building and hauled for land application.

Table 2.9. Current and Projected Biosolids Quantities

Parameter		Current	Projected		
			Phase IIC	Phase III	Phase IV
WAS from MBR					
Average	lb/day	2,140	3,700	5,700	8,700
	gpd	31,680	55,700	85,700	130,700
Maximum Month	lb/day	2,720	5,800	8,000	11,700
	gpd	41,593	86,600	119,500	175,000
Digested Biosolids					
Average	lb/day	1,324	2,400	3,700	5,600
	gpd	7,937	14,300	22,000	33,500
Maximum Month	lb/day	1,683	3,700	5,100	7,500
	gpd	10,087	22,200	30,600	44,800
Biosolids Hauled for Land Application					
Average	Dry tons/yr	242	434	668	1,019
	Wet tons/yr	1,674	3,101	4,772	7,276

Notes:
gpd=gallons per day
tons/yr=tons per year

Current biosolids production was estimated based on operational data and WAS production for 2021, with an average concentration of 8,099 mg/L and an average volatile solids (VS) content of 83 percent. Digested biosolids quantities were estimated based on operational data that showed an average VS reduction of approximately 46 percent, with an average solids concentration of 2 percent. Land applied biosolids averaged approximately 14.4 percent solids.

Projected biosolids quantities were based on the mass of solids wasted from the MBR as predicted by the activated sludge models (see Appendix C), and assuming 0.8 percent WAS concentration. Projected digested biosolids quantities were calculated assuming 45 percent VS reduction and 80 percent VS, and dewatered biosolids were assumed to have 14 percent total solids (TS) concentrations.

Biosolids quality is tested regularly to determine whether regulatory pollutant limits are being met. Records show that the metal concentrations in the City’s biosolids are well below the pollutant limits of Class I biosolids. The City’s biosolids are therefore not limited by the Cumulative Pollutant Limits of Class II. The pathogen density of the sludge typically does not meet the Class I limit; therefore, the biosolids are classified as Class II for management practices and record keeping.

3–Existing Facilities

3.01 Collection System

A sanitary sewer service study was completed in April 2011, and was planned to be updated in a separate study; therefore, analysis of the collection system was not included as part in this study. However, it should be briefly discussed, as all sewage to the WWTF does come from the collection system, and the performance of the collection system can impact the performance of the WWTF. Most notably, the characteristic of the collection system that has the greatest impact on the WWTF involves that of inflow and infiltration (I/I). Community growth also has an impact on the collection system and WWTF.

3.01.1 I/I

Most sanitary sewer systems within Iowa are subject to flow contributions from I/I. I/I refers to clear (nonsewage) water that enters the sewer system. In the case of infiltration, clear water enters by way of leakage at pipe joints or cracks in the pipes. Inflow enters the sanitary sewer system directly through connections of drain tiles, storm sewers, foundation drains, floor drains, sump pump discharges, and roof drains.

Analyses of PHWW, MWW, AWW, and ADW flows provide some insight as to the amount of I/I entering the sanitary sewer system. If the sewer system were free of I/I, the flows would reflect only the amount of potable water supplied to system users. Typically, ADW flow is defined as the average flow that occurs when the groundwater is at normal levels, and I/I is not occurring.

I/I flow contributions can be difficult to eliminate. Causes of I/I are typically hidden underground, and their locations can only be determined through extensive field work and study. Oftentimes, communities spend large amounts of money to investigate I/I, and construct improvements to try to reduce the amount of flow contributed from I/I. However, considering the vast expanse of most sanitary sewer collection systems, service lines, and other connections, efforts to reduce I/I are often not cost effective.

Although the amount of I/I present in the collection system is significant, it does not appear excessive. When considering the characteristically high ground water table present in the City, it is apparent that the amount of relatively new sewer lines throughout the community have been effective in minimizing the amount of I/I that enters the system. Peak flows due to I/I contributions appear to be within acceptable levels when compared to ADW flow. The flow EQ basin is designed to improve WWTF operation during periods of wet weather by storing the excess flow until flows decrease.

3.02 WWTF

Planning for the existing the City's WWTF began in 1994, and construction of the original WWTF was completed in 1998. The original WWTF consisted of preliminary treatment (screening and grit removal), activated sludge SBR treatment, UV disinfection, and aerobic sludge digestion and storage. The 2004 WWTP Improvements project added a flow EQ basin and pumping station. Phase I WWTF improvements, completed in 2008, converted the SBR process to an MBR secondary treatment process and greatly increased the capacity of the WWTF. The latest expansion, Phase II, which expanded the MBR facilities, added nutrient reduction capability, and improved solids handling facilities, was completed in 2018.

The current membrane bioreactor facility includes the following major unit processes. A detailed description of each major unit process, along with an evaluation of their capacity and condition, is provided in the following sections. A site plan showing the layout of the current WWTF is shown in Figure 3.1.

- Flow EQ
- Mechanical screening
- Grit removal system
- Raw wastewater pumping
- Influent flow metering
- Fine screening
- Membrane bioreactors
- UV disinfection system
- Aerobic digestion
- Biosolids dewatering
- Biosolids storage

Wastewater initially enters the Preliminary Treatment Building by gravity. Processes inside the Preliminary Treatment Building include screening, grit removal, raw wastewater pumping and flow measurement. Wastewater first passes through a mechanical rake screen with 1/4-inch openings. Solids in the wastewater large enough to be caught in the screen are transported to a screenings washer/compactor and deposited in a dumpster for landfill disposal. After screening, the wastewater passes through a grit removal process to remove sand and other grit from the wastewater stream. Debris removed in the grit removal process is also placed in a dumpster for landfill disposal. After the grit removal process, the wastewater stream flows into a concrete wet well, where it is pumped by variable-speed, suction-lift pumps to the MBR.

When raw wastewater enters the membrane bioreactor complex, it first passes through 1-millimeter (mm) rotary drum fine screens, which remove small particles that can damage the membranes. The wastewater then flows to the MBR.

DRAWING FILENAME
S:\AME\7000--7099\7037\011\Drawings\CAD\Site Layout - EQ Overflow Options.dwg

PLOT STYLE TABLE	LAYER MNGR NAME	LAYOUT NAME
Color.ctb		FIG 1

DATE	REVISION		BY	DATE
		DESIGNED:	DLW	01/23
		DRAWN:	JAK	01/23
		CHECKED:		
		LAST UPDATE: 10-20-22		

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STRAND ASSOCIATES®

EXISTING WWTP SITE PLAN

WWTP FACILITY PLAN
CITY OF NORTH LIBERTY
NORTH LIBERTY, IOWA

PROJECT NO.
7037.011

SHEET
FIG. 3.1

The MBR process is the “heart” of the WWTF. It includes two biological treatment trains and four membrane trains. Within the treatment trains, the wastewater is mixed with biologically active material, where bacteria and other microorganisms digest organic material present in the wastewater. Each treatment train includes an anaerobic zone for biological phosphorous removal (BPR), an anoxic zone for denitrification and improved membrane filtration, and aerobic zones for organics and ammonia removal. To create an oxygen-rich environment for the bacteria and microorganisms to thrive, an aeration system provides oxygen and mixing in the aerobic zones. The aeration system can be cycled on and off to more closely meet the oxygen demands and minimize foaming. Submersible mixers are provided in the anaerobic and anoxic zones to keep the biological mass in suspension. Submersible propeller pumps and flow tubes are used to recirculate wastewater from the aerobic zone to the anoxic zone and from the anoxic zone to the anaerobic zone to promote biological nitrogen removal (BNR) and BPR. From the aeration basin, mixed liquor (ML) is pumped to the membrane tanks at a rate of up to five times the influent flow rate. The ML is filtered through the submerged membranes to remove virtually all suspended solids. The overflow from the membrane tanks is returned to the aeration basins. The filtered water, or permeate, is discharged to the receiving stream, Muddy Creek. If necessary, the treated water can be passed through the UV disinfection system to kill any pathogenic bacteria that was not removed by the membrane system. Solids handling facilities consist of two aerobic digesters that are used to further digest and stabilize the biological solids that are wasted from the aeration basins. The digested solids (biosolids) are then pumped to the dewatering unit, and then hauled to storage until it can be land applied.

The current and projected flows and loadings for the WWTF were developed in the previous section (refer to Tables 2.4, 2.5, 2.7, and 2.8). A summary of the projected flows and loads are shown in Table 3.1 for reference. In addition, the average, maximum month, and peak 7-day flows for the secondary treatment process are included in this table. The secondary process limiting flows are based on the hydraulic capacity of the membranes and are discussed in further detail in the following sections. These flows and loads were used to evaluate the individual components of the WWTF for both hydraulic and organic capacity.

Table 3.1. Current and Projected Flow and Loads

Parameter		Current	Phase IIB	Phase IIC	Phase III	Phase IV
Population		20,875*	27,800	28,890	40,750	57,480
Flows (MGD)						
ADF		1.774	3.330	2.889	4.075	5.748
ADW Flow		1.694	2.930	2.542	3.586	5.058
AWW Flow		2.767	4.429	3.842	5.420	7.645
Peak 7-Day Wet Weather Flow		3.765	---	5.226	7.371	10.397
MWW Flow		5.088	10.054	9.705	11.484	13.993
PHWW Flow		6.081	16.424	15.915	18.833	22.949
Secondary Treatment Flows (MGD)						
Average Day Flow		---	3.330	2.889	4.075	5.748
Max. Month Flow		---	4.429	3.842	5.420	7.645
Peak 7-Day Flow		---	---	5.226	6.840	10.397
Peak Day Flow		---	6.310	6.840	6.840	11.437
Loadings (lb/day)						
BOD_5	Average Day	3,102	3,592	4,464	6,480	9,324
	Maximum Month	4,245	4,730	5,848	8,220	11,566
	Maximum Day	6,620	7,626	9,265	13,179	18,699
TSS	Average Day	2,864	4,343	4,467	6.839	10,185
	Maximum Month	5,070	5,560	7,074	10,039	14,222
	Maximum Day	10,056	10,638	14,023	19,894	28,175
TKN	Average Day	475	738	763	1,190	1,793
	Maximum Month	657	920	1,026	1,571	2,341
	Maximum Day	738	2,102	1,291	2,110	3,264
TP	Average Day	90	---	146	229	346
	Maximum Month	111	---	191	310	477
	Maximum Day	178	---	306	496	764

*2021 estimated population.

3.02.1 Flow EQ

General Description: A flow EQ basin and pumping station were added during the 2004 improvements project. The flow EQ basin is an earthen basin with a synthetic liner, which was replaced around 2012. During wet weather periods, wastewater flows in excess of the plant capacity overflow into the flow EQ wet well and are pumped to the EQ basin. An 18-inch magnetic flow meter is provided for measuring flow pumped to EQ. When the influent flow to the WWTF returns to normal, the EQ basin contents can flow by gravity back to the WWTF and discharge into the raw wet well via the 8-inch EQ return line. The return flow is measured with an 8-inch magnetic flow meter and controlled by an 8-inch automated plug valve.

Capacity: The flow EQ basin has a total volume of approximately 5.14 million gallons (MG). The EQ pumping station consists of three submersible pumps, each with a design capacity of 2,980 gallons per minute (gpm) at 74.5 feet. Plant operational data shows that one pump will produce approximately 3,150 gpm. With two pumps operating, the pumping capacity is approximately 6,000 gpm (8.64 MGD). This is the "firm" capacity of the pumping station, with one pump out of service. With all three pumps operating, the pumping capacity is approximately 8,000 gpm (11.52 MGD).

The projected PHWW flow is approximately 15.92 MGD for Phase IIC, 18.83 MGD for Phase III, and 22.95 MGD for Phase IV. The flow EQ pumps, together with the raw wastewater pumps will need to handle the peak hourly flow. The raw wastewater pumping capacity (see Section 3.02.2) is 7.0 MGD total and 6.19 MGD firm. The combined pumping capacity, with all pumps in service, is approximately 18.5 MGD. Combined firm pumping capacity, assuming one EQ pump out of service, is 15.64 MGD. The pumps have firm capacity adequate for the current PHWW flow and for the design Phase IIC PHWW flow of 15.92 MGD. As the community grows and flows increase, peak flows should be monitored to determine whether additional pumping capacity is necessary before Phase III. Additional pumping capacity (either raw wastewater, flow EQ, or a combination of the two) will be required for Phase III.

The existing EQ pumps have variable frequency drives (VFDs) to control the speed of the pumps based on water level in the wet well.

To determine the adequacy of the EQ basin, the peak 7-day flow period from the data set was used to estimate the peak 7-day flow at future conditions. The maximum day design flow of the MBR was then subtracted from the influent flow to determine the amount of flow required to be equalized and the cumulative equalized volume over that 7-day period. The results of this analysis are presented in Appendix D. The results of the analysis showed that the EQ basin volume will be adequate through Phase IIC. Beyond Phase IIC, additional volume will be required.

The EQ basin influent and overflow piping will also need to be able to handle the design peak flows. The projected peak pumping rate to the EQ basin for Phase IIC is 8.9 MGD (approximately 6,200 gpm). The existing influent pipe is 18 inches, which is adequate for the projected flows. The overflow pipe from the EQ basin must also be able to handle more than the influent pumping rate. If all three existing EQ pumps are running, the pumping rate is approximately 8,000 gpm. The overflow should be able to handle more than that. There are two existing parallel overflow pipes, 14 inches each, with a total capacity of approximately 9,790 gpm (14.1 MGD). This is adequate to handle the peak flow through Phase IV.

A separate generator is provided for the EQ pumping station. This generator is rated for 350 kilowatts (kW). This should be adequate through Phase IIC, but additional capacity may be required for Phase III and beyond.

Capacity of the return flow piping, valves, and meter must also be considered for future capacity increases. Return flow capacity ranges from approximately 1,675 gpm (2.41 MGD) when the basin is full to approximately 1,350 gpm (1.94 MGD) when the basin is empty. This return rate should allow draining the existing basin within 2.5 to 3 days, which is adequate.

<u>Physical Condition/Performance:</u> The EQ basin and pumping station are in relatively good physical condition and should continue to operate properly within the design parameters. When Phase III is implemented, the EQ basin liner will be close to 20 years old. At that time, the liner should be inspected and repaired or replaced as needed. The EQ pumps will also be nearing the end of their useful life and should be considered for replacement.

Return flow from the EQ basin is automatically controlled by an electrically actuated valve and flow meter to maximize the return flow based on the plant capacity and the raw influent flow. The control valve and meter are in reasonably good condition and should continue to function adequately.

Bypass to the EQ pumping station is currently provided by an overflow in a manhole upstream of the Preliminary Treatment Building (prior to screening and grit removal) and an overflow in the raw wet well (after screening and grit removal). An automated gate is provided on the influent to the Preliminary Treatment Building and is controlled by a float switch in the influent channel just upstream of the screen. If the raw wastewater pumps cannot keep up with the influent flow, the level in the wet well will rise and overflow to the EQ pumping station. If the level in the raw wet well continues to rise and backs up into the channel, or if the flow is more than the screen capacity, the float switch activates and closes the gate. The raw wastewater is then diverted to the EQ pumping station before preliminary treatment. The float will also activate and close the gate if the screen becomes plugged and does not allow enough water to pass through.

Table 3.2. Summary of Deficiencies–Flow EQ

- EQ pumping capacity will need to be increased for Phases III and IV.
- Peak flow rates should be monitored to determine whether additional pumping capacity is needed before implementation of Phase III.
- Standby generator capacity may need to be increased to accommodate the increased pumping capacity.
- Additional EQ basin volume will be required.
- The EQ basin liner should be replaced in Phase III.
- The existing EQ pumps should be replaced in Phase III.

3.02.2 Preliminary Treatment

The preliminary treatment facilities consist of influent flow metering, screening, grit removal, and raw wastewater pumping. The preliminary treatment facilities are located in a building approximately 58 by 34 feet. Raw wastewater enters the influent channel in the lower level, approximately 17 feet below ground level. Flow then passes through the screen, grit chamber, and into the raw wet well. From here it is pumped to the secondary treatment facilities through a magnetic flow meter.

a. Mechanical Screening

General Description: Upon entering the Preliminary Treatment Building, flow travels through an open channel to a flexible rake screen. The screening unit removes debris from the wastewater stream that could otherwise damage the WWTF or overload the fine screens (refer to Section 3.03 for information on the fine screens).

The mechanical screening unit in place at the plant is a Flexible Rake Bar Screen, Model FlexRake® FPFS by Duperon Corporation, with 1/4-inch openings. As waste debris is trapped on the screen, the flexible rake carries the screenings to the main level, where it is deposited in a hopper feeding the screenings wash press. The screenings wash press then washes and compresses the screenings and forces them through a tube and deposits them in a dumpster for removal to the landfill.

Capacity Evaluation: The flexible rake screen has a design capacity of 7.0 MGD (4,861 gpm) with a maximum upstream depth of 3.21 feet. As discussed in the previous section, when flow to the WWTF exceeds the screen capacity, the influent gate is partially closed to restrict flow to preliminary treatment, and excess flow is diverted to the flow EQ pumping station. If the preliminary treatment facilities are designed to handle the peak flow of the secondary treatment process (MBR), with the rest being diverted to flow EQ, the screen has adequate capacity for Phases IIC and III, but inadequate for Phase IV. Additional screening capacity will be required for Phase IV.

Physical Condition/Performance: The flexible rake screen and wash press were installed in 2017 and are in good working order. The screen has performed well and should continue to do so through Phase III.

b. Screen Bypass Channel and Grinder

General Description: In addition to the mechanically cleaned screen located in the primary channel, a grinder is located in an adjacent bypass channel. Typically, all flow passes through the flexible rake screen. The grinder is used only as a bypass to the mechanical screen, for times when the mechanical screen must be taken out of service for maintenance or repairs, or when the screen becomes plugged and cannot handle the flow. An automated gate is located on the bypass channel, which opens when the influent channel water level reaches a high-level set point or the screen fails.

Capacity Evaluation: The grinder has a design capacity of approximately 7 MGD, which is adequate for Phase III, but not for Phase IV.

Physical Condition/Performance: The grinder was installed in 2017 and is in reasonably good condition. There are no known performance issues with the grinder.

c. Grit Removal System

General Description: The next process following screening is the grit removal unit. This process removes heavy fine particles from the wastewater stream such as sand, gravel, and other fine particles. Equipment used in this process includes a Smith & Loveless, Inc. (Smith & Loveless) PISTA® Grit Chamber with a self-priming centrifugal pump. This equipment is located on the lower level of the Preliminary Treatment Building. A concentrated slurry of grit and wastewater is pumped from the grit chamber to the ground level, where it passes through a grit classifier. The grit classifier then dewaters the grit slurry, placing dewatered grit into a dumpster for land disposal, and returning the slurry water to the influent wastewater stream.

Capacity Evaluation: The grit system has a design capacity of 7.0 MGD and can handle higher flows with reduced efficiency. Following the same philosophy used for the screen, if the preliminary treatment facilities are designed to handle the peak hour flow of the MBR, the existing grit system would be adequate through Phase III. Flows in excess of 7.0 MGD would be diverted to the flow EQ lagoon before grit removal so that additional grit capacity would not be required. However, additional capacity would be required for Phase IV.

Physical Condition/Performance: The grit unit and classifier were rebuilt in 2007 and are in fair condition and performing reasonably well. WWTF staff has been maintaining the units and repairing or replacing components as needed. The grit system should continue to operate adequately within design and flow parameters through Phase IIC. Given its age and condition, the grit system will be near the end of its useful life and should be considered for replacement in Phase III.

d. Raw Wastewater Pumping

General Description: After passing through screening and grit removal, wastewater flows to a wet well where it is pumped to the secondary treatment facilities. This is done with the use of three Gorman-Rupp Pumps (Gorman-Rupp) self-priming centrifugal pumps. These pumps are located on the lower level of the Preliminary Treatment Building and have suction lines that extend down into the wet well. The pumps are provided with VFDs, which modulate the pump speed to match the influent flow rate, up to the maximum flow set point.

Capacity Evaluation: Two of the three pumps are Gorman-Rupp Model T-8, with 100-horsepower (hp) motors. Each pump has a capacity of approximately 2,500gpm. The third pump is a Gorman-Rupp Model T-10 with 100-hp motor and a capacity of approximately 3,200 gpm. The firm pumping capacity (with the largest unit out of service) is approximately at 4,300 gpm (6.19 MGD) with two T-8 pumps running. With one T-8 and one T-10 pump running, the capacity is approximately 4,860 gpm (7.0 MGD). The raw wastewater pumps should be capable of pumping the design peak flow of the MBR, which is limited to 6.84 MGD. With all three pumps in service, the capacity is greater than 7.0 MGD. With the largest pump out of service, capacity is limited to 6.19 MGD. The City has a spare T-10 pump on hand that could be installed in place of one of the T-8 pumps, to increase the firm capacity to 7.0 MGD. The City should consider installing the spare T-10 pump to increase firm pumping capacity. IDNR design standards require that raw wastewater pumping capacity equal the PHWW flow with the largest unit out of service. The raw wastewater pumping capacity includes the three raw wastewater pumps and the three flow EQ pumps. With one EQ pump out of service, the firm raw wastewater pumping capacity is approximately 15.64 MGD (7.0 MGD raw wastewater pumps and 8.64 MGD flow EQ pumps). This is adequate for current conditions and just short of design Phase IIC PHWW flow. Additional pumping capacity will be required for Phases III and IV, as noted in the previous section.

Physical Condition/Performance: The Gorman-Rupp pumps and motors were replaced in 2017. New VFDs were also installed at that time. The pumps and associated equipment are in good working condition and should continue to perform adequately within their design parameters.

The wet well size, particularly the operating depth range, is problematic for WWTF operations. During low-flow periods, such as overnight, the pumps cycle on and off several times per hour due to the small wet well and pump turndown limitations. This is undesirable to WWTF staff as it complicates wastewater parameter trending and increases wear on the equipment. As WWTF flows increase, a larger wet well should be provided.

Operators have also expressed concerns with grease accumulation in the wet well. Grease gets trapped in the wet well, and can get as thick as 1 to 3 feet. This reduces the operating depth of the wet well. The grease must be sucked out on average every 6 weeks or so. During high-flow events, the grease gets sucked into the pumps and passes on through to the fine screens. Excessive grease can cause blinding of the fine screens. See Section 3.02.3.b for further discussion of the fine screens.

e. Influent Flow Metering

General Description: Raw wastewater flow metering is provided by a 12-inch magnetic flow meter on the discharge side of the raw wastewater pumps.

Capacity: The 12-inch magnetic flow meter has a flow range of approximately 337 gpm up to 11,000 gpm. At the higher end of the flow range, the velocity is extremely high. The practical flow limit would be approximately 5,000 gpm (7.2 MGD). The required capacity of the magnetic flow meter would be limited to the peak flow capacity of the MBR system, 6.84 MGD. The existing flow meter should be adequate to handle the flows through Phase III.

Physical Condition/Performance: The magnetic flow meter was installed in 2007, and recalibrated in 2017. It is in good working condition and should continue to perform adequately.

f. Ventilation

General Description: The Preliminary Treatment Building is ventilated at a high rate to maintain a safe work environment. The ventilation system consists of direct fired gas make-up air unit/heater (MAH-1), two exhaust fans (EF-1 and EF-2), and various louvers and grills. In 2017, an odor control unit was installed, consisting of a ventilation fan and activated carbon vessel. Odorous gases are collected from the influent channel and wet well, then passed through the activated carbon bed.

Capacity: The MAH-1 is designed for 7,000 cubic feet per minute (cfm), and the two exhaust fans are sized for 3,750 and 3,650 cfm, respectively. IDNR design standards require that ventilation be provided continuously at 12 air changes per hour. This would require approximately 7,000 cfm, so the existing ventilation system has adequate capacity.

Physical Condition/Performance: Although the system is in reasonably good condition, it is nearing the end of its useful life and should be considered for replacement. The odor control unit is performing adequately.

Table 3.3. Summary of Deficiencies–Preliminary Treatment

- Additional screening capacity will be required for Phase IV.
- Additional grit removal capacity will be required for Phase IV.
- Existing grit unit and classifier are nearing the end of their useful life and should be considered for replacement in Phase III.
- Additional raw wastewater pumping capacity will be required for Phases III and IV.
- The wet well is undersized for the plant flows. Additional wet well capacity should be provided.
- Ventilation system for preliminary treatment should be replaced for Phase III.

3.02.3 Secondary Treatment–MBR

The secondary treatment system at the City's WWTF uses an advanced activated sludge process to remove the undesirable components from the wastewater. Naturally occurring microorganisms convert the organic components of wastewater into biological cell mass, carbon dioxide, and water, and convert ammonia into nitrate nitrogen. The system is also designed for BNR, reducing TN and TP in the plant effluent. The wastewater is then filtered through hollow-fiber submerged membranes to produce high-quality effluent with almost no suspended solids and virtually no bacteria. The MBR system consists of many components including fine screens, biological tanks with anaerobic, anoxic, and aerobic zones, mixers, recirculation pumps, aeration system, WAS system, ML recirculation pumps, membrane trains, permeate pumps, backpulse tank, membrane aeration system, chemical feed systems, and compressed air system. Before analysis of each of the components, a general discussion on membrane system reliability is presented.

A. Membrane System Reliability

IDNR design standards establish unit process reliability criteria for conventional treatment processes. Reliability criteria C (14.5.2.3) would apply to the City. Although not directly applicable to an MBR, these criteria can be used to provide guidance when considering reliability criteria for the MBR.

Section 14.5.2.3.1 requires that screens, when used in lieu of primary clarifiers, shall provide peak flow capacity with the largest unit out of service. In addition, Section 15.2.5.2.1 requires a minimum of two screens, each sized for the peak flow capacity. Although the fine screens are not intended to replace primary clarification, applying this criterion would seem reasonable.

Section 14.5.2.3.3 establishes reliability criteria for aeration basins, which would apply to the City's aeration basins. It requires that, with one basin out of service, the remaining basin be able to handle 50 percent of the design loading.

As noted, IDNR design standards do not specifically address reliability criteria for MBRs. Because the membrane system accomplishes solids liquid separation, similar to a final clarifier, it would seem reasonable to apply similar reliability criteria. Section 14.5.2.3.4 requires that final clarifiers provide 75 percent of the design capacity with one unit out of service.

The preceding criteria will be used for evaluating reliability requirements for each of the unit processes within the MBR.

B. Fine Screens

General Description: Raw wastewater that is pumped from preliminary treatment enters the Membrane Building in the screening room. Four internally fed rotary drum fine screens, with 1-mm openings, provide additional screening of the raw wastewater. Two of the screens, manufactured by Baycor, were installed in 2008, and have 48-inch-diameter drums by approximately 9.5 feet long. Two additional screens, manufactured by Parkson Corporation, were install in 2017, and have 60-inch-diameter by 72-inch-long drums. The fine screens remove hair, fibrous material, and other small particles that could damage and/or foul the membranes. The screenings are deposited into a screw conveyor, which transports them to a screenings wash press. The wash press washes and compacts the screenings and deposits them in a dumpster.

The screened wastewater flows out the bottom of the screens, then through 16- and 20-inch pipes to a splitter box and then on to the aeration basins.

To control the flow distribution and rate to each screen, a magnetic flow meter and automated control valve is provided on the influent to each screen.

Capacity: Each fine screen was designed for a capacity of approximately 2.534 MGD. This provides a total capacity of 10 MGD. IDNR design standards require that a minimum of two units be provided, and they be capable of handling the maximum flow with the largest unit out of service. The maximum flow that the screens can handle with one out of service is 7.5 MGD. The peak flow to the MBR for Phase IIC and III is 6.84 MGD. The screens have adequate capacity for Phases IIC and III. Additional fine screening will be necessary for Phase IV.

The screenings conveyor and wash press are each designed for 99 cubic feet (cf) of screenings per hour, significantly higher than the screening load that would be experienced at the anticipated flows. Current screenings loads are estimated at approximately 16 cf per day. The screenings conveyor and wash press should be adequate for Phases IIC and III.

Physical Condition/Performance: The rotary drum fine screens, wash press, and auger are in reasonably good working condition and have been well maintained. The Baycor screens, auger, and wash press will be nearing the end of predicted life after Phase II and should be considered for replacement in Phase III.

The screens have experienced operational issues during peak flow conditions. In one event, the screens became plugged during the night time when no operators were present. Alarms and fail-safes in place did not function properly, and wastewater continued to be pumped to the screens. Raw wastewater spilled out the end of the screens, and flooded the building, causing significant damage. The monitoring instrumentation and fail-safes have been repaired to help minimize the potential of this happening again. However, additional means of preventing this type of failure should be considered. One option would be to relocate the fine screens to a new Preliminary Treatment Building.

The screens become plugged periodically. Every 3 months or so, the screens must be washed with acid to remove items such as lint, hair, and grease. As previously noted, grease that gets trapped in the wet well periodically gets flushed through to the fine screens. This slug of grease can cause plugging problems. To help remove grease and minimize plugging problems, a hot water system was added to the existing spray wash system during the last upgrade. However, the operators have found the hot water spray wash to be ineffective and still rely on periodic manual pressure washing to clean the screens. With 1-mm openings in the screens, this periodic cleaning will likely need to continue.

C. Biological Basins

General Description: From the fine screens, raw wastewater flows through a 20-inch pipe to the influent splitter box, which splits the flow between the two biological trains. Wastewater first enters the anaerobic zone, where it is mixed with recycled ML from the end of the anoxic zone. The anaerobic zone provides an environment for phosphate accumulating organisms (PAO) to flourish and promote phosphorus removal. From the anaerobic zone, wastewater then flows to the anoxic zone, where the wastewater is mixed with recycled ML from the end of the aerobic zone. In the anoxic zone, denitrifying organisms convert nitrate to nitrogen gas for TN removal. After the anoxic zones, the wastewater flows to the aerobic zone. The aeration basins provide an aerobic environment for the microorganisms to consume the organics in the wastewater. The contents of the basins are mixed to contact the microorganisms with the wastewater. This is accomplished by the aeration system. Aeration also provides oxygen used by the microorganisms to stabilize the organics. The aeration system is discussed further in the following section. The contents of the aeration basin (ML) are then pumped by the ML recirculation pumps to the membrane tanks. Overflow from the membrane tanks is returned to the aeration basins.

The City's WWTF has two biological treatment trains. Each train is 146 feet long by 30 feet, 1.5 inches wide, and has a maximum side water depth (SWD) of 20 feet. Total tank depth is 22 feet, allowing for 2 feet of freeboard. Each train has a volume of approximately 625,800 gallons (total volume of 1,251,600 gallons).

Each train is divided into anaerobic, anoxic, and aerobic zones. The anaerobic zones are located at the influent end of the train and have a volume of approximately 67,200 gallons per train. A baffle wall helps prevent short circuiting. The anaerobic zones are mixed by two submersible mixers.

The anoxic zones, located downstream of the anaerobic zones, have a volume of approximately 210,000 gallons per train. The anoxic zones also include a baffle wall and two submersible mixers per train. ML is returned from the anoxic zone to the anaerobic zone with submersible propeller pumps and 16-inch-diameter flow tubes.

Following the anoxic zone, the aerobic zones have a volume of approximately 348,600 gallons per train. Mixing is provided by the aeration system. ML is returned from the aerobic zone to the anoxic zone with submersible propeller pumps and 24-inch-diameter flow tubes.

In addition to the biological trains, the membrane tanks provide some additional aerobic zone volume. Each membrane tank has a volume of approximately 24,500 gallons. With four membrane tanks currently in operation, that provides an additional 98,000 gallons of aeration tank volume. The total treatment volume, including the biological trains and membrane tanks, is approximately 1,350,000 gallons.

Capacity: For Phase IIB, the biological trains were designed for an AWW flow of 4.429 MGD. The peak hydraulic capacity is limited by the peak capacity of the membranes. The system was also designed to treat an average BOD load of 3,592 lb/day, a maximum month load of 4,730 lb/day, and a maximum day load of 7,626 lb/day. This was based on an average ML suspended solids (MLSS) concentration of 8,000 mg/L. Actual operating MLSS concentrations have ranged from approximately 7,000 to 12,000 mg/L and 82 percent volatile.

IDNR design standards provide typical design parameters for conventional activated sludge systems. Although an MBR is not a conventional system, some of the guidelines can be used for comparison purposes. The typical design loading and design parameters, along with current, Phase IIB, and Phase IIC loadings are presented in Table 3.4.

As can be seen in Table 3.4, the organic loading rate is higher than conventional systems. However, with the much higher ML concentrations achievable with the MBR, the organic loading rates can also be much higher. This can be seen in the food to microorganism ratio, which is much lower than conventional systems. To verify this, an activated sludge model was used to evaluate these loading conditions. The model results, presented in Appendix C, show that the biological basins will be adequate for the proposed conditions. The biological basins should be adequate through the projected Phase IIC loading rates. Beyond Phase IIC, additional capacity will be required.

Table 3.4–Biological Basin Loading and Design Parameters

Loading/Design Parameter	IDNR Guidelines [1]	Current Loadings	Phase IIB Loadings	Phase IIC Loadings
Maximum Month BOD Load (lb/day)	---	4,245	4,730	5,848
SRT (days)	15 to 25	24	21	15
OLR (lbs BOD_5/1,000 cf/d)	15	24	26	32
Food to Microorganism Ratio, F:M (lbs BOD_5/lb MLVSS/d)[2]	0.08 to 0.16	0.07	0.07	0.09
MLSS (mg/L)	2,000 to 5,000	8,000	8,000	8,000

Notes:
SRT=Solids Retention Time
OLR=Organic Loading Rate
MLSS=Mixed Liquor Suspended Solids
MLVSS=Mixed Liquor Volatile Suspended Solids
(1)IDNR guidelines for conventional combined carbon oxidation and nitrification activated sludge.
(2) Based on average 80 percent VS concentration.

Physical Condition/Performance: The aeration basins and equipment are in generally good condition and should continue to perform adequately within their design parameters. The facility has consistently met BOD and ammonia effluent limits and is meeting the goals for TN and TP reduction. All tanks, walkways, embeds and grating will require inspection during design.

Aeration Basins 1A and 2A are located downstream of the anoxic zones. These anoxic and aerobic zones are separated by a divider wall with a 4-foot opening on one end to connect them. The recirculation pump from the anaerobic tank to the anoxic tank is located near this opening. The operators have expressed concerns with oxygen migrating into the anoxic and anaerobic basins through the opening and recirculation pump. To address this, the operators have reduced air flow and/or cycled air on/off to Basins 1A and 2A. However, with reduced air flow, there is not adequate mixing in these basins. To address this, submersible mixers should be installed in these basins to allow them to operate as a "swing zone" (either aerobic or anoxic). In addition, the opening in the baffle wall between the two basins could be partially blocked off.

One ongoing operational issue with the MBR system is the degree of foaming that occurs in the aeration basins. This is typical of most MBRs and is not a major issue as long as the foam does not get too deep and can be contained in the basins. Scum troughs and spray nozzles are provided to help reduce the amount of foam accumulation. One way reduce foaming issues in an MBR is to increase sludge wasting and decrease the SRT. However, due to limitations with the solids handling facilities, increasing sludge wasting is currently not feasible. Improvements in the solids handling facilities, which are discussed in later sections, should help reduce the foaming issues.

D. *Aeration System*

General Description: The aeration system provides the oxygen and mixing necessary for the secondary treatment system. It consists of fine bubble diffusers and blowers. The diffusers consist of flexible membrane discs mounted on a polyvinyl chloride (PVC) piping system over the entire floor of the aeration zone. The discs have small slits in them to release the air in fine bubbles, which improves the oxygen transfer efficiency. Basins 1A and 2A contain sixteen 4-inch-diameter laterals and a total of 211 diffusers per basin. Basins 1B and 2B contain thirteen 4-inch-diameter laterals and a total of 731 diffusers per basin. Air is delivered to the diffusers by four positive displacement blowers, one of which serves as back up. The blowers are equipped with VFDs and are controlled based on DO content in the aeration basins. DO probes in each basin provide monitoring and feedback to the control system, which controls blower speed to meet the oxygen demands and maintain a DO setpoint. A common header pipe delivers air from the blowers to the aeration basins. Air flow split between the basins is controlled by electrically actuated butterfly valves (BFV) based on DO in the basins. Air flow rate is measured and recorded by a thermal-mass meter.

Although the blower speed and control valves modulate to try to maintain a set DO, the minimum speed setting on the blowers does not allow air flow to be reduced enough during most operational periods. To better match the lower oxygen demands, the control system allows for cyclic on/off control of the blowers. For each hour of the day, the blowers may be set to run from 0 to 60 minutes during that hour. The operators modify blower on/off times as needed. When the blowers run, the speed is controlled by the DO setpoint.

Capacity Evaluation: The aeration system was designed to deliver up to 5,625 standard cubic feet per minute (scfm) of air. Each blower has a design capacity of 1,875 scfm at 12.4 pounds per square inch (psi). For the Phase IIB design, the required air to treat the peak day load of 7,626 lb/day BOD and 2,102 lb/day TKN was 4,300 scfm. Therefore, the aeration system has approximately 30 percent excess capacity. The Phase IIC peak day load of 9,265 lb/day BOD is approximately 22 percent higher than the Phase II design and the TKN load of 1,291 lb/day is approximately 40 percent lower. The aeration system should be adequate for the increased load. In addition, the blower capacity can be increased by changing the belts and sheaves to increase the blower speed by approximately 10 percent if necessary.

To confirm the capacity of the aeration system to treat the proposed peak loads for Phase IIC, an activated sludge model was used (see Appendix C). Based on the model output, the required air flow for the Phase IIC peak day is approximately 4,480 scfm. The existing aeration system should be adequate through Phase IIC. If additional aeration is needed, the blower output could be increased. As previously noted, this can be accomplished by changing the belts and sheaves. For Phases III and IV, expansion of the aeration system, along with the aeration basins, will be required.

Physical Condition/Performance: The aeration system is generally in good condition and should be capable of performing adequately within its design parameters. The membrane diffusers generally have a life expectancy of 7 years or so, so they may need to be replaced in the next few years. Three blowers were originally installed in 2008 but were rebuilt in 2017. New blower units and motors were installed in the existing enclosures. One new blower was also installed in 2017, so the blowers are approximately 6 years old. They are also in reasonably good condition and should continue to perform adequately. Aerzen, the blower manufacturer, recommends rebuilding the blowers at 40,000 hours of operation.

The operators have experienced difficulties in controlling the DO in the aeration basins and keeping the DO in the basins equal. The current system uses one air header pipe to supply air to all four basins. To help control air flow to the basins, separate air headers could be added for each train. This would allow blowers to be dedicated to each train and allow more precise DO control.

E. WAS System

General Description: The WAS system is used to remove excess biological solids from the aeration basins that are produced during the stabilization of the wastewater. The system is also used to remove foam and scum from the surface of the tanks.

WAS/scum pits are located in the aeration basins and have a maximum operating volume of approximately 13,500 gallons. WAS and floating scum/foam are removed from the top of the aeration basins via downward opening weir gates (one per basin) that discharge into the sludge/scum pits. The gates have electrical actuators for automatic operation. WAS can also be removed from mid-depth in Basins 1B and 2B through electrically actuated valves. Scum troughs that run the length of each basin also discharge into these pits.
Two submersible pumps, one duty and one standby, are used to pump the sludge/scum/foam to the digesters. A magnetic flow meter is used to measure and record the amount of WAS pumped to the digesters.

The controls are set up so that sludge wasting can be automated, based on a target volume of WAS and a set number of wasting cycles per day. A foam wasting cycle is also included in the control system, based on operator input duration and frequency. The water level in the basins is temporarily raised to allow foam/scum to spill over into the troughs. A spray wash system washes the troughs and helps transport the foam to the pit.

Capacity Evaluation: The capacity of the WAS system is limited by the capacity of the WAS pumps. Each pump has a capacity of approximately 390 gpm, which is more than adequate for Phase IIC design conditions. Additional capacity will be required for Phase III.

Physical Condition/Performance: The physical condition of the WAS system is reasonably good. The WAS pumps were originally installed in 2008 and should continue to perform through Phase IIC.

F. *ML Recirculation Pumps*

General Description: The ML recirculation pumps are used to transfer ML from the aeration basins to the membrane tanks. Five pumps are provided, two for each aeration train plus one standby. The design intent is for the pumps to recirculate ML through the membrane tanks at a rate of five times the influent flow rate (up to the maximum month flow rate). This maintains a relatively high velocity of flow past the membranes to reduce plugging of the membranes.

A magnetic flow meter is provided for each pump to monitor the recirculation rate. The pumps are provided with VFDs, which are controlled by the membrane control system, so that the total recirculation flow rate equals five times the membrane system influent flow rate.

Capacity Evaluation: Each pump has a design capacity of 4,400 gpm at 14.5 feet, but this is at a reduced speed of 590 revolutions per minute (rpm). The pumps are direct drive with 900 rpm, 40-hp motors, and the speed is limited to 590 rpm through the VFD. With four pumps running at 590 rpm, this provides a total return flow of 25.34 MGD. Required recirculation flow for Phase IIC is 19.21 MGD, or five times the maximum month flow of 3.842 MGD. The Phase III maximum month design flow is 5.420 MGD. For a recirculation ratio of 5, this requires 27.1 MGD or 4,705 gpm from each pump. The pumps would need to operate at approximately 650 rpm and require 27 hp. This is within the capability of the existing pumps. However, pipe velocity would be relatively high at that flow rate (approximately 10 feet per second [fps]), so it would be desirable to provide a larger or additional pipe. For Phase IV, additional recirculation pumping capacity will be required.

Physical Condition/Performance: The ML recirculation pumps are in good working condition and should continue to perform adequately for the foreseeable future.

G. *Membrane Trains*

General Description: The membrane trains are the heart of the membrane bioreactor process. There are four membrane trains, each train consists of one tank, 9 feet wide by 35 feet long by 10 feet 3 inches deep. Each train has five membrane cassettes. Each cassette has 48 membrane modules, which consist of tens of thousands of membrane fibers. The original modules, installed in 2008, have a total membrane surface area of 340 square feet (sf). Improvements in module design have allowed increased membrane area per module, with currently installed modules having a mix of membrane area, including modules with 340, 370, and 395 sf.

The original membrane system, Phase I installed in 2008, had four membrane cassettes installed in Trains 1 through 3 with 340-sf modules. Phase II expansion of the membrane system was divided into Phases IIA and IIB. Phase IIA included installing four membrane cassettes in Train 4 with 370-sf modules. Phase IIB was planned to expand the membrane system to fully populate the trains with 370-sf modules. This would have provided a total membrane surface area of 355,200 sf.

To maximize the life and value of the installed membranes, the City has been replacing the original membranes over several years. This has resulted in a mixture of modules in the system. Train 1 currently has five cassettes with 395-sf modules that were installed in 2023. Train 2 has five cassettes with 395-sf modules installed in 2021. Trains 3 and 4 each have five cassettes: four cassettes with 370-sf modules and one cassette with 340-sf modules. Because the 340-sf modules are more than 15 years old, these will either need to be removed from service or replaced as the membranes begin to fail. The membranes currently installed are shown in Table 3.5.

Table 3.5. Summary of Membranes Installed

	Train 1	**Train 2**	**Train 3[(1)]**	**Train 4[(1)]**
No. of Cassettes	5	5	5	5
No. of 340-sf Modules	---	---	48	48
No. of 370-sf Modules	---	---	192	192
No. of 395-sf Modules	240	240	---	---
Membrane Area per Train (sf)	94,800	94,800	87,360	87,360
Total Membrane Area (sf)	364,320			
Membrane Area with No. of 340-sf Modules [(1)]	94,800	94,800	71,040	71,040
Total Membrane Area with No. of 340-sf Modules (sf) [(1)]	331,680			

[(1)]The 340-sf modules are more than 15 years old and would not be expected to last another 5 years through Phase IIC. This assumes these membranes are not replaced, so that Trains 3 and 4 have just four cassettes with 370-sf modules.

It should be noted that advancements in the manufacturing process now allow for cassettes with 52 modules that fit in the same footprint, and the membrane surface area per module has increased to 430 sf. When the membranes are replaced, using the higher surface area modules and larger capacity cassettes would allow higher design flows for the system. The membrane supplier is also beginning to introduce modules with 460 sf into the market, which would increase the design capacity of the system. This will be discussed further in the next section.

The membrane fibers are submerged in the tanks, and the permeate pumps are used to pull a vacuum on the fibers and “suck” the water through the fibers. The pore openings in the fibers are very tiny, nominally 0.02 micrometers (µm). The fibers allow the water to pass through, but filter out virtually all suspended solids, bacteria, and some viruses.

There are number of valves and instrumentation that are used to monitor and control the membrane system, including a supervisory control and data acquisition (SCADA) system dedicated to the membrane system. There are also many different systems that support the membrane system, including the permeate pumps, backpulse tank, membrane aeration system, chemical feed systems, and compressed air system. These systems are discussed further in the following sections.

<u>Capacity Evaluation:</u> The capacity of the membrane system is limited by the flux, or flow per unit area, that can be pulled through the membranes. Flux is generally measured in gallons of flow per square foot of membrane surface area per day (gfd). Transmembrane pressure (TMP), or the pressure drop across the membranes, also affects the capacity. The maximum TMP across the membranes is 12 psi, but this is typically limited to 10 psi for operational purposes. The TMP will vary depending on several conditions, including water temperature, condition of the solids, membrane fouling, and age and condition of the membranes. Often, permeability is used to describe the overall performance of the membrane system. Permeability is a combination of flux rate and transmembrane pressure and is expressed as flow rate per unit area per psi of pressure drop across the membranes, or gfd/psi. Because of the large effect of temperature on permeability, this is often normalized to a standard temperature of 70 degrees Fahrenheit (°F) and is referred to as temperature corrected permeability.

The Phase IIC design flux rates for the membrane system are listed in Table 3.6 with all trains in service and with one train out of service. The design allows for treating the more than 90 percent of the maximum month flow with one train out of service. The table also shows the allowable design flux rates. As can be seen, the flux rates for Phase IIC are less than the allowable design flux rates. Additional membrane capacity will be needed for Phase III and Phase IV flows.

Table 3.6. Membrane System Flux Rates

	Allowable Flux Rates	**Phase IIC with Current Membranes** [(2)]		**Phase IIC without 340-sf Modules** [(2)]	
Design Condition	**Flux (gfd)**	**Flux (gfd)**	**Flow (MGD)**	**Flux (gfd)**	**Flow (MGD)**
All Trains in Service[(1)]					
Average Day	10.0	7.9	2.889	8.7	2.889
Maximum Month	14.6	10.5	3.842	11.6	3.842
Maximum 7-Day	16.7	14.3	5.226	15.8	5.226
Maximum Day	19.4	18.8	6.840	20.6	6.840
Peak Hour	22.1	18.8	6.840	20.6	6.840
One Train Out (n-1)[(2)]					
Maximum Month	14.6	14.6	3.935	14.6	3.458

Notes:
(1)Total membrane surface area = 364,320 sf; (n-1) = 269,520 sf (Train 1 or 2 out of service)
(2)Total membrane surface area = 331,680 sf; (n-1) = 236,880 sf (Train 1 or 2 out of service)
(3)Maximum flow is limited to 6.84 MGD due to capacity of permeate pumps.

Physical Condition/Performance: The membrane system is generally in good condition. WWTF staff perform routine, preventative maintenance on a regular basis. They also maintain an extensive spare parts inventory, so that if a piece of equipment breaks down, it can be returned to service within hours.

The membranes appear to be in overall good condition. Membrane effluent quality remains excellent at approximately 0.04 NTU, while the TMPs are still very low at around 2 psi. Permeability remains good at around 12 gfd/psi. The majority of membranes that were originally installed in 2008 have been replaced except for Trains 3 and 4, which each have one cassette of the original 2008 membranes. These older membranes will likely not last through the Phase IIC design conditions. However, they can remain in service until excessive fiber breaks begin to occur. At that point, they should be removed from service. As shown in Table 3.4, even with the two 340-sf module cassettes out of service, the system could handle the Phase IIC design flows and remain within allowable flux rates.

Train 1 membranes were replaced in 2023. Train 2 membranes were all replaced in 2021. For Train 3, membranes in four cassettes were replaced in 2020, and one cassette has the original 2008 membranes. In Train 4, four cassettes were installed new in late 2016, and the fifth cassette was relocated from Train 3 in 2020 and has the original 2008 modules. Presuming a similar membrane life of 12 to 14 years, the membranes will be due to be replaced between 2028 and 2035, around the time Phase III is implemented. The City is planning for their replacement by putting some money aside each year.

The membrane tanks have an epoxy coating system to protect the concrete tanks from corrosion during chemical cleaning of the membranes, which was replaced during the 2018 project. The epoxy coating system should be inspected on a regular basis (yearly) and repaired as necessary. When the membranes are replaced, the coating system will likely need to be replaced as well.

H. Permeate Pumps

General Description: The permeate pumps are used to create a vacuum on the membranes and draw water through the membranes. The membrane filtered water is referred to as permeate. There are four rotary lobe permeate pumps, one per membrane train. There is a magnetic flow meter with each pump to measure the permeate from each individual train, as well as other instrumentation (pressure and temperature transducers and switches) to monitor the performance of the system.

The effluent from the permeate pumps is discharged to the plant outfall. Some of the permeate is sent to the backpulse tank, which is discussed in the following section. The permeate pumps are also used to “backpulse” the membranes. Periodically, the permeate pumps are stopped, and then are started in the reverse direction. Permeate is drawn from the backpulse tank and pumped back through the membranes to knock accumulated solids off the membranes to help maintain permeability.

The permeate pumps have VFDs and are controlled by the membrane control system. The net permeate flow rate is controlled to match the influent flow rate to the membrane system.

Capacity Evaluation: The permeate pumps are each designed for a flow rate of up to 1,424 gpm at 32 feet. However, the maximum flow rate of the permeate pumps does not equate to the maximum production capacity of the membrane system in terms of MGD. That is because the permeate pumps are not producing permeate continuously. Periodically, the membranes must be backpulsed. The membranes are also “relaxed” periodically, where the pumps are stopped for a brief period to allow some of the accumulated solids to slough off of the membranes. As a result, the permeate pumps are only actually withdrawing water from the tanks approximately 83 percent of the time. The pump flow rate must be increased to make up for down time. In addition, the pumps must be sized for the maximum backpulse flow rate resulting in a net permeate production rate of 1,187 gpm (1.71 MGD) per train. The total maximum permeate production capacity of these pumps with all four trains in service is approximately 6.84 MGD. The permeate pumps should be capable of handling the peak flow for the MBR. Flows greater than the permeate production capacity will be sent to the EQ basin. Because the Phase IIC peak flow for the MBR is limited to 6.84 MGD, the permeate pumps should be adequate for Phase IIC. Additional capacity may be needed for Phase III and will be needed for Phase IV.

Physical Condition/Performance: The permeate pumps were replaced during the 2018 project and were rebuilt in 2023, including replacement of the stainless-steel bushings, seals, rotors, and lobes. The pumps are in good working condition and should continue to perform adequately for the foreseeable future. The pumps may need to be rebuilt in 5 years or with the next improvements project.

I. Backpulse Tank

General Description: The backpulse tank is a 3,500-gallon polyethylene tank located downstream of the permeate pumps. A portion of the permeate is sent to this tank and then used to backpulse the membranes. Flow into the backpulse tank is controlled by an electrically actuated valve. There is a check valve on the effluent line that allows flow out but prevents flow into the tank. The backpulse tank also has an overflow line that connects to the plant outfall. The tank is used to store permeate water that is used to backpulse the membrane. In addition, this water is used for nonpotable use throughout the WWTF. Two booster pumps supply water to the nonpotable system.

Capacity Evaluation: The 3,500-gallon capacity tank should be adequate through the Phase IIC expansion. The maximum backpulse flow rate is approximately 1,133 gpm for a duration of 1 minute. In addition, permeate from the operating trains provides additional water for backpulse.

Physical Condition/Performance: The backpulse tank is in good working condition and should continue to perform adequately for the foreseeable future.

Effluent flow metering is currently calculated by adding the flow rates from the magnetic flow meter on each individual membrane train. Any designed improvements will evaluate and plan for the potential future addition of an effluent meter downstream of the permeate tank.

J. Membrane Aeration System

<u>General Description:</u> The membrane aeration system is used to help clean the membranes. When the membranes are in operation, the membrane aeration system agitates the membranes to help knock accumulated solids off. The membrane aeration system consists of four positive displacement blowers, one assigned to each train. The standby blower for the aeration basins also provides backup for the membrane blowers. The newly installed membranes use LEAPmbr technology, which significantly reduces aeration requirements.

<u>Capacity Evaluation:</u> Each membrane aeration blower was designed to deliver up to 1,087 scfm. This is adequate for the Phase IIC, as well as for Phase III. As more membranes are added in Phase IV, more membrane aeration blowers will be required.

<u>Physical Condition/Performance:</u> The membrane aeration system is generally in good working condition. One new blower was added in 2018, and the belts/sheaves were replaced on the existing blowers to better match the air requirements for the LEAPmbr system. In fall 2022, one aeration blower caught on fire. Thankfully, the fire was contained mostly to blower B-85C. The cause was determined to be from an automated valve failing to open, and the pressure relief valve (PRV) failing to open and relieve pressure. As the blower kept running, the belts began to slip and become hot enough to catch fire. City staff is working with the membrane system and blower manufacturers to replace the blower, as well as the PRV, and instrumentation for all four membrane aeration blowers. Once these modifications are made, the blowers should continue to provide adequate service.

In a future project, air flow meters could be added to each membrane train and VFDs could be installed for the blowers to allow better control and monitoring of membrane aeration.

K. *Chemical Feed Systems*

General Description: Chemical feed systems are used to clean the membranes at regular intervals to remove any foulants that accumulate on the membranes and restore their permeability. Citric acid and sodium hypochlorite are used to clean the membranes. Two chemical cleaning schemes are used: maintenance cleans and recovery cleans. Maintenance cleans are typically performed monthly and consist of lower chemical doses and relatively short soak times (typically less than 30 minutes). The intent of these cleans is to help maintain the permeability. Recovery cleans are more intensive chemical cleans designed to restore the membrane permeability to as close to new condition as possible. Recovery cleans use much higher chemical doses and longer soak times (up to 20 hours) and are typically only performed once per year.

Each chemical feed system consists of a storage tank, two feed pumps, and piping and valves to deliver the chemicals to the application point. The chemical feed systems are located in separate rooms with separate entrances to prevent corrosive fumes from entering the rest of the plant.

Capacity Evaluation: The citric acid system includes a 500-gallon storage tank (450 gallon maximum fill capacity) and two feed pumps each rated for up to 7.5 gpm. The sodium hypochlorite system includes a 500-gallon storage tank (450 gallon maximum fill capacity) and two feed pumps each rated for up to 8 gpm. The capacity of the feed systems is adequate for Phases IIC and III.

Physical Condition/Performance: The chemical feed systems are in reasonably good working condition and should continue to perform adequately for the foreseeable future.

L. *Compressed Air System*

General Description: The compressed air system is mainly used to provide compressed air for operation of automated valves and chemical feed pumps. It consists of two two-stage reciprocating air compressors, two 240-gallon receiver tanks, two refrigerated air dryers, and associated piping and valves. Two of each component are provided for redundancy.

Capacity Evaluation: Each air compressor is rated for 52 actual cubic feet per minute (acfm) at 175 psi, while the air dryers are rated at 35 cfm. The compressed air system has more than adequate capacity for Phases IIC and III.

Physical Condition/Performance: The compressed air system is in good working condition and should continue to perform adequately for the foreseeable future.

Table 3.7. Summary of Deficiencies–Secondary Treatment

Fine Screens

- The Baycor fine screens, auger, and wash press will be nearing the end of their predicted life and should be considered for replacement in Phase III.
- Additional fine screening capacity will be required for Phase IV.
- Consider relocating the fine screens to a new Preliminary Treatment Building to eliminate the issue of flooding the Membrane Building.

Biological Basins

- Provide additional basin capacity for Phases III and IV.
- Install submersible mixers in Basins 1A and 2A.
- Consider partially blocking off the opening between the anoxic and aeration basins.

Aeration System

- Expand the aeration system for Phases III and IV.
- Provide separate air pipe headers to each train to allow more precise DO control.

WAS System

- Additional WAS facilities will be required for Phase III.

ML Recirculation Pumps

- Provide additional pipe for ML return to reduce velocity in the pipe for Phase III.

Membrane Trains

- Provide additional membrane capacity for Phase III and IV flows.
- The existing membranes will likely need to be replaced in Phase III.
- Inspect and repair or replace the coating on the membrane tanks when the membranes are replaced.

Permeate Pumps

- Pump capacity may be adequate for Phase III.
- Additional permeate pumping capacity will be required for Phase IV.

Backpulse Tank

- Improve redundancy of effluent metering, which is specifically required by the NPDES permit.

Membrane Aeration System

- Additional membrane aeration capacity will be required as more membranes are added in Phase IV.
- Evaluate with the membrane supplier adding VFDs and air flow meters to each membrane blower or train to monitor membrane aeration.

Chemical Feed Systems

- No deficiencies are noted.

Compressed Air System

- No deficiencies are noted.

3.02.4 UV Disinfection System

General Description: Disinfection of WWTF effluent is typically used to destroy pathogens found in the wastewater. Because pathogen limits have been established for the City's WWTF, disinfection of the treated wastewater must be performed before final discharge to Muddy Creek. The City's WWTF was originally designed to include a UV light disinfection system to accomplish this purpose. UV disinfection uses UV light to kill pathogenic bacteria present in the wastewater stream. UV light is delivered to the wastewater from submerged lamps in the disinfection channel. The lamps are similar to fluorescent lamps in size and shape. The number of lamps in a UV disinfection system is proportional to the flow rate and clarity of the water (transmittance).

The UV system is located south of the Control Building and receives treated water from the MBR before discharging to Muddy Creek. Bypass piping around the UV system is provided for periods when disinfection is not required.

Since implementation of the MBR, the UV system has not been used because the membranes effectively disinfect the effluent by removing all bacteria and most viruses. The plant effluent is routinely tested and consistently shows zero total coliform without the use of the UV system. In the past, IDNR has required the City to maintain the system so that it could be used if necessary. However, given the 15-year history of successful removal of bacteria with the MBR, IDNR is no longer requiring additional disinfection.

Capacity: The UV disinfection system is manufactured by Trojan Technologies and has a rated capacity of 6.50 MGD. The system was originally sized to handle the peak discharge flow rate from the SBRs. Because the SBRs used a batch process, discharge was intermittent, resulting in higher peak flows than are experienced from the MBR facility. If it becomes necessary to re-implement the UV system, it would not have adequate capacity for the Phase IIC peak flows through the MBR facility.

Physical Condition/Performance: The UV system has been maintained and is operational condition. However, the system is 25 years old, and replacement parts have limited availability or not available at all. Because the UV system is no longer required, it should be removed from service and demolished.

Table 3.8. Summary of Deficiencies–UV Disinfection System

• The UV system should be removed from service and demolished.

3.02.5 Solids Handling Facilities

Sludge stabilization at the North Liberty WWTF is accomplished with the use of aerobic digesters. Aerobic digesters employ the use of aeration equipment to maintain adequate oxygen concentration so that aerobic bacteria can thrive and digest the solids. Digested sludge is then pumped to dewatering and hauled to a dewatered biosolids storage building. Dewatered biosolids are hauled to land application approximately every 4 months.

A. Aerobic Digesters

General Description: The City's WWTF uses two aerobic digesters to stabilize the sludge. Aerobic Digester No. 1 is a concrete tank 84 feet by 62 feet by 22 feet deep, with a maximum SWD of 20 feet. Aerobic Digester No. 2 is a concrete tank 62 feet by 62 feet by 22 feet deep, with a maximum SWD of 20 feet. WAS and foam/scum from the aeration basins is pumped to the digesters for treatment. The digesters may be operated in series or in parallel.

The aeration system consists of racks of retrievable coarse bubble diffusers, six in Digester No. 1 and four in Digester No. 2. Digester No. 1 also has a fixed diffuser rack in the middle of the basin. Air is provided to the digesters through two positive displacement blowers. The standby blower used for the secondary treatment aeration system also provides backup for the digester blowers. A common 16-inch air header delivers air to the digesters.

A DO probe is in each digester to monitor the DO level and provide feedback to control the blowers. The blowers have VFDs to modulate speed to maintain the DO set point in the digesters. Electrically actuated valves modulate to control the air flow to each digester. In addition, each digester has a level transducer to monitor the water depth in each tank.

In addition to the mixing provided by the aeration system, each digester also has a floating mixer to help maintain solids in suspension during treatment. Digester No. 1 has two 20-hp mixers, and Digester No. 1 has one 40-hp mixer.

Each digester has a submersible pump that may be used to transfer sludge to the other digester or to sludge loadout. A dewatering feed pump is also located in each digester to pump sludge to the dewatering unit. A telescoping valve is in Digester No. 2 to allow gravity flow between the two tanks. Each digester also has a telescoping valve that can be used to decant supernatant after settling.

Capacity: Digester No. 1 has volume of approximately 0.779 MG and Digester No. 2 has a volume of approximately 0.575 MG, for a total digester volume of 1.354 MG. The Iowa sludge rules, discussed in Chapter 2, set forth requirements for pollutants, pathogens, and vector attraction reduction. To meet the pathogen requirements, aerobic digesters should have a mean cell residence time (average detention time) of 60 days at 15 degrees Celsius (°C) (59°F).

Operating records at the City indicate that digester temperatures drop to around 50°F during the winter months, which indicates that more than 60 days may be required. Vector attraction reduction criteria require that VS be reduced by 38 percent or more. IDNR design standards require a minimum 15-day detention time at 15°C. Ten States Standards also provide some guidance for sizing aerobic digesters based on population equivalent (P.E.) and requires a minimum of 5.625 cf/P.E. at 59°F and 27-day detention time.

Based on the projected biosolids data (see Chapter 2), the digesters provide a detention time of approximately 39 days for the Phase IIC maximum month condition (assumes 2 percent solids concentration). This should provide adequate detention time for digestion through Phase IIC. Additional digester capacity will be required for Phase III.

IDNR Design Standards require aeration be provided to aerobic digesters to maintain a minimum DO level of 1.0 mg/L. If aeration is used for mixing as well, air must be provided at a minimum rate of 30 cfm per 1,000 cf. This would require a minimum of approximately 3,125 cfm for Digester No. 1 and 2,300 cfm for Digester No. 2 (total of 5,425 cfm). The existing blowers have a capacity of approximately 1,875 scfm each, or a total firm capacity of approximately 3,750 scfm. However, because the tanks are equipped with mechanical mixers, the blowers do not need to provide mixing energy. Aeration requirements for sludge digestion were calculated using an aerobic digestion model (see Appendix E) to be 4,137 scfm for Phase IIC design conditions. The blower capacity could be increased by replacing the belts and sheaves, if necessary. Additional capacity will be required for Phase III. Separation of the aeration headers is also recommended to allow for better DO control.

The sludge transfer pumps in the digesters have a rating of 460 gpm at 25 feet total dynamic head (TDH). The existing dewatering feed pumps have a capacity of 66 gpm at 68 feet TDH. These are adequate for existing and Phase IIC conditions.

<u>Physical Condition/Performance:</u> The equipment in the digesters is in good working condition. During the 2007 project, all the diffusers in the digesters were replaced, and the mechanical mixers were rebuilt. The blowers were installed in 2018. The equipment should continue to perform through Phase IIC.

B. Sludge Dewatering

<u>General Description:</u> Digested sludge is pumped by two 6.5-hp submersible pumps, each located in a separate digester, through a common 4-inch force main to sludge dewatering equipment in the Biosolids Dewatering Facility. Each pump has a capacity of 66 gpm at 68 feet of TDH.

The biosolids are dewatered using a Fournier Fan Press dewatering system. Biosolids are fed to a flocculator where polymer and the biosolids are mixed. Biosolids are then fed at a low pressure into the fan press. The fan press consists of six channels for dewatering solids and is powered by a 20-hp motor. Sludge rotates between two parallel revolving plates that press water out of the sludge. At the discharge of the dewatering system, biosolids are at approximately 14 percent solids.

Dewatered biosolids are discharged onto a screw conveyor system that consists of three conveyors. The first conveyor where biosolids are discharged is 38 feet long, is horizontally oriented, and is powered by a 3-hp motor. The second conveyor is vertically oriented and powered by a 7.5-hp motor. The third conveyor is horizontally oriented, powered by a 2-hp motor, and discharges to a truck used for hauling dewatered solids to the storage building. The Biosolids Dewatering Facility and conveyor were sized so that a second fan press could be installed to expand dewatering capacity.

The polymer feed system is in the Biosolids Dewatering Facility and is a skid system in which polymer is metered, diluted, activated, and fed to the dewatering system.

<u>Capacity:</u> Each channel on the fan press can dewater 600 gallons per hour (gph), for a total of 3,600 gph with six channels. The system was designed to dewater 108,000 gallons per week while operating for 30 hours. This provides the City with downtime for cleaning and maintenance of the equipment. For Phase IIC maximum month conditions, 155,400 gallons per week of 2 percent sludge will require dewatering. This would require approximately 43 hours per week of operation. For Phase III maximum month conditions, 214,200 gallons per week of 2 percent sludge will require dewatering. This would require a minimum of 60 hours per week, or six 10-hour days of operation with the existing six-channel fan press. For Phase IV maximum month conditions, 313,600 gallons per week of 2 percent sludge will require dewatering. This would require a minimum of 87 hours per week, or seven 13-hour days of operation with the existing six-channel fan press. An additional fan press will be needed for Phases III and IV. This would allow dewatering to occur within four 8-hour days per week for Phase III and six 8-hour days for Phase IV.

Two fan press units operating together would have a total feed capacity of 7,200 gph (120 gpm). The existing digested sludge feed pumps would need increased in size for Phase III and IV improvements to provide redundancy and feed the maximum capacity of digested sludge to the fan presses.

The existing polymer skid pump can feed up to 2.5 gph of neat polymer. The polymer skid is dedicated to the existing fan press, so a second polymer skid would be added with a new fan press. The existing chemical containment area would need expanded to provide sufficient secondary storage for the polymer and space for the additional polymer feed unit.

The conveyors have a 300-cf per hour capacity, which is sufficient for handling dewatered biosolids through Phase IV with a second fan press added in the Biosolids Dewatering Facility. The existing conveyor discharges into a truck, which is used to transport dewatered biosolids to the Biosolids Dewatering Facility. The storage capacity of the truck and availability of operators to drive the truck limits the volume of biosolids that can be dewatered and stored. To help increase operating time, the conveyor could be extended through the east wall of the Biosolids Dewatering Facility and discharged to a pad or secondary truck outside of the building. For future phases, the conveyor could be extended to a new adjacent dewatered biosolids storage building.

Physical Condition/Performance: The dewatering equipment, conveyors, and polymer feed system are in good working condition and should continue to perform adequately.

C. *Dewatered Biosolids Storage*

General Description: Dewatered biosolids are hauled from the Biosolids Dewatering Facility to the Biosolids Dewatering Facility. The facility is 81 feet wide by 114 feet long and has 8 feet tall side walls. The structure is covered with a metal roof supported by a metal frame. A drain is in the middle of the structure and runs the length of the building. The front of the structure is open to allow equipment to drive into the building.

Land application is the preferred method of sludge disposal. Sludge is removed from the Biosolids Dewatering Facility three or four times each year and is land applied. A contract hauler is used for this service.

Capacity: The composition of the biosolids only allows it to be stacked to approximately 3 feet high. At this depth, the Biosolids Dewatering Facility has approximately 5 months of storage. IDNR requires a minimum of 6 months of storage. For Phase IIC improvements, a gate or other method of blocking the entrance to the facility could be added to allow the City to increase the stack height and increase the storage capacity of the facility. Increasing the stack height to 6 feet in the existing facility would provide for 10 months of storage at current biosolids average production rates and nearly 6 months at Phase IIC average biosolids production rates.

For Phases III and IV, additional dewatered biosolids storage will be required. Approximately 9 months of storage is recommended to allow the City flexibility in the land application schedule.

Physical Condition/Performance: The existing storage facility is in good condition and should continue perform adequately throughout its design life. However, the center trench drain gets plugged with solids and does not function. An electrical panel is also located on the end of the building near the entrance, which should be moved to the outside.

Table 3.9. Summary of Deficiencies–Solids Handling Facilities

Aerobic Digesters

- If additional aeration capacity is required before Phase III, replace the belts and sheaves on the existing blowers to increase blower output.
- Provide additional digester capacity for Phases III and IV.
- Evaluate whether blower PRVs need to be replaced if the blower discharge pressure changes.

Sludge Dewatering

- Extend the existing dewatered sludge conveyor through the east wall of the structure in Phase IIC to allow for additional operational flexibility.
- Install a second six-channel dewatering fan press in Phase III to expand the dewatering capacity.

Dewatered Biosolids Storage

- Provide additional sludge storage capacity for Phase IIC by installing a gate to close off the end of the structure.
- Provide additional sludge storage buildings for Phases III and IV.
- Provide road access around the storage building in Phase III.

3.03 Control Building

The Control Building includes administrative offices, laboratory facilities, restroom and shower facilities, breakroom, and electrical/control room. The building was originally constructed in 1998 and remodeled in 2018. The facility should be adequate through Phases IIC and III. As the community continues to grow, additional space will likely be required for Phase IV.

3.04 Electrical System

The electrical power system is comprised chiefly of two parts. The first part consists of equipment and buildings as part of the originally constructed facility, serving the original Control Building, EQ pumping station and Preliminary Treatment Building, mostly dating to 1998 to 2004. The second part of the electrical power system involves all facilities added with the MBR and afterwards, with most major equipment added in 2008.

As part of substantial improvements made in 2008 and 2018, large portions of the original (1998 to 2004) motor control centers (MCC) and distribution equipment were replaced, though the underground cable and two-part distribution remained intact. The two-part distribution system has resulted in two utility services to the facility and multiple automatic transfer switches (ATS) and multiple backup power generators to distribute power to all buildings and equipment. For purposes of this report section, “Phase 0” will denote infrastructure associated with the original installation and “Phase I” will denote items associated with the MBR expansion.

Facility power is delivered at 480/277 volts (V) from the serving utility. Once power is delivered to a building, each building has distribution panels and MCCs to deliver power to individual pieces of equipment. As part of each building, there exists step-down transformers to achieve 208/120V and additional power panels for process equipment, receptacles, lighting, and all other electrical devices.

Each building has critical power uninterruptible power supplies (UPS), used for power to process controllers, computers, Ethernet network equipment, security, and similar systems.

3.04.1 Utility Power Delivery

Power for “Phase 0” enters via a utility transformer near the Control Building. Three separate feeds are derived from the transformer, as opposed to a customary single feed. The three separate feeds are remnants of construction that has occurred over multiple plant expansions.

- 400 amperes (amps): Control Building
- 600 amps: Preliminary Treatment Building
- 800 amps: EQ Pumping Station

Large portions of the original “Phase 0” power distribution were removed with the conversion from SBR to MBR treatment upgrade, known as Phase I expansion in 2007. In addition, remaining Phase 0 MCCs and VFDs were replaced in the MBR upgrade (Phase II), corresponding to 2018. There are items of the Phase 0 installation that remain in service and should be removed or replaced. Process replacements and upgrades recommended in this study will for the most part result in direct abandonment of nearly all older cable feeders and distribution equipment.
Power for “Phase I” enters via a utility transformer to the east of the MBR Building. There is one 3,000-amp feeder, which equates to 2,600 kilovolt-amperes (kVA), from that transformer to an interior distribution panel inside the MBR Building electrical room. All MBR equipment is fed through this panel, including the Sludge Dewatering Building. Phase I equipment was added as part of the 2008 MBR conversion, and Phase II equipment added as part of the 2018 expansion. Both equipment groups in the MBR Building experienced damage because of the fine screen flooding but have been cleaned and repair or replaced as needed.

3.04.2 Emergency Power Delivery

Emergency power for the facility is supplied via two generators.

The first generator is at the EQ Building, which serves only the EQ pumping needs. It is rated 350 kW, sufficient to run all needed EQ pumps, and is controlled via a dedicated EQ Building ATS. These pieces of equipment are original to the 2004 EQ basin addition and are nearing the end of a typical 20- to 30-year service life. As a backup to the EQ Building generator, there exists a manual transfer switch that allows a connection to the City’s portable 125-kW genset. The backup portable generator can run only one pump and is considered viable as a last-resort option. The manual generator connection was added at after the 2004 original installation.

The second generator is located at the MBR Building and is rated 2,000 kW. It has more than sufficient power to run the entire plant, including the EQ Building (though it does not currently). The output of this generator arrives at a generator switchgear which splits to three feeds, going to the MBR Building, the Control Building and the Preliminary Treatment Building. At each of these buildings there are individual transfer switches that can individually call for a generator run cycle, and control if the downstream loads receive utility power or generator power. These pieces of equipment were placed in service with the 2008 MBR addition and are less than 15 years old and in good condition.

The presence of multiple ATSs, each with a possibility to start the generator and direct power downstream, does introduce complication to the power delivery methods at various locations in the WWTF. In addition, the presence of two ATSs, one for preliminary treatment and pumping and one for secondary treatment, slightly decreases the overall system reliability because both ATSs are required for overall WWTF operation. Preliminary treatment and pumping cannot operate if secondary treatment is not operational. Secondary treatment cannot operate for any length of time if preliminary treatment is not feeding it.

The presence of a dedicated generator and ATS at the EQ Building introduces an operational complication, but does add somewhat to the overall up-time reliability of the combined EQ-pumping and preliminary treatment pumping operations. If all else fails, EQ pumps can pump to the storage basin to buy time while repairs are made to get the WWTF operational.

3.04.3 Power Distribution Topology

In general, all power at the WWTF is transmitted in a radial feed pattern. A large utility transformer (or generator) provides power via a cable system to an ATS, then cables deliver power to large panels where it is split with circuit breaker panels to medium-sized cable feeders, where power is received (typically in an MCC or power panel) and split with circuit breakers to individual loads. Any failure of cable or equipment will affect all downstream equipment, leaving it without power until cables and/or equipment are repaired.

Perhaps the most concerning power path in the current facility configuration is the Preliminary Treatment Building. Utility power is via the transformer at the Control Building and proceeds to the Control Building where it is connected to the dedicated Preliminary Treatment Building ATS. Generator power for this ATS comes from the MBR generator via a long, but relatively new, cable feeder. The output of the ATS is connected to cables that proceed to the Preliminary Treatment Building. Those cables are believed to be original with the 1998 WWTF construction and would be nearing 25 years old. If a failure occurs with any one of those cables, the entire Preliminary Treatment Building would be without power even though utility or generator power would be available. The relatively safe fallback position for this is that the current EQ pumping structure ultimately does not rely on long feeder cables because the backup generator is at the building.

With the expansions presented with Phases III and IV, a power system that delivers redundant power paths to all buildings and processes is highly recommended. This will allow any cable or equipment maintenance/failure to be overcome with operation of various manual circuit breakers to reroute power with minimal down-time and minimal affect to undamaged equipment. Such a system is generally classed as “Secondary Selective.”

A Secondary Selective system involves main power distribution gear split into an A and B distribution, with delivery path via cables also separated and redundant. Power distribution would be via A and B power panels and MCCs with process equipment divided equally among A and B electrical systems. Any single failure of electrical cable or equipment would result with at least one-half of the WWTF being able to run after manual operation of circuit breakers to isolate troubles and reroute power. This redundancy of A and B electrical systems could also incorporate separate A and B electrical rooms to further compartmentalize issues, such as equipment room fires or roof leaks, from affecting equipment from the opposite system. See Figure 3.2.

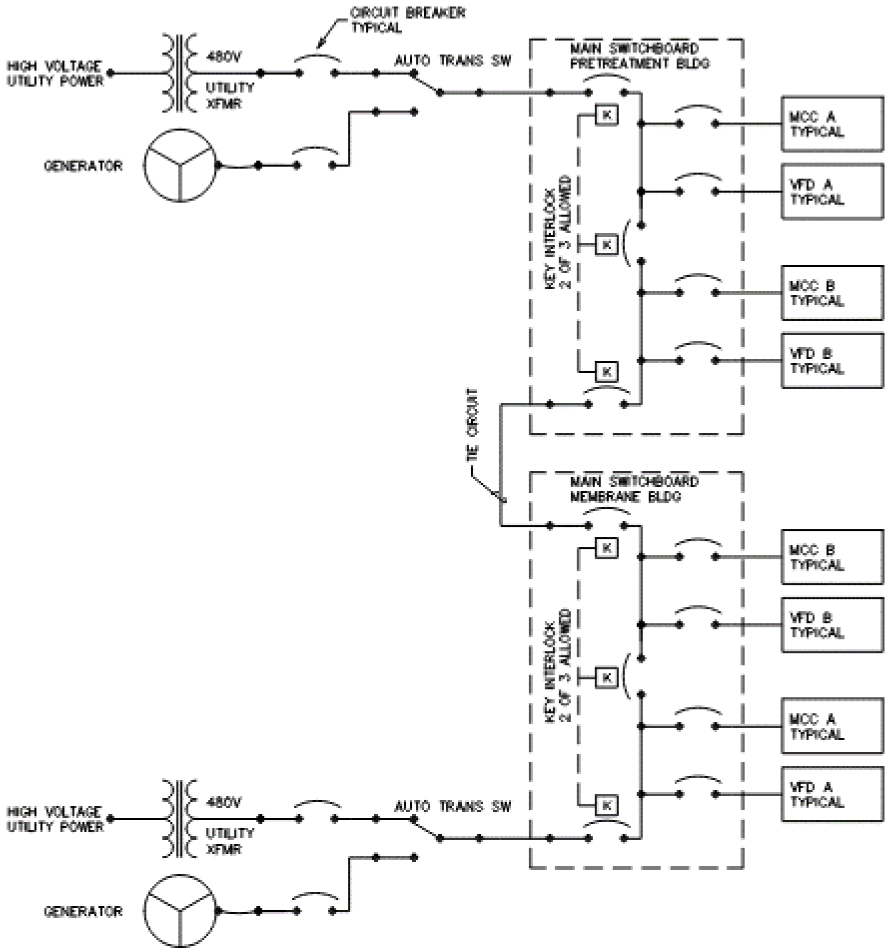

Figure 3.2. Potential Secondary Selective Power Distribution

When fully implemented, there would be utility power (via two transformers) and two separate generators available to power all WWTF equipment. Additionally, no one failure would result in a key plant area to be without power for extended periods. From an equipment standpoint, there would be additional circuit breakers and power panels. Mostly the added expense would be in the form of redundant cable connections between large electrical distribution panels.

3.04.4 Power Consumption and Projections

The WWTF is on a utility rate structure that bills in two parts, based on peak power used and overall energy used. As a result, reliable peak power usage is tracked and available for historical records. Using peak power data, calculations of overall capacity can be made. A review of the utility records for 2022 and 2021 revealed peak demands as follows:

- 804 kW: June 2021
- Less than 700 kW: All remaining 2021

- 701 kW: June 2022
- 701 kW: July 2022
- Less than 600 kW: All remaining 2022

According to WWTF staff, air diffuser upgrades were made after June 2021, which allowed for better use of air and less required blower operation, which directly affected how much power was required. To be conservative, 804 kW will still be used as a safe maximum power peak in load growth estimates.

Projected WWTF expansions for Phased III and IV and associated power demand were made in accordance with quantities and estimated horsepower of proposed motors, noting that various motors do not run all the time and other motors are present to provide redundancy in breakdown and repair scenarios. Projections of peak power needs are as follows:

- 804 kW: Current operation
- 1,520 kW: Phase III projection
- 1,880 kW: Phase IV projection

It is worthy to note that the existing MBR utility service (City-owned equipment) and generator are rated at least 2,000 kW, which appears to be enough to supply all power through Phase IV expansions. However, the existing utility transformer at the MBR service, which is not owned by the City, is rated 1,000 kVA, i.e., approximately one-half of the Phase IV power need. The existing Control Building utility transformer is 500 kVA and is not suitable for use in future phases of facility expansion. Discussions with the serving utility will need to be conducted concerning serving transformer kVA ratings compared to plant loading.

3.04.5 Ground Fault Protection

Power system configuration is 480/277V solidly grounded wye at both utility services. The MBR electrical service is 3000 amps, which is substantially greater than 1,200 amps. This is the limit at which the National Electrical Code requires ground fault protection on main circuit breakers with protection on downstream circuit breakers optional. Ground faults are usually a result of equipment failures or cable insulation breaches that result in a “hot” conductor coming in contact with ground and producing arc flashes. This is a human safety and equipment protection measure, since ground faults that develop can persist indefinitely without tripping a normal circuit breaker.

In the past, the WWTF has experienced multiple ground faults that resulted in the MBR main breaker tripping, leaving the entire MBR process without power, even though generator power was available. Refer to the previous discussion concerning radial power configuration. This has protected staff and equipment, but the related power outages have caused great disruption of operations.

To remedy this, additional ground fault detection breakers could be added to each feeder and load to minimize how much disruption to power supply is made by a ground fault anywhere in the system. This would come with great expense via replacement of all major circuit breakers, and when completed, it would not eliminate disruptions of power associated with inevitable ground faults.

It is recommended that all 480-V power systems be converted to three-phase three-wire with High Resistance Grounding (HRG). By doing so, any ground fault that developed would be detected by the HRG unit with an alarm signal to the control system. However, the ground fault would be allowed to persist indefinitely (without harm to staff or damage to equipment) while operation of equipment and power system remain unchanged. The ground fault could be located and repaired in an orderly manner without impacting operations. As long as a second ground fault does not develop before the first fault is repaired, no breakers will trip, no staff will be at risk, no equipment will be damaged, and operations will continue without interruption.

This would involve one HRG service unit associated with each main breaker; therefore, two required for the entire WWTF. It would also involve locating all loads throughout the WWTF that require 277V and finding alternative means to supply power to them or replacing them with devices that do not require 277V. Typically, these involve lighting and electric heating coils and are usually small loads 30 amps or less. Small "lighting transformers" that develop miniature localized 480/277 three-phase four-wire systems can also be implemented to create local 277V systems but not affect the major process equipment motors and VFDs, which currently do not require 277V.

It is noted that UV systems typically require 480/277V solidly grounded wye systems, but it is a recommendation of this facility plan to remove the UV equipment. If required to stay in service, the UV system would be supplied with its own dedicated 480/277V lighting transformer to supply correct power to it.

3.04.6 VFDs

A good number of the VFDs in the WWTF are older generation Allen-Bradley 700 series. These mostly correspond to projects completed in 2008 and earlier. For those drives, though functioning, spare parts are either not available or inordinately expensive. In addition, typical life spans of this class of equipment, being power-transmitting electronics, is in the 15- to 20-year range, which has already arrived.

At a minimum, spares of newer generation drives should be stocked in anticipation of impending failures. As an alternative, planned replacement of older series drives could be considered. These will include mostly the MBR Building, correlating to the first phase of membrane addition. VFDs in the Preliminary Treatment Building and EQ pumping station were replaced with the 2018 project.

3.05 Process Control Automation

The process control automation system was substantially upgraded with the MBR process expansion, completed in 2018. Key upgrades included dual-processors at most locations and a sitewide, dual-path, fiber-optic cable loop through all processors, which allows the overall control system to keep in operation through any single failure. Upgrades included a SCADA computer server with numerous client applications throughout the WWTF. Programmable logic controllers (PLC) and input/output (I/O) cards are all current-generation equipment with no indications of manufacturer planned obsolescence.

3.05.1 Control System Documentation

The overall control system, like the underlying WWTF, has undergone upgrades corresponding to every process upgrade. As such, several suppliers have provided incrementally modified controls, each project with its related documentation. For each project, only new additions have been shown on the control system drawings. In order to research detailed control wiring for any specific process equipment, it is necessary to search through numerous projects and revisions to understand what is currently installed. This is time intensive and a source of error if all versions of drawings are not researched.

A single set of comprehensive control wiring drawings for each and every process equipment connection in the WWTF needs to be made for a permanent record. The older portions of the WWTF are most susceptible to encountering multiversion control drawings. Due to proposed Phase III expansions, significant portions of the WWTF will be replaced, leaving mostly the MBR Building controls for this effort.

3.05.2 Detailed Control Loop Wiring and Programming

It has been discovered in numerous cases that control wiring shown on drawings does not match what was installed in the field, either in terminal wires that do not match, in protection devices that are cross-wired to the wrong pump, or PLC I/O points that are cross-programmed, attached to the wrong equipment. This has been experienced mostly in the MBR Building with the 2018 expansion.

While outside the scope of this this facility plan, additional efforts should be made to verify all wiring and tag assignments. This could be completed as a separate study, or as part of a future design project.

3.06 Separation Requirements and Land Acquisition

Expansion at the WWTF will require an increase in the “footprint” of the plant. When expanding a WWTF, separation distances dictated by the IDNR must be taken into consideration. IDNR design standards require that a separation distance of at least 1,000 feet from the nearest inhabitable residence, commercial building, or other inhabitable structure be maintained. For existing facilities undergoing an expansion, the separation distance, if already less than 1,000 feet, may be decreased by 10 percent in the expansion. This can limit the ability of an existing facility to expand to meet the growing needs of a community.

Due to the rapid development in the general area of the existing WWTF, it is recommended that the City obtain separation waivers from any individuals that wish to build inhabitable structures within 1,000 feet of the property lines of the existing facilities. Without separation waivers, it could be difficult to construct future improvements, even though the improvements would be within the confines of existing City property.

3.07 Collection System Lift Stations

The collection system in the City includes 11 lift stations. This facility plan includes evaluation of three of the remote lift stations, including the condition of the existing electrical equipment. Condition assessment is based on a site visit to these lift stations in 2022.

A. Cedar Springs Lift Station

The Cedar Springs Lift Station is located near the west end of Willow Lane in the City. It is the largest lift station, with a capacity of 900 gpm, and was constructed in 2002. The collection system area that flows to the lift station is fully developed. Pumps were replaced in 2009 with Flowserve 50-hp pumps, and a soft starters with a hard start bypass was added in 2016.

The piping and valves in the valve vault are in good condition and do not show signs of deterioration. The coating system in the valve vault is in good condition. There is currently no davit crane for lifting the pumps out of the wet well, so a crane truck is required to lift the pumps. A davit crane should be provided.

The lift station motor starters and controllers are installed in a cabinet. The cabinet is not protected from weather, which makes working on the electrical system difficult during inclement weather. The City prefers electrical components be installed in a building. Additionally, the transformer and electrical cabinet concrete pads have settled and are tilted toward one another; therefore, the City is concerned that the pads could be putting pressure on the buried conduits that run between the two pads.

The lift station control cabinet condition is acceptable but showing aged paint finish and minor exterior corrosion. It has been upgraded twice, with remnants of upgrades clearly visible, and cable-bending space surrounding the motor starters at bare-minimum.

The controller is a dedicated pump panel controller (i.e., not a programmable PLC), and monitoring is via a cellular communication and cloud-based

Webservice, OmniSite. OmniSite does not allow remote control or reset functions, only monitoring. The pump controller is obsolete and no longer supported. While it is working, if it fails, direct replacement or repair is not possible.

B. 230th Street Lift Station

The 230th Street Lift Station is located approximately 0.25 mile to the west of 230th Street Northeast and North Highway 965 in the City. This lift station has a capacity of 350 gpm and was constructed in 2003. The existing submersible pumps have 10-hp motors and are powered with full-voltage motor starters.

Corrosion is visible on the pump rails and piping in the wet well. Manhole steps in the valve vault are not accessible form the hatch cover. The City is uncertain whether the gate valves are operational in the valve vault. The valves do not have extension stems, so City staff must enter the valve vault to operate the valves, which is a confined space.

The lift station motor starters and controllers are installed in a cabinet. The cabinet is not protected from weather, which makes working on the electrical system difficult during inclement weather. The City prefers those electrical components be installed in a building.

The lift station control cabinet condition is acceptable but showing aged paint finish and minor exterior corrosion.

The controller is a dedicated pump panel controller (but not a PLC), and monitoring is via a cellular communication and cloud-based Web service, OmniSite. OmniSite does not allow remote control or reset functions, only monitoring. The pump controller is obsolete and no longer supported. While it is working, if it fails, direct replacement or repair is not possible.

C. Progress Park Lift Station

The Progress Park Lift Station is in the industrial park just northeast of the Penn Street exit from Interstate 380, adjacent to Goose Lake Pond in the City. This lift station has a capacity of 600 gpm and was constructed in 2005. A pigging station was installed in 2009. The existing submersible pumps are 25 hp and are operated with soft starts.

Hydrogen sulfide corrosion is an issue at this lift station due to the detention time in the wet well. Pump rail support brackets are corroded, and the coating on the pipe is failing.

The lift station motor starters and controllers are installed in a cabinet. The cabinet is not protected from weather, which makes working on the electrical system difficult during inclement weather. The City prefers electrical components be installed in a building.

The lift station control cabinet condition is acceptable but showing aged paint finish and minor exterior corrosion.

The controller is a dedicated pump panel controller (but not a PLC), and monitoring is via a cellular communication and cloud-based Web service, OmniSite. OmniSite does not allow remote control or reset functions, only monitoring. The pump controller is obsolete and no longer supported. While it is working, if it fails, direct replacement or repair is not possible.

3.08 Summary of Deficiencies

Table 3.10 Summary of Deficiencies

Flow EQ

- Increase the EQ pumping capacity for Phase III and IV.
- Monitor peak flow rates to determine whether additional pumping capacity is needed before implementation of Phase III.
- Increase the standby generator capacity to accommodate the increased pumping capacity.
- Provide additional EQ basin volume.
- Replace the EQ basin liner in Phase III.
- Replace the existing EQ pumps in Phase III.

Preliminary Treatment

- Provide additional screening capacity for Phase IV.
- Provide additional grit removal capacity for Phase IV.
- Consider replacing the existing grit unit and classifier in Phase III as they are nearing the end of their useful life.
- Provide additional raw wastewater pumping capacity for Phases III and IV.
- Provide additional wet well capacity as the wet well is undersized for the plant flows.
- Replace the ventilation system for preliminary treatment for Phase III.

Secondary Treatment

Fine Screens

- Consider replacing the Baycor fine screens, auger, and wash press in Phase III as they will be nearing the end of their predicted life.
- Provide additional fine screening capacity for Phase IV.
- Consider relocating the fine screens to a new Preliminary Treatment Building to eliminate the issue of flooding the Membrane Building.

Biological Basins

- Provide additional basin capacity for Phases III and IV.
- Install submersible mixers in Basins 1A and 2A.
- Consider partially blocking off the opening between the anoxic and aeration basins.

Aeration System

- Expand the aeration system for Phase III and Phase IV.
- Provide separate air pipe headers to each train to allow more precise DO control.

Secondary Treatment (continued) ***WAS System*** • Provide additional WAS facilities for Phase III. ***ML Recirculation Pumps*** • Provide additional pipe for ML return to reduce velocity in the pipe for Phase III. ***Membrane Trains*** • Provide additional membrane capacity for Phase III and IV flows. • Replace the existing membranes in Phase III. • Inspect and repair or replace the coating on the membrane tanks when the membranes are replaced. ***Permeate Pumps*** • Pump capacity may be adequate for Phase III. • Provide additional permeate pumping capacity for Phase IV. ***Backpulse Tank*** • Improve redundancy of effluent metering, which is specifically required by the NPDES permit. ***Membrane Aeration System*** • Additional membrane aeration capacity will be required as more membranes are added in Phase IV. • Evaluate with the membrane supplier adding VFDs and air flow meters to each membrane blower or train to monitor membrane aeration. ***Chemical Feed Systems*** • No deficiencies are noted at this time. ***Compressed Air System*** • No deficiencies are noted at this time.
UV Disinfection System • The UV system should be removed from service and demolished.
Solids Handling Facilities ***Aerobic Digesters*** • If additional aeration capacity is required before Phase III, replace the belts and sheaves on the existing blowers to increase blower output. • Evaluate whether blower PRVs need to be replaced if the blower discharge pressure changes. • Provide additional digester capacity for Phases III and IV.

Solids Handling Facilities (continued)

Sludge Dewatering

- Extend the existing dewatered sludge conveyor through the east wall of the structure in Phase IIC to allow for additional operational flexibility.
- Install a second six-channel dewatering fan press in Phase III to expand dewatering capacity.

Dewatered Biosolids Storage

- Provide additional sludge storage capacity for Phase IIC by installing a gate to close off the end of the structure.
  Provide additional sludge storage buildings for Phases III and IV.

Control Building

- Expand the Control Building in Phase IV to provide additional space.

Electrical System and Emergency Power

- Retire or replace all cable feeders and gear from original WWTF construction.
- Convert power system to three-phase three-wire 480V high resistance ground.
- Create a Secondary Selective redundant power system as expansions allow.
- Replace older generation VFDs that are not related to process upgrades.
- Provide consolidated documentation of detailed control wiring MBR.

Separation Requirements and Land Acquisition

- Obtain separation waivers from individuals that wish to build inhabitable structures within 1,000 feet of the property lines of the existing facilities.

Collection System Lift Stations

Cedar Springs Lift Station

- Install a new davit crane sized to lift the pumps from the wet well.
- Construct a building to house the control panel electrical gear.
- Level the transformer pad.
- Replace pump panel in entirety including new open-source serviceable controller.
- Add communications capability with WWTF SCADA system.

Collection System Lift Stations (continued)

230th Street Lift Station

- Replace pump rails and re-coat piping in the wet well.
- Replace manhole steps in the valve vault and add valve extension stems.
- Replace the valves that are not functioning.
- Construct a building to house the control panel electrical gear.
- Replace existing obsolete controller with open-source serviceable controller.
- Add communications capability with WWTF SCADA.

Progress Park Lift Station

- Replace pump rails and re-coat piping in the wet well.
- Construct a building to house the control panel electrical gear.
- Replace existing obsolete controller with open-source serviceable controller.
- Add communications capability with WWTF SCADA system.

4–Development of Improvement Alternatives

4.01 General

Chapter 3 identifies several needs for the City's WWTF and gives recommendations to improve each component to meet the growing needs of the community. In this section, the recommendations for the individual components are combined into overall project alternatives to best address the needs of the overall WWTF. Due to the relatively rapid growth of the community, the concept of phased expansion will continue to be used.

As noted in the previous chapters, Phase IIB was originally designed for a population of approximately 27,800. The proposed Phase IIC will be designed for a population of 28,900 (projected year 2030 population). Most of the existing facilities are adequate for Phase IIC. The recommended improvements for Phase IIC include improvements to the dewatering and biosolids storage facilities.

Phase III would be designed to meet the projected needs for a population of approximately 40,750. There are several components that need to be addressed in the Phase III expansion. These are summarized in Table 4.1 and described in more detail in the following sections. The recommended improvement and alternatives were developed in enough detail to allow preliminary cost opinions to be developed (see Section 5).

Table 4.1. Phase III Proposed Improvements

Raw Wastewater Pumping and Preliminary Treatment Improvements

- Replace the grit classifier with a grit washer in the existing Preliminary Treatment Building.
- Replace the grit removal equipment.
- Add flood mitigation in the existing fine screen room because this process will remain in the Secondary Treatment Building.

EQ Improvements

- Expand EQ pumping by adding a wet well, valve vault, and piping to connect to the existing EQ pumping. Replace the EQ pumps.
- Expand the EQ pump Electrical Building to house new EQ pumping VFDs and MCCs.
- Replace the existing EQ basin liner.
- EQ Alternatives:
    - Alternative A–Provide a new EQ basin for additional capacity.
    - Alternative B–Provide EQ basin overflow treatment.

Secondary Treatment Improvements • Increase the biological treatment capacity. • Increase the aeration blower capacity. • Increase the sludge wasting capacity. • Provide additional ML return piping. • Replace the membrane with higher capacity modules. • Replace the coating in the membrane tanks.
Solids Handling Facilities • Construct new aerobic digesters. • Expand the solids dewatering capacity. • Provide additional dewatered biosolids storage.
Electrical Additions • Provide a Secondary Selective system. • Include new utility transformer, Genset, ATSs, main switchboard, MCCs, and VFDs for preliminary treatment. • Add a large cable tie to the Membrane Building. • Add Membrane Building switchgear. • Add motor controls as needed for the new digester facility.

Phase IV would be designed for a population of approximately 57,480, which is approximately double the size of Phase IIC. Improvements for Phase IV were generally considered for future site layout, and to determine site space requirements and limitations. The components required for Phase IV expansion are summarized in Table 4.2.

Table 4.2. Phase IV Improvements

<u>Raw Wastewater Pumping and Preliminary Treatment Improvements</u>

- Construct a new raw wastewater pumping station and Preliminary Treatment Building, including screening and grit removal.
- Include a mechanical bar screen in lower level and wash press on the ground floor of the screening facilities. Include a grinder in the bypass channel.
- Grit removal facilities, including a grit washer.
    - Alternative A–Grit removal before pumping
    - Alternative B–Grit removal after pumping
- Provide a new self-cleaning wet well and raw wastewater pumps.
- Provide new fine screens in the Preliminary Treatment Building.
- Provide odor control for the new Preliminary Treatment Building.

<u>EQ Improvements</u>

- No improvements are required.

<u>Secondary Treatment Improvements</u>

- Construct two new membrane tanks.
- Install two new membrane trains.
- Construct a new building to house the membrane equipment.

<u>Solids Handling Facilities</u>

- Construct one additional digester and associated equipment.
- Replace the belts and sheaves in the digester aeration blowers to increase capacity.
- Construct additional dewatered biosolids storage facilities.

<u>Control Building</u>

- Construct a new Control Building with office, laboratory, and support facilities.

<u>Electrical Additions</u>

- Expand the Secondary Selective system.
- Include Membrane Building switchgear and refeed approximately one-half of the MCCs. and VFDs.
- Provide new MCCs and VFDs for the new Membrane Building.
- Replace the 2,000-kW generator.
- Consider replacement of the 3,000-amp ATS with bypass isolation.
- Add motor controls as needed for sludge handling.

Given The City's growth trajectory, it is prudent to consider expansion beyond Phase IV. Potential for Phase V expansion is discussed at the end of this chapter.

4.02 Phase IIC Improvements

For Phase IIC, no improvements would be required to the raw wastewater pumping and preliminary treatment facilities, EQ basin and EQ pumping, and secondary treatment (MBR). Solids handling facility improvements are recommended for Phase IIC.

4.02.1 Solids Handling Facility Improvements

The solids handling facility improvements related to Phase IIC include extending the sludge dewatering conveyor to increase operational flexibility and modifications to the existing Biosolids Dewatering Facility to increase current storage capacity.

A. Biosolids Dewatering Improvements

The conveyor in the existing Biosolids Dewatering Facility will be extended to the north, through the building wall, and discharge on the north side of the building. This will allow for operational flexibility in either parking a truck under the conveyor outlet outside the building or to stack biosolids in this area when the truck is not available or when staff is not available to drive the truck to the Biosolids Dewatering Facility when full. A metal canopy structure will be constructed over the conveyor and loadout area to minimize adding moisture to the dewatered solids from precipitation. A concrete drive will be extended around the north side of the building and connected to the existing drive on the east side of the building.

B. Dewatered Biosolids Storage

Storage capacity will be increased by barricading the entrance to the south side of the storage building with stop logs or containment barrier or gate. This will allow the stack height to be increased to at least 6 feet, which will provide nearly 6 months of storage through Phase IIC at average biosolids production rates. Access to the side of the existing Biosolids Dewatering Facility will be improved with grading and addition of a gravel drive to allow solids to be added from the side of the building.

4.03 Phase III Improvements

The Phase III improvements summarized in Table 4.1 are presented in four categories: Raw Wastewater Pumping and Preliminary Treatment Improvements, EQ Improvements, Secondary Treatment Improvements, and Solids Handling Facilities. The recommended improvements are further described in the following. A general site layout for Phase III improvements is shown in Figure 4.1.

BY	DATE
DESIGNED: DLW	01/23
DRAWN: JAK	01/23
CHECKED:	

LAST UPDATE: 10-20-22

REVISION

DATE

FOX Strand
414 South 17th Street, Suite 107
Ames, Iowa 50010
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STRAND ASSOCIATES®

PHASE III PROPOSED WWTP SITE PLAN

WWTP FACILITY PLAN
CITY OF NORTH LIBERTY
NORTH LIBERTY, IOWA

PROJECT NO.
7037.011

SHEET
FIG. 4.1

DRAWING FILENAME
S:\AME\7000--7099\7037\011\Drawings\CAD\Site Layout - EQ Overflow Options.dwg

PLOT STYLE TABLE	LAYER MNGR NAME	LAYOUT NAME
Color.ctb		FIG 1

4.03.1 Raw Wastewater Pumping and Preliminary Treatment Improvements

Improvements to the existing raw pumping and preliminary treatment will be sized for a peak flow of 7.0 MGD for Phase III. Flows greater than 7.0 MGD will continue to flow to the EQ basin pumping station. The existing Preliminary Treatment Building will remain in operation through Phase III. The existing Preliminary Treatment Building is completely built out and space does not exist around the building to allow for expansion; therefore, expansion beyond 7.0 MGD capacity to support flows through Phase IV would require construction of additional preliminary treatment and raw pumping capacity.

A. Replace the Existing Grit Removal Equipment

The existing vortex grit removal equipment will be replaced in kind within the existing concrete tank. This equipment would remain in operation through Phase III.

B. Replace the Existing Grit Classifier with a Grit Washer

The existing grit classifier is proposed to be replaced with a grit washer. The grit will be pumped from the grit removal tank to the grit washer. The grit washer separates organics from the grit and discharges into the same dumpster as the bar screen. The grit washer separates organics from the grit and discharges washed grit into a dumpster.

C. Install New Raw Wastewater Pumps

The raw wastewater pumps can pump the design peak flow of the MBR, which is limited to 6.84 MGD. With all three existing pumps in service, the capacity is greater than 7.0 MGD. With the largest pump out of service, capacity is limited to 6.19 MGD. The spare T-10 pump will be installed in place of one of the T-8 pumps, to increase the firm capacity to 7.0 MGD.

4.03.2 EQ Improvements

As previously noted in Chapter 3, the existing EQ pumping station does not have adequate capacity for Phase III. Additional pumping capacity will be required.

In addition, the 5.0-MG EQ basin does not have adequate capacity for Phase III. There are three ways of dealing with this capacity issue. The first is to increase the flow to the MBR significantly, such that the existing EQ basin can handle the difference between the peak flow to the WWTF and the peak flow through the MBR. For Phase III, the proposed membrane system capacity (see Section 4.03.3) would require additional EQ volume. Increasing the MBR capacity further would require construction of new membrane basins with all of the ancillary equipment, including a new building. The relative cost of providing additional MBR capacity is significantly higher than providing additional EQ volume.

The second option is to increase the EQ volume by adding more storage basins or tanks. The third option is to limit the required EQ volume by allowing the EQ basin to fill up and overflow during peak flow periods. The overflow from the EQ basin would need to be filtered and disinfected before discharging. These two options are both viable and discussed in further detail in the following and are shown in Figure 4.1.

A. ***EQ Pumping Station***

The existing EQ pumping station will continue to be used, but the existing pumps will be replaced and the existing submersible pumping station wet well will be expanded to house two additional submersible pumps. The total EQ pumping stations will be designed to handle a firm peak flow of 12.0 MGD (18.83 MGD peak flow minus secondary treatment capacity of 7.0 MGD) for Phase III. The three existing EQ pumps would be replaced with new submersible pumps, designed for 2,100 gpm each. Two new pumps with capacities of 2,100 gpm each would be installed in the expanded wet well.

B. ***EQ Basin Alternative A–Provide a New EQ Basin***

As previously discussed, one option for addressing the EQ basin capacity is to construct additional storage volume. For Phase III, an additional 3.0 MG of EQ volume would be required. Several options can be considered for additional EQ volume. The uneven terrain and future location of Forevergreen Road means that siting the basins will be a critical aspect of the design. The existing EQ basin is an earthen basin with a membrane liner, which is typical for WWTFs. Another option would be glass-lined, bolted steel tanks, which can be installed with a sloped concrete floor. Still another option, prestressed pre-cast concrete tanks can be built on-site with deeper walls to reduce the footprint required. These tanks can also include a sloped floor. Cast-in-place concrete tanks are another possibility but are generally more costly than other options.

For this evaluation, prestressed concrete tanks were used. Other types of tanks can be evaluated during design. The additional needed EQ basin volume will be provided with one 3.0-MG tank, each approximately 153 feet diameter by 22 feet deep, located north of the existing dewatered solids storage facility. The EQ pumps would be designed to pump directly to this tank. Overflow pipes would be installed to allow flow by gravity from this tank to the existing basin. EQ return would be from either the basin or the tank back to the pumping station. In addition to new EQ basins, the existing basin liner would be replaced in Phase III.

C. *EQ Basin Alternative B–Provide EQ Basin Overflow Treatment*

Instead of additional storage volume, an EQ basin overflow treatment system could be installed. In this scenario, secondary treatment (MBR) would be designed to handle at least the maximum month flow. Flows in excess of this would be pumped to EQ. When the EQ basin becomes full, excess flow would overflow the EQ basin and be treated before discharging. For Phase III, this would be approximately 12.0 MGD, and approximately 11.5 MGD for Phase IV. The additional capacity required for Phase IV is less than what is needed for Phase II because the secondary treatment capacity in Phase IV is increased so flow would need to be equalized. Therefore, the Phase III design capacity would be adequate for Phase IV.

This alternative provides the advantages of requiring less EQ volume and reducing the MBR peak flow capacity needed. The disadvantages include the added capital and operation and maintenance (O&M) costs for the overflow treatment system.

Treatment would include a filtration system designed for this type of application followed by UV disinfection. These units would be installed in a new building on the south end of the WWTF. The wastewater would overflow by gravity from the existing EQ basin to the new system for treatment. Effluent from the overflow treatment system would be combined with the plant effluent before discharging.

There were two filters that were considered for overflow treatment, the AquaStorm™ disk filter from Aqua Aerobics and the WWETCO Flexfilter™ from WesTech. The AquaStorm filter is a cloth media disk filter that uses a specific media designed for storm sewer, combined sewer, and EQ basin overflow. The cloth filter would need to be periodically backwashed, which is provided by the treated water from the filter. The backwash flow would be returned to the raw pumping station.

Figure 4.2. AquaStorm Filter

The WWETCO Flexfilter is a compressible media filter that uses a semi-bouyant media designed for storm sewer, combined sewer, and EQ basin overflow. The filter would need to be periodically backwashed, which is provided by the treated water from the filter combined with air. The backwash flow would be returned to the raw pumping station.

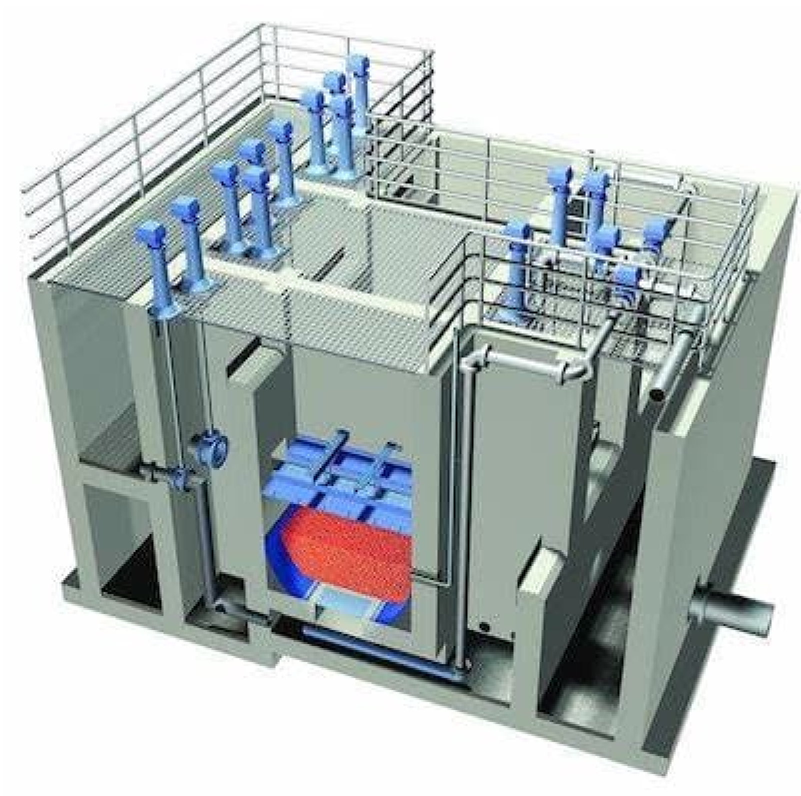


Figure 4.3. WWETCO FlexFilter

For this evaluation, two AquaStorm cloth media filters were included, each with a capacity of 6.2 MGD, for a total capacity of 12.4 MGD.

After the filtration system, UV disinfection will be required to meet *E. coli* limits. There are several options for UV disinfection, including standard horizontal, inclined, and enclosed. It is beyond the scope of the facility plan to provide a complete evaluation of each of these options. For this application, the enclosed unit would likely be the most cost effective and appropriate for the intermittent flow with long periods of down time. If this option is selected, a more complete evaluation will be completed during the design phase.

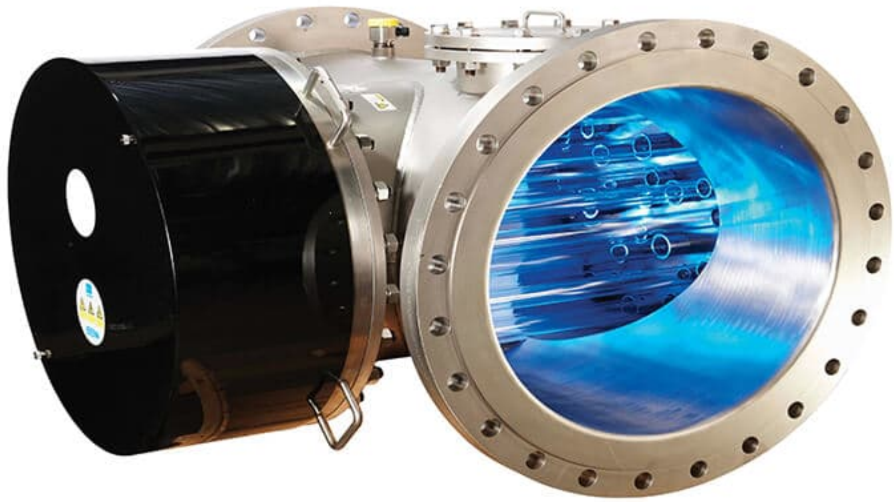


Figure 4.4. Typical Enclosed UV Disinfection System

4.03.3 Secondary Treatment Improvements

The secondary treatment improvements related to Phase III generally include improvements to the MBR system and associated equipment, as well as the biological basins and associated equipment. Each component is discussed in further detail in the following.

A. Increase Biological Treatment Capacity

The existing digester tanks will be converted into biological tanks to expand the treatment capacity. This will be a mirror image of the existing tanks and double the size. Splitter structures will be provided to split flow equally to all basins. The two additional biological trains will provide approximately 625,800 gallons each. Total volume with all four trains would be approximately 2,558,400 gallons (2,601,200 gallons including the membrane tanks). Similar to the existing trains, each new train will be divided into anaerobic, anoxic, and aerobic zones. The aerobic zones will include a new fine bubble diffused aeration system. Mixers will be provided in the anaerobic and anoxic zones. Recirculation pumps and flow tubes will be provided for returning mixed liquid from the anoxic zone to the anaerobic zone and from the aerobic zone to the anoxic zone for nutrient removal. As noted in Chapter 3, to improve the operational flexibility, submersible mixers will also be installed in aerobic Zones 1A, 2A, 3A, and 4A.

With the expanded biological basins, the loading and design parameters are shown in Table 4.3 for Phases III and IV. As can be seen in the table, the organic loading rate is higher than conventional systems, but still within acceptable parameters for an MBR. The food to microorganism ratio is on the lower range of conventional systems. An activated sludge model was used to evaluate these loading conditions. The model results, presented in Appendix C, show that the aeration basis will be adequate for the proposed conditions. The expanded aeration basins will be adequate through the projected Phase III and IV loading rates.

Table 4.3. Biological Basin Loading and Design Parameters

Loading and Design Parameter	IDNR Guidelines[1]	Phase III Loadings	Phase IV Loadings
Maximum Month BOD Load (lb/day)	---	8,220	11,566
SRT (days)	15 to 25	20	15
OLR (lbs BOD_5/1,000 cf/d)	15	23.6	33.3
Food to Microorganism Ratio, F:M (lbs BOD_5/lb MLVSS/d)[2]	0.08 to 0.16	0.07	0.09
MLSS (mg/L)	2,000 to 5,000	7,600	8,300

(1)IDNR guidelines for conventional combined carbon oxidation and nitrification activated sludge.
(2)Based on average 73 percent VS concentration.

B. Increase Aeration Blower Capacity

The existing aeration blowers have a firm capacity of 5,625 scfm (four blowers: three on duty and one on standby). For Phase III peak demand, a blower capacity of 6,300 scfm is required if the denitrification and membrane aeration credits are included. Therefore, additional blower capacity will be required for Phase III. To provide this additional capacity, the two existing digester blowers will be converted to aeration blowers. Each digester blower has the same capacity (1,875 scfm) as the aeration blowers. This would provide a total firm capacity of 9,375 scfm.

C. Increase Sludge Wasting Capacity

With the addition of new biological trains, a new sludge wasting system will be provided, similar to existing. WAS/scum pits will be located in the aeration basins to allow removal of floating scum/foam and WAS with automated gates and valves. Two new WAS pumps and a flow meter will also be provided.

The existing WAS pumps will also need to be replaced to allow pumping to the new digesters.

D. ML Recirculation Pumping

As noted in Chapter 3, the existing recirculation pumps should be capable of providing the required flow, or 5,175 gpm each. To reduce pipe velocities, a new

20-inch discharge pipe will be installed parallel to the two existing pipes. This will keep discharge pipe velocity at approximately 6.5 fps at maximum flow.

E. Replace Membranes with Higher Capacity Modules

To meet the projected flows for Phase III, additional membrane capacity will be required. Around the time Phase III will likely be implemented, the existing membranes will be nearing the end of their useful life. To get the additional capacity required for Phase III, the existing membranes will be replaced with new modules that have more membrane area per unit. The new modules would have 430 sf of membrane area each compared to the existing modules that have 370 to 395 sf. In addition, the existing cassettes can be replaced with new cassettes that allow up to 52 modules per cassette (existing cassettes have 48 modules). This provides a significant increase in membrane surface area. As the existing membranes come due for replacement, they will be replaced with 430-sf modules and the higher capacity cassettes. The new cassettes will fit into the existing membrane tanks. While it is likely the membranes would be replaced in stages over a number of years, this analysis assumes that all membranes will be replaced as part of the Phase III project.

When the new cassettes are installed, the total membrane surface area will be 447,200 sf. The resulting flux rates for the Phase III design flow conditions are presented in Table 4.4.

Table 4.4. Phase III Membrane System Flux Rates

Design Condition	Phase III Design Flux Rates(1)		Allowable Flux Rates(1)	
	Flux (gfd)	**Flow (4) (MGD)**	**Flux (gfd)**	**Flow (MGD)**
All Trains in Service(1)				
Average Day	9.1	4.075	10.0	4.472
Maximum Month	12.1	5.420	14.6	6.529
Maximum 7-Day	15.3	6.840	16.7	7.468
Maximum Day	15.3	6.840	19.4	8.676
Peak Hour	15.3	6.840	22.1	9.883
One Train out of Service (n-1)(2)				
Maximum Month(3)	14.6	4.897	14.6	4.897

(1)Total membrane surface area = 447,200 sf; assumes all modules are 430 sf and 52 modules per cassette.
(2)Total membrane surface area = 335,400 sf with one train out of service; assumes all modules are 430 sf and 52 modules per cassette.
(3)Capacity with one train out of service (based on maximum 30-day flow capacity) exceeds ADF and also exceeds 75 percent of maximum month flow.
(4)Peak flows limited by capacity of permeate pumps.

Flow to secondary treatment (MBR) will be limited to a maximum of 6.84 MGD. Flows exceeding the secondary treatment capacity will be sent to the EQ basins.

The new membrane cassettes and modules, as well as any modifications to existing piping, valves, and controls, will be provided by the manufacturer of the original system (Veolia). When replacing the existing membranes, it could be staged so that one membrane train is replaced per year over a 4-year period. This would help spread the cost over a number of years and minimize disruption to the existing WWTF. The existing permeate pumps and blowers will continue to be used for Phase III.

4.03.4 Solids Handling Facilities

The improvements to the solids handling facilities for Phase III involve constructing new aerobic digesters, expanding the dewatering facility capacity, and adding another dewatered sludge storage facility. Each component is discussed in further detail in the following.

A. Install New Aerobic Digesters

New aerobic digesters will be installed west of the existing Membrane Building. There will be three common wall concrete tanks designed to provide 60 days of detention time at the Phase III design average load at 2 percent solids. This provides approximately 45 days at maximum month loading. The tanks will be 70 by 70 by 22 feet SWD each (approximately 0.8 MG each).

Each tank will be outfitted with fixed full-floor coverage coarse bubble diffusers and telescoping valves to allow for decanting. Five blowers will be provided: one for each digester plus one spare, each sized for 2,100 scfm. Each digester will be provided with submersible mixers to provide mixing when the blowers are off or provide supplemental mixing when the blowers are on. Three sludge transfer pumps will be provided to transfer sludge from between digesters and feed the dewatering unit. Tank covers will be provided to maintain heat in the tanks for process stability and reduce freezing potential.

A digester Control Building will be provided next to the digesters to house the blowers, sludge transfer pumps, and electrical equipment. The building will be approximately 90 by 60 feet.

B. Biosolids Dewatering

For Phase III improvements, a second six-channel fan press will be installed in the existing Biosolids Dewatering Facility. This will increase the capacity of the dewatering equipment to 7,200 gph and will allow the maximum month biosolids produced to be dewatered in four 8-hour days per week. A second polymer skid system will be added. No improvements to the existing conveyor are anticipated because it has sufficient capacity for the Phase III dewatered biosolids rates. The City has discussed installing a second dewatering unit prior to Phase III if a used unit becomes available for purchase. For purposes of this study, it is assumed the dewatering unit will be installed with Phase III improvements.

C. Biosolids Storage Facilities

Additional dewatered biosolids storage facilities will be constructed east of the existing facility to store the dewatered biosolids. Storage will consist of four common wall bays each with dimensions of 45 feet wide by 120 feet long with 8-foot-high side walls. Combined with the existing storage building, a total of 9 months of storage will be provided. The structure will be covered with a metal roof supported by metal framing, similar to the existing Biosolids Dewatering Facility. The floor of each bay will be sloped toward the back of the bay to promote solids to stack higher. Stop logs or gates will be installed at the entrance to each bay. An average 4-foot stack height is anticipated.

The existing conveyor will be extended by adding additional conveyor sections with a discharge gate to each storage bay. Trucking dewatered biosolids to the existing Biosolids Dewatering Facility will still be required.

The existing drive will be extended to the front of the new storage bays. A driveway will also be added to allow truck traffic to enter the facility from the future Forevergreen Road, and exit the facility toward the northwest via Abigail Avenue to Front Street Northeast.

4.03.5 Electrical Additions

To accomplish a Secondary Selective system, an all-new power distribution system would be put into place, corresponding to Phase III improvements. All new power equipment will be required as part of Phase III, so it is minimal added cost to configure it in that manner at that time. Part of the electrical work would involve preparation of Phase IV work, which includes demolition of the Control Building and related utility service and power distribution.

This would involve the following new features:

- Utility service Transformer 1,000 to 1,500 kVA
- Genset, approximately 2,000 kW
- 3,000-amp ATS, bypass isolation

- 3,000-amp main switchboard, double-ended
- Motor control centers and VFDs
- Large cable tie to MBR Building gear, approximately 2,000 amps
- MBR area switchgear addition to add tie breaker
- Additions to the MBR Building to accommodate process equipment updates.
- Add motor controls as need for new digester facility.
- Implement high resistance grounding system.

The end result of Phase III would feature an A and B electrical system at the new Preliminary Treatment Building, which includes new EQ pumping. Power would be from a new utility service and local generator with a backup source of power available from the Phase I MBR electrical gear. Power from the new construction would also be available to the existing MBR Building as an added backup.

4.04 Phase IV Improvements

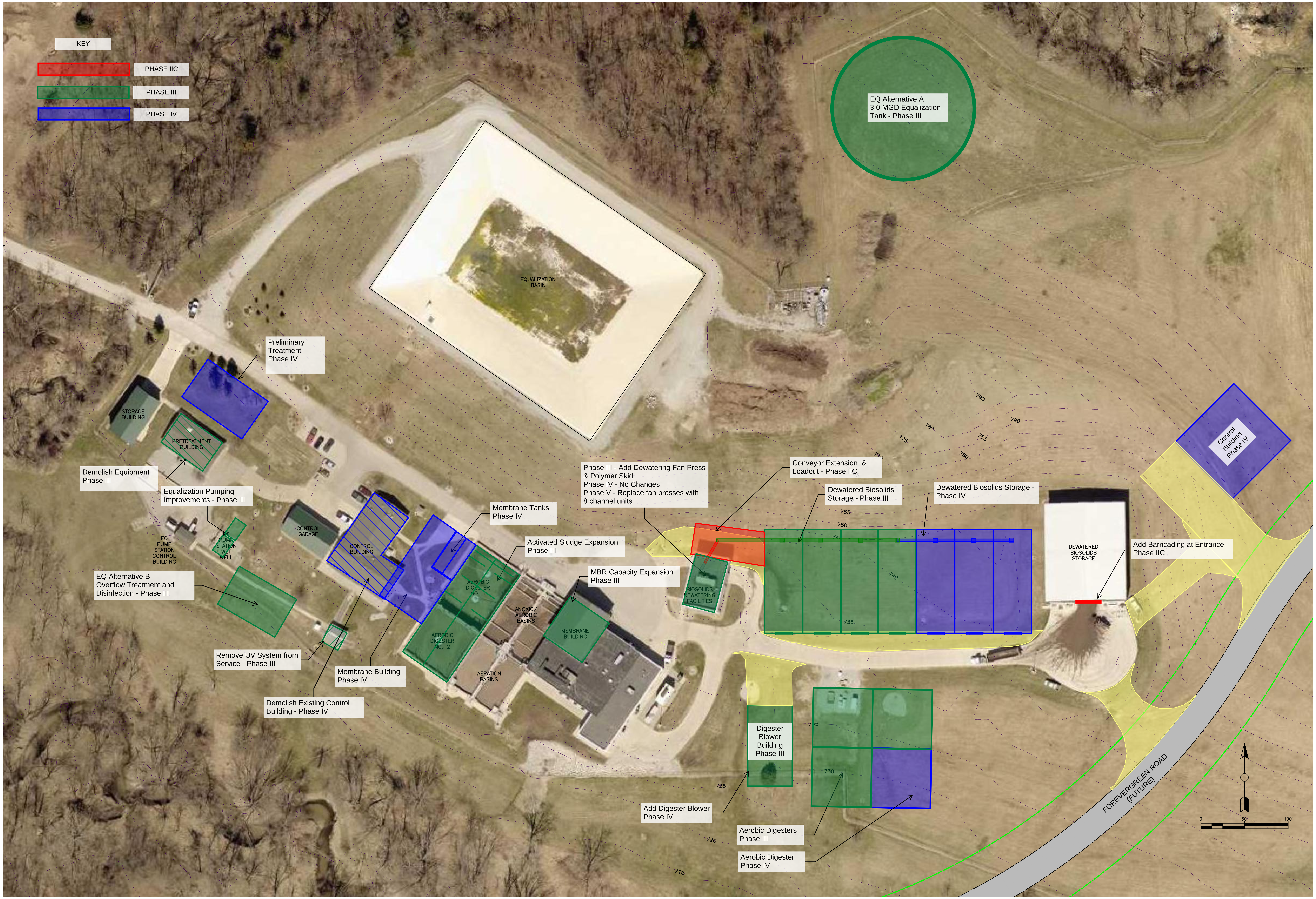
The Phase IV improvements summarized in Table 4.2 are presented in five categories: Raw Wastewater Pumping and Preliminary Treatment, Secondary Treatment Improvements, Solids Handling Facilities, and Control Building. No additional EQ upgrades are required for facilitating the increased Phase IV flow capacity. The recommended improvements are further described in the following. A general site layout for Phase IV improvements is shown in Figure 4.5.

4.04.1 Raw Wastewater Pumping and Preliminary Treatment Improvements

The new raw wastewater pump station and preliminary treatment facilities, in conjunction with the EQ facilities described in the following section, will be designed to handle the proposed PHWW flow for Phase IV. Consideration will also be given to expanding beyond Phase IV.

A. Construct a New Raw Wastewater Pumping Station and Preliminary Treatment Structure

A new building will be built between the existing Preliminary Treatment Building and the access drive. A new sanitary sewer will be routed around the existing storage building to the new Preliminary Treatment Building. This building will have three levels. The lower level will include a mechanical bar screen, a bypass channel with grinder, a self-cleaning wet well, raw wastewater pumps, and magnetic flow meters. The ground floor will house the screening wash press and grit washer, and will have an access hatch with a crane for removal of the raw pumps. The mezzanine will house the fine screens and screenings wash press, which will deposit screenings down a chute into a dumpster on the ground floor. Two options are being considered for the location of grit removal. For Alternative A, grit removal would be installed in the lower level between the



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STRAND ASSOCIATES

PHASE IV PROPOSED WWTP SITE PLAN

WWTP FACILITY PLAN
CITY OF NORTH LIBERTY
NORTH LIBERTY, IOWA

BY	DATE
DESIGNED: DLW	01/23
DRAWN: JAK	01/23
CHECKED:	

LAST UPDATE: 10-20-22

DATE	REVISION

PROJECT NO.
7037.011

SHEET
FIG. 4.5

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LAYOUT NAME
FIG 1

LAYER MNGR NAME

PLOT STYLE TABLE
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screen and the wet well. For Alternative B, grit removal would be installed after raw wastewater pumping and the fine screens on the mezzanine level.

The new raw wastewater pumping station and preliminary treatment structure, including the influent channels, wet well, and building space would be sized for the Phase V design conditions, or allow space for expansion to Phase V.

B. *Install a New Mechanical Bar Screen*

To provide increased flow capacity, a new bar screen will be required. The new bar screen will be installed in the lower level of the new pumping station. The screen will be designed for the Phase IV peak hour flow of 23 MGD with 1/4-inch openings. Space will be provided for an additional screen to meet Phase V requirements. The screen will extend from the lower-level channel elevation through the floor to the ground level where it will discharge into a new wash press. This will require a height of approximately 24 feet.

There are several screen alternatives that can be used in this application. One option is a multi-rake screen such as the Schloss® screen from Smith & Loveless and the VMR screen from Vulcan. Multi-rake bar screens are automatic, self-cleaning mechanical bar screens that are well suited for deep channels and large amounts of screenings. Another option is the Mensch Super Duty™ mechanical bar screen from Vulcan, which uses a single articulated arm to perform the self-cleaning function. This type of screen is also suited to the depth required for this project. These screens are illustrated in Figures 4.6 and 4.7 below.

Figure 4.6. Multi-Rake Screen from Vulcan

Figure 4.7. Mensch Screen from Vulcan

Each of these types of screens are valid selections for this application. For this evaluation, it was assumed that a multi-rake screen would be used. Alternative types of screens can be explored during design.

C. Install New Grit Removal System

Grit removal has several benefits to a wastewater treatment system. First, removing grit can improve the life of downstream pumps and conveyances. Second, removal of grit aids in the sludge processing system, as there will be less fixed solids wasted from the biological system. This improves the capacity of the digesters and sludge dewatering system. Third, removing grit reduces the risk of solids building up in downstream tanks and wet wells. There are several options for grit removal, including vortex grit chambers, high-performance vortex chambers, and HeadCell™ grit chambers.

Vortex grit chambers are separation basins where the water is forced to swirl around a cylindrical tank, both by hydraulic motion of the tank arrangement and with a propeller that constantly rotates in the tank. Grit particles are forced to the outer wall of the chamber and settled to the floor where they make their way into a lower chamber and then are pumped out for removal. The constant stirring also prevents lighter organic solids from settling in the unit, reducing the load on the grit washer. Vortex grit chambers are common units available from several manufacturers.

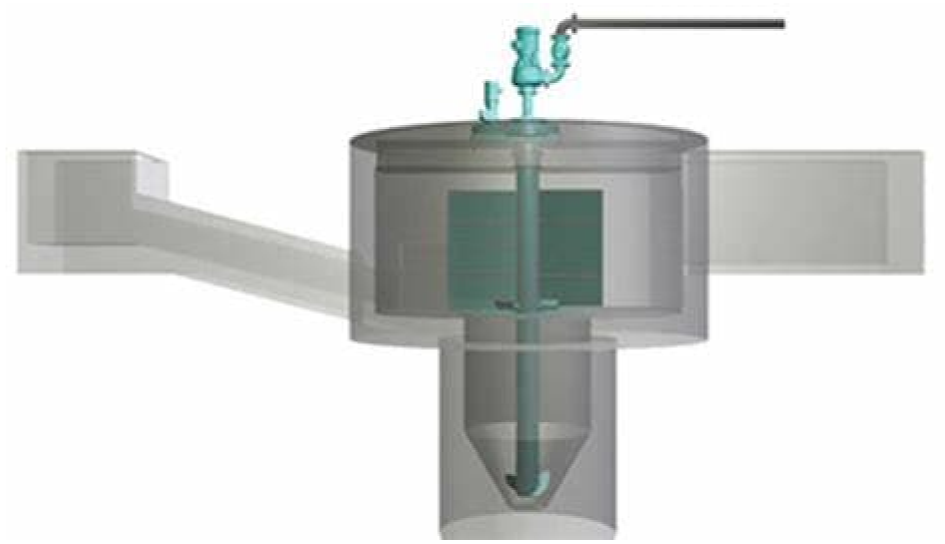


Figure 4.8. Typical Vortex Grit Chamber by Smith & Loveless

Manufacturers of grit chambers have developed alternative technologies to settle finer grit particles. One of the newer options is the Smith & Loveless INVORSOR™ grit chamber, a vortex grit chamber with inclined plates set in the settling chamber. This system offers similar benefits to the vortex unit, but will also remove grit smaller than 75 micron.

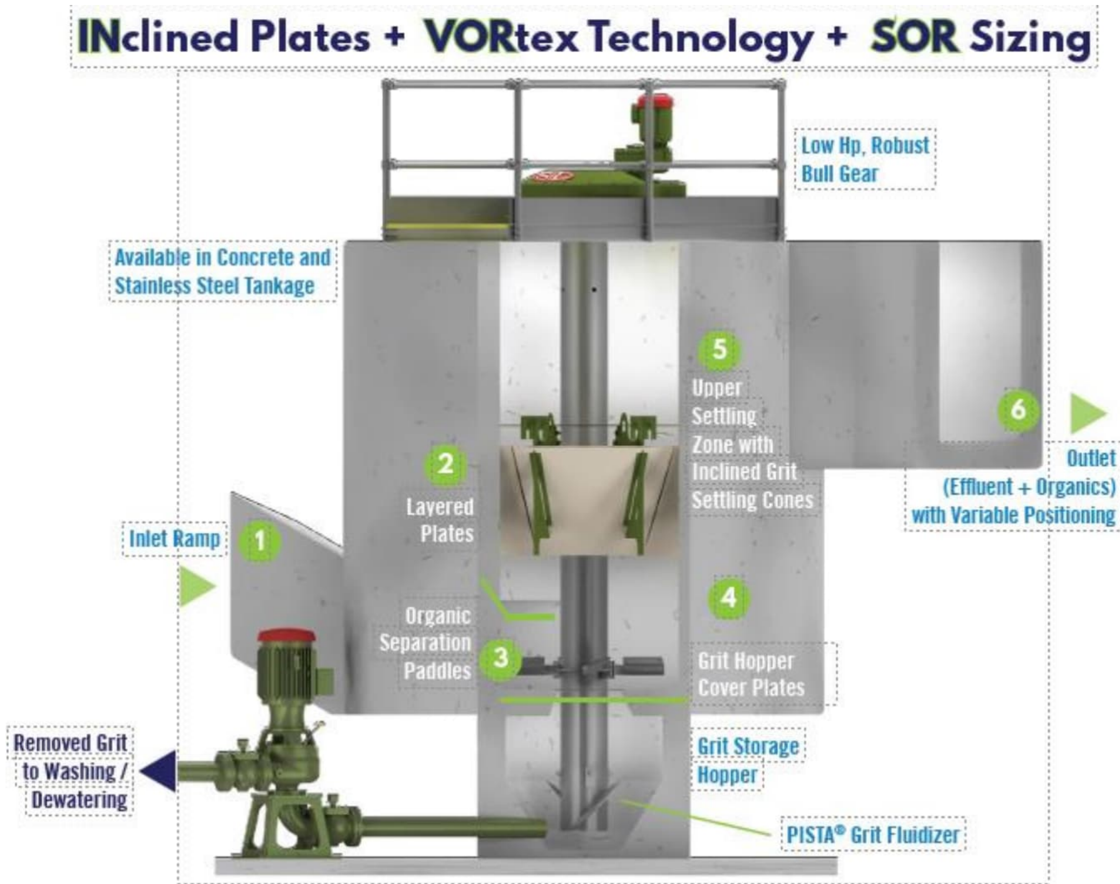


Figure 4.9. INVORSOR Unit from Smith & Loveless

Finally, HeadCell units operate on a similar principle of inclined plates set in the grit chamber. The grit settles onto the plates, then into the center of the basin. A nonpotable water stream keeps the settled grit fluid to allow it to be pumped out of the system. There are no moving parts in the tank.

Figure 4.10. HeadCell System with Grit Washer

Grit removal can be located either before or after pumping. The advantages of placing the chambers before the pumps is that it provides protection for the raw wastewater and EQ pumps and keeps grit out of the EQ basin. The advantage of placing the chambers after the fine screens is that they only need to treat the flow to the MBR systems, which has a significant cost savings. This also allows the grit chambers to be constructed at grade, also providing significant cost savings.

Alternative A, grit removal before pumping, would be designed for the Phase IV PHWW flow of 23 MGD. This would require one 16 feet by 16 feet by 24 feet deep HeadCell unit or one 16-foot-diameter vortex grit chamber. Space would be provided for an additional grit unit for future expansion.

For Alternative B, grit removal after pumping, the grit unit would be installed downstream of the fine screens and sized for the maximum design flow through the MBR, or 11.44 MGD for Phase IV. This would require one 16 feet by 16 feet by 18 feet deep HeadCell unit or one 12-foot-diameter vortex grit chamber. Space would be provided for an additional grit unit for future expansion.

In either option, the grit will be pumped to a grit washer. The grit washer separates organics from the grit and discharges into the same dumpster as the bar screen and the fine screens. The design will include space for an additional grit washer for future expansion. The cost opinions presented in Chapter 5 are based on the HeadCell grit removal system. Other systems can be evaluated during preliminary design.

D. Add Grinder in Bypass Channel

To maintain the level of treatment for the new system, a grinder will be installed in the bypass channel. The grinder will only be used when the mechanically cleaned screen is out of service. In addition to the grinder, automated control gates will be added to automatically divert flow to the grinder if the screen fails.

E. Install New Raw Wastewater Pumps

As previously discussed in Section 3, the raw wastewater pumping capacity will need to be expanded for Phase IV requirements. Four raw wastewater pumps will be installed to increase the firm capacity to 11.44 MGD to match the Phase IV MBR maximum design capacity. The pumps will be designed to minimize cycling during low-flow periods. In combination with the flow EQ pumps discussed in the following section, the pumps would be designed to handle the Phase IV peak hour flow. Each pumping unit would be provided with a VFD.

The pumping station will use the self-cleaning wet well design to minimize accumulation of solids in the wet well. In Strand's opinion, the self-cleaning option offers many benefits at a relatively low difference in cost to conventional wet well designs. The evaluation was based on using a self-cleaning wet well design. Other wet well configurations can be evaluated during the design phase, if necessary.

Several different pumping options can be used with the self-cleaning wet well design, including horizontal end-suction centrifugal, vertical turbine solids handling, submersible, and self-priming pumps. For this evaluation, horizontal end-suction centrifugal pumps were used. Alternative pump types can be considered during preliminary design.

F. Fine Screen Improvements

Because of the operational issues experienced with the existing fine screens and the need for increased capacity, new fine screens will be installed in the Preliminary Treatment Building to replace the fine screens in the Membrane Building. The fine screens will be located on the mezzanine level at approximately 738 feet elevation to allow gravity flow to secondary treatment. Several options are available for fine screens, including band screens and drum screens. All these options can be provided with 1-mm openings.

Band screens are a center flow screen where the wastewater is directed through the sides of the screening mechanism. The screening elements remove the solids as the water passes through the unit. As solids are removed, head loss builds up until a set level is reached upstream of the unit. The control system then initiates a cycle, where the screening elements are rotated out of the water and up into the solids removal system. A wash bar removes debris from the elements, which are then transported to a wash press. Cleaned elements are rotated into the flow channel to continue treatment. There are several options for the screening elements, including mesh, perforated plate, and folded perforated plate.

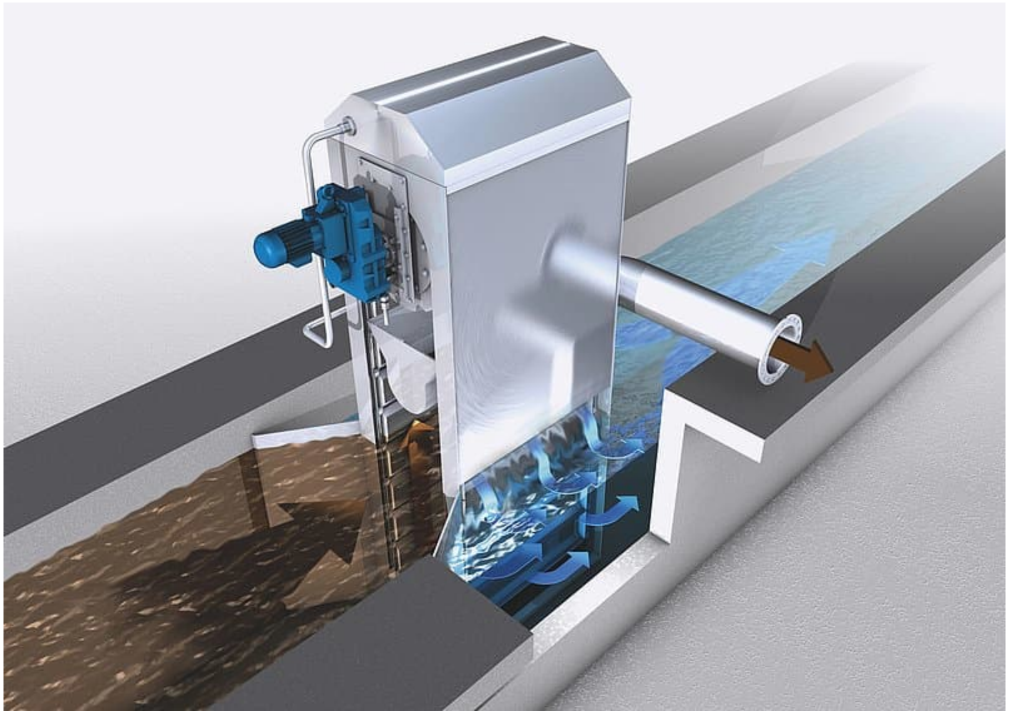


Figure 4.11. CenterMax® Band Screen from Huber

Rotating drum screens are a center flow screen where the wastewater flows through the unit in line with the flow in the channel. The unit is controlled in a similar fashion to other screens. When the control level is reached, the drum will begin to rotate while brushes and a wash bar removes the waste from the drum. An augur transports the solids out to a wash press. While there are several options for the screening mechanism, the perforated plate is the option that has 1-mm openings available.

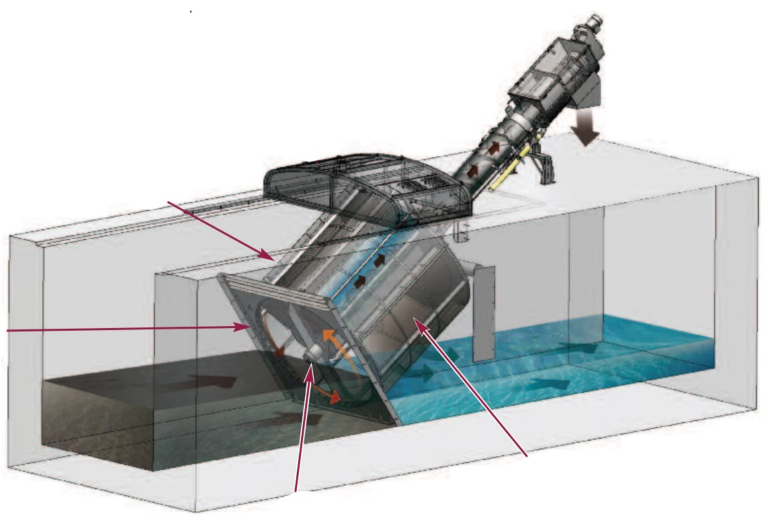


Figure 4.12. Saveco Flo-Drum In-Channel Rotating Drum Screen

For this evaluation, rotating drum screens were used. Three units are proposed for Phase IV to provide a minimum fine screening capacity of 11.44 MGD with full redundancy. Alternative fine screens can be considered during preliminary design.

G. Add Odor Control to Raw Wastewater Pumping Station and Preliminary Treatment Building

Several options are available for odor control. General categories include source reduction or elimination, liquid treatment, and air treatment technologies. Due to the difficulty in identifying and eliminating sources and causes of odors in the City system, this option was not considered as a viable alternative. Liquid treatment technologies generally involve some type of chemical addition to reduce the formation of odorous gases. While these technologies can be effective and do not require a large capital investment to implement, the ongoing cost of chemicals often makes these options cost prohibitive. Air treatment technologies include chemical scrubbers, carbon adsorption, biological filters or scrubbers, and non-carbon adsorption.

The existing Preliminary Treatment Building includes a carbon absorption system, which appears to be working adequately. Because a detailed odor control study is outside the scope of this facility plan, it was assumed that a carbon-adsorption-type system similar to the existing would be used for the new facility.

4.04.2 Secondary Treatment Improvements

The secondary treatment improvements related to Phase IV generally include expanding the MBR system and associated equipment. Each component is discussed in further detail in the following.

A. Increase Aeration Blower Capacity

The Phase III improvements would increase the blower firm capacity to 9,375 scfm. For Phase IV peak demand, required blower capacity is 9,669 scfm. The existing blower capacity could be increased by approximately 3 percent by changing the belts and sheaves. Additional blowers would not be required for Phase IV.

B. Construct New Membrane Tanks

Two new membrane tanks would be constructed for Phase IV. The tanks would be located northwest of the existing aerobic digesters, where the current Control Building is located. The membrane tanks would be approximately 28.5 feet by 8 feet by 13 feet deep. The tanks would be designed to hold a total of four membrane cassettes. Similar to the existing membrane tanks, a canopy would be constructed over the tanks with a bridge crane to remove the cassettes. A membrane cleaning tank would be provided, similar to the existing one.

C. *Membrane Equipment*

The proposed system is based on the Veolia LEAPmbr, the same as the existing. Membranes would be installed in the two new tanks. These two new trains would have four membrane cassettes each. The cassettes hold 64 modules each, for 256 modules per train. The proposed membrane modules are the ZeeWeed 500EV-530, with 530 sf of membrane area per module. This provides additional membrane area of 135,380 sf per train (271,360 sf total). The total membrane surface area, including membranes installed for Phase III, would be 718,560 sf. The resulting flux rates for the Phase IV design flow conditions are presented in Table 4.5.

Table 4.5. Phase IV Membrane System Flux Rates

Design Condition	Phase IV Design Flux Rates(1)		Allowable Flux Rates(1)	
	Flux (gfd)	Flow(4) (MGD)	Flux (gfd)	Flow (MGD)
All Trains in Service(1)				
Average Day	8.0	5.748	10.0	7.186
Maximum Month	10.6	7.645	14.6	10.491
Maximum 7-Day	14.5	10.394	16.7	12.000
Maximum Day	15.9	11.437	19.4	13.940
Peak Hour	15.9	11.437	22.1	15.880
One Train out of Service (n-1)(2)				
Maximum Month(3)	14.6	8.510	14.6	10.491

(1)Total membrane surface area = 718,560 sf; assumes all Phase III modules are 430 sf and 52 modules per cassette and Phase IV modules are 530 sf and 64 modules per cassette.
(2)Total membrane surface area = 582,880 sf with one train out of service; assumes one Phase IV train is out of service.
(3)Capacity with one train out of service (based on maximum 30-day flow capacity) exceeds maximum month flow.

The membrane equipment package will include all necessary valves, equipment, instrumentation, and controls. Equipment will include permeate collection and air distribution header piping, backpulse tank, permeate pumps, ML recirculation pumps, membrane air scour blowers, chemical feed systems for membrane cleaning, and an air compressor and drier for pneumatic valve operation.

D. *Construct New Membrane Building*

A new Membrane Building will be constructed northwest of the existing aerobic digesters, next to the new membrane tanks, where the existing Control Building is located. The building would house the membrane equipment and piping, including the blowers, permeate pumps, ML recirculation pumps, chemical feed systems, and the compressed air system. The building would be approximately 5,000 sf and constructed of precast concrete panels.

4.04.3 Solids Handling Facility Improvements

The solids handling facility improvements related to Phase IV include expanding the sludge dewatering capacity and increase storage capacity. Figure 4.5 illustrates the proposed location of the solids handling improvements.

A. Biosolids Dewatering

Improvements made in Phase III will have sufficient capacity for Phase IV biosolids production of 313,600 gallons per week under maximum month loading conditions. Six 8-hour days will be required to dewater this volume of biosolids. Under average day production conditions, dewatering would be complete in four 8-hour days based on 234,500 gallons per week.

B. Biosolids Storage Facilities

Improvements made in Phase III would provide for approximately 6 months of biosolids storage for Phase IV average conditions. Three additional 45- by 120-foot biosolids storage bays would be added to increase storage capacity to 9 months and provide additional flexibility for land application. The design of the additional storage bays will match those added in Phase III. The conveyor will be extended by adding three additional conveyor segments with a gate at each bay.

4.04.4 Control Building

In Phase IV, the existing Control Building will be demolished to allow the space for the new membrane tanks and Membrane Building. A new Control Building will be constructed at the east side of the site near the proposed entrance from the future Forevergreen Road extension. The new building would be approximately 1.5 times the size of the existing Control Building, or approximately 9,000 sf, to allow room for future growth. The new building would have similar functions as the existing building and include offices, conference room, break room, locker rooms, laboratory, and other facilities. Parking would be provided along the south side of the new Control Building.

4.04.5 Electrical Additions

The Secondary Selective system would be expanded to fully complete the concept at the existing MBR Building. Mostly this will involve creation of a B electrical distribution system and refeeding approximately one-half of the existing MCC and VFD equipment from it, not replacement of all equipment. The new MBR Building will be configured to mirror the A and B system completed in Phase III.

By the time Phase IV is implemented, the existing MBR generator would be approximately 25 years old, and would likely be ready for major rework or replacement. In addition, the existing transfer switch will likely be ready for major service or replacement, especially because it is located outdoors, which has a tendency to shorten equipment life.

This would involve the following new features:

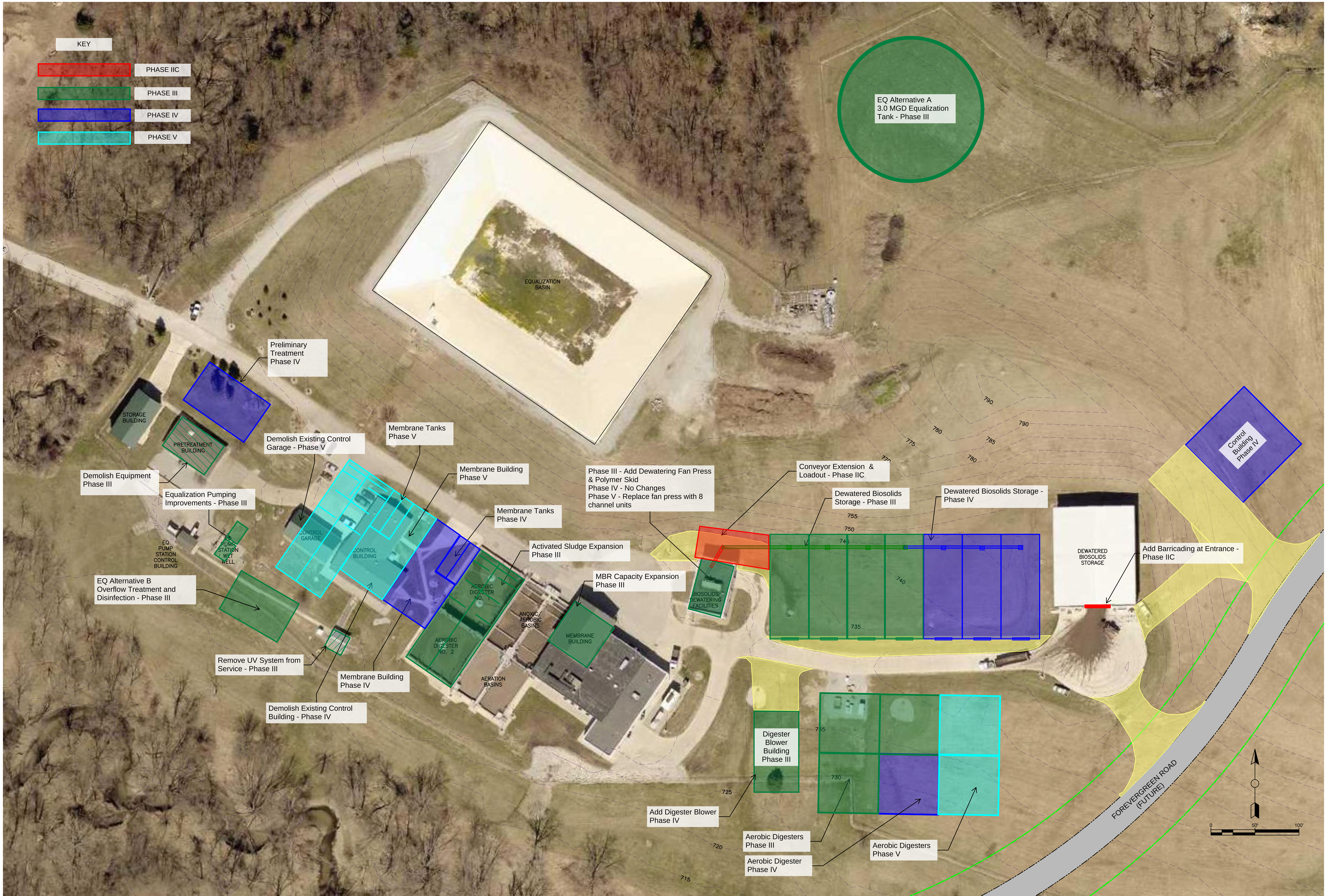
- Existing MBR Building switchgear B bus addition.
- Refeed approximately one-half of the existing MBR Building MCCs and VFDs from B switchgear.
- Add new MCCs and VFDs relating to the new MBR Building, with A and B configuration.
- Replace the 2,000-kW generator.
- Consider replacement of 3,000-amp ATS with bypass isolation
- Add motor controls as needed for sludge handling.

The end result of Phase IV would feature an A and B electrical system for the entire facility, except possibly the sludge handling areas. Power to the entire facility would be available from either utility service transformer or either generator.

4.05 Phase V Improvements

As the City's population continues to grow, expansion beyond Phase IV will likely be required. Phase V was presented earlier in this plan as being sized for a population of approximately 80,000. While it is likely that Phase V will be broken up into multiple phases when it is implemented, it is presented here as a single phase.

The Phase V expansion project will require significant improvements to all areas of the WWTF: preliminary treatment and flow EQ, secondary treatment, and solids handling facilities. A detailed analysis of the Phase V expansion is beyond the scope of this plan, and since it will likely not occur for many years, would not be of real value at this time. Phase V is discussed here in general terms as far as what will likely be required, and how those improvements could potentially be implemented at the existing site. Figure 4.13 shows a potential layout for the Phase V facilities.



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		CHECKED:	
		LAST UPDATE: 10-20-22	

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PHASE V PROPOSED WWTP SITE PLAN
WWTP FACILITY PLAN
CITY OF NORTH LIBERTY
NORTH LIBERTY, IOWA

PROJECT NO.
7037.011

SHEET
FIG. 4.13

4.05.1 Raw Wastewater Pumping and Preliminary Treatment Facilities

For Phase V, raw wastewater pumping and preliminary treatment facilities will need to be expanded for the higher flows anticipated. This would include additional screens, additional grit removal, and expanded pumping capacity. The Phase III Raw Wastewater Pumping Station and Preliminary Treatment Building will be designed to allow for this expansion.

4.05.2 EQ Pumping Station and EQ Basin

For Phase V, additional EQ pumping capacity will be required. A new EQ pump station would need to be constructed to replace the existing. Additional EQ basin volume would also be required. However, given site space restrictions, installing additional EQ basins is not practical. Instead of more volume, EQ overflow treatment could be installed.

4.05.3 Secondary Treatment Improvements

Secondary treatment improvements for Phase V would include expanding the membrane system to accommodate the additional flow and expanding the biological basins to handle the increased loads to the WWTF.

A. Membrane Tanks and Equipment

Two new membrane tanks would be constructed, similar in size to the Phase IV expansion. Membranes would be installed in the two new tanks. This would bring the total MBR capacity to 9.9 MGD for ADF and 14.5 MGD for maximum month flow. New Membrane Building, similar to the Phase IV expansion, would be constructed to house the new pumps, blowers, valves, piping, and instrumentation.

B. Biological Treatment Tanks

Two new biological treatment trains would be constructed to provide the needed additional volume. The trains would be similar in size to the existing trains, and anaerobic, anoxic, and aerobic zones. Recirculation piping and pumps, mixers, and aeration system would also be provided.

4.05.4 Solids Handling Facility Improvements

Solids handing facility improvements for Phase V would involve adding aerobic digesters, increasing sludge dewatering capacity, and providing additional biosolids storage.

A. Aerobic Digesters and Sludge Thickening

The digesters proposed for Phase III would be sized to accommodate Phase IV design conditions. To provide additional capacity for Phase V, two new digesters could be constructed, similar in size to the digesters installed for Phase III. Additional or larger blowers and pumps would also be needed.

B. Biosolids Dewatering

The existing fan presses would be replaced with new equipment in Phase V because these units would have been in operation for more than 20 years. If the same dewatering technology is selected, two eight-channel fan presses would provide the capacity needed to dewater 435,500 gallons per week of 2 percent biosolids under maximum month conditions. The polymer feed systems would also need replaced in Phase V.

C. Biosolids Storage Facilities

The total storage capacity constructed through Phase IV improvements would provide 6 months of storage of 14.4 percent solids biosolids through Phase V. Additional storage could be achieved by stacking sludge higher than 4 feet because the storage facilities have 8-foot-high walls. The conveyor system may also need replaced due to age; however, the existing conveyor system would have sufficient capacity through Phase V.

4.06 Lift Stations

The collection system in the City includes of 11 lift stations. This facility plan includes evaluation of three of the remote lift station including the condition of the existing electrical equipment. Condition assessment is based on a site visit to these lift stations in 2022.

4.06.1 Cedar Springs Lift Station

Proposed improvements for the Cedar Springs Lift Station include the following. The improvements could be incorporated in the Phase III project or completed as a separate project.

1. Upgrade electrical and controls including a new pump control panel and controller, including monitoring and ability to control from the WWTF SCADA system. These improvements would likely occur with the Phase III improvements because the lift station will be nearly 30 years old. Much of the existing electrical cabinets and instrumentation will be beyond its useful life.
2. Install a prefabricated precast building to house control cabinets and protect them from weather. Install a conduit from the building to the wet well to allow for future installation of chemical feed system for odor control.

3. Replace pumps in kind or install Gorman-Rupp self-priming pumps. There are no issues with using submersible pumps; however, adding a building would be an opportunity to install Gorman-Rupp self-priming pumps on grade so they can be worked on without using a crane and do not sit in the wastewater.
4. Install City fiber to the control panel to create a data highway connection to the WWTF SCADA computer system.
5. Recoat piping in the wet well.
6. Consider phasing and staging of any improvements carefully to keep the existing lift station in service while improvements are being made.

4.06.2 230th Street Lift Station

Recommended improvements for the 230th Street Lift Station include the following. The improvements could be incorporated in the Phase III project or completed as a separate project.

1. Upgrade electrical and controls including a new pump controller, including monitoring and ability to control from the WWTF SCADA system.
2. Install a prefabricated precast building to house control cabinets and protect them from weather. Install a conduit from the building to the wet well to allow for future installation of chemical feed system for odor control.
3. Install City fiber to the control panel to create a data highway connection to the WWTF SCADA computer system..
4. Install extension stems and valve boxes in the valve vault to improve accessibility to operate valves.
5. Replace pump rails and discharge piping.

4.06.3 Progress Park Lift Station

Recommended improvements for the Progress Park Lift Station include the following. The improvements could be incorporated in the Phase III project or completed as a separate project.

1. Upgrade electrical and controls including a new pump controller, including monitoring and ability to control from the WWTF SCADA system.
2. Install a prefabricated precast building to house control cabinets and protect them from weather. Install a conduit from the building to the wet well to allow for future installation of chemical feed system for odor control.
3. Install City fiber to the control panel to create a data highway connection to the WWTF SCADA computer system.
4. Replace the pump rail brackets.
5. Repaint the discharge piping.

5–Opinion of Cost

5.01 Capital Costs

For the improvements identified in Section 4, budgetary capital cost opinions have been prepared. The opinions of probable cost (OPC) involve a significant amount of judgment at this early stage of planning and should be considered only approximate in nature. Generally, planning level estimates are considered to have an accuracy of ±25 percent. More refined estimates will be possible during subsequent design phases of the project.

Costs were derived using previous Strand cost data, supplier quotations, and published cost data. Capital cost opinions are intended to include all project costs, including construction cost, contingencies, design fees, field exploration, construction-phase engineering services, and an allowance for owner's legal and administrative fees. All capital cost opinions are based on recent economic conditions, with no allowance for future inflation.

5.01.1 Capital Cost Opinion–Phase IIC

The OPC for Phase IIC improvements is presented in Table 5.1. It includes all the Phase IIC improvements noted in Section 4.

Table 5.1. Phase IIC–OPC

Item	Cost Opinion
Dewatering and Biosolids Storage	
Conveyor and Canopy Structure	$437,000
Site Paving/Grading	$62,000
Dewatered Biosolids Storage	
Gate at Building Entrance	$21,000
Sitework and Seeding	$17,000
Subtotal	**$537,000**
General Requirements (15%)	$81,000
Electrical and Controls (20%)	$162,000
Mechanical and HVAC (0%)	$0
Painting (5%)	$27,000
Undefined Scope (20%)	$108,000
Construction Subtotal	**$915,000**
Contingencies (10%)	$92,000
Construction Total	**$1,007,000**
Engineering, Legal, and Administration (18%)	$182,000
Total Project Cost	**$1,189,000**

5.01.2 Capital Cost Opinion–Phase III

The OPC for Phase III improvements is presented in Table 5.2, which includes all the Phase III improvements noted in Section 4. In Section 4, two alternatives were presented for flow EQ: Alternative A–New EQ Basin; Alternative B–EQ Overflow Treatment. These alternatives are presented below.

Table 5.2. Phase III–OPC

Description	EQ Basin Expansion (Alternative A)	Peak Flow Treatment (Alternative B)
Existing Preliminary Treatment Improvements		
Replace Grit Washer	$192,000	$192,000
Rebuild Grit Removal System	$78,000	$78,000
EQ Pumping Station and EQ Basin		
Replace EQ Liner	$197,000	$197,000
EQ Pumping Station	$1,077,000	$1,077,000
EQ Basin Expansion/Treatment	$3,512,000	$4,248,000
Secondary Treatment Improvements		
Biological Treatment Trains	$1,865,000	$1,865,000
Sludge Wasting Improvements	$300,000	$300,000
ML Recirculation Pumping	$332,000	$332,000
Replace Membranes	$3,895,000	$3,895,000
Solid Handling Facility Improvements		
Aerobic Digesters and Control Building	$6,402,000	$6,402,000
Biosolids Dewatering	$617,000	$617,000
Biosolids Storage Facilities	$3,716,000	$3,716,000
UV Demolition	$26,000	$26,000
Lift Station Improvements (excluding electrical)	$288,000	$288,000
Subtotal	**$22,497,000**	**$23,233,000**
General Requirements (15%)	$3,375,000	$3,485,000
Sitework (10%)	$2,250,000	$2,324,000
Electrical and Controls (30%)	$6,750,000	$6,970,000
Mechanical and HVAC (10%)	$2,250,000	$2,324,000
Painting (2%)	$450,000	$465,000
Undefined Scope (20%)	$4,500,000	$4,647,000
Construction Subtotal	**$42,072,000**	**$43,448,000**
Contingencies (10%)	$4,208,000	$4,345,000
Construction Total	**$46,280,000**	**$47,793,000**
Engineering, Legal, and Administration (15%)	$6,942,000	$7,169,000
Total Project Cost	**$53,222,000**	**$54,962,000**

5.01.3 Capital Cost Opinion–Phase IV

The OPC for Phase IV improvements are presented in Table 5.3. It includes all the Phase IV improvements noted in Section 4 including the two alternatives presented for preliminary treatment: Alternative A–Grit Removal Before Pumping and Alternative B–Grit Removal After Pumping.

Table 5.3. Phase IV–OPC

Description	Grit Removal Before Pumping (Alternative A)	Grit Removal After Pumping (Alternative B)
Raw Wastewater Pumping and Preliminary Treatment		
Pumping and Preliminary Treatment Structure	$5,045,000	$4,631,000
Mechanical Screens & Wash Press	$435,000	$435,000
Grit Removal and Grit Washer	$891,000	$704,000
Raw Wastewater Pumping	$1,264,000	$1,264,000
Fine Screens	$1,305,000	$1,305,000
Odor Control	$663,000	$663,000
Secondary Treatment Improvements		
Aeration Blower Modifications	$62,000	$62,000
Membrane System	$6,071,000	$6,071,000
Membrane Building	$1,523,000	$1,523,000
Solid Handling Facility Improvements		
Aerobic Digesters and Control Building	$1,627,000	$1,627,000
Biosolids Storage Facilities	$2,624,000	$2,624,000
New Control Building and Demolish Existing	$2,887,000	$2,887,000
Subtotal	**$24,397,000**	**$23,796,000**
General Requirements (15%)	$3,660,000	$3,570,000
Sitework (10%)	$2,440,000	$2,380,000
Electrical & Controls (30%)	$7,320,000	$7,139,000
Mechanical & HVAC (20%)	$4,880,000	$4,760,000
Painting (2%)	$488,000	$476,000
Undefined Scope (20%)	$4,880,000	$4,760,000
Construction Subtotal	**$48,065,000**	**$46,881,000**
Contingencies (10%)	$4,807,000	$4,689,000
Construction Total	**$52,872,000**	**$51,570,000**
Engineering, Legal, and Administration (15%)	$7,931,000	$7,736,000
Total Project Cost	**$60,803,000**	**$59,306,000**

6–Summary and Recommendations

6.01 Summary

The Phase II improvements, completed in 2018, were intended for a design population 27,800. The current population estimate is around 20,875. Based on the evaluation completed in this facility plan, the WWTF should have adequate capacity through Phase IIC projected flows and loads (estimated population of 28,890). With current population projections, this should be around year 2030. However, some improvements to the solids handling facilities are proposed prior to implementation of Phase III. The OPC for these Phase IIC improvements is $1.19 million.

Evaluation of the existing facilities identified several needed improvements to meet the Phase III design capacity. Proposed improvements include increasing raw pumping, flow EQ pumping, and flow EQ storage. Preliminary treatment improvements include replacing the existing grit removal equipment and adding grit washing. Secondary treatment improvements include additional biological treatment tanks, replacing the membranes with higher capacity modules, and other minor improvements to equipment and piping. Solids handling facility improvements include constructing new aerobic digesters and a digester Control Building, increasing solids dewatering capacity, and providing additional dewatered biosolids storage. The OPC for the proposed Phase III improvements is around $53.22 million for Alternative A–EQ Basin and $54.96 million for Alternative B–Peak Flow Treatment. Presuming The City continues to grow as projected, the Phase III expansion should be completed before 2030 (or before an equivalent population of 28,890 is reached). The Phase III expansion would be designed to handle a population of approximately 40,750 (projected year 2040).

As the Phase III design population is reached, Phase IV improvements would need to be completed. Phase IV improvements include constructing a new raw wastewater pumping station and Preliminary Treatment Building including fine screening. Secondary treatment improvements include expanding the membrane system by adding two new membrane trains (with associated equipment) and a new Membrane Building. Phase IV would also include additional dewatered biosolids storage facilities and a new Control Building. The OPC for the proposed Phase IV improvements Alternative A–Grit Removal Before Pumping is approximately $60.80 million and Alternative B–Grit Removal After Pumping is $59.31 million. The Phase IV expansion would be designed to handle a population of approximately 54,480 (projected year 2050).

The facility plan also considers expansion beyond Phase IV. Although a detailed analysis and cost opinion is not presented, a conceptual plan has been developed for a Phase IV expansion.

6.02 Financing Options

The following are presented as typical funding and financing options for municipal wastewater projects of this scale. The City should consult with a trusted financial advisor before selecting appropriate financing/funding for this project.

Clean Water State Revolving Fund (CWSRF) Loan

The CWSRF loan program is administered by the IDNR and the Iowa Finance Authority. The program offers a relatively low interest rate, which is currently set at 2.54 percent plus a 0.25 percent servicing fee (for a total rate of 2.79 percent), for loans up to 20 years. User rates must be capable of generating 10 percent in excess of annual debt service, and there is a 0.5 percent loan origination fee. Projects may be eligible for payback periods up to 30 years, but the interest rate is usually increased by 1 percent for projects with periods longer than 20 years. The loan can be used to pay for applicable engineering, legal, administrative, and construction project costs.

The CWSRF program offers a Planning and Design Loan option, which can provide a 0 percent interest loan for up to 3 years with no initiation or servicing fees. This loan can be used to pay for most costs related to project plan preparation, including engineering fees, soils investigations, and similar costs. At the end of the 3-year period, the loan is rolled into a CWSRF Construction Loan or is repaid when permanent financing is obtained.

The CWSRF program does come with some drawbacks. “Davis Bacon wages” would apply and would set the minimum wage rates that must be paid during construction. This tends to increase the overall cost of the project, but the exact impact is project specific and difficult to predict. In addition, the American Iron and Steel requirement would apply, mandating that most steel and iron used on the project be produced in the United States. This requirement can also increase project costs. The program also requires that an environmental review process be completed before proceeding with construction of the project.

Municipal Bonds

General Obligation (GO) Bonds are supported by the ability of the City to impose property taxes sufficient to retire the bonds. Therefore, the risk to bond holders is minimal, and the interest rate is typically relatively low.

Municipalities are limited to having the amount of outstanding GO Bonds not to exceed a total percentage of total assessed property value. Due to the limitation and other available methods of financing municipal utilities, GO Bonds are typically reserved for financing projects in departments within the General Fund such as streets, libraries, fire stations, swimming pools, and public works. Wastewater projects may be financed through GO Bonds with revenues from the utility transferred to the General Fund for debt retirement. However, the municipality as a whole is still subject to the percentage limit.

Revenue Bonds are retired by the revenues generated from user rates. Because revenue projections are based on projected sales often at higher user rates, there is a degree of risk associated with the purchase of such bonds. As a result, the interest rate is typically higher than with GO Bonds, and a projection of excess revenues (coverage factor) is typically necessary to obtain the lowest interest rate.

Reserve Funds

The City may elect to offset a portion of the project cost using saved reserve funds from within the utility or other sources.

There is no intent to recommend a CWSRF loan or any other type of funding. The City should consult with a trusted financial advisor to provide guidance on which type of funding is recommended for the City, the loan term is preferred, and the final impact on sewer user fees.

6.03 Potential Impact on User Rates

As with any capital-intensive wastewater project, the financed portion as well and O&M expenses will need to be funded through user rates. A detailed evaluation of the potential impact of this project on user rates is beyond the scope of this study. The City should consult with a trusted financial advisor to provide guidance on which type of funding is recommended for the City, the preferred loan term, and the final impact on sewer user fees.

The City developed a financial forecasting model, which is included in Appendix F, to determine estimated impacts on user rates to support the projects recommended in this facility plan. Based on this model, rate increases of 5 to 6 percent annually are needed between fiscal year 2026 and 2036 and an annual rate increase of 2 to 3 percent between fiscal year 2039 and 2045 to support phased projects and maintain a reserve fund balance of at least $3.1 million in the next 10 years and $10.0 million from year 10 to year 20.

6.04 Recommendations

Based on the evaluations presented in this report, the following recommendations are offered:

1. The City should consider implementing the Phase IIC improvements in the near term to address operational deficiencies with the current solids handling facilities.

2. As growth continues, the City should plan to complete Phase III, Alternative A improvements before reaching a population of 28,890. Improvements would need to be completed by 2030 to provide sufficient treatment capacity through 2040.

3. The concepts presented in this facility plan should be reviewed and discussed and decisions made regarding the specific features and components to be included in the selected plan.
4. Part of the decision process will include deciding how quickly to expand the facilities to meet the growing needs of the community. The City should concur with the concepts as presented or direct that revised analyses be made.
5. Following acceptance by the City, the facility plan should be submitted to IDNR for review and approval.
6. Following comment by the IDNR, the preliminary design phase of the selected project should be initiated, as appropriate.

Once a decision is reached, then discussions can proceed on various preliminary design aspects associated with the selected plan. Some of the recommendations and analyses discussed in this plan may merit more detailed examination. During the design development stage, numerous decision points will arise regarding specific features of the proposed project. It can then be decided which of the recommendations to include in the selected plan and which deviations to make from the concepts proposed by this analysis.

6.05 Schedule

The following schedule is proposed for completing the Phase IIC and III improvements as outlined in this report, presuming population growth is as projected. The City should continue to monitor population growth and adjust the schedule accordingly.

Table 6.1. Proposed Project Schedule

Project Milestone	**Month and Year**
Receive revised Wasteload Allocation from IDNR	June 2025
Issue Antidegradation Alternatives Analysis for Public Comment	July 2025
Submit Antidegradation Alternatives Analysis to IDNR	August 2025
Submit Facility Plan to IDNR	August 2025
IDNR Facility Plan Review	August through December 2025
Phase IIC	
Project Design	January through May 2026
IDNR Review and Permitting	June 2026 through September 2026
Bidding and Construction	October 2026 through December 2027
Phase III	
Project Design	January 2026 through June 2027
IDNR Review and Permitting	July 2027 through December 2027
Bidding	January 2028 through February 2028
Construction	March 2028 through August 2030

APPENDIX A

NPDES PERMIT

STATE OF IOWA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROGRAM
AMENDMENT TO NPDES PERMIT

Iowa NPDES Permit #:	5252001
Date of Issuance:	November 1, 2020
Date of Expiration:	October 31, 2025
Date of this Amendment:	**June 1, 2023**
EPA Number:	IA0032905

Name and Mailing Address of Applicant:

CITY OF NORTH LIBERTY
PO BOX 77
NORTH LIBERTY, IA 50232

Identity and Location of Facility:

NORTH LIBERTY, CITY OF STP
Township 80N, Range 06W, Section 19, Johnson County

Pursuant to the authority Iowa Code Section 455B.174, and of Rule 567--64.3, Iowa Administrative Code, the Director of the Iowa Department of Natural Resources has issued the above referenced permit. Pursuant to the same authority the Director hereby amends said permit as set forth below:

The permit is being amended to remove the Nutrient Reduction Requirements page and to add annual average mass limits for total nitrogen and total phosphorus as the facility has met the goals of Iowa's Nutrient Reduction Strategy. Also, the Standard Conditions and Significant Industrial User pages (last 4 pages) have been updated to reflect recent updates. Please replace your permit with the enclosed amended permit.

Please replace your current NPDES permit with the attached amended permit.

For the Department of Natural Resources:

By Ben Hucka Digitally signed by Ben Hucka Date: 2023.05.25 13:41:03 -05'00'

Ben Hucka
NPDES Section
ENVIRONMENTAL SERVICES DIVISION

STATE OF IOWA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROGRAM
AMENDMENT TO NPDES PERMIT

Iowa NPDES Permit #:	5252001
Date of Issuance:	November 1, 2020
Date of Expiration:	October 31, 2025
Date of this Amendment:	**November 1, 2021**
EPA Number:	IA0032905

Name and Mailing Address of Applicant:

CITY OF NORTH LIBERTY
PO BOX 77
NORTH LIBERTY, IA 50232

Identity and Location of Facility:

NORTH LIBERTY, CITY OF STP
Township 80N, Range 06W, Section 19, Johnson County

Pursuant to the authority Iowa Code Section 455B.174, and of Rule 567--64.3, Iowa Administrative Code, the Director of the Iowa Department of Natural Resources has issued the above referenced permit. Pursuant to the same authority the Director hereby amends said permit as set forth below:

The permit is amended to remove the chloride monitoring requirement, final limits, and compliance schedule as the facility has presented sampling results that demonstrate there is no reasonable potential for the final effluent from the facility to cause or contribute to a violation of the chloride water quality standards.

Please replace your current NPDES permit with the attached amended permit.

For the Department of Natural Resources:

By Karen Lodden Digitally signed by Karen Lodden Date: 2021.10.07 08:12:48 -05'00'

Karen Lodden
NPDES Section
ENVIRONMENTAL SERVICES DIVISION

STATE OF IOWA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROGRAM
AMENDMENT TO NPDES PERMIT

Iowa NPDES Permit #:	5252001
Date of Issuance:	November 1, 2020
Date of Expiration:	October 31, 2025
Date of this Amendment:	**June 1, 2021**
EPA Number:	IA0032905

Name and Mailing Address of Applicant:

CITY OF NORTH LIBERTY
PO BOX 77
NORTH LIBERTY, IA 50232

Identity and Location of Facility:

NORTH LIBERTY, CITY OF STP
Township 80N, Range 06W, Section 19, Johnson County

Pursuant to the authority Iowa Code Section 455B.174, and of Rule 567--64.3, Iowa Administrative Code, the Director of the Iowa Department of Natural Resources has issued the above referenced permit. Pursuant to the same authority the Director hereby amends said permit as set forth below:

The permit is amended to include total nitrogen and total phosphorus raw waste monitoring requirements. The correction is on permit page # 7. Please replace your current NPDES permit with the attached amended permit.

For the Department of Natural Resources:

By Karen Lodden Digitally signed by Karen Lodden Date: 2021.05.27 08:56:38 -05'00'

Karen Lodden
NPDES Section
ENVIRONMENTAL SERVICES DIVISION

IOWA DEPARTMENT OF NATURAL RESOURCES
National Pollutant Discharge Elimination System (NPDES) Permit

OWNER NAME & ADDRESS

CITY OF NORTH LIBERTY
PO BOX 77
NORTH LIBERTY, IA 52317-0077

FACILITY NAME & ADDRESS

NORTH LIBERTY CITY OF STP
405 ABIGAIL AVE
NORTH LIBERTY, IA 52317

Section 19, T80N, R06W
Johnson County

IOWA NPDES PERMIT NUMBER: 5252001
DATE OF ISSUANCE: 11/01/2020
DATE OF EXPIRATION: 10/31/2025

YOU ARE REQUIRED TO FILE FOR RENEWAL OF THIS PERMIT BY: 05/04/2025
EPA NUMBER: IA0032905

This permit is issued pursuant to the authority of section 402(b) of the Clean Water Act (33 U.S.C. 1342(b)), Iowa Code section 455B.174, and rule 567-64.3, Iowa Administrative Code. You are authorized to operate the disposal system and to discharge the pollutants specified in this permit in accordance with the effluent limitations, monitoring requirements and other terms set forth in this permit.

You may appeal any condition of this permit by filing a written notice of appeal and request for administrative hearing with the director of the department within 30 days of permit issuance.

Any existing, unexpired Iowa operation permit or Iowa NPDES permit previously issued by the department for the facility identified above is revoked by the issuance of this permit. This provision does not apply to any authorization to discharge under the terms and conditions of a general permit issued by the department or to any permit issued exclusively for the discharge of stormwater.

FOR THE DEPARTMENT OF NATURAL RESOURCES

By Karen Lodden Digitally signed by Karen Lodden
Date: 2020.10.12 12:10:38 -05'00'

Karen Lodden
NPDES Section, Environmental Services Division

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Outfall No.: 001 DISCHARGE FROM A MEMBRANE BIOREACTOR WASTEWATER TREATMENT FACILITY.

Receiving Stream: MUDDY CREEK

Route of Flow: MUDDY CREEK TO THE IOWA RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW2) are those in which flow or other physical characteristics are capable of supporting a resident aquatic community that includes a variety of native nongame fish and invertebrate species. The flow and other physical characteristics limit the maintenance of warm water game fish populations. These waters generally consist of small perennially flowing streams.

Outfall No.: 002 BYPASS AT EQ BASIN OVERFLOW

Receiving Stream: MUDDY CREEK

Route of Flow: MUDDY CREEK TO IOWA RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW2) are those in which flow or other physical characteristics are capable of supporting a resident aquatic community that includes a variety of native nongame fish and invertebrate species. The flow and other physical characteristics limit the maintenance of warm water game fish populations. These waters generally consist of small perennially flowing streams.

Bypasses from any portion of a treatment facility or from a sanitary sewer collection system designed to carry only sewage are prohibited.

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Effluent Limitations:

You are prohibited from discharging pollutants except in compliance with the following effluent limitations:

001 DISCHARGE FROM A MEMBRANE BIOREACTOR WASTEWATER TREATMENT FACILITY.

Outfall: 001 Effective Dates: 11/01/2020 to 10/31/2025			
Parameter	**Season**	**Limit Type**	**Limits**
CBOD5			**85% Removal Required**
	Yearly	7 Day Average	40 MG/L 1478 LBS/DAY
	Yearly	30 Day Average	25 MG/L 923 LBS/DAY
TOTAL SUSPENDED SOLIDS			**85% Removal Required**
	Yearly	7 Day Average	45 MG/L 1662 LBS/DAY
	Yearly	30 Day Average	30 MG/L 1108 LBS/DAY
AMMONIA NITROGEN (N)			
	JAN	30 Day Average	3.4 MG/L 125.8 LBS/DAY
	JAN	Daily Maximum	15.2 MG/L 561.0 LBS/DAY
	FEB	30 Day Average	4.0 MG/L 146.0 LBS/DAY
	FEB	Daily Maximum	14.2 MG/L 524.4 LBS/DAY
	MAR	30 Day Average	3.4 MG/L 125.8 LBS/DAY
	MAR	Daily Maximum	14.7 MG/L 542.5 LBS/DAY
	APR	30 Day Average	1.5 MG/L 56.3 LBS/DAY
	APR	Daily Maximum	15.7 MG/L 580.0 LBS/DAY
	MAY	30 Day Average	1.7 MG/L 64.2 LBS/DAY
	MAY	Daily Maximum	15.2 MG/L 561.0 LBS/DAY
	JUN	30 Day Average	1.3 MG/L 48.4 LBS/DAY
	JUN	Daily Maximum	14.4 MG/L 533.4 LBS/DAY
	JUL	30 Day Average	1.0 MG/L 37.1 LBS/DAY
	JUL	Daily Maximum	14.0 MG/L 513.4 LBS/DAY
	AUG	30 Day Average	1.0 MG/L 35.3 LBS/DAY
	AUG	Daily Maximum	13.3 MG/L 487.6 LBS/DAY
	SEP	30 Day Average	1.1 MG/L 39.0 LBS/DAY
	SEP	Daily Maximum	16.5 MG/L 609.2 LBS/DAY

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Outfall: 001 Effective Dates: 11/01/2020 to 10/31/2025			
Parameter	**Season**	**Limit Type**	**Limits**
AMMONIA NITROGEN (N)			
	OCT	30 Day Average	1.6 MG/L 57.5 LBS/DAY
	OCT	Daily Maximum	15.7 MG/L 580.0 LBS/DAY
	NOV	30 Day Average	2.3 MG/L 85.7 LBS/DAY
	NOV	Daily Maximum	14.7 MG/L 542.5 LBS/DAY
	DEC	30 Day Average	2.5 MG/L 91.4 LBS/DAY
	DEC	Daily Maximum	16.0 MG/L 589.6 LBS/DAY
ACUTE TOXICITY, CERIODAPHNIA			
	Yearly	Daily Maximum	1 NO TOXICITY
ACUTE TOXICITY, PIMEPHALES			
	Yearly	Daily Maximum	1 NO TOXICITY
DISSOLVED OXYGEN			
	Yearly	Daily Minimum	5.0 MG/L
PH			
	Yearly	Daily Maximum	9.0 STD UNITS
	Yearly	Daily Minimum	6.5 STD UNITS
E. COLI			
	MAR	Geometric Mean	126 #/100 ML
	APR	Geometric Mean	126 #/100 ML
	MAY	Geometric Mean	126 #/100 ML
	JUN	Geometric Mean	126 #/100 ML
	JUL	Geometric Mean	126 #/100 ML
	AUG	Geometric Mean	126 #/100 ML
	SEP	Geometric Mean	126 #/100 ML
	OCT	Geometric Mean	126 #/100 ML
	NOV	Geometric Mean	126 #/100 ML

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Outfall: 001 Effective Dates: 06/01/2023 to 10/31/2025			
Parameter	**Season**	**Limit Type**	**Limits**
ANNUAL AVERAGE NITROGEN DISCHARGED (AS N)			
	Yearly	Annual Average	167 LBS/DAY
ANNUAL AVERAGE PHOSPHORUS DISCHARGED (AS P)			
	Yearly	Annual Average	60 LBS/DAY

Facility Name: NORTH LIBERTY CITY OF STP
Permit Number: 5252001

Monitoring and Reporting Requirements

(a) Samples and measurements taken shall be representative of the volume and nature of the monitored wastewater.

(b) Analytical and sampling methods specified in 40 CFR Part 136 or other methods approved in writing by the department shall be utilized. All effluent samples for which a limit applies must be analyzed using sufficiently sensitive methods (i.e. testing procedures) approved under 567 IAC Chapter 63 and 40 CFR Part 136 for the analysis of pollutants or pollutant parameters or as required under 40 CFR chapter I, subchapter N or O.

For the purposes of this paragraph, an approved method is sufficiently sensitive when:
(1) the method minimum level (ML) is at or below the level of the effluent limit established in the permit for the measured pollutant or pollutant parameter; or
(2) the method has the lowest ML of the approved analytical methods for the measured pollutant or pollutant parameter.

Samples collected for operational testing need not be analyzed by approved analytical methods; however, commonly accepted test methods should be used.

(c) You are required to report all data including calculated results needed to determine compliance with the limitations contained in this permit. The results of any monitoring not specified in this permit performed at the compliance monitoring point and analyzed according to 40 CFR Part 136 shall be included in the calculation and reporting of any data submitted in accordance with this permit. This includes daily maximums and minimums, 30-day averages and 7-day averages for all parameters that have concentration (mg/l) and mass (lbs/day) limits. In addition, flow data shall be reported in million gallons per day (MGD).

(d) Records of monitoring activities and results shall include for all samples: the date, exact place and time of the sampling; the dates the analyses were performed; who performed the analyses; the analytical techniques or methods used; and the results of such analyses.

(e) Results of all monitoring shall be recorded on forms provided by, or approved by, the department, and shall be submitted to the appropriate regional field office of the department by the fifteenth day following the close of the reporting period. Your reporting period is on a MONTHLY basis, ending on the last day of each reporting period.

(f) Operational performance monitoring for treatment unit process control shall be conducted to ensure that the facility is properly operated in accordance with its design. The results of any operational performance monitoring need not be reported to the department, but shall be maintained in accordance with rule 567 IAC 63.2 (455B). The results of any operational performance monitoring specified in this permit shall be submitted to the department in accordance with these reporting requirements.

(g) Chapter 63 of the rules provides you with further explanation of your monitoring requirements.

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from Permit Issue Date to Permit Expire Date				
001	BIOCHEMICAL OXYGEN DEMAND (BOD5)	2 TIMES PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	RAW WASTE
001	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	NITROGEN, TOTAL KJELDAHL (AS N)	1 EVERY MONTH	24 HOUR COMPOSITE	RAW WASTE
001	PH	2 TIMES PER WEEK	GRAB	RAW WASTE
001	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	RAW WASTE
001	TOTAL SUSPENDED SOLIDS	2 TIMES PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	ACUTE TOXICITY, CERIODAPHNIA	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	FINAL EFFLUENT
001	ACUTE TOXICITY, PIMEPHALES	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	FINAL EFFLUENT
001	AMMONIA NITROGEN (N)	2 TIMES PER WEEK	24 HOUR COMPOSITE	FINAL EFFLUENT
001	CBOD5	2 TIMES PER WEEK	24 HOUR COMPOSITE	FINAL EFFLUENT
001	DISSOLVED OXYGEN	2 TIMES PER WEEK	GRAB	FINAL EFFLUENT
001	E. COLI	GEO. MEAN 1/3 MONTHS	GRAB	FINAL EFFLUENT
001	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	FINAL EFFLUENT
001	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	FINAL EFFLUENT
001	PH	2 TIMES PER WEEK	GRAB	FINAL EFFLUENT
001	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	FINAL EFFLUENT
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	FINAL EFFLUENT
001	TOTAL SUSPENDED SOLIDS	2 TIMES PER WEEK	24 HOUR COMPOSITE	FINAL EFFLUENT
The following monitoring requirements shall be in effect from 06/01/2023 to 10/31/2025				
001	ANNUAL AVERAGE NITROGEN DISCHARGED (AS N)	1 EVERY 12 MONTHS	CALCULATED	CALCULATION REPORTED ANNUALLY ON DMR
001	ANNUAL AVERAGE PHOSPHORUS DISCHARGED (AS P)	1 EVERY 12 MONTHS	CALCULATED	CALCULATION REPORTED ANNUALLY ON DMR

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Special Monitoring Requirements

Outfall # **Description**

001 **E. COLI**

The limit for E. coli specified on the effluent limitations page of this permit for Outfall 001 is a geometric mean. The disinfection season is established in the Iowa Administrative Code, Subparagraph 567 IAC 61.3(3)"a"(1), and is in effect from March 15 to November 15. Any disinfection system (chlorine, UV light, etc.) shall be operated to comply with the limit during the entire disinfection season whenever wastewater is being discharged from Outfall 001.

The facility must collect and analyze a minimum of five samples in one calendar month during each 3-month period from March 15 to November 15. The 3-month periods are March – May, June – August, and September – November. The collection of five samples in each 3-month period will result in a minimum of 15 samples being collected during a calendar year. For example, for the first 3-month period, the operator may choose April as the calendar month to collect the 5 individual E. coli samples to determine compliance with the limits. The operator may also choose the months of March or May as well, as long as each of the 5 samples is collected during a single calendar month. The same principle applies to the other two 3-month periods during the disinfection season. The following requirements apply to the individual samples collected in one calendar month:
Samples must be spaced over one calendar month.
No more than one sample can be collected on any one day.
There must be a minimum of two days between each sample.
No more than two samples may be collected in a period of seven consecutive days.

If the effluent has been disinfected using chlorine, ultraviolet light (UV), or any other process intended to disrupt the biological integrity of the E. coli, the samples shall be analyzed using the Most Probable Number method found in Standard Method 9223B (Colilert® or Colilert-18® made by IDEXX Laboratories, Inc.). If the effluent has not been disinfected the samples may be analyzed using either the MPN method above or EPA Method 1603: Escherichia coli (E. coli) in water by membrane filtration using modified membrane-thermotolerant E. coli agar (modified mTEC) or mColiBlue-24® made by the Hach Company.

The geometric mean must be calculated using all valid sample results collected during a month. The geometric mean formula is as follows: Geometric Mean = (Sample one * Sample two * Sample three * Sample four *Sample five…Sample N)^(1/N), which is the Nth root of the result of the multiplication of all of the sample results where N = the number of samples. If a sample result is a less than value, the value reported by the lab without the less than sign should be used in the geometric mean calculation.

The geometric mean can be calculated in one of the following ways:
Use a scientific calculator that can calculate the powers of numbers.
Enter the samples in Microsoft Excel and use the function "GEOMEAN" to perform the calculation.
Use the geometric mean calculator on the Iowa DNR webpage at:
http://www.iowadnr.gov/InsideDNR/RegulatoryWater/NPDESWastewaterPermitting/NPDESOperatorInformation/BacteriaSampling.aspx.

NITROGEN, TOTAL (AS N)

Total nitrogen shall be determined by testing for Total Kjeldahl Nitrogen (TKN) and nitrate + nitrite nitrogen and reporting the sum of the TKN and nitrate + nitrite results (reported as N). Nitrate + nitrite can be analyzed together or separately.

Special Monitoring Requirements continued

Outfall #	Description
001	**ANNUAL AVERAGE NITROGEN DISCHARGED (AS N)**

ANNUALLY FROM THE PERMIT AMENDMENT DATE JUNE 1, 2023, CALCULATE THE AVERAGE OF ALL TOTAL NITROGEN MASS (LBS/DAY) SAMPLE RESULTS FROM THE PREVIOUS 12 MONTHS. REPORT THE ANNUAL AVERAGE IN THE DISCHARGE MONITORING REPORT (DMR) DUE JULY 15th EACH YEAR.

CALCULATION: SUM OF ALL MASS MEASUREMENTS (LBS/DAY) IN THE LAST 12 MONTHS DIVIDED BY THE TOTAL NUMBER OF MEASUREMENTS IN THE LAST 12 MONTHS.

ANNUAL AVERAGE PHOSPHORUS DISCHARGED (AS P)

ANNUALLY FROM THE PERMIT AMENDMENT DATE JUNE 1, 2023, CALCULATE THE AVERAGE OF ALL TOTAL PHOSPHORUS MASS (LBS/DAY) SAMPLE RESULTS FROM THE PREVIOUS 12 MONTHS. REPORT THE ANNUAL AVERAGE IN THE DISCHARGE MONITORING REPORT (DMR) DUE JULY 15th EACH YEAR.

CALCULATION: SUM OF ALL MASS MEASUREMENTS (LBS/DAY) IN THE LAST 12 MONTHS DIVIDED BY THE TOTAL NUMBER OF MEASUREMENTS IN THE LAST 12 MONTHS.

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Outfall Number: 001

Ceriodaphnia and Pimephales Toxicity Effluent Testing

1. For facilities that have not been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within three (3) months of permit issuance. For facilities that have been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within twelve months (12) of the last toxicity test.

2. The test organisms that are to be used for acute toxicity testing shall be Ceriodaphnia dubia and Pimephales promelas. The acute toxicity testing procedures used to demonstrate compliance with permit limits shall be those listed in 40 CFR Part 136 and adopted by reference in rule 567 IAC 63.1(1). The method for measuring acute toxicity is specified in USEPA, October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. USEPA, Office of Water, Washington, D.C., EPA 821-R-02-012.

3. The diluted effluent sample must contain a minimum of 100.00 % effluent and no more than 0.00 % of culture water.

4. One valid positive toxicity result will require, at a minimum, quarterly testing for effluent toxicity until three successive tests are determined not to be positive.

5. Two successive valid positive toxicity results or three positive results out of five successive valid effluent toxicity tests will require a toxicity reduction evaluation to be completed to eliminate the toxicity.

6. A non-toxic test result shall be indicated as a "1" on the monthly operation report. A toxic test result shall be indicated as a "2" on the monthly operation report. DNR Form 542-1381 shall also be submitted to the DNR field office along with the monthly operation report.

Ceriodaphnia and Pimephales Toxicity Effluent Limits

The maximum limit of "1" for the parameters Acute Toxicity, Ceriodaphnia and Acute Toxicity, Pimephales means no positive toxicity results.

Definition: "Positive toxicity result" means a statistical difference of mortality rate between the control and the diluted effluent sample. For more information, see USEPA, October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, USEPA, Office of Water, Washington, D.C., EPA 821-R-02-012.

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

Design Capacity

Design: 2

The design capacity for the treatment works is specified in Construction Permit Number 2015-0264-S, issued March 04, 2015. The treatment plant is designed to treat:

* An average dry weather (ADW) flow of 2.9300 Million Gallons Per Day (MGD).
* An average wet weather (AWW) flow of 4.4290 Million Gallons Per Day (MGD).
* A maximum wet weather (MWW) flow of 10.0540 Million Gallons Per Day (MGD).
* A design 5-day biochemical oxygen demand (BOD5) load of 4730 lbs/day.
* A design Total Kjeldahl Nitrogen (TKN) load of 920.00 lbs/day.
* A design Total Suspended Solids (TSS) load of 5560 lbs/day.

Operator Certification Type/Grade: WW/IV

Wastes in such volumes or quantities as to exceed the design capacity of the treatment works or reduce the effluent quality below that specified in the operation permit of the treatment works are considered to be a waste which interferes with the operation or performance of the treatment works and are prohibited by subrule IAC 567-62.1(7).

SEWAGE SLUDGE HANDLING AND DISPOSAL REQUIREMENTS

"Sewage sludge" is solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge does not include the grit and screenings generated during preliminary treatment.

1. The permittee shall comply with all existing Federal and State laws and regulations that apply to the use and disposal of sewage sludge and with technical standards developed pursuant to Section 405(d) of the Clean Water Act when such standards are promulgated. If an applicable numerical limit or management practice for pollutants in sewage sludge is promulgated after issuance of this permit that is more stringent than a sludge pollutant limit or management practice specified in existing Federal or State laws or regulations, this permit shall be modified, or revoked and reissued, to conform to the regulations promulgated under Section 405(d) of the Clean Water Act. The permittee shall comply with the limitation no later than the compliance deadline specified in the applicable regulations.

2. The permittee shall provide written notice to the Department of Natural Resources prior to any planned changes in sludge disposal practices.

3. Land application of sewage sludge shall be conducted in accordance with criteria established in rule IAC 567 67.1 through 67.11 (455B).

Facility Name: NORTH LIBERTY CITY OF STP

Permit Number: 5252001

SIGNIFICANT INDUSTRIAL USER LIMITATIONS, MONITORING AND REPORTING REQUIREMENTS

1. You must enforce the pollutant limits for each significant industrial user that are listed elsewhere in this permit. Violation of a treatment agreement limit is prohibited by subrule 567 IAC 62.1(6). Monitoring of each significant industrial user is required elsewhere in this permit.

2. Monitoring of each significant industrial user is required elsewhere in this permit. Results of the required monitoring shall be included on your discharge monitoring report, which must be submitted by the fifteenth of the following month.

3. You are required to notify the department, in writing, of any of the following:

   (a) 180 days prior to the introduction of pollutants to your facility from a significant industrial user. A significant industrial user means an industrial user of a treatment works that:
      (1) Discharges an average of 25,000 gallons per day or more of process wastewater excluding sanitary, noncontact cooling and boiler blowdown wastewater;
      (2) Contributes a process waste stream which makes up five percent or more of the average dry weather hydraulic or organic capacity of the publicly-owned treatment works:
      (3) Is subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; or
      (4) Is designated by the department as a significant industrial user on the basis that the contributing industry, either singly or in combination with other contributing industries, has a reasonable potential for adversely affecting the operation of or effluent quality from the publicly-owned treatment works or for violating any pretreatment standards or requirements.

   (b) 60 days prior to a proposed expansion, production increase or process modification that may result in the discharge of a new pollutant or a discharge in excess of limitations stated in the existing treatment agreement.

   (c) 10 days prior to any commitment by you to accept waste from any new significant industrial user. Your written notification must include a new or revised treatment agreement in accordance with rule 64.3(5)(455B).

4. You shall require all users of your facility to comply with Sections 204(b), 307, and 308 of the Clean Water Act.

   (a) Section 204(b) requires that all users of the treatment works constructed with funds provided under Sections 201(g) or 601 of the Act to pay their proportionate share of the costs of operation, maintenance and replacement of the treatment works.

   (b) Section 307 of the Act requires users to comply with pretreatment standards promulgated by EPA for pollutants that would cause interference with the treatment process or would pass through the treatment works.

   (c) Section 308 of the Act requires users to allow access at reasonable times to state and EPA inspectors for the purpose of sampling the discharge and reviewing and copying records.

STANDARD CONDITIONS

1. **ADMINISTRATIVE RULES -** Rules of the Iowa Department of Natural Resources (department) that govern the operation of a facility in connection with this permit are published in Part 567 of the Iowa Administrative Code (IAC) in Chapters 60-65, 67, and 121. Reference to the term "rule" in this permit means the designated provision of Part 567 of the IAC. Reference to the term "CFR" means the Code of Federal Regulations.

2. **LIMIT DEFINITIONS -**
   (a) 7 day average means the arithmetic mean (average) of pollutant parameter values for samples collected in a period of seven consecutive days. The first 7-day period shall begin with the first day of the month. ***{567 IAC 60.2}***
   (b) 30 day average means the arithmetic mean of pollutant parameter values for samples collected in a period of 30 consecutive days. ***{567 IAC 60.2}***
   (c) Daily maximum means the total discharge by mass, volume, or concentration during a twenty-four hour period. ***{567 IAC 60.2}***

3. **MONITORING AND RECORDS OF OPERATION -**
   (a) Electronic reporting. Records of operation required by this permit shall be electronically submitted to the department within 15 days following the close of the monthly reporting period, in accordance with the monitoring requirements incorporated in this permit, unless an approval for paper submittal of records of operation has been obtained in accordance with 567 IAC 63.7(2).
   (b) Maintenance of records. You shall retain for a minimum of three years all paper and electronic records of monitoring activities and results including all original strip chart recordings for continuous monitoring instrumentation and calibration and maintenance records. ***{567 IAC 63.2(3)}***
   (c) Any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or both. ***{40 CFR 122.41(j)(5)}***

4. **USE OF CERTIFIED LABORATORIES -** Analyses of wastewater, groundwater or sewage sludge that are required to be submitted as a result of this permit must be performed by a laboratory certified by the State of Iowa. Routine, on-site monitoring for pH, temperature, dissolved oxygen, total residual chlorine and other pollutants that must be analyzed immediately upon sample collection, physical measurements, and operational performance monitoring specified in 567 IAC 63.3(4) are excluded from this requirement. ***{567 IAC 63.1}***

5. **DUTY TO PROVIDE INFORMATION -** You must furnish to the director, within a reasonable time, any information the director may request to determine compliance with this permit or determine whether cause exists for amending, revoking and reissuing, or terminating this permit, in accordance with 567 IAC 64.3(11)"*c*". You must also furnish to the director, upon request, copies of any records required to be kept by this permit. If you become aware that you failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, you must promptly submit such facts or information. If you become aware that you failed to submit any relevant facts in any report to the director, including records of operation, you shall promptly submit such facts or information. ***{567 IAC 60.4(2)"a", 567 IAC 63.7(6), 40 CFR 122.41(h)}***

6. **DUTY TO REAPPLY AND PERMIT CONTINUATION -** If you wish to continue to discharge after the expiration date of this permit, you must file a complete application for reissuance at least 180 days prior to the expiration date of this permit. If a timely and sufficient application is submitted, this permit will remain in effect until the department makes a final determination on the permit application. ***{567 IAC 64.8(1), Iowa Code 17A.18}***

7. **DUTY TO COMPLY -** You must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Iowa Code and the Clean Water Act and is grounds for enforcement action; permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. Issuance of this permit does not relieve you of the responsibility to comply with all local, state and federal laws, ordinances, regulations or other legal requirements applying to the operation of your facility. ***{567 IAC 64.7(4)"E", 40 CFR 122.41(a)}***

8. **DUTY TO MITIGATE -** You shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. ***{567 IAC 64.7(7)"i", 40 CFR 122.41(d)}***

9. **PROPER OPERATION AND MAINTENANCE -** All facilities and control systems shall be operated as efficiently as possible and maintained in good working order. A sufficient number of staff, adequately trained and knowledgeable in the operation of your facility, shall be retained at all times. Adequate laboratory controls and appropriate quality assurance procedures shall be provided to maintain compliance with the conditions of this permit. ***{567 IAC 64.7(7)"f", 40 CFR 122.41(e)}***

10. **SIGNATORY REQUIREMENTS -** Applications, discharge monitoring reports, or other information submitted to the department in connection with this permit must be signed and certified in accordance with 567 IAC 64.3(8).

11. **TRANSFER OF TITLE OR OWNER ADDRESS CHANGE -** If title to your facility, or any part of it, is transferred, the new owner shall be subject to this permit. You are required to notify the new owner of the requirements of this permit in writing prior to any transfer of title. The department shall be notified in writing within 30 days of the occurrence. No transfer of the authorization to discharge from the facility represented by the permit shall take place prior to notifying the department of the transfer of title. Whenever the address of the owner is changed, the department shall be notified in writing within 30 days of the address change. ***{567 IAC 64.14}***

STANDARD CONDITIONS

12. **PERMIT MODIFICATION, SUSPENSION OR REVOCATION -** This permit may be amended, revoked and reissued, or terminated in whole or in part for cause including, but not limited to, those specified in 567 IAC 64.3(11)*"b"*. This permit may be modified due to conditions or information on which this permit is based, including any new standard the department may adopt that would change the required effluent limits. If a toxic pollutant is present in your discharge and more stringent standards for toxic pollutants are established under Section 307(a) of the Clean Water Act, this permit will be modified in accordance with the new standards. The filing of a request for a permit amendment, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition. ***{567 IAC 64.3(11)"d", 64.7(7)"b" and "g", 40 CFR 122.62(a)(6)}***

13. **TWENTY-FOUR HOUR REPORTING -** You shall report any noncompliance that may endanger human health or the environment, including, but not limited to, violations of maximum daily limits for any toxic pollutant (listed as toxic in Section 307(a)(1) of the Clean Water Act) or hazardous substance (as designated in 40 CFR Part 116 pursuant to 311 of the Act). Information shall be provided orally to the appropriate regional field office of the department within 24 hours from the time you become aware of the circumstances. A written submission that includes a description of noncompliance and its cause; the period of noncompliance including exact dates and times; whether the noncompliance has been corrected or the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent a reoccurrence of the noncompliance must be provided to the appropriate field office within 5 days of the occurrence. ***{567 IAC 63.12, 40 CFR 122.41(l)(6)}***

14. **OTHER NONCOMPLIANCE -** You shall report all instances of noncompliance not reported under Condition #13 at the time discharge monitoring reports are submitted. The report shall contain the information listed in Condition #13. You shall give advance notice to the appropriate regional field office of the department of any planned activity which may result in noncompliance with permit requirements. Notice is required only when previous notice has not been given to any other section of the department. ***{567 IAC 63.7(5), 63.14 and 63.15, 40 CFR 122.41(l)(7)}***

15. **INSPECTION OF PREMISES, RECORDS, EQUIPMENT, METHODS AND DISCHARGES -** You are required to permit authorized personnel to:
    (a) Enter upon the premises where a regulated facility or activity is located or conducted or where records are kept under conditions of this permit;
    (b) Provide access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
    (c) Inspect, at reasonable times, any facilities, equipment, practices or operations regulated or required under this permit; and
    (d) Sample or monitor, at reasonable times, to assure compliance or as otherwise authorized by the Clean Water Act.
    {567 IAC 64.7(7)"c", 40 CFR 122.41(i)}

16. **NOTICE OF CHANGED CONDITIONS -** You are required to notify the director of any changes in existing conditions or information on which this permit is based, including, but not limited to, the following:
    (a) If your facility is a publicly owned treatment works (POTW) or otherwise accepts waste for treatment from an indirect discharger or industrial contributor, you must notify the director if there is any substantial change in the volume or character of pollutants being introduced to the POTW by an indirect discharger or industrial contributor. See 567 IAC 64.3(5) and 64.7(7)"*d*" for further requirements. ***{40 CFR 122.42(b)}***
    (b) If your facility has a manufacturing, commercial, mining, or silviculture discharge, you must notify the director as soon as you know or have reason to believe that any activity has occurred or will occur which would result in the discharge of any toxic pollutant which is not limited in this permit. ***{40 CFR 122.42(a)}***
    (c) You must notify the director if you have begun or will begin to use or manufacture, as an intermediate or final product or byproduct, any toxic pollutant which was not reported in the permit application. ***{40 CFR 122.21(g)(9})***

17. **PLANNED CHANGES -** You shall give notice to the appropriate regional field office of the department 30 days prior to any planned physical alterations or additions to the permitted facility. Facility expansions, production increases, or process modifications which result in new or increased discharges of pollutants must be reported by submission of a new permit application. If any modification of, addition to, or construction of a disposal system is to be made, you must first obtain a written construction permit from this department. In addition, no construction activity that will result in disturbance of one acre or more shall be initiated without first obtaining coverage under NPDES General Permit No. 2.
    Notice is required only when:
    (a) Notice has not been given to any other section of the department:
    (b) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source as defined in 567 IAC 60.2;
    (c) The alteration or addition results in a significant change in sludge use or disposal practices; or
    (d) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants that are not subject to effluent limitations in the permit.
    {567 IAC 63.13, 567 IAC 64.2 and 64.7(7)"a"}

18. **FAILURE TO SUBMIT FEES -** This permit may be revoked, in whole or in part, if the appropriate permit fees are not submitted within thirty (30) days of the date of notification that such fees are due. ***{567 IAC 64.16(1)}***

STANDARD CONDITIONS

19. **BYPASSES -** "Bypass" means the diversion of waste streams from any portion of a treatment facility or collection system. A bypass does not include internal operational waste stream diversions that are part of the design of the treatment facility, maintenance diversions where redundancy is provided, diversions of wastewater from one point in a collection system to another point in a collection system, or wastewater backups into buildings that are caused in the building lateral or private sewer line. ***{567 IAC 60.2)}***
    (a) Prohibition. Bypasses from any portion of a treatment facility or from a sanitary sewer collection system designed to carry only sewage are prohibited, in accordance with 567 IAC 63.6(1). The department may not assess a civil penalty against a permittee for a bypass if the permittee has complied with all of the following:
        i. The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
        ii. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
        iii. The permittee submitted notices as required by 567 IAC 63.6.
    (b) Anticipated bypass. Except for bypasses that occur as a result of mechanical failure or acts beyond the control of the owner or operator of a waste disposal system (unanticipated bypasses), the owner or operator shall obtain written permission from the department prior to any discharge of sewage or wastes from a waste disposal system not authorized by this permit. The Director may approve an anticipated bypass after considering its adverse effects if the Director determines that it will meet the three conditions listed above and a request for bypass has been submitted to the appropriate regional field office of the department at least ten days prior to the expected event, in accordance with the requirements listed in 567 IAC 63.6(2).
    (c) Unanticipated bypass. In the event that a bypass or upset occurs without prior notice having been provided pursuant to 567 IAC 63.6(2) or as a result of mechanical failure or acts beyond the control of the owner or operator, the owner or operator of the treatment facility or collection system shall notify the department by telephone as soon as possible but not later than 24 hours after the onset or discovery in accordance with the requirements in 567 IAC 63.6(3). A written submission describing the bypass shall also be provided within five days of the time the permittee becomes aware of the bypass, in accordance with the requirements in 567 IAC 63.6(3)"*d*".
    (d) Reporting. Bypasses shall be reported in accordance with 567 IAC 63.6.
    {567 IAC 63.6}

20. **UPSETS -** "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.
    (a) Effect of an upset. An upset constitutes an affirmative defense to the assessment of a civil penalty for noncompliance with technology-based permit effluent limitations if the requirements of paragraph (b) of this condition are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.
    (b) Conditions necessary for demonstration of an upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed operating logs or other relevant evidence, that;
        i. An upset occurred and that the permittee can identify the cause(s) of the upset;
        ii. The permitted facility was at the time being properly operated;
        iii. The permittee submitted notice of the upset to the department in accordance with 567 IAC 63.6(3); and
        iv. The permittee complied with any remedial measures required by the department in accordance with 567 IAC 63.6(6)"*b*"(4).
    (c) Burden of Proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.
    {567 IAC 63.6}

21. **NEED TO HALT OR REDUCE ACTIVITY NOT A DEFENSE -** It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. ***{567 IAC 64.7(7)"j", 40 CFR 122.41(c)}***

22. **PROPERTY RIGHTS -** This permit does not convey any property rights of any sort or any exclusive privilege. ***{567 IAC 64.4(3)"b", 40 CFR 122.41(g)}***

23. **EFFECT OF A PERMIT -** Compliance with a permit during its term constitutes compliance, for purposes of enforcement, with Sections 301, 302, 306, 307, 318, 403 and 405(a)-(b) of the Clean Water Act, and equivalent limitations and standards set out in 567 IAC Chapters 61 and 62. ***{567 IAC 64.4(3)"a"}***

24. **SEVERABILITY -** The provisions of this permit are severable. If any provision or application of any provision to any circumstance is found to be invalid by this department or a court of law, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected by such finding.

APPENDIX B

PLANT FLOW AND LOADING DATA

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DATE: August 31, 2022

TO: IDNR Wastewater Engineering Section

RE: Wastewater Treatment Plant Proposed Design Flows and Loads
City of North Liberty, Iowa

The following summarizes the proposed design flows and loadings for the City of North Liberty, Iowa, wastewater treatment plant and associated facility plan.

Design Population

Several of the proposed design criteria were developed based on population. United States Census data was used to establish an estimate of current population and to help establish trends for future growth. The 2020 Census reported the population of North Liberty, Iowa, at 20,479 people, and the estimated 2021 population is 20,875 people.

Economic activity in the state and industrial activity in a geographical area can have a significant effect on population growth. Observation of past population growth is not necessarily an accurate predictor of future growth, but it does provide an indicator of the probable limits of the magnitude of population changes. The average growth per decade for the State of Iowa was 2.4% from 1990 to 2020. However, the North Liberty area has experienced a higher rate of growth over the past 30 years, which averages over 50% per decade. The rate of growth has decreased over the past approximately 5 years but is still averaging 22% per decade. The City is concurrently updating their comprehensive plan in which they are projecting population growth of 3.5% annually. The same population growth rate was used to estimate projected populations through year 2050.

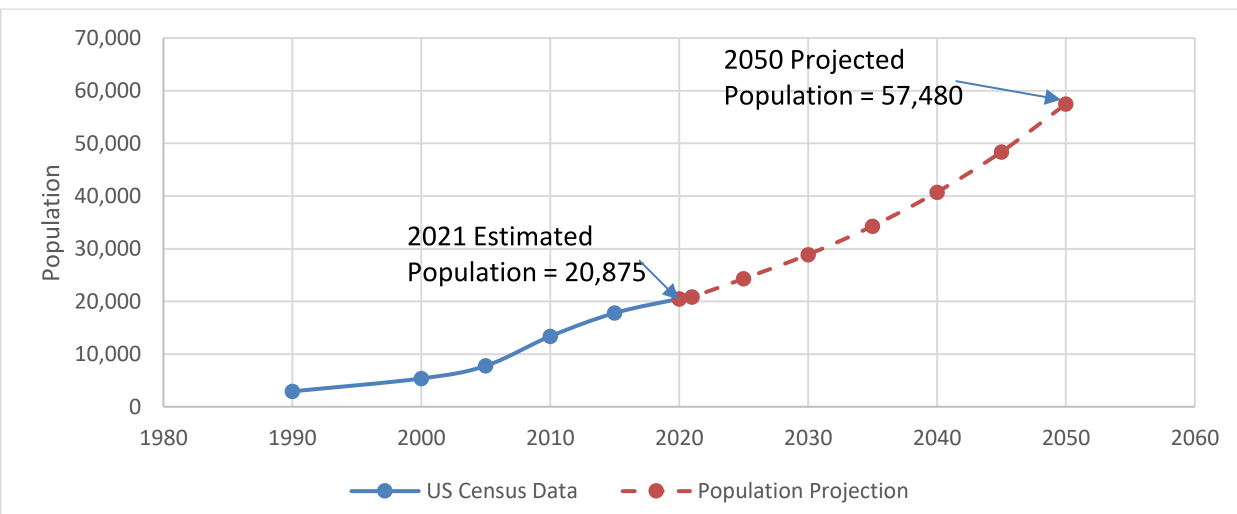

Figure 1: North Liberty, Iowa - Historical and Projected Population

Current and Projected Flows

Current and projected flows are summarized in Table 1 below. Plant influent is metered by a magnetic flow meter. The plant has an equalization basin, and flow to the basin and return flow from the basin is metered separately with magnetic flow meters. Historical flow data was evaluated from January 2017 to April 2022 for the total flow to the facility, which includes domestic and commercial flows. The City does not have any Significant Industrial Users (SIUs) with pretreatment agreements.

Table 1. Current and Projected Flows

Parameter	Phase II Design Flows	Current Flows	2030 Projected Flows	2040 Projected Flows	2050 Projected Flows
Population	27,800	20,875	28,890	40,750	57,480
Average Flow, MGD	3.330	1.774	3.178	4.483	6.323
Average Dry Weather Flow (ADW), MGD	2.930	1.694	2.797	3.945	5.564
Average Wet Weather Flow (AWW), MGD	4.429	2.767	4.227	5.962	8.4019
Maximum Wet Weather Flow (MWW), MGD	10.054	5.088	9.883	11.840	14.601
Peak 7-Day Wet Weather Flow, MGD	---	3.765	5.748	8.108	11.437
Peak Hour Wet Weather Flow (PHWW), MGD	16.424	6.081	16.209	19.418	23.945

The rationale for current and projected flows identified in Table 1 is summarized below:

- **Average flow** is the average flow reported over the data collection period. The average flow rate during the study period was 1.774 MGD, which is about 90 gallons per capita per day (gpcpd). However, the average flow rate per capita ranged from 77 gpcpd to 98 gpcpd. During this timeframe, the city has been in a relatively dry period and has not experienced a 10-year storm event. Previous studies have assumed 120 gallons per capita per day (gpcpd) flow. The projected average domestic flow rates for 2030, 2040, and 2050 were estimated by adding a per capita flow rate of 110 gpcpd for the estimated population growth from 2021 to 2050 to the current average flow.

- **Average Dry Weather (ADW) flow** is the average flow when groundwater is at or near normal, and runoff is not occurring over a 30-day period. This is generally considered to occur during winter months of January and February. North Liberty's ADW flow was determined by averaging flows for January and February from 2017 to 2022. This is in conformance with the methodology informally adopted by IDNR to estimate ADW flow to represent normal flows without the influence of inflow and infiltration (I/I) of rainwater.

  The ADW flow rate per capita is approximately 86 gpcpd. Typical dry weather flow ranges 70 to 100 gpcpd. The ratio of current ADW:ADF flow is about 0.95. The 2014 facility plan estimated the ADW:ADF flow ratio to be about 0.88. Given the dry conditions over the current data set, and projected higher per capita ADF in the future, a ADW:ADF ratio of 0.88 was used for the projected ADW flows for 2030, 2040, and 2050.

- **Average Wet Weather (AWW-30) flow** is the average flow for the wettest 30 consecutive days over the data period evaluated. The maximum 30-day flow for the study period was 2.767 MGD, which was recorded from May 8, 2019, through June 6, 2019. The collection system did not experience a 10-year rain event during the data period evaluated so the AWW-30 flow was lower than anticipated.

  Projected AWW flows were estimated by multiplying the projected average daily flows by a ratio of 1.33, which is the same AWW to ADF ratio used in the 2014 facility plan.

- **Maximum Wet Weather (MWW) flow** is the peak day flow reported over the time span evaluated. The maximum day flow during the study period was 5.077 MGD on October 6, 2018. As stated above, no 10-year storms occurred during the data period evaluated, so the MWW flow was lower than it could have potentially been if there was a 10-year storm in the period evaluated.

  The Projected MWW flow was determined to be 7.915 MGD in the 2014 facility plan, and the facility is currently rated for a MWW flow of 10.054 MGD (Phase II Design). The projected MWW flows were estimated by using the previous 2014 MWW flow of 7.915 MGD plus 110 gpcpd times the population growth from 2014 (16,960 people) to the 2045 design year times a peaking factor of 1.5.

- **Peak 7-day Wet Weather Flow** is defined by IDNR as the wettest recorded seven consecutive days. IDNR has proposed using this design flow for sizing equalization storage volumes. This occurred between October 6, 2018, and October 12, 2018, for the evaluated data set with a recorded average flow of 3.765 MGD. As previously noted, there were no 10-year storms during the study period, so the peak 7-day wet weather flow was lower than anticipated if a 10-year storm had occurred during the evaluation period.

  The projected 7-day wet weather flows were estimated by multiplying the ratio of the current maximum 7-day flow to the maximum 30-day flow (1.36) by the projected AWW.

- **Peak Hourly Wet Weather (PHWW) flow** is the highest peak flow over an hour measured at the plant. The city's recorded peak hour wet weather flow was less than anticipated due to not having any 10-year storm events during the study period. The ratio of the peak hour flow to the peak day flow was calculated as 1.64 in the 2014 facility plan. The projected PHWW flows were estimated by multiplying the projected MWW flows by a peaking factor of 1.64.

Current and Projected Loadings

Current and projected loadings are summarized in the Table 2 below. Current loadings are based on historical data from January 2017 through April 2022. The City samples influent parameter concentrations from the common influent line. The average population over the study period was 19,771. This value was used to calculate average day per capita loading. The per capita Maximum

Month and Maximum Day loads were calculated based on the estimated population the year the load occurred. Projected loadings are also summarized in Table 2.

Table 2. Current and Projected Influent Loads

Parameter	Phase II Design Loads		Current Loads		2030 Projected Loads		2040 Projected Loads		2050 Projected Loads	
Population	27,800		20,875		28,890		40,750		57,480	
	Total	**Per Capita**	**Total**	**Per Capita**	**Total**	**Per Capita**	**Total**	**Per Capita**	**Total**	**Per Capita**
BOD, Average	3,592	**0.13**	3,102	**0.16**	4,464	**0.15**	6,480	**0.16**	**9,324**	**0.16**
BOD, Maximum Month	4,730	**0.17**	4,245	**0.21**	5,848	**0.20**	8,220	**0.20**	**11,566**	**0.20**
BOD, Maximum Day	7,626	**0.27**	6,620	**0.32**	9,265	**0.32**	13,179	**0.32**	**18,699**	**0.33**
TSS, Average	4,343	**0.16**	2,864	**0.14**	4,467	**0.15**	6.839	**0.17**	**10,185**	**0.18**
TSS, Maximum Month	5,560	**0.20**	5,070	**0.27**	7,074	**0.24**	10,039	**0.25**	**14,222**	**0.25**
TSS, Maximum Day	10,638	**0.38**	10,056	**0.54**	14,023	**0.49**	19,894	**0.49**	**28,175**	**0.49**
TKN, Average	738	**0.027**	475	**0.023**	763	**0.026**	1,190	**0.029**	**1,793**	**0.031**
TKN, Maximum Month	920	**0.033**	657	**0.031**	1,026	**0.036**	1,571	**0.039**	**2,341**	**0.041**
TKN, Maximum Day	2,102	**0.076**	738	**0.035**	1,291	**0.045**	2,110	**0.052**	**3,264**	**0.057**
Phosphorus, Average	---	**---**	90	**0.0043**	146	**0.0051**	229	**0.0056**	**346**	**0.0060**
Phosphorus, Maximum Month	---	**---**	111	**0.0053**	191	**0.0066**	310	**0.0076**	**477**	**0.0083**
Phosphorus, Maximum Day	---	**---**	178	**0.0085**	306	**0.0106**	496	**0.0122**	**764**	**0.0133**

The rationale for determining the projected loadings is summarized as follows:

(1) Average Day Loads: Projected loads were determined by increasing current average day loads by projected population increase and a per capita loading rate of 0.17 pounds per day (ppd) for BOD_5, 0.20 ppd for TSS, and 0.036 ppd for TKN as shown in Table 3. Typical per capita values for total phosphorus (TP) loading at a domestic plant range from 0.007 to 0.010 ppd per capita per *Design of Municipal Wastewater Treatment Plant MOP 8, Fifth Edition*, page 2-42 Table 2.11. The 0.007 ppd value was selected, which is higher than the current phosphorus loading.

(2) Max Month Loads: The upper range of IDNR Design Standards and Ten States Standards recommended per capita loadings are 0.22 ppd for BOD_5, 0.25 ppd for TSS, and 0.046 ppd for TKN. In *MOP 8*, the upper range of per capita for TP is 0.010 ppd. These values were used to estimate maximum month additional loadings from projected population increases and were added to the current maximum month loads from the study period.

(3) Maximum Day Loads: Projected maximum day loading was calculated using per capita loading rates calculated using a ratio of the existing maximum day to maximum month ratio for the

BOD, TSS, and Phosphorus. The TKN was assumed to be 1.5, as the existing system ratio of 1.12 was not sufficiently conservative.

Loading Data Modification

One influent data point for total suspended solids in the original data set was determined to be an outlier and removed from the data (Table 5). Walsh's test for outliers was conducted to identify potential outliers on all the loading parameters in the operating data. The results of TSS Walsh's test are shown in Figure 2. A line is drawn below the lowest determined outlier. All data points located below the outlier line were included in the analysis to produce the loadings in this report. No other parameters had any identified outliers.

Table 5: Influent Sample Outliers as Determine by Walsh's Test

Parameter	Date	Removed Datum	Next Highest Datum
TSS, lbs/day	2/17/2022	13,736	10,056

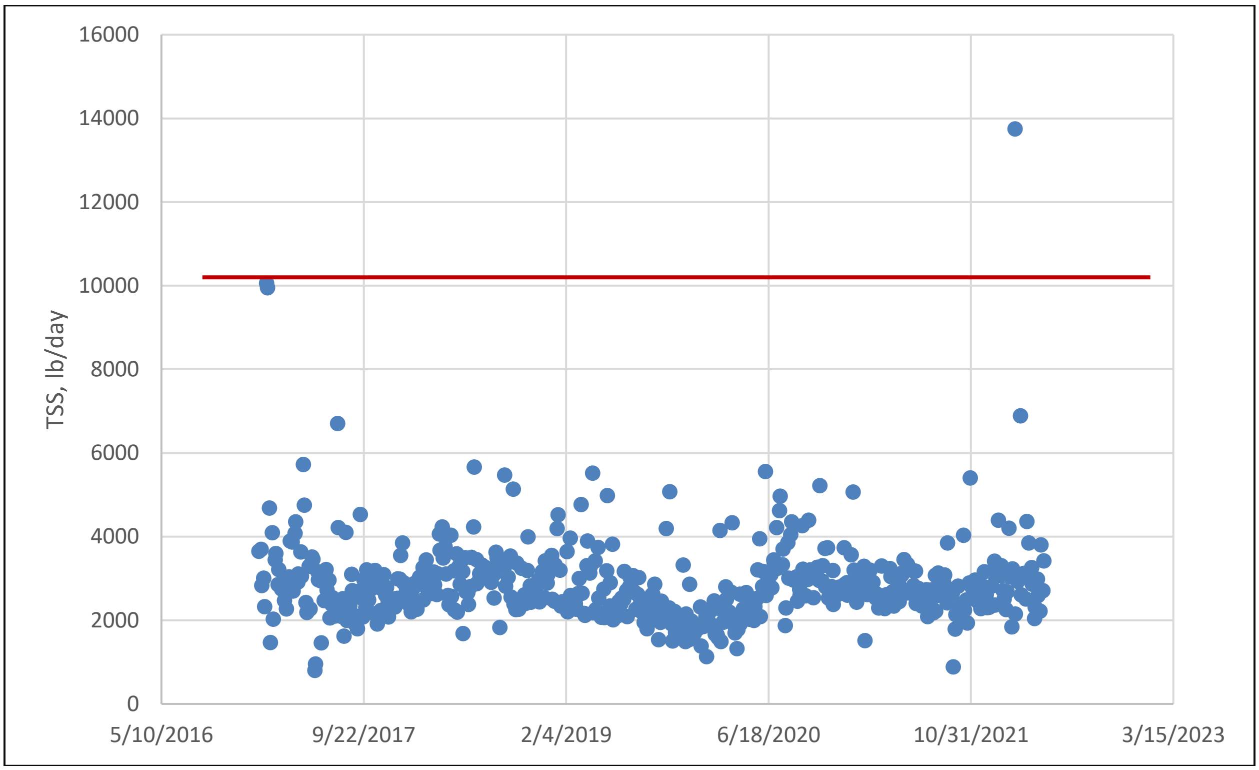

Figure 2. Walsh's Test for Outliers – TSS Results

APPENDIX C

ACTIVATED SLUDGE MODEL

ACTIVATED SLUDGE MODEL

North Liberty WWTP Improvements		Date:	1/19/23
2489-11A.300		Revised:	3/12/2023

CURRENT FLOWS AND LOADS

Design Case 1: AWW Flow, Peak Load, Summer

Flow =	2.77	MGD	
BOD =	6620	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	10056	lbs/d	
TKN =	788	lb/d	(includes 50 lbs/d from dewatering filterate)

MODEL INPUTS:

			Sludge age	12.0	days
Flow	2.77	mgd	Effluent SS	0	mg/L
Basin temperature	20	°C	RAS/WAS Concentration	0.80%	
Number of Basins	2	each			
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4877	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.706	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	7282	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	315.6	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10056	#/day			
	435.8	mg/L	Alpha	0.53764	
TKN	788	#/day	Beta	0.95	
	34.1	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	8044.8	#/day	Field elevation	730	ft
	348.6	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.79	mg/L	Effluent BOD	1.79	mg/L
Active Microbial VSS (Ma)	966.9	mg/L	BOD O2 uptake (method 1)	29.9	mg/L/hr
Lysed Cell VSS (Me)	1113.8	mg/L		337.08	#/hr
Inert Influent VSS (Mi)	3430.7	mg/L	TKN O2 uptake (method 1)	12.5	mg/L/hr
Inert, Inorganic SS (Mf)	2352.3	mg/L		140.60	#/hr
MLSS (BOD)	7863.7	mg/L	Total O2 uptake (method 1)	42.4	mg/L/hr
				477.7	#/hr
Unmetabolized NH3 (F-N)	0.023	mg/L			
Active N-Microbial VSS (Ma-N)	78.2	mg/L	Denitrification O2 Credit (method 1)	42.18	#/hr
Lysed N-Cell VSS (Me)	90.1	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	16.8	mg/L	Total O2 from Aeration System	310.2	#/hr
MLSS (NH3)	185.2	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8048.8	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5679.7	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	70.6%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.114	0.2-0.6 for com	SOR/AOR	2.53	
Total WAS Volatiles	5327.4	#/day			
Total WAS	7549.6	#/day	Air temperature	40.0	°C
WAS Flow	112467	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	13.84	mgd			

No credit for denitrification or membrane aeration			Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1207.4	#/hr	Standard O2 Rate Req'd (SOR)	784.0	#/hr
(method 1)	28979	#/day	(method 1)	18816	#/day
SCFM required	3478	scfm	SCFM required	2259	scfm
ACFM at air temperature (mth 1)	3991	acfm	ACFM at air temperature (mth 1)	2591	acfm

Credit for membrane aeration only			Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	890.6	#/hr	Standard O2 Rate Req'd (SOR)	1100.8	#/hr
(method 1)	21375	#/day	(method 1)	26420	#/day
SCFM required	2566	scfm	SCFM required	3171	scfm
ACFM at air temperature (mth 1)	2944	acfm	ACFM at air temperature (mth 1)	3639	acfm

ACTIVATED SLUDGE MODEL

North Liberty WWTP Improvements Date: 1/19/23

2489-11A.300 Revised: 3/12/2023

CURRENT FLOWS AND LOADS

Design Case 2: ADW Flow, Peak Load, Summer

Flow =	1.69	MGD	
BOD =	6620	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	10056	lbs/d	
TKN =	788	lb/d	(includes 50 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	1.69	mgd	Sludge age	12.0	days
			Effluent SS	0	mg/L
Basin temperature	20	°C	RAS/WAS Concentration	0.81%	
Number of Basins	2	each			
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.7967	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	19.121	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	7282	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	515.4	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10056	#/day			
	711.8	mg/L	Alpha	0.537429	
TKN	788	#/day	Beta	0.95	
	55.8	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	8044.8	#/day	Field elevation	730	ft
	569.4	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.79	mg/L	Effluent BOD	1.79	mg/L
Active Microbial VSS (Ma)	969.0	mg/L	BOD O2 uptake (method 1)	30.0	mg/L/hr
Lysed Cell VSS (Me)	1116.3	mg/L		337.82	#/hr
Inert Influent VSS (Mi)	3430.7	mg/L	TKN O2 uptake (method 1)	12.5	mg/L/hr
Inert, Inorganic SS (Mf)	2352.7	mg/L		140.64	#/hr
MLSS (BOD)	7868.7	mg/L	Total O2 uptake (method 1)	42.5	mg/L/hr
				478.5	#/hr
Unmetabolized NH3 (F-N)	0.023	mg/L			
Active N-Microbial VSS (Ma-N)	78.3	mg/L	Denitrification O2 Credit (method 1)	42.19	#/hr
Lysed N-Cell VSS (Me)	90.1	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	16.8	mg/L	Total O2 from Aeration System	310.9	#/hr
MLSS (NH3)	185.2	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8053.9	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5684.4	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	70.6%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.114	0.2-0.6 for com	SOR/AOR	2.53	
Total WAS Volatiles	5331.8	#/day			
Total WAS	7554.4	#/day	Air temperature	40.0	°C
WAS Flow	112467	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	8.47	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1209.9	#/hr
(method 1)	29037	#/day
SCFM required	3485	scfm
ACFM at air temperature (mth 1)	3999	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	786.3	#/hr
(method 1)	18870	#/day
SCFM required	2265	scfm
ACFM at air temperature (mth 1)	2599	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	893.0	#/hr
(method 1)	21431	#/day
SCFM required	2572	scfm
ACFM at air temperature (mth 1)	2952	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1103.2	#/hr
(method 1)	26477	#/day
SCFM required	3178	scfm
ACFM at air temperature (mth 1)	3646	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
2489-11A.300

Date: 1/19/23
Revised: 3/12/2023

CURRENT FLOWS AND LOADS
Design Case 3: AWW Flow, Peak Month, Summer

Flow =	2.77	MGD
BOD =	4245	lbs/d
TSS =	5070	lbs/d
TKN =	697	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	2.77	mgd	Sludge age	23.7	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4877	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.706	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4245	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	184.0	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5070	#/day			
	219.7	mg/L	Alpha	0.539224	
TKN	697	#/day	Beta	0.95	
	30.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4056	#/day	Field elevation	730	ft
	175.8	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.04	mg/L	Effluent BOD	1.04	mg/L
Active Microbial VSS (Ma)	608.0	mg/L	BOD O2 uptake (method 1)	18.5	mg/L/hr
Lysed Cell VSS (Me)	1383.4	mg/L		207.85	#/hr
Inert Influent VSS (Mi)	3416.1	mg/L	TKN O2 uptake (method 1)	11.2	mg/L/hr
Inert, Inorganic SS (Mf)	2334.2	mg/L		125.76	#/hr
MLSS (BOD)	7741.8	mg/L	Total O2 uptake (method 1)	29.6	mg/L/hr
				333.6	#/hr
Unmetabolized NH3 (F-N)	0.020	mg/L			
Active N-Microbial VSS (Ma-N)	74.6	mg/L	Denitrification O2 Credit (method 1)	37.73	#/hr
Lysed N-Cell VSS (Me)	169.8	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	24.4	mg/L	Total O2 from Aeration System	170.6	#/hr
MLSS (NH3)	268.9	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8010.7	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5652.0	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	70.6%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.067	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	2684.3	#/day			
Total WAS	3804.5	#/day	Air temperature	40.0	°C
WAS Flow	56945	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	13.84	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	840.8	#/hr
(method 1)	20179	#/day
SCFM required	2422	scfm
ACFM at air temperature (mth 1)	2779	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	429.8	#/hr
(method 1)	10316	#/day
SCFM required	1238	scfm
ACFM at air temperature (mth 1)	1421	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	524.9	#/hr
(method 1)	12598	#/day
SCFM required	1512	scfm
ACFM at air temperature (mth 1)	1735	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	745.7	#/hr
(method 1)	17897	#/day
SCFM required	2148	scfm
ACFM at air temperature (mth 1)	2465	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
2489-11A.300

Date: 1/19/23
Revised: 3/12/2023

CURRENT FLOWS AND LOADS
Design Case 4: AWW Flow, Peak Month, Winter

Flow =	2.77	MGD
BOD =	4245	lbs/d
TSS =	5070	lbs/d
TKN =	697	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	2.77	mgd	Sludge age	21.8	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4877	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.706	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4245	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	184.0	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5070	#/day			
	219.7	mg/L	Alpha	0.538415	
TKN	697	#/day	Beta	0.95	
	30.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4056	#/day	Field elevation	730	ft
	175.8	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.38	mg/L	Effluent BOD	2.38	mg/L
Active Microbial VSS (Ma)	1239.5	mg/L	BOD O2 uptake (method 1)	16.8	mg/L/hr
Lysed Cell VSS (Me)	1126.3	mg/L		189.61	#/hr
Inert Influent VSS (Mi)	3142.3	mg/L	TKN O2 uptake (method 1)	11.0	mg/L/hr
Inert, Inorganic SS (Mf)	2200.5	mg/L		123.58	#/hr
MLSS (BOD)	7708.6	mg/L	Total O2 uptake (method 1)	27.8	mg/L/hr
				313.2	#/hr
Unmetabolized NH3 (F-N)	0.047	mg/L			
Active N-Microbial VSS (Ma-N)	153.2	mg/L	Denitrification O2 Credit (method 1)	37.08	#/hr
Lysed N-Cell VSS (Me)	139.2	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	29.2	mg/L	Total O2 from Aeration System	150.8	#/hr
MLSS (NH3)	321.6	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8030.2	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5800.4	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.2%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.065	0.2-0.6 for com	SOR/AOR	2.42	
Total WAS Volatiles	2994.8	#/day			
Total WAS	4146.1	#/day	Air temperature	40.0	°C
WAS Flow	61908	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	13.84	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	759.0	#/hr
(method 1)	18216	#/day
SCFM required	2187	scfm
ACFM at air temperature (mth 1)	2509	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	365.4	#/hr
(method 1)	8770	#/day
SCFM required	1053	scfm
ACFM at air temperature (mth 1)	1208	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	455.3	#/hr
(method 1)	10927	#/day
SCFM required	1312	scfm
ACFM at air temperature (mth 1)	1505	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	669.2	#/hr
(method 1)	16060	#/day
SCFM required	1928	scfm
ACFM at air temperature (mth 1)	2212	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
2489-11A.300

Date: 1/19/23
Revised: 3/12/2023

CURRENT FLOWS AND LOADS
Design Case 5: ADW Flow, Peak Month, Summer

Flow =	1.69	MGD
BOD =	4245	lbs/d
TSS =	5070	lbs/d
TKN =	697	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	1.69	mgd	Sludge age	23.7	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.7967	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	19.121	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4245	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	300.5	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5070	#/day			
	358.9	mg/L	Alpha	0.53902	
TKN	697	#/day	Beta	0.95	
	49.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4056	#/day	Field elevation	730	ft
	287.1	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.04	mg/L	Effluent BOD	1.04	mg/L
Active Microbial VSS (Ma)	609.4	mg/L	BOD O2 uptake (method 1)	18.5	mg/L/hr
Lysed Cell VSS (Me)	1386.4	mg/L		208.31	#/hr
Inert Influent VSS (Mi)	3416.1	mg/L	TKN O2 uptake (method 1)	11.2	mg/L/hr
Inert, Inorganic SS (Mf)	2334.7	mg/L		125.79	#/hr
MLSS (BOD)	7746.6	mg/L	Total O2 uptake (method 1)	29.7	mg/L/hr
				334.1	#/hr
Unmetabolized NH3 (F-N)	0.020	mg/L			
Active N-Microbial VSS (Ma-N)	74.7	mg/L	Denitrification O2 Credit (method 1)	37.74	#/hr
Lysed N-Cell VSS (Me)	169.9	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	24.5	mg/L	Total O2 from Aeration System	171.0	#/hr
MLSS (NH3)	269.0	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8015.6	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5656.5	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	70.6%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.067	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	2686.4	#/day			
Total WAS	3806.8	#/day	Air temperature	40.0	°C
WAS Flow	56945	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	8.47	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	842.4	#/hr
(method 1)	20217	#/day
SCFM required	2427	scfm
ACFM at air temperature (mth 1)	2784	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	431.2	#/hr
(method 1)	10349	#/day
SCFM required	1242	scfm
ACFM at air temperature (mth 1)	1425	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	526.4	#/hr
(method 1)	12633	#/day
SCFM required	1516	scfm
ACFM at air temperature (mth 1)	1740	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	747.2	#/hr
(method 1)	17933	#/day
SCFM required	2153	scfm
ACFM at air temperature (mth 1)	2470	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
2489-11A.300 Revised: 3/12/2023

CURRENT FLOWS AND LOADS
Design Case 6: ADW Flow, Peak Month, Winter

Flow =	1.69	MGD
BOD =	4245	lbs/d
TSS =	5070	lbs/d
TKN =	697	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	1.69	mgd	Sludge age	21.8	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.7967	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	19.121	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4245	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	300.5	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5070	#/day			
	358.9	mg/L	Alpha	0.537862	
TKN	697	#/day	Beta	0.95	
	49.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4056	#/day	Field elevation	730	ft
	287.1	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.39	mg/L	Effluent BOD	2.39	mg/L
Active Microbial VSS (Ma)	1245.8	mg/L	BOD O2 uptake (method 1)	16.9	mg/L/hr
Lysed Cell VSS (Me)	1132.0	mg/L		190.56	#/hr
Inert Influent VSS (Mi)	3142.3	mg/L	TKN O2 uptake (method 1)	11.0	mg/L/hr
Inert, Inorganic SS (Mf)	2201.7	mg/L		123.66	#/hr
MLSS (BOD)	7721.7	mg/L	Total O2 uptake (method 1)	27.9	mg/L/hr
				314.2	#/hr
Unmetabolized NH3 (F-N)	0.047	mg/L			
Active N-Microbial VSS (Ma-N)	153.3	mg/L	Denitrification O2 Credit (method 1)	37.10	#/hr
Lysed N-Cell VSS (Me)	139.3	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	29.3	mg/L	Total O2 from Aeration System	151.8	#/hr
MLSS (NH3)	321.8	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8043.5	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5812.5	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.3%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.065	0.2-0.6 for com	SOR/AOR	2.43	
Total WAS Volatiles	3001.1	#/day			
Total WAS	4153.0	#/day	Air temperature	40.0	°C
WAS Flow	61908	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	8.47	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	762.3	#/hr
(method 1)	18295	#/day
SCFM required	2196	scfm
ACFM at air temperature (mth 1)	2520	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	368.2	#/hr
(method 1)	8838	#/day
SCFM required	1061	scfm
ACFM at air temperature (mth 1)	1217	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	458.2	#/hr
(method 1)	10998	#/day
SCFM required	1320	scfm
ACFM at air temperature (mth 1)	1515	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	672.3	#/hr
(method 1)	16135	#/day
SCFM required	1937	scfm
ACFM at air temperature (mth 1)	2222	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
2489-11A.300

Date: 1/19/23
Revised: 3/12/2023

CURRENT FLOWS AND LOADS
Design Case 7: Average Flow & Load, Summer

Flow =	1.77	MGD
BOD =	3102	lbs/d
TSS =	2864	lbs/d
TKN =	515	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	1.77	mgd	Sludge age	40.0	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.7608	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	18.258	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	3102	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	209.7	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	2864	#/day			
	193.6	mg/L	Alpha	0.537704	
TKN	515	#/day	Beta	0.95	
	34.8	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	2291.2	#/day	Field elevation	730	ft
	154.9	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	0.76	mg/L	Effluent BOD	0.76	mg/L
Active Microbial VSS (Ma)	460.4	mg/L	BOD O2 uptake (method 1)	13.9	mg/L/hr
Lysed Cell VSS (Me)	1767.8	mg/L		156.07	#/hr
Inert Influent VSS (Mi)	3257.0	mg/L	TKN O2 uptake (method 1)	8.3	mg/L/hr
Inert, Inorganic SS (Mf)	2258.4	mg/L		93.43	#/hr
MLSS (BOD)	7743.6	mg/L	Total O2 uptake (method 1)	22.2	mg/L/hr
				249.5	#/hr
Unmetabolized NH3 (F-N)	0.015	mg/L			
Active N-Microbial VSS (Ma-N)	57.0	mg/L	Denitrification O2 Credit (method 1)	28.03	#/hr
Lysed N-Cell VSS (Me)	219.1	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	27.6	mg/L	Total O2 from Aeration System	96.1	#/hr
MLSS (NH3)	303.7	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8047.3	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5761.3	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.6%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.048	0.2-0.6 for com	SOR/AOR	2.53	
Total WAS Volatiles	1621.2	#/day			
Total WAS	2264.4	#/day	Air temperature	40.0	°C
WAS Flow	33740	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	8.87	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	630.6	#/hr
(method 1)	15134	#/day
SCFM required	1817	scfm
ACFM at air temperature (mth 1)	2084	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	243.0	#/hr
(method 1)	5831	#/day
SCFM required	700	scfm
ACFM at air temperature (mth 1)	803	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	313.8	#/hr
(method 1)	7532	#/day
SCFM required	904	scfm
ACFM at air temperature (mth 1)	1037	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	559.7	#/hr
(method 1)	13434	#/day
SCFM required	1612	scfm
ACFM at air temperature (mth 1)	1850	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
2489-11A.300

Date: 1/19/23
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CURRENT FLOWS AND LOADS
Design Case 8: Average Flow & Load, Winter

Flow =	1.77	MGD
BOD =	3102	lbs/d
TSS =	2864	lbs/d
TKN =	515	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	1.77	mgd	Sludge age	37.3	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.7608	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	18.258	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	3102	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	209.7	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	2864	#/day			
	193.6	mg/L	Alpha	0.537849	
TKN	515	#/day	Beta	0.95	
	34.8	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	2291.2	#/day	Field elevation	730	ft
	154.9	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.75	mg/L	Effluent BOD	1.75	mg/L
Active Microbial VSS (Ma)	983.8	mg/L	BOD O2 uptake (method 1)	13.1	mg/L/hr
Lysed Cell VSS (Me)	1529.4	mg/L		147.39	#/hr
Inert Influent VSS (Mi)	3037.1	mg/L	TKN O2 uptake (method 1)	8.2	mg/L/hr
Inert, Inorganic SS (Mf)	2149.5	mg/L		92.38	#/hr
MLSS (BOD)	7699.8	mg/L	Total O2 uptake (method 1)	21.3	mg/L/hr
				239.8	#/hr
Unmetabolized NH3 (F-N)	0.035	mg/L			
Active N-Microbial VSS (Ma-N)	122.4	mg/L	Denitrification O2 Credit (method 1)	27.72	#/hr
Lysed N-Cell VSS (Me)	190.3	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	31.3	mg/L	Total O2 from Aeration System	86.7	#/hr
MLSS (NH3)	344.0	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8043.8	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5863.0	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.9%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.047	0.2-0.6 for com	SOR/AOR	2.43	
Total WAS Volatiles	1769.2	#/day			
Total WAS	2427.3	#/day	Air temperature	40.0	°C
WAS Flow	36182	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	8.87	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	581.7	#/hr
(method 1)	13961	#/day
SCFM required	1676	scfm
ACFM at air temperature (mth 1)	1923	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	210.4	#/hr
(method 1)	5049	#/day
SCFM required	606	scfm
ACFM at air temperature (mth 1)	695	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	277.6	#/hr
(method 1)	6663	#/day
SCFM required	800	scfm
ACFM at air temperature (mth 1)	918	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	514.5	#/hr
(method 1)	12347	#/day
SCFM required	1482	scfm
ACFM at air temperature (mth 1)	1700	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
7037.011 Revised: 3/12/2023

PHASE IIB DESIGN
Design Case 1: AWW Flow, Peak Load, Summer

Flow =	4.43	MGD	
BOD =	7626	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	10638	lbs/d	
TKN =	2152	lb/d	(includes 50 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	4.43	mgd	Sludge age	10.5	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3047	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.313	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	8388.6	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	227.1	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10638	#/day			
	288.0	mg/L	Alpha	0.538697	
TKN	2152	#/day	Beta	0.95	
	58.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	8510.4	#/day	Field elevation	730	ft
	230.4	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.05	mg/L	Effluent BOD	2.05	mg/L
Active Microbial VSS (Ma)	1087.0	mg/L	BOD O2 uptake (method 1)	33.9	mg/L/hr
Lysed Cell VSS (Me)	1095.7	mg/L		381.11	#/hr
Inert Influent VSS (Mi)	3175.6	mg/L	TKN O2 uptake (method 1)	34.0	mg/L/hr
Inert, Inorganic SS (Mf)	2203.0	mg/L		382.70	#/hr
MLSS (BOD)	7561.4	mg/L	Total O2 uptake (method 1)	67.9	mg/L/hr
				763.8	#/hr
Unmetabolized NH3 (F-N)	0.063	mg/L			
Active N-Microbial VSS (Ma-N)	209.1	mg/L	Denitrification O2 Credit (method 1)	114.81	#/hr
Lysed N-Cell VSS (Me)	210.8	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	42.0	mg/L	Total O2 from Aeration System	523.7	#/hr
MLSS (NH3)	462.0	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8023.4	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5778.3	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	72.0%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.129	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	6194.2	#/day			
Total WAS	8600.8	#/day	Air temperature	40.0	°C
WAS Flow	128533	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	22.15	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1926.9	#/hr
(method 1)	46246	#/day
SCFM required	5551	scfm
ACFM at air temperature (mth 1)	6369	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1321.1	#/hr
(method 1)	31706	#/day
SCFM required	3806	scfm
ACFM at air temperature (mth 1)	4367	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1610.7	#/hr
(method 1)	38657	#/day
SCFM required	4640	scfm
ACFM at air temperature (mth 1)	5324	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1637.3	#/hr
(method 1)	39294	#/day
SCFM required	4717	scfm
ACFM at air temperature (mth 1)	5412	acfm

ACTIVATED SLUDGE MODEL
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Date: 1/19/23
Revised: 3/12/2023

PHASE IIB DESIGN
Design Case 2: ADW Flow, Peak Load, Summer

Flow =	2.93	MGD	
BOD =	7626	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	10638	lbs/d	
TKN =	2152	lb/d	(includes 50 lbs/d from dewatering filterate)

MODEL INPUTS:

			Sludge age	10.5	days
Flow	2.93	mgd	Effluent SS	0	mg/L
Basin temperature	20	°C	RAS/WAS Concentration	0.80%	
Number of Basins	2	each			
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4606	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.055	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	8388.6	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	343.3	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10638	#/day			
	435.3	mg/L	Alpha	0.538384	
TKN	2152	#/day	Beta	0.95	
	88.1	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	8510.4	#/day	Field elevation	730	ft
	348.3	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.06	mg/L	Effluent BOD	2.06	mg/L
Active Microbial VSS (Ma)	1090.4	mg/L	BOD O2 uptake (method 1)	34.0	mg/L/hr
Lysed Cell VSS (Me)	1099.1	mg/L		382.28	#/hr
Inert Influent VSS (Mi)	3175.6	mg/L	TKN O2 uptake (method 1)	34.0	mg/L/hr
Inert, Inorganic SS (Mf)	2203.7	mg/L		382.84	#/hr
MLSS (BOD)	7568.8	mg/L	Total O2 uptake (method 1)	68.0	mg/L/hr
				765.1	#/hr
Unmetabolized NH3 (F-N)	0.063	mg/L			
Active N-Microbial VSS (Ma-N)	209.2	mg/L	Denitrification O2 Credit (method 1)	114.85	#/hr
Lysed N-Cell VSS (Me)	210.9	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	42.0	mg/L	Total O2 from Aeration System	524.9	#/hr
MLSS (NH3)	462.1	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8030.9	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5785.2	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	72.0%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.129	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	6201.5	#/day			
Total WAS	8608.9	#/day	Air temperature	40.0	°C
WAS Flow	128533	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	14.65	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1931.3	#/hr
(method 1)	46352	#/day
SCFM required	5564	scfm
ACFM at air temperature (mth 1)	6384	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1325.0	#/hr
(method 1)	31801	#/day
SCFM required	3817	scfm
ACFM at air temperature (mth 1)	4380	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1615.0	#/hr
(method 1)	38759	#/day
SCFM required	4652	scfm
ACFM at air temperature (mth 1)	5338	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1641.4	#/hr
(method 1)	39394	#/day
SCFM required	4729	scfm
ACFM at air temperature (mth 1)	5425	acfm

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Date: 1/19/23
Revised: 3/12/2023

PHASE IIB DESIGN
Design Case 3: AWW Flow, Peak Month, Summer

Flow =	4.43	MGD
BOD =	4730	lbs/d
TSS =	5560	lbs/d
TKN =	960	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	4.43	mgd	Sludge age	21.2	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3047	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.313	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4730	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	128.1	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5560	#/day			
	150.5	mg/L	Alpha	0.538901	
TKN	960	#/day	Beta	0.95	
	26.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4448	#/day	Field elevation	730	ft
	120.4	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.16	mg/L	Effluent BOD	1.16	mg/L
Active Microbial VSS (Ma)	668.8	mg/L	BOD O2 uptake (method 1)	20.4	mg/L/hr
Lysed Cell VSS (Me)	1361.2	mg/L		229.19	#/hr
Inert Influent VSS (Mi)	3351.1	mg/L	TKN O2 uptake (method 1)	15.4	mg/L/hr
Inert, Inorganic SS (Mf)	2297.4	mg/L		172.90	#/hr
MLSS (BOD)	7678.6	mg/L	Total O2 uptake (method 1)	35.7	mg/L/hr
				402.1	#/hr
Unmetabolized NH3 (F-N)	0.028	mg/L			
Active N-Microbial VSS (Ma-N)	101.8	mg/L	Denitrification O2 Credit (method 1)	51.87	#/hr
Lysed N-Cell VSS (Me)	207.2	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	30.9	mg/L	Total O2 from Aeration System	224.9	#/hr
MLSS (NH3)	339.9	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8018.5	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5690.1	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.0%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.074	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	3021.0	#/day			
Total WAS	4257.2	#/day	Air temperature	40.0	°C
WAS Flow	63660	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	22.15	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1014.0	#/hr
(method 1)	24335	#/day
SCFM required	2921	scfm
ACFM at air temperature (mth 1)	3352	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	567.1	#/hr
(method 1)	13610	#/day
SCFM required	1634	scfm
ACFM at air temperature (mth 1)	1874	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	697.9	#/hr
(method 1)	16750	#/day
SCFM required	2011	scfm
ACFM at air temperature (mth 1)	2307	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	883.2	#/hr
(method 1)	21196	#/day
SCFM required	2544	scfm
ACFM at air temperature (mth 1)	2919	acfm

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North Liberty WWTP Improvements Date: 1/19/23
7037.011 Revised: 3/12/2023

PHASE IIB DESIGN
Design Case 4: AWW Flow, Peak Month, Winter

Flow =	4.43	MGD
BOD =	4730	lbs/d
TSS =	5560	lbs/d
TKN =	960	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	4.43	mgd	Sludge age	19.3	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3047	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.313	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4730	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	128.1	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5560	#/day			
	150.5	mg/L	Alpha	0.538652	
TKN	960	#/day	Beta	0.95	
	26.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4448	#/day	Field elevation	730	ft
	120.4	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.63	mg/L	Effluent BOD	2.63	mg/L
Active Microbial VSS (Ma)	1339.2	mg/L	BOD O2 uptake (method 1)	18.3	mg/L/hr
Lysed Cell VSS (Me)	1077.3	mg/L		206.16	#/hr
Inert Influent VSS (Mi)	3050.8	mg/L	TKN O2 uptake (method 1)	15.1	mg/L/hr
Inert, Inorganic SS (Mf)	2148.4	mg/L		169.52	#/hr
MLSS (BOD)	7615.7	mg/L	Total O2 uptake (method 1)	33.4	mg/L/hr
				375.7	#/hr
Unmetabolized NH3 (F-N)	0.064	mg/L			
Active N-Microbial VSS (Ma-N)	206.0	mg/L	Denitrification O2 Credit (method 1)	50.86	#/hr
Lysed N-Cell VSS (Me)	165.7	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	37.2	mg/L	Total O2 from Aeration System	199.5	#/hr
MLSS (NH3)	408.8	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8024.5	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5838.9	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.8%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.072	0.2-0.6 for com	SOR/AOR	2.42	
Total WAS Volatiles	3405.2	#/day			
Total WAS	4679.8	#/day	Air temperature	40.0	°C
WAS Flow	69927	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	22.15	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	910.1	#/hr
(method 1)	21842	#/day
SCFM required	2622	scfm
ACFM at air temperature (mth 1)	3008	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	483.3	#/hr
(method 1)	11598	#/day
SCFM required	1392	scfm
ACFM at air temperature (mth 1)	1597	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	606.5	#/hr
(method 1)	14555	#/day
SCFM required	1747	scfm
ACFM at air temperature (mth 1)	2005	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	786.9	#/hr
(method 1)	18885	#/day
SCFM required	2267	scfm
ACFM at air temperature (mth 1)	2601	acfm

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Date: 1/19/23
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PHASE IIB DESIGN
Design Case 5: ADW Flow, Peak Month, Summer

Flow =	2.93	MGD
BOD =	4730	lbs/d
TSS =	5560	lbs/d
TKN =	960	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	2.93	mgd	Sludge age	21.2	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4606	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.055	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4730	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	193.6	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5560	#/day			
	227.5	mg/L	Alpha	0.538611	
TKN	960	#/day	Beta	0.95	
	39.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4448	#/day	Field elevation	730	ft
	182.0	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.16	mg/L	Effluent BOD	1.16	mg/L
Active Microbial VSS (Ma)	670.9	mg/L	BOD O2 uptake (method 1)	20.4	mg/L/hr
Lysed Cell VSS (Me)	1365.4	mg/L		229.89	#/hr
Inert Influent VSS (Mi)	3351.1	mg/L	TKN O2 uptake (method 1)	15.4	mg/L/hr
Inert, Inorganic SS (Mf)	2298.1	mg/L		172.96	#/hr
MLSS (BOD)	7685.4	mg/L	Total O2 uptake (method 1)	35.8	mg/L/hr
				402.8	#/hr
Unmetabolized NH3 (F-N)	0.028	mg/L			
Active N-Microbial VSS (Ma-N)	101.8	mg/L	Denitrification O2 Credit (method 1)	51.89	#/hr
Lysed N-Cell VSS (Me)	207.3	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	30.9	mg/L	Total O2 from Aeration System	225.6	#/hr
MLSS (NH3)	340.0	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8025.4	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5696.5	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.0%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.074	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	3024.4	#/day			
Total WAS	4260.9	#/day	Air temperature	40.0	°C
WAS Flow	63660	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	14.65	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1016.5	#/hr
(method 1)	24395	#/day
SCFM required	2928	scfm
ACFM at air temperature (mth 1)	3360	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	569.3	#/hr
(method 1)	13663	#/day
SCFM required	1640	scfm
ACFM at air temperature (mth 1)	1882	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	700.2	#/hr
(method 1)	16805	#/day
SCFM required	2017	scfm
ACFM at air temperature (mth 1)	2314	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	885.5	#/hr
(method 1)	21253	#/day
SCFM required	2551	scfm
ACFM at air temperature (mth 1)	2927	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
7037.011 Revised: 3/12/2023

PHASE IIB DESIGN
Design Case 6: ADW Flow, Peak Month, Winter

Flow =	2.93	MGD
BOD =	4730	lbs/d
TSS =	5560	lbs/d
TKN =	960	lb/d (includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	2.93	mgd	Sludge age	19.3	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4606	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.055	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4730	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	193.6	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	5560	#/day			
	227.5	mg/L	Alpha	0.537865	
TKN	960	#/day	Beta	0.95	
	39.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	4448	#/day	Field elevation	730	ft
	182.0	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.65	mg/L	Effluent BOD	2.65	mg/L
Active Microbial VSS (Ma)	1348.6	mg/L	BOD O2 uptake (method 1)	18.4	mg/L/hr
Lysed Cell VSS (Me)	1084.8	mg/L		207.61	#/hr
Inert Influent VSS (Mi)	3050.8	mg/L	TKN O2 uptake (method 1)	15.1	mg/L/hr
Inert, Inorganic SS (Mf)	2150.1	mg/L		169.67	#/hr
MLSS (BOD)	7634.3	mg/L	Total O2 uptake (method 1)	33.5	mg/L/hr
				377.3	#/hr
Unmetabolized NH3 (F-N)	0.064	mg/L			
Active N-Microbial VSS (Ma-N)	206.1	mg/L	Denitrification O2 Credit (method 1)	50.90	#/hr
Lysed N-Cell VSS (Me)	165.8	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	37.2	mg/L	Total O2 from Aeration System	201.0	#/hr
MLSS (NH3)	409.1	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8043.4	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5856.2	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.8%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.072	0.2-0.6 for com	SOR/AOR	2.43	
Total WAS Volatiles	3415.3	#/day			
Total WAS	4690.9	#/day	Air temperature	40.0	°C
WAS Flow	69927	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	14.65	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	915.3	#/hr
(method 1)	21966	#/day
SCFM required	2637	scfm
ACFM at air temperature (mth 1)	3025	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	487.7	#/hr
(method 1)	11705	#/day
SCFM required	1405	scfm
ACFM at air temperature (mth 1)	1612	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	611.2	#/hr
(method 1)	14669	#/day
SCFM required	1761	scfm
ACFM at air temperature (mth 1)	2020	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	791.8	#/hr
(method 1)	19003	#/day
SCFM required	2281	scfm
ACFM at air temperature (mth 1)	2617	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
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PHASE IIB DESIGN
Design Case 7: Average Flow & Load, Summer

Flow =	3.33	MGD
BOD =	3592	lbs/d
TSS =	4343	lbs/d
TKN =	778	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	3.33	mgd	Sludge age	27.8	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4053	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	9.727	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	3592	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	129.3	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	4343	#/day			
	156.4	mg/L	Alpha	0.538958	
TKN	778	#/day	Beta	0.95	
	28.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	3474.4	#/day	Field elevation	730	ft
	125.1	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	0.88	mg/L	Effluent BOD	0.88	mg/L
Active Microbial VSS (Ma)	520.1	mg/L	BOD O2 uptake (method 1)	15.7	mg/L/hr
Lysed Cell VSS (Me)	1388.0	mg/L		177.26	#/hr
Inert Influent VSS (Mi)	3432.5	mg/L	TKN O2 uptake (method 1)	12.5	mg/L/hr
Inert, Inorganic SS (Mf)	2336.1	mg/L		140.61	#/hr
MLSS (BOD)	7676.8	mg/L	Total O2 uptake (method 1)	28.2	mg/L/hr
				317.9	#/hr
Unmetabolized NH3 (F-N)	0.023	mg/L			
Active N-Microbial VSS (Ma-N)	84.3	mg/L	Denitrification O2 Credit (method 1)	42.18	#/hr
Lysed N-Cell VSS (Me)	225.0	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	30.9	mg/L	Total O2 from Aeration System	150.4	#/hr
MLSS (NH3)	340.3	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8017.1	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5650.0	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	70.5%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.056	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	2287.6	#/day			
Total WAS	3246.0	#/day	Air temperature	40.0	°C
WAS Flow	48547	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	16.65	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	801.5	#/hr
(method 1)	19237	#/day
SCFM required	2309	scfm
ACFM at air temperature (mth 1)	2649	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	379.1	#/hr
(method 1)	9099	#/day
SCFM required	1092	scfm
ACFM at air temperature (mth 1)	1253	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	485.5	#/hr
(method 1)	11652	#/day
SCFM required	1399	scfm
ACFM at air temperature (mth 1)	1605	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	695.2	#/hr
(method 1)	16684	#/day
SCFM required	2003	scfm
ACFM at air temperature (mth 1)	2298	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
7037.011 Revised: 3/12/2023

PHASE II DESIGN
Design Case 8: Average Flow & Load, Winter

Flow =	3.33	MGD
BOD =	3592	lbs/d
TSS =	4343	lbs/d
TKN =	778	lb/d (includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	3.33	mgd	Sludge age	25.7	days
			Effluent SS	0	mg/L
Basin temperature	8	°C	RAS/WAS Concentration	0.80%	
Number of Basins	2	each			
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4053	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	9.727	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	3592	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	129.3	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	4343	#/day			
	156.4	mg/L	Alpha	0.539366	
TKN	778	#/day	Beta	0.95	
	28.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	3474.4	#/day	Field elevation	730	ft
	125.1	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.01	mg/L	Effluent BOD	2.01	mg/L
Active Microbial VSS (Ma)	1075.5	mg/L	BOD O2 uptake (method 1)	14.5	mg/L/hr
Lysed Cell VSS (Me)	1152.1	mg/L		163.29	#/hr
Inert Influent VSS (Mi)	3173.2	mg/L	TKN O2 uptake (method 1)	12.3	mg/L/hr
Inert, Inorganic SS (Mf)	2206.0	mg/L		138.44	#/hr
MLSS (BOD)	7606.9	mg/L	Total O2 uptake (method 1)	26.8	mg/L/hr
				301.7	#/hr
Unmetabolized NH3 (F-N)	0.052	mg/L			
Active N-Microbial VSS (Ma-N)	175.7	mg/L	Denitrification O2 Credit (method 1)	41.53	#/hr
Lysed N-Cell VSS (Me)	188.2	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	36.4	mg/L	Total O2 from Aeration System	134.9	#/hr
MLSS (NH3)	400.4	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8007.3	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5764.9	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.0%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.055	0.2-0.6 for com	SOR/AOR	2.42	
Total WAS Volatiles	2524.8	#/day			
Total WAS	3506.9	#/day	Air temperature	40.0	°C
WAS Flow	52514	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	16.65	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	729.9	#/hr
(method 1)	17519	#/day
SCFM required	2103	scfm
ACFM at air temperature (mth 1)	2413	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	326.3	#/hr
(method 1)	7830	#/day
SCFM required	940	scfm
ACFM at air temperature (mth 1)	1078	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	426.7	#/hr
(method 1)	10242	#/day
SCFM required	1229	scfm
ACFM at air temperature (mth 1)	1410	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	629.5	#/hr
(method 1)	15107	#/day
SCFM required	1813	scfm
ACFM at air temperature (mth 1)	2081	acfm

ACTIVATED SLUDGE MODEL

North Liberty WWTP Improvements

7037.011

Date: 1/19/23
Revised: 3/12/2023

PHASE IIC DESIGN

Design Case 1: AWW Flow, Peak Load, Summer

Flow =	4.23	MGD	
BOD =	9265	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	14023	lbs/d	
TKN =	1341	lb/d	(includes 50 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	4.23	mgd	Sludge age	8.2	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3193	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.663	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	10191.5	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	289.1	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	14023	#/day			
	397.8	mg/L	Alpha	0.538035	
TKN	1341	#/day	Beta	0.95	
	38.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	11218.4	#/day	Field elevation	730	ft
	318.2	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.49	mg/L	Effluent BOD	2.49	mg/L
Active Microbial VSS (Ma)	1262.6	mg/L	BOD O2 uptake (method 1)	39.8	mg/L/hr
Lysed Cell VSS (Me)	993.9	mg/L		448.22	#/hr
Inert Influent VSS (Mi)	3269.1	mg/L	TKN O2 uptake (method 1)	21.1	mg/L/hr
Inert, Inorganic SS (Mf)	2268.9	mg/L		237.01	#/hr
MLSS (BOD)	7794.5	mg/L	Total O2 uptake (method 1)	60.9	mg/L/hr
				685.2	#/hr
Unmetabolized NH3 (F-N)	0.039	mg/L			
Active N-Microbial VSS (Ma-N)	124.5	mg/L	Denitrification O2 Credit (method 1)	71.10	#/hr
Lysed N-Cell VSS (Me)	98.0	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	22.3	mg/L	Total O2 from Aeration System	488.8	#/hr
MLSS (NH3)	244.9	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8039.3	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5748.2	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.5%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.158	0.2-0.6 for com	SOR/AOR	2.53	
Total WAS Volatiles	7890.2	#/day			
Total WAS	11035.1	#/day	Air temperature	40.0	°C
WAS Flow	164585	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	21.14	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1730.8	#/hr
(method 1)	41539	#/day
SCFM required	4986	scfm
ACFM at air temperature (mth 1)	5721	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1234.6	#/hr
(method 1)	29631	#/day
SCFM required	3557	scfm
ACFM at air temperature (mth 1)	4081	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1414.2	#/hr
(method 1)	33941	#/day
SCFM required	4074	scfm
ACFM at air temperature (mth 1)	4674	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1551.2	#/hr
(method 1)	37229	#/day
SCFM required	4469	scfm
ACFM at air temperature (mth 1)	5127	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 1/19/23
Revised: 3/12/2023

PHASE IIC DESIGN
Design Case 2: ADW Flow, Peak Load, Summer

Flow =	2.80	MGD	
BOD =	9265	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	14023	lbs/d	
TKN =	1341	lb/d	(includes 50 lbs/d from dewatering filtrate)

MODEL INPUTS:

				Sludge age	8.2	days
Flow	2.80	mgd		Effluent SS	0	mg/L
Basin temperature	20	°C		RAS/WAS Concentration	0.80%	
Number of Basins	2	each				
Volume per Basin	0.6748	mg				
Basin volume	1.350	mg		BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4825	days		BOD Synthesis Factor (Ks)	12.7	1/hour
	11.580	hours		Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	10191.5	#/day		NH3 Metabolism Factor (Km-N)	127	1/hour
	436.9	mg/L		NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	14023	#/day				
	601.1	mg/L		Alpha	0.53773	
TKN	1341	#/day		Beta	0.95	
	57.5	mg/L		Residual DO	2	mg/L
TKN Portion to be oxidized	100%			Diffuser depth	19	feet
VSS/TSS	0.8		(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	11218.4	#/day		Field elevation	730	ft
	480.9	mg/L		Relative humidity	70.0%	
				Standard Oxygen Transfer Eff.	33%	
				Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.50	mg/L	Effluent BOD	2.50	mg/L
Active Microbial VSS (Ma)	1266.3	mg/L	BOD O2 uptake (method 1)	39.9	mg/L/hr
Lysed Cell VSS (Me)	996.8	mg/L		449.53	#/hr
Inert Influent VSS (Mi)	3269.1	mg/L	TKN O2 uptake (method 1)	21.1	mg/L/hr
Inert, Inorganic SS (Mf)	2269.5	mg/L		237.09	#/hr
MLSS (BOD)	7801.7	mg/L	Total O2 uptake (method 1)	61.0	mg/L/hr
				686.6	#/hr
Unmetabolized NH3 (F-N)	0.039	mg/L			
Active N-Microbial VSS (Ma-N)	124.6	mg/L	Denitrification O2 Credit (method 1)	71.13	#/hr
Lysed N-Cell VSS (Me)	98.1	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	22.3	mg/L	Total O2 from Aeration System	490.2	#/hr
MLSS (NH3)	244.9	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8046.7	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5754.9	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.5%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.157	0.2-0.6 for com	SOR/AOR	2.53	
Total WAS Volatiles	7899.4	#/day			
Total WAS	11045.2	#/day	Air temperature	40.0	°C
WAS Flow	164585	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	13.99	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1735.3	#/hr
(method 1)	41647	#/day
SCFM required	4999	scfm
ACFM at air temperature (mth 1)	5736	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1238.8	#/hr
(method 1)	29731	#/day
SCFM required	3569	scfm
ACFM at air temperature (mth 1)	4095	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1418.5	#/hr
(method 1)	34045	#/day
SCFM required	4086	scfm
ACFM at air temperature (mth 1)	4689	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1555.5	#/hr
(method 1)	37333	#/day
SCFM required	4481	scfm
ACFM at air temperature (mth 1)	5142	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 1/19/23
Revised: 3/12/2023

PHASE IIC DESIGN
Design Case 3: AWW Flow, Peak Month, Summer

Flow =	4.23	MGD
BOD =	5848	lbs/d
TSS =	7074	lbs/d
TKN =	1066	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	4.23	mgd	Sludge age	16.6	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3193	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.663	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	5848	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	165.9	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	7074	#/day			
	200.7	mg/L	Alpha	0.537891	
TKN	1066	#/day	Beta	0.95	
	30.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	5659.2	#/day	Field elevation	730	ft
	160.5	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.43	mg/L	Effluent BOD	1.43	mg/L
Active Microbial VSS (Ma)	807.2	mg/L	BOD O2 uptake (method 1)	24.7	mg/L/hr
Lysed Cell VSS (Me)	1286.4	mg/L		278.35	#/hr
Inert Influent VSS (Mi)	3338.5	mg/L	TKN O2 uptake (method 1)	17.0	mg/L/hr
Inert, Inorganic SS (Mf)	2295.9	mg/L		191.30	#/hr
MLSS (BOD)	7728.1	mg/L	Total O2 uptake (method 1)	41.7	mg/L/hr
				469.7	#/hr
Unmetabolized NH3 (F-N)	0.031	mg/L			
Active N-Microbial VSS (Ma-N)	110.3	mg/L	Denitrification O2 Credit (method 1)	57.39	#/hr
Lysed N-Cell VSS (Me)	175.8	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	28.6	mg/L	Total O2 from Aeration System	286.9	#/hr
MLSS (NH3)	314.7	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8042.8	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5718.3	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.1%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.091	0.2-0.6 for com	SOR/AOR	2.53	
Total WAS Volatiles	3877.3	#/day			
Total WAS	5453.4	#/day	Air temperature	40.0	°C
WAS Flow	81301	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	21.14	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1186.6	#/hr
(method 1)	28478	#/day
SCFM required	3418	scfm
ACFM at air temperature (mth 1)	3922	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	724.9	#/hr
(method 1)	17399	#/day
SCFM required	2088	scfm
ACFM at air temperature (mth 1)	2396	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	869.9	#/hr
(method 1)	20878	#/day
SCFM required	2506	scfm
ACFM at air temperature (mth 1)	2875	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1041.6	#/hr
(method 1)	24998	#/day
SCFM required	3001	scfm
ACFM at air temperature (mth 1)	3443	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 1/19/23
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PHASE IIC DESIGN
Design Case 4: AWW Flow, Peak Month, Winter

Flow =	4.23	MGD
BOD =	5848	lbs/d
TSS =	7074	lbs/d
TKN =	1066	lb/d (includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	4.23	mgd	Sludge age	14.9	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3193	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.663	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	5848	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	165.9	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	7074	#/day			
	200.7	mg/L	Alpha	0.537768	
TKN	1066	#/day	Beta	0.95	
	30.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	5659.2	#/day	Field elevation	730	ft
	160.5	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	3.26	mg/L	Effluent BOD	3.26	mg/L
Active Microbial VSS (Ma)	1565.3	mg/L	BOD O2 uptake (method 1)	21.8	mg/L/hr
Lysed Cell VSS (Me)	972.1	mg/L		244.91	#/hr
Inert Influent VSS (Mi)	2996.6	mg/L	TKN O2 uptake (method 1)	16.6	mg/L/hr
Inert, Inorganic SS (Mf)	2126.6	mg/L		186.85	#/hr
MLSS (BOD)	7660.6	mg/L	Total O2 uptake (method 1)	38.4	mg/L/hr
				431.8	#/hr
Unmetabolized NH3 (F-N)	0.071	mg/L			
Active N-Microbial VSS (Ma-N)	216.0	mg/L	Denitrification O2 Credit (method 1)	56.06	#/hr
Lysed N-Cell VSS (Me)	134.2	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	35.0	mg/L	Total O2 from Aeration System	250.4	#/hr
MLSS (NH3)	385.2	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8045.8	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5884.1	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	73.1%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.088	0.2-0.6 for com	SOR/AOR	2.43	
Total WAS Volatiles	4444.9	#/day			
Total WAS	6077.9	#/day	Air temperature	40.0	°C
WAS Flow	90577	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	21.14	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1047.6	#/hr
(method 1)	25144	#/day
SCFM required	3018	scfm
ACFM at air temperature (mth 1)	3463	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	607.5	#/hr
(method 1)	14581	#/day
SCFM required	1750	scfm
ACFM at air temperature (mth 1)	2008	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	743.5	#/hr
(method 1)	17845	#/day
SCFM required	2142	scfm
ACFM at air temperature (mth 1)	2458	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	911.6	#/hr
(method 1)	21879	#/day
SCFM required	2626	scfm
ACFM at air temperature (mth 1)	3013	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
7037.011 Revised: 3/12/2023

PHASE IIC DESIGN
Design Case 5: ADW Flow, Peak Month, Summer

Flow =	2.80	MGD
BOD =	5848	lbs/d
TSS =	7074	lbs/d
TKN =	1066	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	2.80	mgd	Sludge age	16.6	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4825	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.580	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	5848	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	250.7	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	7074	#/day			
	303.3	mg/L	Alpha	0.537607	
TKN	1066	#/day	Beta	0.95	
	45.7	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	5659.2	#/day	Field elevation	730	ft
	242.6	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.43	mg/L	Effluent BOD	1.43	mg/L
Active Microbial VSS (Ma)	809.6	mg/L	BOD O2 uptake (method 1)	24.8	mg/L/hr
Lysed Cell VSS (Me)	1290.2	mg/L		279.17	#/hr
Inert Influent VSS (Mi)	3338.5	mg/L	TKN O2 uptake (method 1)	17.0	mg/L/hr
Inert, Inorganic SS (Mf)	2296.5	mg/L		191.36	#/hr
MLSS (BOD)	7734.8	mg/L	Total O2 uptake (method 1)	41.8	mg/L/hr
				470.5	#/hr
Unmetabolized NH3 (F-N)	0.031	mg/L			
Active N-Microbial VSS (Ma-N)	110.4	mg/L	Denitrification O2 Credit (method 1)	57.41	#/hr
Lysed N-Cell VSS (Me)	175.9	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	28.6	mg/L	Total O2 from Aeration System	287.8	#/hr
MLSS (NH3)	314.8	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8049.7	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5724.5	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.1%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.091	0.2-0.6 for com	SOR/AOR	2.53	
Total WAS Volatiles	3881.5	#/day			
Total WAS	5458.1	#/day	Air temperature	40.0	°C
WAS Flow	81301	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	13.99	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1189.4	#/hr
(method 1)	28547	#/day
SCFM required	3427	scfm
ACFM at air temperature (mth 1)	3932	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	727.5	#/hr
(method 1)	17460	#/day
SCFM required	2096	scfm
ACFM at air temperature (mth 1)	2405	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	872.6	#/hr
(method 1)	20943	#/day
SCFM required	2514	scfm
ACFM at air temperature (mth 1)	2884	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1044.3	#/hr
(method 1)	25064	#/day
SCFM required	3008	scfm
ACFM at air temperature (mth 1)	3452	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 1/19/23
Revised: 3/12/2023

PHASE IIC DESIGN
Design Case 6: ADW Flow, Peak Month, Winter

Flow =	2.80	MGD
BOD =	5848	lbs/d
TSS =	7074	lbs/d
TKN =	1066	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	2.80	mgd		Sludge age	14.8	days
				Effluent SS	0	mg/L
Basin temperature	8	°C		RAS/WAS Concentration	0.80%	
Number of Basins	2	each				
Volume per Basin	0.6748	mg				
Basin volume	1.350	mg		BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4825	days		BOD Synthesis Factor (Ks)	12.7	1/hour
	11.580	hours		Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	5848	#/day		NH3 Metabolism Factor (Km-N)	127	1/hour
	250.7	mg/L		NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	7074	#/day				
	303.3	mg/L		Alpha	0.538895	
TKN	1066	#/day		Beta	0.95	
	45.7	mg/L		Residual DO	2	mg/L
TKN Portion to be oxidized	100%			Diffuser depth	19	feet
VSS/TSS	0.8		(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	5659.2	#/day		Field elevation	730	ft
	242.6	mg/L		Relative humidity	70.0%	
				Standard Oxygen Transfer Eff.	33%	
				Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	3.28	mg/L	Effluent BOD	3.28	mg/L
Active Microbial VSS (Ma)	1573.1	mg/L	BOD O2 uptake (method 1)	21.9	mg/L/hr
Lysed Cell VSS (Me)	970.4	mg/L		246.26	#/hr
Inert Influent VSS (Mi)	2976.5	mg/L	TKN O2 uptake (method 1)	16.6	mg/L/hr
Inert, Inorganic SS (Mf)	2114.7	mg/L		186.96	#/hr
MLSS (BOD)	7634.7	mg/L	Total O2 uptake (method 1)	38.5	mg/L/hr
				433.2	#/hr
Unmetabolized NH3 (F-N)	0.071	mg/L			
Active N-Microbial VSS (Ma-N)	215.8	mg/L	Denitrification O2 Credit (method 1)	56.09	#/hr
Lysed N-Cell VSS (Me)	133.1	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	34.9	mg/L	Total O2 from Aeration System	251.8	#/hr
MLSS (NH3)	383.9	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8018.6	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5869.0	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	73.2%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.089	0.2-0.6 for com	SOR/AOR	2.42	
Total WAS Volatiles	4463.5	#/day			
Total WAS	6098.3	#/day	Air temperature	40.0	°C
WAS Flow	91189	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	13.99	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1049.0	#/hr
(method 1)	25176	#/day
SCFM required	3022	scfm
ACFM at air temperature (mth 1)	3467	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	609.7	#/hr
(method 1)	14633	#/day
SCFM required	1756	scfm
ACFM at air temperature (mth 1)	2015	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	745.5	#/hr
(method 1)	17892	#/day
SCFM required	2148	scfm
ACFM at air temperature (mth 1)	2464	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	913.2	#/hr
(method 1)	21916	#/day
SCFM required	2631	scfm
ACFM at air temperature (mth 1)	3018	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
7037.011 Revised: 3/12/2023

PHASE IIC DESIGN
Design Case 7: Average Flow & Load, Summer

Flow =	3.18	MGD
BOD =	4464	lbs/d
TSS =	4467	lbs/d
TKN =	803	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	3.18	mgd	Sludge age	25.5	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4247	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	10.192	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4464	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	168.4	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	4467	#/day			
	168.5	mg/L	Alpha	0.538529	
TKN	803	#/day	Beta	0.95	
	30.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	3573.6	#/day	Field elevation	730	ft
	134.8	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.09	mg/L	Effluent BOD	1.09	mg/L
Active Microbial VSS (Ma)	642.5	mg/L	BOD O2 uptake (method 1)	19.5	mg/L/hr
Lysed Cell VSS (Me)	1572.9	mg/L		219.33	#/hr
Inert Influent VSS (Mi)	3238.4	mg/L	TKN O2 uptake (method 1)	12.9	mg/L/hr
Inert, Inorganic SS (Mf)	2245.6	mg/L		145.00	#/hr
MLSS (BOD)	7699.4	mg/L	Total O2 uptake (method 1)	32.4	mg/L/hr
				364.3	#/hr
Unmetabolized NH3 (F-N)	0.023	mg/L			
Active N-Microbial VSS (Ma-N)	86.5	mg/L	Denitrification O2 Credit (method 1)	43.50	#/hr
Lysed N-Cell VSS (Me)	211.7	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	29.8	mg/L	Total O2 from Aeration System	195.5	#/hr
MLSS (NH3)	328.0	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8027.4	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5752.0	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.7%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.069	0.2-0.6 for com	SOR/AOR	2.52	
Total WAS Volatiles	2538.9	#/day			
Total WAS	3543.3	#/day	Air temperature	40.0	°C
WAS Flow	52925	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	15.89	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	919.4	#/hr
(method 1)	22066	#/day
SCFM required	2649	scfm
ACFM at air temperature (mth 1)	3039	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	493.3	#/hr
(method 1)	11840	#/day
SCFM required	1421	scfm
ACFM at air temperature (mth 1)	1631	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	603.1	#/hr
(method 1)	14475	#/day
SCFM required	1737	scfm
ACFM at air temperature (mth 1)	1993	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	809.6	#/hr
(method 1)	19431	#/day
SCFM required	2332	scfm
ACFM at air temperature (mth 1)	2676	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements Date: 1/19/23
7037.011 Revised: 3/12/2023

PHASE IIC DESIGN
Design Case 8: Average Flow & Load, Winter

Flow =	3.18	MGD
BOD =	4464	lbs/d
TSS =	4467	lbs/d
TKN =	803	lb/d

(includes 40 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	3.18	mgd	Sludge age	23.2	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	2	each	RAS/WAS Concentration	0.80%	
Volume per Basin	0.6748	mg			
Basin volume	1.350	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4247	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	10.192	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	4464	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	168.4	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	4467	#/day			
	168.5	mg/L	Alpha	0.538853	
TKN	803	#/day	Beta	0.95	
	30.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	3573.6	#/day	Field elevation	730	ft
	134.8	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.50	mg/L	Effluent BOD	2.50	mg/L
Active Microbial VSS (Ma)	1315.3	mg/L	BOD O2 uptake (method 1)	17.8	mg/L/hr
Lysed Cell VSS (Me)	1271.9	mg/L		200.59	#/hr
Inert Influent VSS (Mi)	2946.3	mg/L	TKN O2 uptake (method 1)	12.7	mg/L/hr
Inert, Inorganic SS (Mf)	2100.2	mg/L		142.56	#/hr
MLSS (BOD)	7633.7	mg/L	Total O2 uptake (method 1)	30.5	mg/L/hr
				343.2	#/hr
Unmetabolized NH3 (F-N)	0.054	mg/L			
Active N-Microbial VSS (Ma-N)	178.4	mg/L	Denitrification O2 Credit (method 1)	42.77	#/hr
Lysed N-Cell VSS (Me)	172.5	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	35.1	mg/L	Total O2 from Aeration System	175.1	#/hr
MLSS (NH3)	385.9	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8019.6	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5884.3	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	73.4%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.067	0.2-0.6 for com	SOR/AOR	2.42	
Total WAS Volatiles	2854.8	#/day			
Total WAS	3890.8	#/day	Air temperature	40.0	°C
WAS Flow	58172	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	15.89	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	831.0	#/hr
(method 1)	19943	#/day
SCFM required	2394	scfm
ACFM at air temperature (mth 1)	2747	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	423.9	#/hr
(method 1)	10174	#/day
SCFM required	1221	scfm
ACFM at air temperature (mth 1)	1401	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	527.5	#/hr
(method 1)	12659	#/day
SCFM required	1520	scfm
ACFM at air temperature (mth 1)	1743	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	727.4	#/hr
(method 1)	17458	#/day
SCFM required	2095	scfm
ACFM at air temperature (mth 1)	2404	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 2/10/23
Revised: 3/12/20023

PHASE III DESIGN
Design Case 2: ADW Flow, Peak Load, Summer

Flow =	5.96	MGD	
BOD =	13179	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	19894	lbs/d	
TKN =	2210	lb/d	(includes 100 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	5.96	mgd	Sludge age	10.2	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.72%	
Volume per Basin	0.6503	mg			
Basin volume	2.601	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4363	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	10.471	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	14496.9	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	291.6	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	19894	#/day			
	400.1	mg/L	Alpha	0.572991	
TKN	2210	#/day	Beta	0.95	
	44.4	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	15915.2	#/day	Field elevation	730	ft
	320.1	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.84	mg/L	Effluent BOD	1.84	mg/L
Active Microbial VSS (Ma)	972.6	mg/L	BOD O2 uptake (method 1)	61.2	mg/L/hr
Lysed Cell VSS (Me)	952.4	mg/L		761.34	#/hr
Inert Influent VSS (Mi)	2993.2	mg/L	TKN O2 uptake (method 1)	32.5	mg/L/hr
Inert, Inorganic SS (Mf)	2063.2	mg/L		404.65	#/hr
MLSS (BOD)	6981.4	mg/L	Total O2 uptake (method 1)	93.7	mg/L/hr
				1166.0	#/hr
Unmetabolized NH3 (F-N)	0.033	mg/L			
Active N-Microbial VSS (Ma-N)	110.9	mg/L	Denitrification O2 Credit (method 1)	121.40	#/hr
Lysed N-Cell VSS (Me)	108.6	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	22.0	mg/L	Total O2 from Aeration System	919.3	#/hr
MLSS (NH3)	241.5	mg/L		73.9	
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7222.9	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5137.7	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.1%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.130	0.2-0.6 for com	SOR/AOR	2.37	
Total WAS Volatiles	10927.2	#/day			
Total WAS	15362.1	#/day	Air temperature	40.0	°C
WAS Flow	255020	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	29.81	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	2765.5	#/hr
(method 1)	66371	#/day
SCFM required	7967	scfm
ACFM at air temperature (mth 1)	9141	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	2180.3	#/hr
(method 1)	52327	#/day
SCFM required	6281	scfm
ACFM at air temperature (mth 1)	7207	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	2468.2	#/hr
(method 1)	59237	#/day
SCFM required	7110	scfm
ACFM at air temperature (mth 1)	8158	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	2477.6	#/hr
(method 1)	59461	#/day
SCFM required	7137	scfm
ACFM at air temperature (mth 1)	8189	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 2/10/23
Revised: 3/12/20023

PHASE III DESIGN
Design Case 2: ADW Flow, Peak Load, Summer

Flow =	3.95	MGD	
BOD =	13179	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	19894	lbs/d	
TKN =	2210	lb/d	(includes 100 lbs/d from dewatering filterate)

MODEL INPUTS:

			Sludge age	10.2	days
Flow	3.95	mgd	Effluent SS	0	mg/L
Basin temperature	20	°C	RAS/WAS Concentration	0.72%	
Number of Basins	4	each			
Volume per Basin	0.6503	mg			
Basin volume	2.601	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.6594	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	15.825	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	14496.9	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	440.6	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	19894	#/day			
	604.7	mg/L	Alpha	0.572788	
TKN	2210	#/day	Beta	0.95	
	67.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65	Effective Saturation Depth	32.5%	tank depth
VSS	15915.2	#/day	Field elevation	730	ft
	483.7	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.85	mg/L	Effluent BOD	1.85	mg/L
Active Microbial VSS (Ma)	974.7	mg/L	BOD O2 uptake (method 1)	61.3	mg/L/hr
Lysed Cell VSS (Me)	954.4	mg/L		762.98	#/hr
Inert Influent VSS (Mi)	2993.2	mg/L	TKN O2 uptake (method 1)	32.5	mg/L/hr
Inert, Inorganic SS (Mf)	2063.6	mg/L		404.76	#/hr
MLSS (BOD)	6985.9	mg/L	Total O2 uptake (method 1)	93.8	mg/L/hr
				1167.7	#/hr
Unmetabolized NH3 (F-N)	0.033	mg/L			
Active N-Microbial VSS (Ma-N)	111.0	mg/L	Denitrification O2 Credit (method 1)	121.43	#/hr
Lysed N-Cell VSS (Me)	108.7	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	22.0	mg/L	Total O2 from Aeration System	921.0	#/hr
MLSS (NH3)	241.6	mg/L		74.0	
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7227.5	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5141.9	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.1%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.130	0.2-0.6 for com	SOR/AOR	2.37	
Total WAS Volatiles	10936.1	#/day			
Total WAS	15371.9	#/day	Air temperature	40.0	°C
WAS Flow	255020	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	19.73	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	2770.6	#/hr
(method 1)	66494	#/day
SCFM required	7981	scfm
ACFM at air temperature (mth 1)	9158	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	2185.1	#/hr
(method 1)	52443	#/day
SCFM required	6295	scfm
ACFM at air temperature (mth 1)	7223	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	2473.2	#/hr
(method 1)	59357	#/day
SCFM required	7125	scfm
ACFM at air temperature (mth 1)	8175	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	2482.5	#/hr
(method 1)	59579	#/day
SCFM required	7151	scfm
ACFM at air temperature (mth 1)	8205	acfm

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PHASE III DESIGN
Design Case 3: AWW Flow, Peak Month, Summer

Flow =	5.96	MGD
BOD =	8220	lbs/d
TSS =	10039	lbs/d
TKN =	1651	lb/d

(includes 80 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	5.96	mgd	Sludge age	20.0	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.70%	
Volume per Basin	0.6503	mg			
Basin volume	2.601	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4363	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	10.471	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	8220	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	165.3	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10039	#/day			
	201.9	mg/L	Alpha	0.581358	
TKN	1651	#/day	Beta	0.95	
	33.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8		(0.65- Effective Saturation Depth	32.5%	tank depth
VSS	8031.2	#/day	Field elevation	730	ft
	161.5	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.05	mg/L	Effluent BOD	1.05	mg/L
Active Microbial VSS (Ma)	601.5	mg/L	BOD O2 uptake (method 1)	18.3	mg/L/hr
Lysed Cell VSS (Me)	1154.8	mg/L		397.78	#/hr
Inert Influent VSS (Mi)	2961.6	mg/L	TKN O2 uptake (method 1)	13.7	mg/L/hr
Inert, Inorganic SS (Mf)	2026.6	mg/L		297.20	#/hr
MLSS (BOD)	6744.6	mg/L	Total O2 uptake (method 1)	32.0	mg/L/hr
				695.0	#/hr
Unmetabolized NH3 (F-N)	0.025	mg/L			
Active N-Microbial VSS (Ma-N)	90.4	mg/L	Denitrification O2 Credit (method 1)	89.16	#/hr
Lysed N-Cell VSS (Me)	173.5	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	26.4	mg/L	Total O2 from Aeration System	480.5	#/hr
MLSS (NH3)	290.3	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7034.9	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	4981.8	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	70.8%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.076	0.2-0.6 for com	SOR/AOR	2.34	
Total WAS Volatiles	5403.8	#/day			
Total WAS	7630.7	#/day	Air temperature	40.0	°C
WAS Flow	130060	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	29.81	mgd			

No credit for denitrification or membrane aeration			Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1624.6	#/hr	Standard O2 Rate Req'd (SOR)	1123.2	#/hr
(method 1)	38991	#/day	(method 1)	26957	#/day
SCFM required	4680	scfm	SCFM required	3236	scfm
ACFM at air temperature (mth 1)	5370	acfm	ACFM at air temperature (mth 1)	3713	acfm

Credit for membrane aeration only			Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1331.6	#/hr	Standard O2 Rate Req'd (SOR)	1416.2	#/hr
(method 1)	31959	#/day	(method 1)	33989	#/day
SCFM required	3836	scfm	SCFM required	4080	scfm
ACFM at air temperature (mth 1)	4402	acfm	ACFM at air temperature (mth 1)	4681	acfm

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PHASE III DESIGN
Design Case 4: AWW Flow, Peak Month, Winter

Flow =	5.96	MGD
BOD =	8220	lbs/d
TSS =	10039	lbs/d
TKN =	1651	lb/d

(includes 80 lbs/d from dewatering filtrate)

MODEL INPUTS:

Flow	5.96	mgd	Sludge age	20.0	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.77%	
Volume per Basin	0.6503	mg			
Basin volume	2.601	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4363	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	10.471	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	8220	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	165.3	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10039	#/day			
	201.9	mg/L	Alpha	0.554256	
TKN	1651	#/day	Beta	0.95	
	33.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65·	Effective Saturation Depth	32.5%	tank depth
VSS	8031.2	#/day	Field elevation	730	ft
	161.5	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.39	mg/L	Effluent BOD	2.39	mg/L
Active Microbial VSS (Ma)	1223.6	mg/L	BOD O2 uptake (method 1)	16.7	mg/L/hr
Lysed Cell VSS (Me)	1020.0	mg/L		362.34	#/hr
Inert Influent VSS (Mi)	2961.6	mg/L	TKN O2 uptake (method 1)	13.5	mg/L/hr
Inert, Inorganic SS (Mf)	2075.4	mg/L		292.04	#/hr
MLSS (BOD)	7280.5	mg/L	Total O2 uptake (method 1)	30.2	mg/L/hr
				654.4	#/hr
Unmetabolized NH3 (F-N)	0.057	mg/L			
Active N-Microbial VSS (Ma-N)	185.2	mg/L	Denitrification O2 Credit (method 1)	87.61	#/hr
Lysed N-Cell VSS (Me)	154.4	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	34.0	mg/L	Total O2 from Aeration System	441.4	#/hr
MLSS (NH3)	373.5	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7654.1	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5544.7	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.4%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.068	0.2-0.6 for com	SOR/AOR	2.35	
Total WAS Volatiles	6014.4	#/day			
Total WAS	8302.4	#/day	Air temperature	40.0	°C
WAS Flow	130060	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	29.81	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1540.6	#/hr
(method 1)	36974	#/day
SCFM required	4438	scfm
ACFM at air temperature (mth 1)	5092	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1039.2	#/hr
(method 1)	24942	#/day
SCFM required	2994	scfm
ACFM at air temperature (mth 1)	3435	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1245.5	#/hr
(method 1)	29892	#/day
SCFM required	3588	scfm
ACFM at air temperature (mth 1)	4117	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1334.3	#/hr
(method 1)	32023	#/day
SCFM required	3844	scfm
ACFM at air temperature (mth 1)	4410	acfm

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PHASE III DESIGN
Design Case 5: ADW Flow, Peak Month, Summer

Flow =	3.95	MGD
BOD =	8220	lbs/d
TSS =	10039	lbs/d
TKN =	1651	lb/d (includes 80 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	3.95	mgd	Sludge age	20.0	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.70%	
Volume per Basin	0.6503	mg			
Basin volume	2.601	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.6594	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	15.825	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	8220	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	249.8	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10039	#/day			
	305.1	mg/L	Alpha	0.581169	
TKN	1651	#/day	Beta	0.95	
	50.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65·	Effective Saturation Depth	32.5%	tank depth
VSS	8031.2	#/day	Field elevation	730	ft
	244.1	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.05	mg/L	Effluent BOD	1.05	mg/L
Active Microbial VSS (Ma)	602.8	mg/L	BOD O2 uptake (method 1)	18.4	mg/L/hr
Lysed Cell VSS (Me)	1157.3	mg/L		398.64	#/hr
Inert Influent VSS (Mi)	2961.6	mg/L	TKN O2 uptake (method 1)	13.7	mg/L/hr
Inert, Inorganic SS (Mf)	2027.0	mg/L		297.28	#/hr
MLSS (BOD)	6748.7	mg/L	Total O2 uptake (method 1)	32.1	mg/L/hr
				695.9	#/hr
Unmetabolized NH3 (F-N)	0.025	mg/L			
Active N-Microbial VSS (Ma-N)	90.4	mg/L	Denitrification O2 Credit (method 1)	89.18	#/hr
Lysed N-Cell VSS (Me)	173.6	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	26.4	mg/L	Total O2 from Aeration System	481.4	#/hr
MLSS (NH3)	290.4	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7039.1	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	4985.7	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	70.8%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.076	0.2-0.6 for com	SOR/AOR	2.34	
Total WAS Volatiles	5408.0	#/day			
Total WAS	7635.3	#/day	Air temperature	40.0	°C
WAS Flow	130060	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	19.73	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1627.3	#/hr
(method 1)	39056	#/day
SCFM required	4688	scfm
ACFM at air temperature (mth 1)	5379	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1125.7	#/hr
(method 1)	27017	#/day
SCFM required	3243	scfm
ACFM at air temperature (mth 1)	3721	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1334.3	#/hr
(method 1)	32022	#/day
SCFM required	3844	scfm
ACFM at air temperature (mth 1)	4410	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1418.8	#/hr
(method 1)	34051	#/day
SCFM required	4087	scfm
ACFM at air temperature (mth 1)	4690	acfm

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PHASE III DESIGN
Design Case 6: ADW Flow, Peak Month, Winter

Flow =	3.95	MGD
BOD =	8220	lbs/d
TSS =	10039	lbs/d
TKN =	1651	lb/d

(includes 80 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	3.95	mgd	Sludge age	20.0	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.77%	
Volume per Basin	0.6503	mg			
Basin volume	2.601	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.6594	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	15.825	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	8220	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	249.8	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10039	#/day			
	305.1	mg/L	Alpha	0.553728	
TKN	1651	#/day	Beta	0.95	
	50.2	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	8031.2	#/day	Field elevation	730	ft
	244.1	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.40	mg/L	Effluent BOD	2.40	mg/L
Active Microbial VSS (Ma)	1229.6	mg/L	BOD O2 uptake (method 1)	16.8	mg/L/hr
Lysed Cell VSS (Me)	1025.0	mg/L		364.12	#/hr
Inert Influent VSS (Mi)	2961.6	mg/L	TKN O2 uptake (method 1)	13.5	mg/L/hr
Inert, Inorganic SS (Mf)	2076.5	mg/L		292.21	#/hr
MLSS (BOD)	7292.7	mg/L	Total O2 uptake (method 1)	30.3	mg/L/hr
				656.3	#/hr
Unmetabolized NH3 (F-N)	0.057	mg/L			
Active N-Microbial VSS (Ma-N)	185.3	mg/L	Denitrification O2 Credit (method 1)	87.66	#/hr
Lysed N-Cell VSS (Me)	154.5	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	34.0	mg/L	Total O2 from Aeration System	443.3	#/hr
MLSS (NH3)	373.8	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7666.4	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	5556.0	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	72.5%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.068	0.2-0.6 for com	SOR/AOR	2.36	
Total WAS Volatiles	6026.6	#/day			
Total WAS	8315.8	#/day	Air temperature	40.0	°C
WAS Flow	130060	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	19.73	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1546.6	#/hr
(method 1)	37119	#/day
SCFM required	4455	scfm
ACFM at air temperature (mth 1)	5112	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1044.7	#/hr
(method 1)	25073	#/day
SCFM required	3010	scfm
ACFM at air temperature (mth 1)	3453	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1251.3	#/hr
(method 1)	30031	#/day
SCFM required	3605	scfm
ACFM at air temperature (mth 1)	4136	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1340.1	#/hr
(method 1)	32161	#/day
SCFM required	3860	scfm
ACFM at air temperature (mth 1)	4429	acfm

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PHASE III DESIGN
Design Case 7: Average Flow & Load, Summer

Flow =	4.48	MGD
BOD =	6480	lbs/d
TSS =	6839	lbs/d
TKN =	1270	lb/d

(includes 80 lbs/d from dewatering filtrate)

MODEL INPUTS:

Flow	4.48	mgd		Sludge age	20.0	days
Basin temperature	20	°C		Effluent SS	0	mg/L
Number of Basins	4	each		RAS/WAS Concentration	0.50%	
Volume per Basin	0.6503	mg				
Basin volume	2.601	mg		BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.5802	days		BOD Synthesis Factor (Ks)	12.7	1/hour
	13.926	hours		Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	6480	#/day		NH3 Metabolism Factor (Km-N)	127	1/hour
	173.3	mg/L		NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	6839	#/day				
	182.9	mg/L		Alpha	0.67868	
TKN	1270	#/day		Beta	0.95	
	34.0	mg/L		Residual DO	2	mg/L
TKN Portion to be oxidized	100%			Diffuser depth	19	feet
VSS/TSS	0.8		(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	5471.2	#/day		Field elevation	730	ft
	146.3	mg/L		Relative humidity	70.0%	
				Standard Oxygen Transfer Eff.	33%	
				Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	0.83	mg/L	Effluent BOD	0.83	mg/L
Active Microbial VSS (Ma)	474.9	mg/L	BOD O2 uptake (method 1)	14.5	mg/L/hr
Lysed Cell VSS (Me)	911.8	mg/L		314.08	#/hr
Inert Influent VSS (Mi)	2017.6	mg/L	TKN O2 uptake (method 1)	10.5	mg/L/hr
Inert, Inorganic SS (Mf)	1399.7	mg/L		228.66	#/hr
MLSS (BOD)	4803.9	mg/L	Total O2 uptake (method 1)	25.0	mg/L/hr
				542.7	#/hr
Unmetabolized NH3 (F-N)	0.019	mg/L			
Active N-Microbial VSS (Ma-N)	69.5	mg/L	Denitrification O2 Credit (method 1)	68.60	#/hr
Lysed N-Cell VSS (Me)	133.5	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	20.3	mg/L	Total O2 from Aeration System	348.8	#/hr
MLSS (NH3)	223.4	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	5027.3	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	3607.3	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.8%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.083	0.2-0.6 for com	SOR/AOR	2.00	
Total WAS Volatiles	3912.9	#/day			
Total WAS	5453.1	#/day	Air temperature	40.0	°C
WAS Flow	130060	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	22.42	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1086.8	#/hr
(method 1)	26083	#/day
SCFM required	3131	scfm
ACFM at air temperature (mth 1)	3592	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	698.5	#/hr
(method 1)	16763	#/day
SCFM required	2012	scfm
ACFM at air temperature (mth 1)	2309	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	835.8	#/hr
(method 1)	20060	#/day
SCFM required	2408	scfm
ACFM at air temperature (mth 1)	2763	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	949.4	#/hr
(method 1)	22786	#/day
SCFM required	2735	scfm
ACFM at air temperature (mth 1)	3138	acfm

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PHASE III DESIGN
Design Case 8: Average Flow & Load, Winter

Flow =	4.48	MGD
BOD =	6480	lbs/d
TSS =	6839	lbs/d
TKN =	1270	lb/d

(includes 80 lbs/d from dewatering filtrate)

MODEL INPUTS:

Flow	4.48	mgd	Sludge age	20.0	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.55%	
Volume per Basin	0.6503	mg			
Basin volume	2.601	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.5802	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	13.926	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	6480	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	173.3	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	6839	#/day			
	182.9	mg/L	Alpha	0.653457	
TKN	1270	#/day	Beta	0.95	
	34.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	5471.2	#/day	Field elevation	730	ft
	146.3	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.89	mg/L	Effluent BOD	1.89	mg/L
Active Microbial VSS (Ma)	968.0	mg/L	BOD O2 uptake (method 1)	13.2	mg/L/hr
Lysed Cell VSS (Me)	807.0	mg/L		286.67	#/hr
Inert Influent VSS (Mi)	2017.6	mg/L	TKN O2 uptake (method 1)	10.4	mg/L/hr
Inert, Inorganic SS (Mf)	1438.5	mg/L		224.74	#/hr
MLSS (BOD)	5231.1	mg/L	Total O2 uptake (method 1)	23.6	mg/L/hr
				511.4	#/hr
Unmetabolized NH3 (F-N)	0.044	mg/L			
Active N-Microbial VSS (Ma-N)	142.5	mg/L	Denitrification O2 Credit (method 1)	67.42	#/hr
Lysed N-Cell VSS (Me)	118.8	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	26.1	mg/L	Total O2 from Aeration System	318.7	#/hr
MLSS (NH3)	287.5	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	5518.5	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	4053.9	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	73.5%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.074	0.2-0.6 for com	SOR/AOR	2.00	
Total WAS Volatiles	4397.3	#/day			
Total WAS	5986.0	#/day	Air temperature	40.0	°C
WAS Flow	130060	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	22.42	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1021.2	#/hr
(method 1)	24509	#/day
SCFM required	2942	scfm
ACFM at air temperature (mth 1)	3375	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	636.3	#/hr
(method 1)	15271	#/day
SCFM required	1833	scfm
ACFM at air temperature (mth 1)	2103	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	770.9	#/hr
(method 1)	18503	#/day
SCFM required	2221	scfm
ACFM at air temperature (mth 1)	2548	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	886.6	#/hr
(method 1)	21278	#/day
SCFM required	2554	scfm
ACFM at air temperature (mth 1)	2930	acfm

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PHASE IV DESIGN
Design Case 1: AWW Flow, Peak Load, Summer

Flow =	8.40	MGD	
BOD =	18699	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	28175	lbs/d	
TKN =	3414	lb/d	(includes 150 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	8.40	mgd	Sludge age	7.5	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.77%	
Volume per Basin	0.66255	mg			
Basin volume	2.650	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3154	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.570	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	20568.9	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	293.5	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	28175	#/day			
	402.1	mg/L	Alpha	0.553123	
TKN	3414	#/day	Beta	0.95	
	48.7	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	22540	#/day	Field elevation	730	ft
	321.7	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.56	mg/L	Effluent BOD	2.56	mg/L
Active Microbial VSS (Ma)	1273.4	mg/L	BOD O2 uptake (method 1)	81.9	mg/L/hr
Lysed Cell VSS (Me)	916.9	mg/L		1052.21	#/hr
Inert Influent VSS (Mi)	3059.4	mg/L	TKN O2 uptake (method 1)	48.4	mg/L/hr
Inert, Inorganic SS (Mf)	2131.1	mg/L		621.76	#/hr
MLSS (BOD)	7380.8	mg/L	Total O2 uptake (method 1)	130.2	mg/L/hr
				1674.0	#/hr
Unmetabolized NH3 (F-N)	0.051	mg/L			
Active N-Microbial VSS (Ma-N)	158.5	mg/L	Denitrification O2 Credit (method 1)	186.53	#/hr
Lysed N-Cell VSS (Me)	114.1	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	27.3	mg/L	Total O2 from Aeration System	1362.1	#/hr
MLSS (NH3)	299.8	mg/L		106.0	mg/L/hr
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7680.6	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5522.2	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.9%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.169	0.2-0.6 for com	SOR/AOR	2.46	
Total WAS Volatiles	16274.1	#/day			
Total WAS	22634.9	#/day	Air temperature	40.0	°C
WAS Flow	353360	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	42.01	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	4112.9	#/hr
(method 1)	98709	#/day
SCFM required	11848	scfm
ACFM at air temperature (mth 1)	13594	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	3346.7	#/hr
(method 1)	80320	#/day
SCFM required	9641	scfm
ACFM at air temperature (mth 1)	11062	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	3804.9	#/hr
(method 1)	91319	#/day
SCFM required	10961	scfm
ACFM at air temperature (mth 1)	12577	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	3654.6	#/hr
(method 1)	87710	#/day
SCFM required	10528	scfm
ACFM at air temperature (mth 1)	12080	acfm

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PHASE IV DESIGN
Design Case 2: ADW Flow, Peak Load, Summer

Flow =	5.56	MGD	
BOD =	18699	lbs/d	(peak BOD load = BOD load * 1.1)
TSS =	28175	lbs/d	
TKN =	3414	lb/d	(includes 150 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	5.56	mgd
Basin temperature	20	°C
Number of Basins	4	each
Volume per Basin	0.66255	mg
Basin volume	2.650	mg
Detention time	0.4763	days
	11.431	hours
BOD	20568.9	#/day
	443.3	mg/L
TSS	28175	#/day
	607.2	mg/L
TKN	3414	#/day
	73.6	mg/L
TKN Portion to be oxidized	100%	
VSS/TSS	0.8	
VSS	22540	#/day
	485.7	mg/L

	Sludge age	7.5	days
	Effluent SS	0	mg/L
	RAS/WAS Concentration	0.77%	
	BOD Metabolism Factor (Km)	15	1/hour
	BOD Synthesis Factor (Ks)	12.7	1/hour
	Endogenous Decay Factor (Ke)	0.02	1/hour
	NH3 Metabolism Factor (Km-N)	127	1/hour
	NH3 Synthesis Factor (Ks-N)	80	1/hour
	Alpha	0.552814	
	Beta	0.95	
	Residual DO	2	mg/L
	Diffuser depth	19	feet
(0.65·	Effective Saturation Depth	32.5%	tank depth
	Field elevation	730	ft
	Relative humidity	70.0%	
	Standard Oxygen Transfer Eff.	33%	
	Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000	
Unmetabolized BOD5 (F)	2.57	mg/L
Active Microbial VSS (Ma)	1277.2	mg/L
Lysed Cell VSS (Me)	919.6	mg/L
Inert Influent VSS (Mi)	3059.4	mg/L
Inert, Inorganic SS (Mf)	2131.8	mg/L
MLSS (BOD)	7387.9	mg/L
Unmetabolized NH3 (F-N)	0.051	mg/L
Active N-Microbial VSS (Ma-N)	158.5	mg/L
Lysed N-Cell VSS (Me)	114.1	mg/L
Inert, N-Inorganic SS (Mf)	27.3	mg/L
MLSS (NH3)	299.9	mg/L
MLSS (total)	7687.8	mg/L
MLVSS (total)	5528.8	mg/L
% Volatile	71.9%	
F/M ratio	0.168	0.2-0.6 for com
Total WAS Volatiles	16293.5	#/day
Total WAS	22656.3	#/day
WAS Flow	353360	gpd
RAS Flow	27.82	mgd

Nitri. BOD	0.00	mg/L
Effluent BOD	2.57	mg/L
BOD O2 uptake (method 1)	82.1	mg/L/hr
	1055.32	#/hr
TKN O2 uptake (method 1)	48.4	mg/L/hr
	621.98	#/hr
Total O2 uptake (method 1)	130.5	mg/L/hr
	1677.3	#/hr
Denitrification O2 Credit (method 1)	186.59	#/hr
Credit for Membrane Aeration	125.33	#/hr
Total O2 from Aeration System	1365.4	#/hr
	106.2	mg/L/hr
Site atmospheric pressure (20C)	14.32	psi
C^*_{ST} (O2 saturation at T)	9.08	mg/L
Water vapor pressure at basin T	0.34	psi
$C^*_{\infty 20}$	10.53	mg/L
SOR/AOR	2.46	
Air temperature	40.0	°C
Water vapor pressure at air T	1.08	psi

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	4123.4	#/hr
(method 1)	98961	#/day
SCFM required	11878	scfm
ACFM at air temperature (mth 1)	13629	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	3356.5	#/hr
(method 1)	80557	#/day
SCFM required	9669	scfm
ACFM at air temperature (mth 1)	11095	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	3815.3	#/hr
(method 1)	91566	#/day
SCFM required	10991	scfm
ACFM at air temperature (mth 1)	12611	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	3664.7	#/hr
(method 1)	87952	#/day
SCFM required	10557	scfm
ACFM at air temperature (mth 1)	12113	acfm

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Date: 2/13/23
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PHASE IV DESIGN
Design Case 3: AWW Flow, Peak Month, Summer

Flow =	8.40	MGD
BOD =	11566	lbs/d
TSS =	14222	lbs/d
TKN =	2461	lb/d

(includes 120 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	8.40	mgd	Sludge age	15.0	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.75%	
Volume per Basin	0.66255	mg			
Basin volume	2.650	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3154	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.570	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	11566	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	165.1	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	14222	#/day			
	203.0	mg/L	Alpha	0.56005	
TKN	2461	#/day	Beta	0.95	
	35.1	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	11377.6	#/day	Field elevation	730	ft
	162.4	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.44	mg/L	Effluent BOD	1.44	mg/L
Active Microbial VSS (Ma)	803.4	mg/L	BOD O2 uptake (method 1)	24.7	mg/L/hr
Lysed Cell VSS (Me)	1156.9	mg/L		545.67	#/hr
Inert Influent VSS (Mi)	3088.6	mg/L	TKN O2 uptake (method 1)	19.9	mg/L/hr
Inert, Inorganic SS (Mf)	2126.4	mg/L		440.86	#/hr
MLSS (BOD)	7175.2	mg/L	Total O2 uptake (method 1)	44.6	mg/L/hr
				986.5	#/hr
Unmetabolized NH3 (F-N)	0.036	mg/L			
Active N-Microbial VSS (Ma-N)	128.2	mg/L	Denitrification O2 Credit (method 1)	132.26	#/hr
Lysed N-Cell VSS (Me)	184.6	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	31.3	mg/L	Total O2 from Aeration System	728.9	#/hr
MLSS (NH3)	344.0	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7519.2	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5361.5	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.3%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.098	0.2-0.6 for com	SOR/AOR	2.43	
Total WAS Volatiles	7900.3	#/day			
Total WAS	11079.6	#/day	Air temperature	40.0	°C
WAS Flow	176680	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	42.01	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	2393.9	#/hr
(method 1)	57453	#/day
SCFM required	6896	scfm
ACFM at air temperature (mth 1)	7913	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1768.8	#/hr
(method 1)	42452	#/day
SCFM required	5096	scfm
ACFM at air temperature (mth 1)	5847	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	2089.8	#/hr
(method 1)	50154	#/day
SCFM required	6020	scfm
ACFM at air temperature (mth 1)	6907	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	2072.9	#/hr
(method 1)	49751	#/day
SCFM required	5972	scfm
ACFM at air temperature (mth 1)	6852	acfm

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PHASE IV DESIGN
Design Case 4: AWW Flow, Peak Month, Winter

Flow =	8.40	MGD
BOD =	11566	lbs/d
TSS =	14222	lbs/d
TKN =	2461	lb/d (includes 120 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	8.40	mgd	Sludge age	15.0	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.83%	
Volume per Basin	0.66255	mg			
Basin volume	2.650	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.3154	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	7.570	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	11566	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	165.1	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	14222	#/day			
	203.0	mg/L	Alpha	0.527497	
TKN	2461	#/day	Beta	0.95	
	35.1	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65·	Effective Saturation Depth	32.5%	tank depth
VSS	11377.6	#/day	Field elevation	730	ft
	162.4	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	3.28	mg/L	Effluent BOD	3.28	mg/L
Active Microbial VSS (Ma)	1578.7	mg/L	BOD O2 uptake (method 1)	21.9	mg/L/hr
Lysed Cell VSS (Me)	987.0	mg/L		484.82	#/hr
Inert Influent VSS (Mi)	3088.6	mg/L	TKN O2 uptake (method 1)	19.5	mg/L/hr
Inert, Inorganic SS (Mf)	2186.9	mg/L		431.45	#/hr
MLSS (BOD)	7841.1	mg/L	Total O2 uptake (method 1)	41.5	mg/L/hr
				916.3	#/hr
Unmetabolized NH3 (F-N)	0.084	mg/L			
Active N-Microbial VSS (Ma-N)	254.4	mg/L	Denitrification O2 Credit (method 1)	129.44	#/hr
Lysed N-Cell VSS (Me)	159.0	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	41.3	mg/L	Total O2 from Aeration System	661.5	#/hr
MLSS (NH3)	454.8	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8295.9	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	6067.6	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	73.1%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.086	0.2-0.6 for com	SOR/AOR	2.47	
Total WAS Volatiles	8940.7	#/day			
Total WAS	12224.1	#/day	Air temperature	40.0	°C
WAS Flow	176680	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	42.01	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	2266.6	#/hr
(method 1)	54398	#/day
SCFM required	6529	scfm
ACFM at air temperature (mth 1)	7492	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1636.4	#/hr
(method 1)	39273	#/day
SCFM required	4714	scfm
ACFM at air temperature (mth 1)	5409	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1956.5	#/hr
(method 1)	46957	#/day
SCFM required	5636	scfm
ACFM at air temperature (mth 1)	6467	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1946.4	#/hr
(method 1)	46713	#/day
SCFM required	5607	scfm
ACFM at air temperature (mth 1)	6433	acfm

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PHASE IV DESIGN
Design Case 5: ADW Flow, Peak Month, Summer

Flow =	5.56	MGD
BOD =	11566	lbs/d
TSS =	14222	lbs/d
TKN =	2461	lb/d

(includes 120 lbs/d from dewatering filterate)

MODEL INPUTS:					
Flow	5.56	mgd	Sludge age	15.0	days
Basin temperature	20	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.75%	
Volume per Basin	0.66255	mg			
Basin volume	2.650	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4763	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.431	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	11566	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	249.2	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	14222	#/day			
	306.5	mg/L	Alpha	0.559769	
TKN	2461	#/day	Beta	0.95	
	53.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	11377.6	#/day	Field elevation	730	ft
	245.2	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:					
Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.45	mg/L	Effluent BOD	1.45	mg/L
Active Microbial VSS (Ma)	805.8	mg/L	BOD O2 uptake (method 1)	24.8	mg/L/hr
Lysed Cell VSS (Me)	1160.3	mg/L		547.28	#/hr
Inert Influent VSS (Mi)	3088.6	mg/L	TKN O2 uptake (method 1)	20.0	mg/L/hr
Inert, Inorganic SS (Mf)	2127.0	mg/L		441.02	#/hr
MLSS (BOD)	7181.6	mg/L	Total O2 uptake (method 1)	44.7	mg/L/hr
				988.3	#/hr
Unmetabolized NH3 (F-N)	0.037	mg/L			
Active N-Microbial VSS (Ma-N)	128.2	mg/L	Denitrification O2 Credit (method 1)	132.31	#/hr
Lysed N-Cell VSS (Me)	184.6	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	31.3	mg/L	Total O2 from Aeration System	730.7	#/hr
MLSS (NH3)	344.1	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	7525.7	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	5367.4	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	71.3%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.097	0.2-0.6 for com	SOR/AOR	2.43	
Total WAS Volatiles	7909.0	#/day			
Total WAS	11089.2	#/day	Air temperature	40.0	°C
WAS Flow	176680	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	27.82	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	2399.4	#/hr
(method 1)	57585	#/day
SCFM required	6912	scfm
ACFM at air temperature (mth 1)	7931	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1773.9	#/hr
(method 1)	42573	#/day
SCFM required	5110	scfm
ACFM at air temperature (mth 1)	5863	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	2095.1	#/hr
(method 1)	50282	#/day
SCFM required	6035	scfm
ACFM at air temperature (mth 1)	6925	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	2078.2	#/hr
(method 1)	49876	#/day
SCFM required	5987	scfm
ACFM at air temperature (mth 1)	6869	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 2/13/23
Revised: 3/12/2023

PHASE IV DESIGN
Design Case 6: ADW Flow, Peak Month, Winter

Flow =	5.56	MGD
BOD =	11566	lbs/d
TSS =	14222	lbs/d
TKN =	2461	lb/d

(includes 120 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	5.56	mgd	Sludge age	15.0	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.83%	
Volume per Basin	0.66255	mg			
Basin volume	2.650	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4763	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	11.431	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	11566	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	249.2	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	14222	#/day			
	306.5	mg/L	Alpha	0.526706	
TKN	2461	#/day	Beta	0.95	
	53.0	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65·	Effective Saturation Depth	32.5%	tank depth
VSS	11377.6	#/day	Field elevation	730	ft
	245.2	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	3.30	mg/L	Effluent BOD	3.30	mg/L
Active Microbial VSS (Ma)	1589.3	mg/L	BOD O2 uptake (method 1)	22.1	mg/L/hr
Lysed Cell VSS (Me)	993.7	mg/L		488.10	#/hr
Inert Influent VSS (Mi)	3088.6	mg/L	TKN O2 uptake (method 1)	19.5	mg/L/hr
Inert, Inorganic SS (Mf)	2188.7	mg/L		431.80	#/hr
MLSS (BOD)	7860.2	mg/L	Total O2 uptake (method 1)	41.6	mg/L/hr
				919.9	#/hr
Unmetabolized NH3 (F-N)	0.084	mg/L			
Active N-Microbial VSS (Ma-N)	254.6	mg/L	Denitrification O2 Credit (method 1)	129.54	#/hr
Lysed N-Cell VSS (Me)	159.2	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	41.4	mg/L	Total O2 from Aeration System	665.0	#/hr
MLSS (NH3)	455.1	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	8315.3	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	6085.3	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	73.2%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.086	0.2-0.6 for com	SOR/AOR	2.48	
Total WAS Volatiles	8966.8	#/day			
Total WAS	12252.7	#/day	Air temperature	40.0	°C
WAS Flow	176680	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	27.82	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	2279.0	#/hr
(method 1)	54695	#/day
SCFM required	6565	scfm
ACFM at air temperature (mth 1)	7533	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1647.5	#/hr
(method 1)	39541	#/day
SCFM required	4746	scfm
ACFM at air temperature (mth 1)	5446	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1968.5	#/hr
(method 1)	47243	#/day
SCFM required	5671	scfm
ACFM at air temperature (mth 1)	6506	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1958.0	#/hr
(method 1)	46993	#/day
SCFM required	5641	scfm
ACFM at air temperature (mth 1)	6472	acfm

ACTIVATED SLUDGE MODEL

North Liberty WWTP Improvements Date: 2/13/23

7037.011 Revised: 3/12/2023

PHASE IV DESIGN

Design Case 7: Average Flow & Load, Summer

Flow =	6.32	MGD
BOD =	9324	lbs/d
TSS =	10185	lbs/d
TKN =	1913	lb/d

(includes 120 lbs/d from dewatering filterate)

MODEL INPUTS:

			Sludge age	15.0	days
Flow	6.32	mgd	Effluent SS	0	mg/L
Basin temperature	20	°C	RAS/WAS Concentration	0.56%	
Number of Basins	4	each			
Volume per Basin	0.66255	mg			
Basin volume	2.650	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4191	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	10.059	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	9324	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	176.8	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10185	#/day			
	193.1	mg/L	Alpha	0.649175	
TKN	1913	#/day	Beta	0.95	
	36.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	8148	#/day	Field elevation	730	ft
	154.5	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	1.0000		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	1.16	mg/L	Effluent BOD	1.16	mg/L
Active Microbial VSS (Ma)	649.1	mg/L	BOD O2 uptake (method 1)	19.9	mg/L/hr
Lysed Cell VSS (Me)	934.6	mg/L		440.84	#/hr
Inert Influent VSS (Mi)	2211.9	mg/L	TKN O2 uptake (method 1)	15.5	mg/L/hr
Inert, Inorganic SS (Mf)	1540.8	mg/L		342.78	#/hr
MLSS (BOD)	5336.3	mg/L	Total O2 uptake (method 1)	35.5	mg/L/hr
				783.6	#/hr
Unmetabolized NH3 (F-N)	0.028	mg/L			
Active N-Microbial VSS (Ma-N)	99.7	mg/L	Denitrification O2 Credit (method 1)	102.83	#/hr
Lysed N-Cell VSS (Me)	143.5	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	24.3	mg/L	Total O2 from Aeration System	555.5	#/hr
MLSS (NH3)	267.5	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	5603.8	mg/L	C^*_{ST} (O2 saturation at T)	9.08	mg/L
MLVSS (total)	4038.7	mg/L	Water vapor pressure at basin T	0.34	psi
% Volatile	72.1%		$C^*_{\infty 20}$	10.53	mg/L
F/M ratio	0.104	0.2-0.6 for com	SOR/AOR	2.09	
Total WAS Volatiles	5951.1	#/day			
Total WAS	8257.3	#/day	Air temperature	40.0	°C
WAS Flow	176680	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	31.62	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1640.5	#/hr
(method 1)	39371	#/day
SCFM required	4726	scfm
ACFM at air temperature (mth 1)	5422	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1162.8	#/hr
(method 1)	27908	#/day
SCFM required	3350	scfm
ACFM at air temperature (mth 1)	3843	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1378.1	#/hr
(method 1)	33074	#/day
SCFM required	3970	scfm
ACFM at air temperature (mth 1)	4555	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1425.2	#/hr
(method 1)	34205	#/day
SCFM required	4106	scfm
ACFM at air temperature (mth 1)	4711	acfm

ACTIVATED SLUDGE MODEL
North Liberty WWTP Improvements
7037.011

Date: 2/13/23
Revised: 3/12/2023

PHASE IV DESIGN
Design Case 8: Average Flow & Load, Winter

Flow =	6.32	MGD
BOD =	9324	lbs/d
TSS =	10185	lbs/d
TKN =	1913	lb/d

(includes 120 lbs/d from dewatering filterate)

MODEL INPUTS:

Flow	6.32	mgd	Sludge age	15.0	days
Basin temperature	8	°C	Effluent SS	0	mg/L
Number of Basins	4	each	RAS/WAS Concentration	0.62%	
Volume per Basin	0.66255	mg			
Basin volume	2.650	mg	BOD Metabolism Factor (Km)	15	1/hour
Detention time	0.4191	days	BOD Synthesis Factor (Ks)	12.7	1/hour
	10.059	hours	Endogenous Decay Factor (Ke)	0.02	1/hour
BOD	9324	#/day	NH3 Metabolism Factor (Km-N)	127	1/hour
	176.8	mg/L	NH3 Synthesis Factor (Ks-N)	80	1/hour
TSS	10185	#/day			
	193.1	mg/L	Alpha	0.618369	
TKN	1913	#/day	Beta	0.95	
	36.3	mg/L	Residual DO	2	mg/L
TKN Portion to be oxidized	100%		Diffuser depth	19	feet
VSS/TSS	0.8	(0.65-	Effective Saturation Depth	32.5%	tank depth
VSS	8148	#/day	Field elevation	730	ft
	154.5	mg/L	Relative humidity	70.0%	
			Standard Oxygen Transfer Eff.	33%	
			Air temperature	104	°F

MODEL OUTPUTS:

Temperature correction factor	0.4342		Nitri. BOD	0.00	mg/L
Unmetabolized BOD5 (F)	2.66	mg/L	Effluent BOD	2.66	mg/L
Active Microbial VSS (Ma)	1278.9	mg/L	BOD O2 uptake (method 1)	17.8	mg/L/hr
Lysed Cell VSS (Me)	799.6	mg/L		392.78	#/hr
Inert Influent VSS (Mi)	2211.9	mg/L	TKN O2 uptake (method 1)	15.2	mg/L/hr
Inert, Inorganic SS (Mf)	1590.3	mg/L		335.58	#/hr
MLSS (BOD)	5880.7	mg/L	Total O2 uptake (method 1)	33.0	mg/L/hr
				728.4	#/hr
Unmetabolized NH3 (F-N)	0.065	mg/L			
Active N-Microbial VSS (Ma-N)	197.8	mg/L	Denitrification O2 Credit (method 1)	100.67	#/hr
Lysed N-Cell VSS (Me)	123.7	mg/L	Credit for Membrane Aeration	125.33	#/hr
Inert, N-Inorganic SS (Mf)	32.2	mg/L	Total O2 from Aeration System	502.3	#/hr
MLSS (NH3)	353.7	mg/L			
			Site atmospheric pressure (20C)	14.32	psi
MLSS (total)	6234.4	mg/L	C^*_{ST} (O2 saturation at T)	11.86	mg/L
MLVSS (total)	4611.9	mg/L	Water vapor pressure at basin T	0.15	psi
% Volatile	74.0%		$C^*_{\infty 20}$	10.52	mg/L
F/M ratio	0.091	0.2-0.6 for com	SOR/AOR	2.11	
Total WAS Volatiles	6795.7	#/day			
Total WAS	9186.4	#/day	Air temperature	40.0	°C
WAS Flow	176680	gpd	Water vapor pressure at air T	1.08	psi
RAS Flow	31.62	mgd			

No credit for denitrification or membrane aeration		
Standard O2 Rate Req'd (SOR)	1536.9	#/hr
(method 1)	36887	#/day
SCFM required	4428	scfm
ACFM at air temperature (mth 1)	5080	acfm

Credit for denitrification & membrane aeration		
Standard O2 Rate Req'd (SOR)	1060.0	#/hr
(method 1)	25441	#/day
SCFM required	3054	scfm
ACFM at air temperature (mth 1)	3504	acfm

Credit for membrane aeration only		
Standard O2 Rate Req'd (SOR)	1272.5	#/hr
(method 1)	30539	#/day
SCFM required	3666	scfm
ACFM at air temperature (mth 1)	4206	acfm

Credit for denitrification only		
Standard O2 Rate Req'd (SOR)	1324.5	#/hr
(method 1)	31788	#/day
SCFM required	3816	scfm
ACFM at air temperature (mth 1)	4378	acfm

APPENDIX D

FLOW EQUALIZATION BASIN
SIZING ANALYSIS

PHASE III DESIGN Equalization Basin Sizing - (Design based on September 19 - October 18, 2018 WW Flow Records)

City of North Liberty WWTF
PN: 7037.011
Prepared by: SJT
Date Prepared: 1/16/2023

Last Update: 3/20/2025

<u>INPUTS</u>

Existing EQ Volume =	5.14	MGal
Input Safey Factor =	10.00%	*Allows for non-continuous EQ return and a*
Target Required EQ Volume</=	4.6727273	Mgal
Beginning EQ Volume =	0	Mgal
Allowable Mech Plant Influent =	6.84	mgd

	AWW	MWW	Peak 7-D
urrent Flow:	2.767	5.088	3.765
hase III Flow:	5.42	11.484	7.371
atio of Flows:	1.886	2.257	1.958

Total storage required= 7.980
Additional storage needed = 2.840 MG

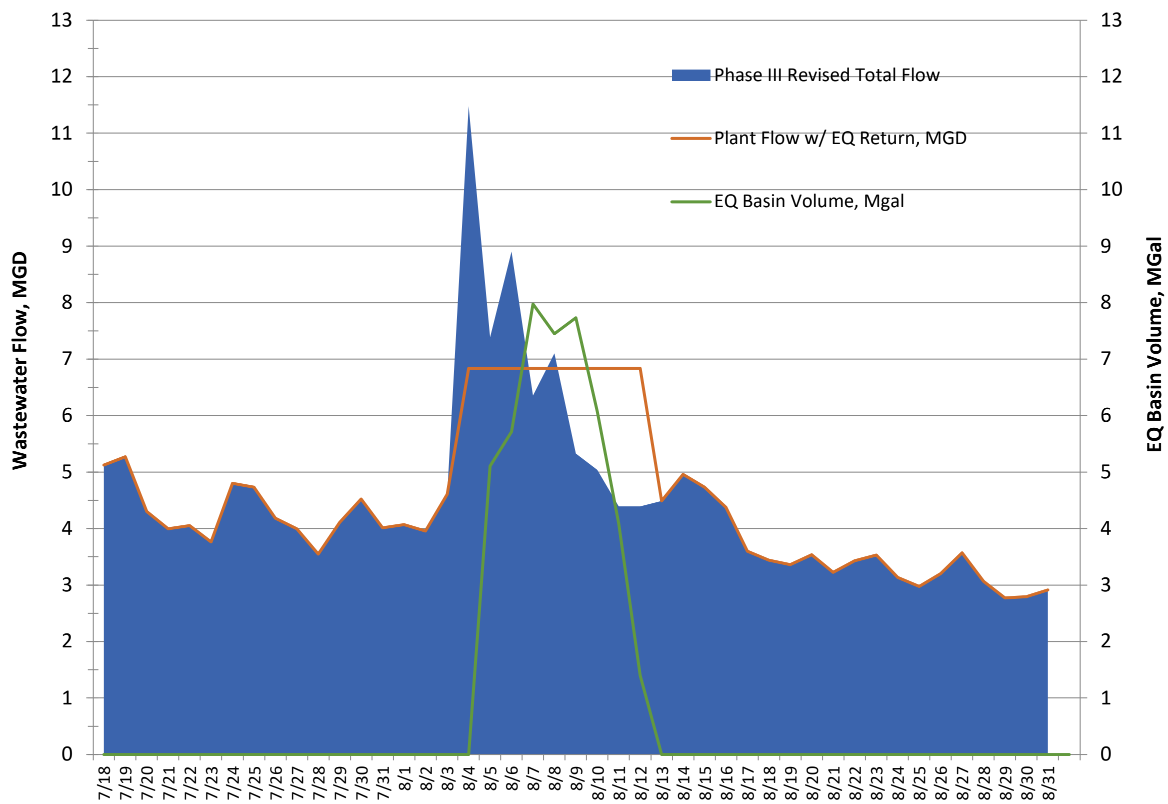
Design volume =	3 MG=	401,070	cf
Depth=	22	ft	
Area=	18,230	ft	
diameter	152.35	ft	

	Total (Current) Raw Flow mgd	Phase III Revised Total Flow mgd	Plant Flow (w/o EQ Return) mgd	Plant Flow w/ EQ Return, MGD	Flow to EQ mgd	EQ Return Flow mgd	EQ Volume Mgal	EQ Basin Volume, Mgal	Max 30-Day Total Flow (MGD)	Max 30-Day Mech Plant Flow (MGD)
9/19/2018	2.717	5.125	5.125	5.125	0.000	0.000	0.000	0.000	**5.067**	**5.106**
9/20/2018	2.796	5.274	5.274	5.274	0.000	0.000	0.000	0.000	**5.016**	5.055
9/21/2018	2.282	4.304	4.304	4.304	0.000	0.000	0.000	0.000	**4.955**	4.994
9/22/2018	2.118	3.995	3.995	3.995	0.000	0.000	0.000	0.000	**4.923**	4.962
9/23/2018	2.149	4.053	4.053	4.053	0.000	0.000	0.000	0.000	**4.908**	4.947
9/24/2018	1.994	3.761	3.761	3.761	0.000	0.000	0.000	0.000	**4.880**	4.919
9/25/2018	2.545	4.800	4.800	4.800	0.000	0.000	0.000	0.000	**4.869**	4.908
9/26/2018	2.510	4.734	4.734	4.734	0.000	0.000	0.000	0.000	**4.827**	4.866
9/27/2018	2.219	4.185	4.185	4.185	0.000	0.000	0.000	0.000	**4.773**	4.813
9/28/2018	2.119	3.997	3.997	3.997	0.000	0.000	0.000	0.000	**4.733**	4.772
9/29/2018	1.880	3.546	3.546	3.546	0.000	0.000	0.000	0.000	**4.706**	4.746
9/30/2018	2.179	4.110	4.110	4.110	0.000	0.000	0.000	0.000	**4.707**	4.746
10/1/2018	2.399	4.525	4.525	4.525	0.000	0.000	0.000	0.000	**4.672**	4.712
10/2/2018	2.127	4.012	4.012	4.012	0.000	0.000	0.000	0.000	**4.614**	4.653
10/3/2018	2.159	4.072	4.072	4.072	0.000	0.000	0.000	0.000	**4.573**	4.613
10/4/2018	2.096	3.953	3.953	3.953	0.000	0.000	0.000	0.000	**4.535**	4.574
10/5/2018	2.444	4.610	4.610	4.610	0.000	0.000	0.000	0.000		
10/6/2018	**5.088**	11.484	6.840	6.840	4.644	0.000	4.644	5.108		
10/7/2018	3.917	7.388	6.840	6.840	0.548	0.000	5.192	5.711		
10/8/2018	4.720	8.903	6.840	6.840	2.063	0.000	7.255	**7.980**		
10/9/2018	3.369	6.354	6.354	6.840	0.000	0.486	6.769	7.446		
10/10/2018	3.765	7.101	6.840	6.840	0.261	0.000	7.031	7.734		
10/11/2018	2.825	5.328	5.328	6.840	0.000	1.512	5.519	6.071		
10/12/2018	2.671	5.038	5.038	6.840	0.000	1.802	3.717	4.089		
10/13/2018	2.329	4.393	4.393	6.840	0.000	2.447	1.270	**1.397**		
10/14/2018	2.330	4.395	4.395	6.840	0.000	2.445	0.000	0.000		
10/15/2018	2.379	4.487	4.487	4.487	0.000	0.000	0.000	0.000		
10/16/2018	2.628	4.957	4.957	4.957	0.000	0.000	0.000	0.000		
10/17/2018	2.510	4.734	4.734	4.734	0.000	0.000	0.000	0.000		
10/18/2018	2.320	4.376	4.376	4.376	0.000	0.000	0.000	0.000		
10/19/2018	1.908	3.599	3.599	3.599	0.000	0.000	0.000	0.000		
10/20/2018	1.824	3.440	3.440	3.440	0.000	0.000	0.000	0.000		
10/21/2018	1.781	3.359	3.359	3.359	0.000	0.000	0.000	0.000		
10/22/2018	1.874	3.535	3.535	3.535	0.000	0.000	0.000	0.000		
10/23/2018	1.711	3.227	3.227	3.227	0.000	0.000	0.000	0.000		
10/24/2018	1.817	3.427	3.427	3.427	0.000	0.000	0.000	0.000		
10/25/2018	1.873	3.533	3.533	3.533	0.000	0.000	0.000	0.000		
10/26/2018	1.661	3.133	3.133	3.133	0.000	0.000	0.000	0.000		
10/27/2018	1.576	2.973	2.973	2.973	0.000	0.000	0.000	0.000		

10/28/2018	1.697	3.201	3.201	3.201	0.000	0.000	0.000	0.000		
10/29/2018	1.892	3.569	3.569	3.569	0.000	0.000	0.000	0.000		
10/30/2018	1.627	3.069	3.069	3.069	0.000	0.000	0.000	0.000		
10/31/2018	1.470	2.773	2.773	2.773	0.000	0.000	0.000	0.000		
11/1/2018	1.480	2.792	2.792	2.792	0.000	0.000	0.000	0.000		
11/2/2018	1.543	2.910	2.910	2.910	0.000	0.000	0.000	0.000		
AVG	2.340	4.456	4.289	**4.482**	0.167	0.193	0.920	1.012		
MAX	5.088	11.484	6.840	6.840	4.644	2.447	7.255	**7.980**	**5.067**	**5.106** MGD*
MIN	1.470	2.773	2.773	2.773	0.000	0.000	0.000	0.000		

*Design 30-Day Flow During Peak Month w/ EQ Return

AWW = 4.482



PHASE IV DESIGN Equalization Basin Sizing - (Design based on September 19 - October 18, 2018 WW Flow Records)

City of North Liberty WWTF
PN: 7037.011
Prepared by: SJT
Date Prepared: 1/16/2023

Last Update: 1/17/2023

INPUTS

Existing EQ Volume =	5.14	MGal
Input Safey Factor =	10.00%	*Allows for non-continuous EQ return and*
Target Required EQ Volume</=	4.6727273	Mgal
Beginning EQ Volume =	0	Mgal
Allowable Mech Plant Influent =	11.44	mgd

	AWW	MWW	Peak 7-D
Current Flow:	2.767	5.088	3.765
Phase IV Flow:	7.645	13.99	10.397
Ratio of Flows:	2.764	2.750	2.761

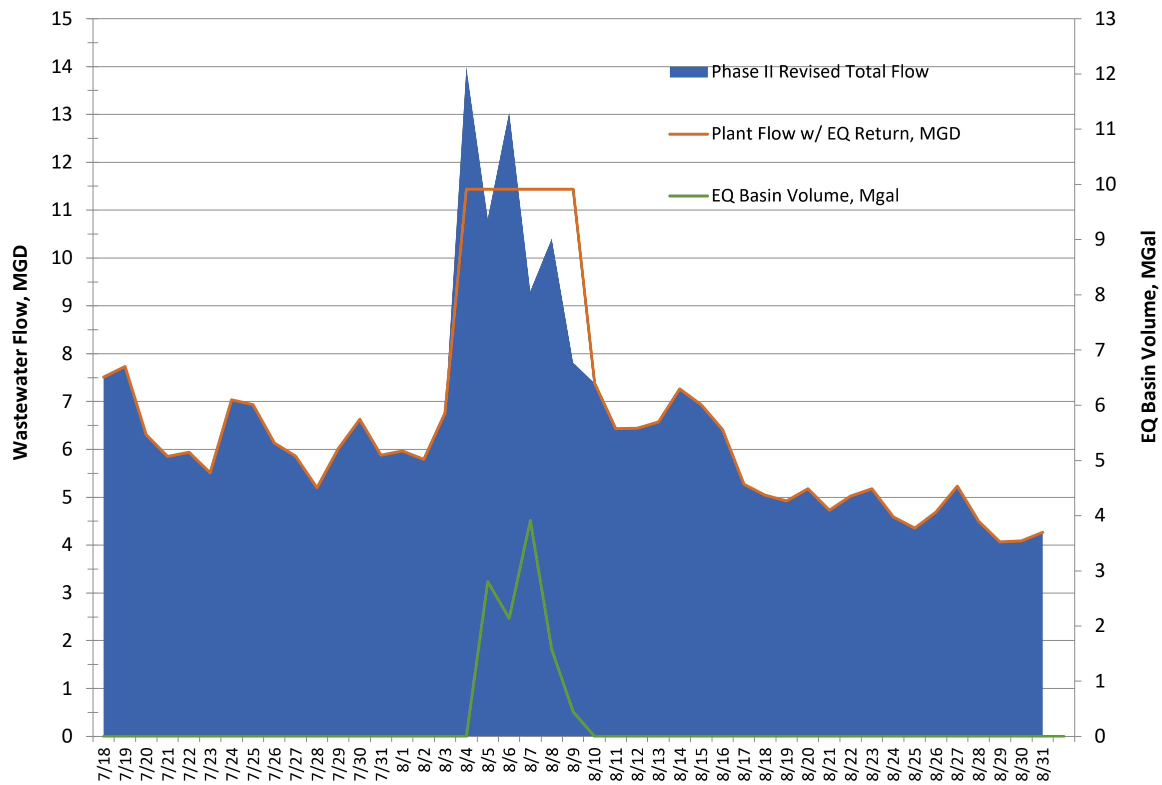
Total storage required=	3.910			
Additional storage needed =	-1.230	MG		
Design volume =	0	MG=	-	cf
Depth=	22	ft		
Area=	-	ft		
diameter	-	ft		

	Total (Current) Raw Flow mgd	Phase II Revised Total Flow mgd	Plant Flow (w/o EQ Return) mgd	Plant Flow w/ EQ Return, MGD	Flow to EQ mgd	EQ Return Flow mgd	EQ Volume Mgal	EQ Basin Volume, Mgal	Max 30-Day Total Flow (MGD)	Max 30-Day Mech Plant Flow (MGD)
9/19/2018	2.717	7.511	7.511	7.511	0.000	0.000	0.000	0.000	**7.331**	**7.438**
9/20/2018	2.796	7.729	7.729	7.729	0.000	0.000	0.000	0.000	**7.256**	7.364
9/21/2018	2.282	6.308	6.308	6.308	0.000	0.000	0.000	0.000	**7.167**	7.274
9/22/2018	2.118	5.855	5.855	5.855	0.000	0.000	0.000	0.000	**7.120**	7.228
9/23/2018	2.149	5.941	5.941	5.941	0.000	0.000	0.000	0.000	**7.098**	7.206
9/24/2018	1.994	5.512	5.512	5.512	0.000	0.000	0.000	0.000	**7.058**	7.165
9/25/2018	2.545	7.035	7.035	7.035	0.000	0.000	0.000	0.000	**7.041**	7.149
9/26/2018	2.510	6.938	6.938	6.938	0.000	0.000	0.000	0.000	**6.979**	7.087
9/27/2018	2.219	6.134	6.134	6.134	0.000	0.000	0.000	0.000	**6.901**	7.009
9/28/2018	2.119	5.858	5.858	5.858	0.000	0.000	0.000	0.000	**6.842**	6.949
9/29/2018	1.880	5.197	5.197	5.197	0.000	0.000	0.000	0.000	**6.803**	6.911
9/30/2018	2.179	6.023	6.023	6.023	0.000	0.000	0.000	0.000	**6.804**	6.912
10/1/2018	2.399	6.632	6.632	6.632	0.000	0.000	0.000	0.000	**6.753**	6.861
10/2/2018	2.127	5.880	5.880	5.880	0.000	0.000	0.000	0.000	**6.668**	6.775
10/3/2018	2.159	5.968	5.968	5.968	0.000	0.000	0.000	0.000	**6.608**	6.716
10/4/2018	2.096	5.794	5.794	5.794	0.000	0.000	0.000	0.000	**6.551**	6.659
10/5/2018	2.444	6.756	6.756	6.756	0.000	0.000	0.000	0.000		
10/6/2018	**5.088**	13.990	11.437	11.437	2.553	0.000	2.553	2.808		
10/7/2018	3.917	10.828	10.828	11.437	0.000	0.609	1.944	2.138		
10/8/2018	4.720	13.048	11.437	11.437	1.611	0.000	3.555	**3.910**		
10/9/2018	3.369	9.313	9.313	11.437	0.000	2.124	1.431	1.574		
10/10/2018	3.765	10.408	10.408	11.437	0.000	1.029	0.401	0.441		
10/11/2018	2.825	7.809	7.809	11.437	0.000	3.628	0.000	0.000		
10/12/2018	2.671	7.384	7.384	7.384	0.000	0.000	0.000	0.000		
10/13/2018	2.329	6.438	6.438	6.438	0.000	0.000	0.000	**0.000**		
10/14/2018	2.330	6.441	6.441	6.441	0.000	0.000	0.000	0.000		
10/15/2018	2.379	6.576	6.576	6.576	0.000	0.000	0.000	0.000		
10/16/2018	2.628	7.265	7.265	7.265	0.000	0.000	0.000	0.000		
10/17/2018	2.510	6.938	6.938	6.938	0.000	0.000	0.000	0.000		
10/18/2018	2.320	6.413	6.413	6.413	0.000	0.000	0.000	0.000		
10/19/2018	1.908	5.274	5.274	5.274	0.000	0.000	0.000	0.000		
10/20/2018	1.824	5.042	5.042	5.042	0.000	0.000	0.000	0.000		
10/21/2018	1.781	4.923	4.923	4.923	0.000	0.000	0.000	0.000		
10/22/2018	1.874	5.180	5.180	5.180	0.000	0.000	0.000	0.000		
10/23/2018	1.711	4.730	4.730	4.730	0.000	0.000	0.000	0.000		
10/24/2018	1.817	5.023	5.023	5.023	0.000	0.000	0.000	0.000		
10/25/2018	1.873	5.178	5.178	5.178	0.000	0.000	0.000	0.000		
10/26/2018	1.661	4.592	4.592	4.592	0.000	0.000	0.000	0.000		
10/27/2018	1.576	4.357	4.357	4.357	0.000	0.000	0.000	0.000		
10/28/2018	1.697	4.691	4.691	4.691	0.000	0.000	0.000	0.000		

10/29/2018	1.892	5.230	5.230	5.230	0.000	0.000	0.000	0.000			
10/30/2018	1.627	4.498	4.498	4.498	0.000	0.000	0.000	0.000			
10/31/2018	1.470	4.064	4.064	4.064	0.000	0.000	0.000	0.000			
11/1/2018	1.480	4.091	4.091	4.091	0.000	0.000	0.000	0.000			
11/2/2018	1.543	4.265	4.265	4.265	0.000	0.000	0.000	0.000			
AVG	2.340	6.468	6.375	**6.540**	0.093	0.164	0.220	0.242			
MAX	5.088	13.990	11.437	11.437	2.553	3.628	3.555	**3.910**	**7.331**	**7.438**	MGD*
MIN	1.470	4.064	4.064	4.064	0.000	0.000	0.000	0.000			

*Design 30-Day Flow During Peak Month w/ EQ Return

AWW = 6.540



APPENDIX E

AEROBIC DIGESTION MODEL

Aerobic Digester Design Calculations SJT
North Liberty WWTP Improvements Date 1/30/2023
7037.011 Revised 3/14/2023

PHASE IIC
Design Case 1: Peak Month WAS, summer, parallel flow

MODEL INPUTS:

Ke	0.48	/day	- endogenous metabolism factor at 20 degrees C
$M_{T\text{-}w} = M_{T\text{-}Dinf}$	5523	#/day	- waste biological solids loading on digester
$Ma_w = Ma_{Dinf}$	3940	#/day	- active mass in waste activated sludge
Influent VSS/TSS	71%		
$C_w = C_D$	20000	mg/L	- digester sludge SS concentration
Basin temperature	30	°C	
Basin 1 volume	0.779	mg	
Basin 2 volume	0.575	mg	
Total volume	1.354	mg	
Total liquid detention time	40.9	days	
Q_D	33110	gpd	- net liquid quantity influent to digester
Alpha	0.72		0.6 fine bubble, .72 jet, 0.85 cb
Beta	0.95		
Residual DO	1	mg/L	
Diffuser depth	19	feet	
Effective Saturation Depth	30.0%	tank depth --->	Coarse bubble = 26-34%
Field elevation	730	ft	Fine bubble = 21-44%
Relative humidity	70.0%		Low speed surface aeration = 5-7%
Standard Oxygen Transfer Eff.	10.0%		Coarse bubble diffuser
Air temperature	104	°F	

MODEL OUTPUTS:

Temperature correction factor	2.0042		
Ma_{Dw}	97.7	#/day	- active mass wasted from digester
Delta M_v	3074.1	#/day	
$M_{T\text{-}Dw}$	866.2	#/day	- net change in VSS
VSS destruction	78.0%		- total solids wasted from digester
TSS in digester	8867	mg/L	
O_2 for mass destruction	175.48	#/hour	
O_2 for nitrification	72.52	#/hour	
Total oxygen required	248.00	#/hour	
	21.98	mg/L/hr	
Site atmospheric pressure (20C)	14.32	psi	M&E equation
C^*_{ST} (O2 saturation at T)	7.57	mg/L	SAV equation
Water vapor pressure at basin T	0.62	psi	SAV equation
$C^*_{\infty 20}$	10.43	mg/L	MOP 63 eq. 4
SOR/AOR	1.62		MOP 63 eq. 14
Air temperature	40.0	°C	
Water vapor pressure at air T	1.08	psi	
Standard O2 Rate Req'd (SOR)	402.1	#/hr	
	9651	#/day	
SCFM required	3852	scfm	MOP 63 p. 48
	21.3	scfm/1,000 cf	(20-40 scfm/1,000cf typical for mixing)
ACFM at air temperature (mth 1)	4419	acfm	MOP 63 p. 49
	24.4	acfm/1,000 cf	

Aerobic Digester Design Calculations SJT
North Liberty WWTP Improvements Date 1/30/2023
7037.011 Revised 3/14/2023

PHASE IIC
Design Case 2: Peak Month WAS, winter, parallel flow

MODEL INPUTS:

Ke	0.48	/day	- endogenous metabolism factor at 20 degrees C
$M_{T\text{-}w} = M_{T\text{-}Dinf}$	6098	#/day	- waste biological solids loading on digester
$Ma_w = Ma_{Dinf}$	4464	#/day	- active mass in waste activated sludge
Influent VSS/TSS	73%		
$C_w = C_D$	20000	mg/L	- digester sludge SS concentration
Basin temperature	10	°C	
Basin 1 volume	0.779	mg	
Basin 2 volume	0.575	mg	
Total volume	1.354	mg	
Total liquid detention time	37.0	days	
Q_D	36559	gpd	- net liquid quantity influent to digester
Alpha	0.72		0.6 fine bubble, .72 jet, 0.85 cb
Beta	0.95		
Residual DO	1	mg/L	
Diffuser depth	19	feet	
Effective Saturation Depth	30.0%	tank depth --->	Coarse bubble = 26-34%
Field elevation	730	ft	Fine bubble = 21-44%
Relative humidity	70.0%		Low speed surface aeration = 5-7%
Standard Oxygen Transfer Eff.	10.0%		Coarse bubble diffuser
Air temperature	30	°F	

MODEL OUTPUTS:

Temperature correction factor	0.4989		
Ma_{Dw}	452.2	#/day	- active mass wasted from digester
Delta M_v	3209.0	#/day	
$M_{T\text{-}Dw}$	1254.5	#/day	- net change in VSS
VSS destruction	71.9%		- total solids wasted from digester
TSS in digester	9475	mg/L	
O_2 for mass destruction	183.18	#/hour	
O_2 for nitrification	75.71	#/hour	
Total oxygen required	258.89	#/hour	
	22.94	mg/L/hr	
Site atmospheric pressure (20C)	14.32	psi	M&E equation
C^*_{ST} (O2 saturation at T)	11.30	mg/L	SAV equation
Water vapor pressure at basin T	0.17	psi	SAV equation
$C^*_{\infty 20}$	10.39	mg/L	MOP 63 eq. 4
SOR/AOR	1.67		MOP 63 eq. 14
Air temperature	-1.1	°C	
Water vapor pressure at air T	0.10	psi	
Standard O2 Rate Req'd (SOR)	431.9	#/hr	
	10364	#/day	
SCFM required	4137	scfm	MOP 63 p. 48
	22.9	scfm/1,000 cf	(20-40 scfm/1,000cf typical for mixing)
ACFM at air temperature (mth 1)	3925	acfm	MOP 63 p. 49
	21.7	acfm/1,000 cf	

Aerobic Digester Design Calculations SJT
North Liberty WWTP Improvements Date 1/30/2023
7037.011 Revised 5/6/2023

PHASE III
Design Case 1: Peak Month WAS, summer, parallel flow

MODEL INPUTS:

Ke	0.48	/day	- endogenous metabolism factor at 20 degrees C
$M_{T\text{-}w} = M_{T\text{-}Dinf}$	7635	#/day	- waste biological solids loading on digester
$Ma_w = Ma_{Dinf}$	5408	#/day	- active mass in waste activated sludge
Influent VSS/TSS	71%		
$C_w = C_D$	20000	mg/L	- digester sludge SS concentration
Basin temperature	30	°C	
Basin Volume	0.806	mg	
Number of Basins	3	each	
Total volume	2.419	mg	
Total liquid detention time	52.8	days	
Q_D	45773	gpd	- net liquid quantity influent to digester

Alpha	0.72		0.6 fine bubble, .72 jet, 0.85 cb
Beta	0.95		
Residual DO	1	mg/L	
Diffuser depth	19	feet	
Effective Saturation Depth	30.0%	tank depth --->	Coarse bubble = 26-34%
Field elevation	730	ft	Fine bubble = 21-44%
Relative humidity	70.0%		Low speed surface aeration = 5-7%
Standard Oxygen Transfer Eff.	10.0%		Coarse bubble diffuser
Air temperature	104	°F	

MODEL OUTPUTS:

Temperature correction factor	2.0042		
Ma_{Dw}	104.3	#/day	- active mass wasted from digester
Delta M_v	4242.9	#/day	
$M_{T\text{-}Dw}$	1165.1	#/day	- net change in VSS
VSS destruction	78.5%		- total solids wasted from digester
TSS in digester	8886	mg/L	

O_2 for mass destruction	242.20	#/hour	
O_2 for nitrification	100.10	#/hour	
Total oxygen required	342.30	#/hour	
	16.98	mg/L/hr	

Site atmospheric pressure (20C)	14.32	psi	M&E equation
C^*_{ST} (O2 saturation at T)	7.57	mg/L	SAV equation
Water vapor pressure at basin T	0.62	psi	SAV equation
$C^*_{\infty 20}$	10.43	mg/L	MOP 63 eq. 4
SOR/AOR	1.62		MOP 63 eq. 14
Air temperature	40.0	°C	
Water vapor pressure at air T	1.08	psi	

Standard O2 Rate Req'd (SOR)	555.0	#/hr	
	13320	#/day	
SCFM required	5316	scfm	MOP 63 p. 48
	16.4	scfm/1,000 cf	(20-40 scfm/1,000cf typical for mixing)
ACFM at air temperature (mth 1)	6100	acfm	MOP 63 p. 49
	18.9	acfm/1,000 cf	

Aerobic Digester Design Calculations SJT
North Liberty WWTP Improvements Date 1/30/2023
7037.011 Revised 5/6/2023

PHASE III
Design Case 2: Peak Month WAS, winter, parallel flow

MODEL INPUTS:

Ke	0.48	/day	- endogenous metabolism factor at 20 degrees C
$M_{T\text{-}w} = M_{T\text{-}Dinf}$	8316	#/day	- waste biological solids loading on digester
$Ma_w = Ma_{Dinf}$	6027	#/day	- active mass in waste activated sludge
Influent VSS/TSS	72%		
$C_w = C_D$	20000	mg/L	- digester sludge SS concentration
Basin temperature	10	°C	
Basin Volume	0.806	mg	
Number of Basins	3	each	
Total volume	2.419	mg	
Total liquid detention time	48.5	days	
Q_D	49856	gpd	- net liquid quantity influent to digester
Alpha	0.72		0.6 fine bubble, .72 jet, 0.85 cb
Beta	0.95		
Residual DO	1	mg/L	
Diffuser depth	19	feet	
Effective Saturation Depth	30.0%	tank depth --->	Coarse bubble = 26-34%
Field elevation	730	ft	Fine bubble = 21-44%
Relative humidity	70.0%		Low speed surface aeration = 5-7%
Standard Oxygen Transfer Eff.	10.0%		Coarse bubble diffuser
Air temperature	30	°F	

MODEL OUTPUTS:

Temperature correction factor	0.4989		
Ma_{Dw}	477.6	#/day	- active mass wasted from digester
Delta M_v	4439.5	#/day	
$M_{T\text{-}Dw}$	1587.5	#/day	- net change in VSS
VSS destruction	73.7%		- total solids wasted from digester
TSS in digester	9323	mg/L	
O_2 for mass destruction	253.42	#/hour	
O_2 for nitrification	104.74	#/hour	
Total oxygen required	358.16	#/hour	
	17.76	mg/L/hr	
Site atmospheric pressure (20C)	14.32	psi	M&E equation
C^*_{ST} (O2 saturation at T)	11.30	mg/L	SAV equation
Water vapor pressure at basin T	0.17	psi	SAV equation
$C^*_{\infty 20}$	10.39	mg/L	MOP 63 eq. 4
SOR/AOR	1.67		MOP 63 eq. 14
Air temperature	-1.1	°C	
Water vapor pressure at air T	0.10	psi	
Standard O2 Rate Req'd (SOR)	597.5	#/hr	
	14339	#/day	
SCFM required	5723	scfm	MOP 63 p. 48
	17.7	scfm/1,000 cf	(20-40 scfm/1,000cf typical for mixing)
ACFM at air temperature (mth 1)	5430	acfm	MOP 63 p. 49
	16.8	acfm/1,000 cf	

Aerobic Digester Design Calculations SJT
North Liberty WWTP Improvements Date 1/30/2023
7037.011 Revised 5/6/2023

PHASE IV
Design Case 1: Peak Month WAS, summer, parallel flow

MODEL INPUTS:

Ke	0.48	/day	- endogenous metabolism factor at 20 degrees C
$M_{T\text{-}w} = M_{T\text{-}Dinf}$	11089	#/day	- waste biological solids loading on digester
$Ma_w = Ma_{Dinf}$	7909	#/day	- active mass in waste activated sludge
Influent VSS/TSS	71%		
$C_w = C_D$	20000	mg/L	- digester sludge SS concentration
Basin temperature	30	°C	
Basin Volume	0.806	mg	
Number of Basins	4	each	
Total volume	3.225	mg	
Total liquid detention time	48.5	days	
Q_D	66481	gpd	- net liquid quantity influent to digester

Alpha	0.72		0.6 fine bubble, .72 jet, 0.85 cb
Beta	0.95		
Residual DO	1	mg/L	
Diffuser depth	19	feet	
Effective Saturation Depth	30.0%	tank depth --->	Coarse bubble = 26-34%
Field elevation	730	ft	Fine bubble = 21-44%
Relative humidity	70.0%		Low speed surface aeration = 5-7%
Standard Oxygen Transfer Eff.	10.0%		Coarse bubble diffuser
Air temperature	104	°F	

MODEL OUTPUTS:

Temperature correction factor	2.0042		
Ma_{Dw}	165.9	#/day	- active mass wasted from digester
Delta M_v	6194.5	#/day	
$M_{T\text{-}Dw}$	1714.5	#/day	- net change in VSS
VSS destruction	78.3%		- total solids wasted from digester
TSS in digester	8828	mg/L	

O_2 for mass destruction	353.60	#/hour	
O_2 for nitrification	146.14	#/hour	
Total oxygen required	499.74	#/hour	
	18.59	mg/L/hr	

Site atmospheric pressure (20C)	14.32	psi	M&E equation
C^*_{ST} (O2 saturation at T)	7.57	mg/L	SAV equation
Water vapor pressure at basin T	0.62	psi	SAV equation
$C^*_{\infty 20}$	10.43	mg/L	MOP 63 eq. 4
SOR/AOR	1.62		MOP 63 eq. 14
Air temperature	40.0	°C	
Water vapor pressure at air T	1.08	psi	

Standard O2 Rate Req'd (SOR)	810.3	#/hr	
	19447	#/day	
SCFM required	7761	scfm	MOP 63 p. 48
	18.0	scfm/1,000 cf	(20-40 scfm/1,000cf typical for mixing)
ACFM at air temperature (mth 1)	8905	acfm	MOP 63 p. 49
	20.7	acfm/1,000 cf	

Aerobic Digester Design Calculations SJT
North Liberty WWTP Improvements Date 1/30/2023
7037.011 Revised 5/6/2023

PHASE IV
Design Case 2: Peak Month WAS, winter, parallel flow

MODEL INPUTS:

Ke	0.48	/day	- endogenous metabolism factor at 20 degrees C
$M_{T-w} = M_{T-Dinf}$	12253	#/day	- waste biological solids loading on digester
$Ma_w = Ma_{Dinf}$	8967	#/day	- active mass in waste activated sludge
Influent VSS/TSS	73%		
$C_w = C_D$	20000	mg/L	- digester sludge SS concentration
Basin temperature	10	°C	
Basin Volume	0.806	mg	
Number of Basins	4	each	
Total volume	3.225	mg	
Total liquid detention time	43.9	days	
Q_D	73457	gpd	- net liquid quantity influent to digester
Alpha	0.72		0.6 fine bubble, .72 jet, 0.85 cb
Beta	0.95		
Residual DO	1	mg/L	
Diffuser depth	19	feet	
Effective Saturation Depth	30.0%	tank depth --->	Coarse bubble = 26-34%
Field elevation	730	ft	Fine bubble = 21-44%
Relative humidity	70.0%		Low speed surface aeration = 5-7%
Standard Oxygen Transfer Eff.	10.0%		Coarse bubble diffuser
Air temperature	30	°F	

MODEL OUTPUTS:

Temperature correction factor	0.4989		
Ma_{Dw}	778.7	#/day	- active mass wasted from digester
Delta M_v	6550.5	#/day	
M_{T-Dw}	2416.3	#/day	- net change in VSS
VSS destruction	73.1%		- total solids wasted from digester
TSS in digester	9308	mg/L	
O_2 for mass destruction	373.93	#/hour	
O_2 for nitrification	154.54	#/hour	
Total oxygen required	528.46	#/hour	
	19.66	mg/L/hr	
Site atmospheric pressure (20C)	14.32	psi	M&E equation
C^*_{ST} (O2 saturation at T)	11.30	mg/L	SAV equation
Water vapor pressure at basin T	0.17	psi	SAV equation
$C^*_{\infty 20}$	10.39	mg/L	MOP 63 eq. 4
SOR/AOR	1.67		MOP 63 eq. 14
Air temperature	-1.1	°C	
Water vapor pressure at air T	0.10	psi	
Standard O2 Rate Req'd (SOR)	881.5	#/hr	
	21157	#/day	
SCFM required	8444	scfm	MOP 63 p. 48
	19.6	scfm/1,000 cf	(20-40 scfm/1,000cf typical for mixing)
ACFM at air temperature (mth 1)	8012	acfm	MOP 63 p. 49
	18.6	acfm/1,000 cf	

APPENDIX F

RATE AND BUDGET PROJECTIONS

2025 Wastewater Facility Plan

Financial Forecasting Model

WASTEWATER OPERATING FUND	FY24 Actual	FY25 Budget	FY26 Budget	FY27 Estimated	FY28 Estimated	FY29 Estimated	FY30 Estimated	FY31 Estimated	FY32 Estimated	FY33 Estimated	FY34 Estimated	FY35 Estimated	FY36 Estimated	FY37 Estimated	FY38 Estimated	FY39 Estimated
Budget Inflation Rate				1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%
Number of Accounts	9,460	9,505	9,800	9,947	10,096	10,248	10,401	10,557	10,716	10,876	11,040	11,205	11,373	11,544	11,717	11,893
Gallons Sold	445,183,000	424,473,000	460,000,000	466,900,000	473,903,500	481,012,053	488,227,233	495,550,642	502,983,901	510,528,660	518,186,590	525,959,389	533,848,780	541,856,511	549,984,359	558,234,124
Proposed Rate Increase	0%	0%	6%	6%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0%	0%	3%
Base Rate	$ 31.24	$ 31.24	$ 33.11	$ 35.10	$ 36.86	$ 38.70	$ 40.63	$ 42.67	$ 44.80	$ 47.04	$ 49.39	$ 51.86	$ 54.45	$ 54.45	$ 54.45	$ 56.09
Rate/1000 Gallons	$ 5.63	$ 5.63	$ 5.97	$ 6.33	$ 6.64	$ 6.97	$ 7.32	$ 7.69	$ 8.07	$ 8.48	$ 8.90	$ 9.35	$ 9.81	$ 9.81	$ 9.81	$ 10.11
Revenues																
Wastewater Sales	$ 5,345,791	$ 5,257,337	$ 5,879,214	$ 6,325,447	$ 6,741,345	$ 7,184,588	$ 7,656,975	$ 8,160,421	$ 8,696,969	$ 9,268,794	$ 9,878,218	$ 10,527,710	$ 11,219,907	$ 11,388,206	$ 11,559,029	$ 12,084,387
Sales Tax	$ 8,181	$ -	$ 35,000	$ 35,350	$ 35,704	$ 36,061	$ 36,421	$ 36,785	$ 37,153	$ 37,525	$ 37,900	$ 38,279	$ 38,662	$ 39,048	$ 39,439	$ 39,833
Connection Fees/Permits	$ 15,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
Use of Money	$ 55,198	$ 20,000	$ 20,000	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300
Miscellaneous	$ 260,848	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
Transfers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Accounts Receivable/Payable	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**$ 5,685,018**	**$ 5,308,337**	**$ 5,965,214**	**$ 6,392,097**	**$ 6,808,348**	**$ 7,251,949**	**$ 7,724,696**	**$ 8,228,506**	**$ 8,765,422**	**$ 9,337,619**	**$ 9,947,418**	**$ 10,597,289**	**$ 11,289,869**	**$ 11,458,554**	**$ 11,629,768**	**$ 12,155,520**
Expenditures																
Budget Inflation Rate		8.32%	7.79%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Personnel Services	$ 779,766	$ 899,295	$ 934,384	$ 981,103	$ 1,115,158	$ 1,170,916	$ 1,229,462	$ 1,290,935	$ 1,355,482	$ 1,423,256	$ 1,494,419	$ 1,569,140	$ 1,647,597	$ 1,729,977	$ 1,816,475	$ 1,907,299
Services & Commodities	$ 1,059,409	$ 1,323,550	$ 1,503,450	$ 1,578,623	$ 1,657,554	$ 1,740,431	$ 1,827,453	$ 1,918,826	$ 2,014,767	$ 2,115,505	$ 2,221,280	$ 2,332,344	$ 2,448,962	$ 2,571,410	$ 2,699,980	$ 2,834,979
Capital	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transfers																
Equipment Revolving	$ 58,000	$ 50,000	$ 54,500	$ -	$ 158,000	$ 450,000	$ 75,000	$ 120,000	$ 170,000	$ 170,000	$ 170,000	$ 170,000	$ 170,000	$ 170,000	$ 170,000	$ 170,000
Computer Revolving	$ 4,300	$ 4,300	$ 4,300	$ 4,300	$ 4,300	$ 4,300	$ 4,300	$ 4,730	$ 4,730	$ 4,730	$ 4,730	$ 4,730	$ 5,160	$ 5,160	$ 5,160	$ 5,160
Capital Reserve	$ 295,000	$ 318,000	$ 515,000	$ 670,000	$ 250,000	$ 290,000	$ 345,000	$ 320,000	$ 320,000	$ 320,000	$ 320,000	$ 320,000	$ 320,000	$ 320,000	$ 320,000	$ 320,000
Revenue Debt	$ 1,627,769	$ 1,773,352	$ 1,778,501	$ 1,792,779	$ 1,858,475	$ 1,650,824	$ 1,646,770	$ 1,643,470	$ 1,639,908	$ 1,636,086	$ 1,632,002	$ 1,628,658	$ 1,624,038	$ 1,620,157	$ -	$ -
GO Debt	$ 1,093,563	$ 951,903	$ 945,228	$ 609,453	$ 474,753	$ 468,953	$ 468,003	$ 471,753	$ 470,103	$ 388,106	$ 387,456	$ 386,506	$ -	$ -	$ -	$ -
Billing & Accounting	$ 261,562	$ 290,022	$ 311,947	$ 327,544	$ 343,922	$ 361,118	$ 379,174	$ 398,132	$ 418,039	$ 438,941	$ 460,888	$ 483,932	$ 508,129	$ 533,535	$ 560,212	$ 588,223
Upcoming Projects																
Sewer Main Capacity Improvements [$2.4 million GO]		$ -	$ -	$ -	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000
Plant Expansion, Phase 2C [$1.1 million GO]					$ 134,400	$ 134,355	$ 134,945	$ 135,373	$ 135,638	$ 134,449	$ 134,436	$ 135,563	$ 135,186	$ 134,610		
Plant Expansion, Phase 3 [$53 million SRF]								$ 3,373,947	$ 3,675,510	$ 3,677,454	$ 3,677,454	$ 3,675,510	$ 3,677,022	$ 3,676,428	$ 3,679,128	$ 3,679,560
Plant Expansion, Phase 4 [$61 million SRF]		$ -	$ -	$ -	$ -	$ -	$ -									
Total Expenditures	**$ 5,179,369**	**$ 5,610,422**	**$ 6,047,310**	**$ 5,963,802**	**$ 6,221,562**	**$ 6,495,898**	**$ 6,335,107**	**$ 9,902,166**	**$ 10,429,177**	**$ 10,533,526**	**$ 10,727,664**	**$ 10,931,383**	**$ 10,761,093**	**$ 10,986,277**	**$ 9,475,956**	**$ 9,730,221**
Net Change in Fund Balance	**$ 505,650**	**$ (302,085)**	**$ (82,096)**	**$ 428,295**	**$ 586,786**	**$ 756,051**	**$ 1,389,589**	**$ (1,673,660)**	**$ (1,663,755)**	**$ (1,195,907)**	**$ (780,247)**	**$ (334,093)**	**$ 528,776**	**$ 472,278**	**$ 2,153,812**	**$ 2,425,299**
Beginning Fund Balance	$ 5,176,091	$ 5,681,740	$ 5,379,655	$ 5,297,559	$ 5,725,854	$ 6,312,640	$ 7,068,691	$ 8,458,280	$ 6,784,621	$ 5,120,865	$ 3,924,959	$ 3,144,712	$ 2,810,618	$ 3,339,394	$ 3,811,672	$ 5,965,484
Ending Fund Balance	**$ 5,681,740**	**$ 5,379,655**	**$ 5,297,559**	**$ 5,725,854**	**$ 6,312,640**	**$ 7,068,691**	**$ 8,458,280**	**$ 6,784,621**	**$ 5,120,865**	**$ 3,924,959**	**$ 3,144,712**	**$ 2,810,618**	**$ 3,339,394**	**$ 3,811,672**	**$ 5,965,484**	**$ 8,390,784**
% Reserved	109.70%	95.89%	87.60%	96.01%	101.46%	108.82%	133.51%	68.52%	49.10%	37.26%	29.31%	25.71%	31.03%	34.69%	62.95%	86.23%
Personnel Cost in $	$ 1,041,328	$ 1,189,317	$ 1,246,331	$ 1,308,648	$ 1,459,080	$ 1,532,034	$ 1,608,636	$ 1,689,067	$ 1,773,521	$ 1,862,197	$ 1,955,307	$ 2,053,072	$ 2,155,726	$ 2,263,512	$ 2,376,687	$ 2,495,522
Personnel % of Wastewater	20.11%	21.20%	20.61%	21.94%	23.45%	23.58%	25.39%	17.06%	17.01%	17.68%	18.23%	18.78%	20.03%	20.60%	25.08%	25.65%
Debt Service Coverage																
Net Revenue/All Revenue Debt	2.20	1.58	1.81	1.95	1.99	2.41	2.60	0.92	0.94	1.01	1.09	1.17	1.26	1.25	1.78	1.85
Required Coverage	1.20	1.20	1.20	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Difference (Actual vs. Required)	**1.00**	**0.38**	**0.61**	**0.85**	**0.89**	**1.31**	**1.50**	**(0.18)**	**(0.16)**	**(0.09)**	**(0.01)**	**0.07**	**0.16**	**0.15**	**0.68**	**0.75**

2025 Wastewater Facility Plan

Financial Forecasting Model

WASTEWATER OPERATING FUND	FY40 Estimated	FY41 Estimated	FY42 Estimated	FY43 Estimated	FY44 Estimated	FY45 Estimated	FY46 Estimated	FY47 Estimated	FY48 Estimated
Budget Inflation Rate	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%
Number of Accounts	12,071	12,252	12,436	12,623	12,812	13,004	13,199	13,397	13,598
Gallons Sold	566,607,636	575,106,751	583,733,352	592,489,352	601,376,692	610,397,343	619,553,303	628,846,603	638,279,302
Proposed Rate Increase	3%	3%	3%	3%	2%	2%	0%	0%	0%
Base Rate	$ 57.77	$ 59.50	$ 61.29	$ 63.13	$ 64.39	$ 65.68	$ 65.68	$ 65.68	$ 65.68
Rate/1000 Gallons	$ 10.41	$ 10.72	$ 11.05	$ 11.38	$ 11.60	$ 11.84	$ 11.84	$ 11.84	$ 11.84
Revenues									
Wastewater Sales	$ 12,633,622	$ 13,207,821	$ 13,808,116	$ 14,435,695	$ 14,945,275	$ 15,472,843	$ 15,704,936	$ 15,940,510	$ 16,179,617
Sales Tax	$ 40,232	$ 40,634	$ 41,040	$ 41,451	$ 41,865	$ 42,284	$ 42,707	$ 43,134	$ 43,565
Connection Fees/Permits	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
Use of Money	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300
Miscellaneous	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
Transfers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Accounts Receivable/Payable	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**$ 12,705,154**	**$ 13,279,754**	**$ 13,880,456**	**$ 14,508,446**	**$ 15,018,440**	**$ 15,546,427**	**$ 15,778,942**	**$ 16,014,944**	**$ 16,254,482**
Expenditures									
Budget Inflation Rate	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Personnel Services	$ 2,002,664	$ 2,102,797	$ 2,207,937	$ 2,318,334	$ 2,434,251	$ 2,555,963	$ 2,683,762	$ 2,817,950	$ 2,958,847
Services & Commodities	$ 2,976,728	$ 3,125,565	$ 3,281,843	$ 3,445,935	$ 3,618,232	$ 3,799,143	$ 3,989,100	$ 4,188,555	$ 4,397,983
Capital	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transfers									
Equipment Revolving	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000
Computer Revolving	$ 5,160	$ 5,590	$ 5,590	$ 5,590	$ 5,590	$ 5,590	$ 6,020	$ 6,020	$ 6,020
Capital Reserve	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000
Revenue Debt	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
GO Debt	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Billing & Accounting	$ 617,634	$ 648,515	$ 680,941	$ 714,988	$ 750,738	$ 788,275	$ 827,688	$ 869,073	$ 912,526
Upcoming Projects									
Sewer Main Capacity Improvements [$2.4 million GO]	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000	$ 225,000			
Plant Expansion, Phase 2C [$1.1 million GO]									
Plant Expansion, Phase 3 [$53 million SRF]	$ 3,677,724	$ 3,679,020	$ 3,677,886	$ 3,679,722	$ 3,678,966	$ 3,675,618	$ 3,680,478	$ 3,677,022	$ 3,676,212
Plant Expansion, Phase 4 [$61 million SRF]			$ 3,811,311	$ 4,151,965	$ 4,154,161	$ 4,154,161	$ 4,151,965	$ 4,153,673	$ 4,153,002
Total Expenditures	**$ 10,144,910**	**$ 10,426,487**	**$ 14,530,508**	**$ 15,181,534**	**$ 15,506,937**	**$ 15,843,750**	**$ 15,979,013**	**$ 16,352,293**	**$ 16,744,591**
Net Change in Fund Balance	**$ 2,560,244**	**$ 2,853,267**	**$ (650,052)**	**$ (673,089)**	**$ (488,497)**	**$ (297,323)**	**$ (200,071)**	**$ (337,349)**	**$ (490,108)**
Beginning Fund Balance	$ 8,390,784	$ 10,951,028	$ 13,804,295	$ 13,154,243	$ 12,481,154	$ 11,992,657	$ 11,695,334	$ 11,495,263	$ 11,157,914
Ending Fund Balance	**$ 10,951,028**	**$ 13,804,295**	**$ 13,154,243**	**$ 12,481,154**	**$ 11,992,657**	**$ 11,695,334**	**$ 11,495,263**	**$ 11,157,914**	**$ 10,667,806**
% Reserved	107.95%	132.40%	90.53%	82.21%	77.34%	73.82%	71.94%	68.23%	63.71%
Personnel Cost in $	$ 2,620,298	$ 2,751,313	$ 2,888,878	$ 3,033,322	$ 3,184,988	$ 3,344,238	$ 3,511,450	$ 3,687,022	$ 3,871,373
Personnel % of Wastewater	25.83%	26.39%	19.88%	19.98%	20.54%	21.11%	21.98%	22.55%	23.12%
Debt Service Coverage									
Net Revenue/All Revenue Debt	1.93	2.01	1.03	1.03	1.05	1.07	1.06	1.04	1.02
Required Coverage	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Difference (Actual vs. Required)	**0.83**	**0.91**	**(0.07)**	**(0.07)**	**(0.05)**	**(0.03)**	**(0.04)**	**(0.06)**	**(0.08)**

WASTEWATER OPERATING FUND	FY49 Estimated	FY50 Estimated	FY51 Estimated	FY52 Estimated	FY53 Estimated	FY54 Estimated	FY55 Estimated	FY56 Estimated	FY57 Estimated
Budget Inflation Rate	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%
Number of Accounts	13,802	14,009	14,219	14,433	14,649	14,869	15,092	15,318	15,548
Gallons Sold	647,853,491	657,571,293	667,434,863	677,446,386	687,608,082	697,922,203	708,391,036	719,016,901	729,802,155
Proposed Rate Increase	0%	0%	0%	0%	0%	0%	0%	0%	0%
Base Rate	$ 65.68	$ 65.68	$ 65.68	$ 65.68	$ 65.68	$ 65.68	$ 65.68	$ 65.68	$ 65.68
Rate/1000 Gallons	$ 11.84	$ 11.84	$ 11.84	$ 11.84	$ 11.84	$ 11.84	$ 11.84	$ 11.84	$ 11.84
Revenues									
Wastewater Sales	$ 16,422,312	$ 16,668,646	$ 16,918,676	$ 17,172,456	$ 17,430,043	$ 17,691,494	$ 17,956,866	$ 18,226,219	$ 18,499,612
Sales Tax	$ 44,001	$ 44,441	$ 44,885	$ 45,334	$ 45,787	$ 46,245	$ 46,708	$ 47,175	$ 47,646
Connection Fees/Permits	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
Use of Money	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300
Miscellaneous	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
Transfers	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Accounts Receivable/Payable	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**$ 16,497,612**	**$ 16,744,387**	**$ 16,994,861**	**$ 17,249,090**	**$ 17,507,130**	**$ 17,769,039**	**$ 18,034,874**	**$ 18,304,694**	**$ 18,578,559**
Expenditures									
Budget Inflation Rate	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Personnel Services	$ 3,106,789	$ 3,262,129	$ 3,425,235	$ 3,596,497	$ 3,776,322	$ 3,965,138	$ 4,163,395	$ 4,371,565	$ 4,590,143
Services & Commodities	$ 4,617,882	$ 4,848,777	$ 5,091,215	$ 5,345,776	$ 5,613,065	$ 5,893,718	$ 6,188,404	$ 6,497,824	$ 6,822,715
Capital	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transfers									
Equipment Revolving	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000	$ 220,000
Computer Revolving	$ 6,020	$ 6,020	$ 6,450	$ 6,450	$ 6,450	$ 6,450	$ 6,450	$ 6,450	$ 6,450
Capital Reserve	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000	$ 420,000
Revenue Debt	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
GO Debt	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Billing & Accounting	$ 958,153	$ 1,006,060	$ 1,056,363	$ 1,109,181	$ 1,164,640	$ 1,222,873	$ 1,284,016	$ 1,348,217	$ 1,415,628
Upcoming Projects									
Sewer Main Capacity Improvements [$2.4 million GO]									
Plant Expansion, Phase 2C [$1.1 million GO]									
Plant Expansion, Phase 3 [$53 million SRF]	$ 3,677,886	$ 3,676,482							
Plant Expansion, Phase 4 [$61 million SRF]	$ 4,156,052	$ 4,156,540	$ 4,154,466	$ 4,155,930	$ 4,154,649	$ 4,156,723	$ 4,155,869	$ 4,152,087	$ 4,157,577
Total Expenditures	**$ 17,162,782**	**$ 17,596,008**	**$ 14,373,730**	**$ 14,853,835**	**$ 15,355,126**	**$ 15,884,902**	**$ 16,438,134**	**$ 17,016,143**	**$ 17,632,513**
Net Change in Fund Balance	**$ (665,170)**	**$ (851,621)**	**$ 2,621,131**	**$ 2,395,255**	**$ 2,152,004**	**$ 1,884,137**	**$ 1,596,739**	**$ 1,288,551**	**$ 946,046**
Beginning Fund Balance	$ 10,667,806	$ 10,002,636	$ 9,151,015	$ 11,772,146	$ 14,167,402	$ 16,319,406	$ 18,203,543	$ 19,800,282	$ 21,088,833
Ending Fund Balance	**$ 10,002,636**	**$ 9,151,015**	**$ 11,772,146**	**$ 14,167,402**	**$ 16,319,406**	**$ 18,203,543**	**$ 19,800,282**	**$ 21,088,833**	**$ 22,034,878**
% Reserved	58.28%	52.01%	81.90%	95.38%	106.28%	114.60%	120.45%	123.93%	124.97%
Personnel Cost in $	$ 4,064,942	$ 4,268,189	$ 4,481,599	$ 4,705,679	$ 4,940,963	$ 5,188,011	$ 5,447,411	$ 5,719,782	$ 6,005,771
Personnel % of Wastewater	23.68%	24.26%	31.18%	31.68%	32.18%	32.66%	33.14%	33.61%	34.06%
Debt Service Coverage									
Net Revenue/All Revenue Debt	1.00	0.97	1.79	1.73	1.67	1.61	1.54	1.47	1.38
Required Coverage	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Difference (Actual vs. Required)	**(0.10)**	**(0.13)**	**0.69**	**0.63**	**0.57**	**0.51**	**0.44**	**0.37**	**0.28**

2025 Wastewater Facility Plan

Financial Forecasting Model

WASTEWATER CAPITAL FUNDS	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39
	Actual	**Budget**	**Budget**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**	**Estimated**
Wastewater Capital Fund Summary (611)																
Beginning Balance	$ 3,206,041	$ 2,230,350	$ 2,450,350	$ 2,370,350	$ 2,590,350	$ 2,810,350	$ 3,030,350	$ 3,250,350	$ 3,570,350	$ 3,940,350	$ 4,310,350	$ 4,680,350	$ 5,050,350	$ 5,420,350	$ 5,790,350	$ 6,160,350
Developer Fees	*$ 151,043*															
Transfer from Wastewater Utility Fund	*$ 353,000*	*$ 368,000*	*$ 569,500*	*$ 670,000*	*$ 408,000*	*$ 740,000*	*$ 420,000*	*$ 440,000*	*$ 490,000*	*$ 490,000*	*$ 490,000*	*$ 490,000*	*$ 490,000*	*$ 490,000*	*$ 490,000*	*$ 490,000*
Projects Funded/Projected																
Fleet/Attachments	*$ 4,880*		*$ 20,000*		*$ 158,000*	*$ 450,000*	*$ 75,000*									
Equipment	*$ 45,045*	*$ 50,000*	*$ 34,500*													
Facilities/System (lift stations, plant, manholes)		*$ 98,000*	*$ 295,000*	*$ 450,000*	*$ 30,000*	*$ 70,000*	*$ 125,000*									
Membranes	*$ 341,194*		*$ 300,000*													
TBD								*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*
Transfer to WW Capital Projects Fund	*$ 1,088,615*															
Ending Balance	**$ 2,230,350**	**$ 2,450,350**	**$ 2,370,350**	**$ 2,590,350**	**$ 2,810,350**	**$ 3,030,350**	**$ 3,250,350**	**$ 3,570,350**	**$ 3,940,350**	**$ 4,310,350**	**$ 4,680,350**	**$ 5,050,350**	**$ 5,420,350**	**$ 5,790,350**	**$ 6,160,350**	**$ 6,530,350**
Wastewater Capital Projects Fund Summary (613)																
Beginning Balance	$ (1,088,615)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transfer from Wastewater Capital Fund	*$ 1,088,615*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
Projects Funded/Projected																
TBD																
Ending Balance	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Reserve Fund Balance	**$ 2,230,350**	**$ 2,450,350**	**$ 2,370,350**	**$ 2,590,350**	**$ 2,810,350**	**$ 3,030,350**	**$ 3,250,350**	**$ 3,570,350**	**$ 3,940,350**	**$ 4,310,350**	**$ 4,680,350**	**$ 5,050,350**	**$ 5,420,350**	**$ 5,790,350**	**$ 6,160,350**	**$ 6,530,350**
Assigned Balance (savings for future expenditures, FY balance as listed)																
Membrane Replacement	$ 1,126,128	$ 1,346,128	$ 1,266,128	$ 1,486,128	$ 1,706,128	$ 1,926,128	$ 2,146,128	$ 2,366,128	$ 2,586,128	$ 2,806,128	$ 3,026,128	$ 3,246,128	$ 3,466,128	$ 3,686,128	$ 3,906,128	$ 4,126,128
Total Unassigned Balance	$ 1,104,222	$ 1,104,222	$ 1,104,222	$ 1,104,222	$ 1,104,222	$ 1,104,222	$ 1,104,222	$ 1,204,222	$ 1,354,222	$ 1,504,222	$ 1,654,222	$ 1,804,222	$ 1,954,222	$ 2,104,222	$ 2,254,222	$ 2,404,222

2025 Wastewater Facility Plan

Financial Forecasting Model

WASTEWATER CAPITAL FUNDS	FY40 Estimated	FY41 Estimated	FY42 Estimated	FY43 Estimated	FY44 Estimated	FY45 Estimated	FY46 Estimated	FY47 Estimated	FY48 Estimated	FY49 Estimated	FY50 Estimated	FY51 Estimated	FY52 Estimated	FY53 Estimated	FY54 Estimated	FY55 Estimated	FY56 Estimated	FY57 Estimated
Wastewater Capital Fund Summary (611)																		
Beginning Balance	$ 6,530,350	$ 7,050,350	$ 7,570,350	$ 8,090,350	$ 8,610,350	$ 9,130,350	$ 9,650,350	$ 10,170,350	$ 10,690,350	$ 11,210,350	$ 11,730,350	$ 12,250,350	$ 12,770,350	$ 13,290,350	$ 13,810,350	$ 14,330,350	$ 14,850,350	$ 15,370,350
Developer Fees																		
Transfer from Wastewater Utility Fund	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*	*$ 640,000*
Projects Funded/Projected																		
Fleet/Attachments																		
Equipment																		
Facilities/System (lift stations, plant, manholes)																		
Membranes																		
TBD	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*	*$ 120,000*
Transfer to WW Capital Projects Fund																		
Ending Balance	**$ 7,050,350**	**$ 7,570,350**	**$ 8,090,350**	**$ 8,610,350**	**$ 9,130,350**	**$ 9,650,350**	**$ 10,170,350**	**$ 10,690,350**	**$ 11,210,350**	**$ 11,730,350**	**$ 12,250,350**	**$ 12,770,350**	**$ 13,290,350**	**$ 13,810,350**	**$ 14,330,350**	**$ 14,850,350**	**$ 15,370,350**	**$ 15,890,350**
Wastewater Capital Projects Fund Summary (613)																		
Beginning Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transfer from Wastewater Capital Fund	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
Projects Funded/Projected																		
TBD																		
Ending Balance	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Total Capital Reserve Fund Balance	**$ 7,050,350**	**$ 7,570,350**	**$ 8,090,350**	**$ 8,610,350**	**$ 9,130,350**	**$ 9,650,350**	**$ 10,170,350**	**$ 10,690,350**	**$ 11,210,350**	**$ 11,730,350**	**$ 12,250,350**	**$ 12,770,350**	**$ 13,290,350**	**$ 13,810,350**	**$ 14,330,350**	**$ 14,850,350**	**$ 15,370,350**	**$ 15,890,350**
Assigned Balance (savings for future expenditures, FY balance as listed)																		
Membrane Replacement	$ 4,346,128	$ 4,566,128	$ 4,786,128	$ 5,006,128	$ 5,226,128	$ 5,446,128	$ 5,666,128	$ 5,886,128	$ 6,106,128	$ 6,326,128	$ 6,546,128	$ 6,766,128	$ 6,986,128	$ 7,206,128	$ 7,426,128	$ 7,646,128	$ 7,866,128	$ 8,086,128
Total Unassigned Balance	$ 2,704,222	$ 3,004,222	$ 3,304,222	$ 3,604,222	$ 3,904,222	$ 4,204,222	$ 4,504,222	$ 4,804,222	$ 5,104,222	$ 5,404,222	$ 5,704,222	$ 6,004,222	$ 6,304,222	$ 6,604,222	$ 6,904,222	$ 7,204,222	$ 7,504,222	$ 7,804,222

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